

Official Journal

of the European Union

L 230



English edition

Legislation

Volume 53

31 August 2010

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Price: EUR 10

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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

*(Non-legislative acts)***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 13-H of the Economic Commission for Europe of the United Nations (UN/ECE) —
Uniform provisions concerning the approval of passenger cars with regard to braking**

Incorporating all valid text up to:

Supplement 9 to the original version of the Regulation — Date of entry into force: 17 March 2010

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1. SCOPE

1.1. This Regulation applies to the braking of vehicles of categories M1 and N1 ⁽¹⁾.

1.2. This Regulation does not cover:

1.2.1. vehicles with a design speed not exceeding 25 km/h;

1.2.2. vehicles fitted for invalid drivers.

2. DEFINITIONS

For the purposes of this Regulation,

2.1. 'Approval of a vehicle' means the approval of a vehicle type with regard to braking.

2.2. 'Vehicle type' means a category of vehicles which do not differ in such essential respects as:

2.2.1. the maximum mass, as defined in paragraph 2.11 below;

2.2.2. the distribution of mass among the axles;

2.2.3. the maximum design speed;

2.2.4. a different type of braking equipment, with more particular reference to the presence or otherwise of equipment for braking a trailer or any presence of electric braking system;

2.2.5. the engine type;

⁽¹⁾ This Regulation offers an alternative set of requirements for category N1 vehicles to those contained in Regulation No 13. Contracting Parties that apply both Regulation No 13 and this Regulation recognize approvals to either Regulation as equally valid. M1 and N1 categories of vehicles are defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (TRANS/WP.29/78/Rev.1/Amend.2, as last amended by Amend.4).

- 2.2.6. the number and ratios of gears;
- 2.2.7. the final drive ratios;
- 2.2.8. the tyre dimensions.
- 2.3. 'Braking equipment' means the combination of parts whose function is progressively to reduce the speed of a moving vehicle or bring it to a halt, or to keep it stationary if it is already halted; these functions are specified in paragraph 5.1.2 below. The equipment consists of the control, the transmission, and the brake proper.
- 2.4. 'Control' means the part actuated directly by the driver to furnish to the transmission the energy required for braking or controlling it. This energy may be the muscular energy of the driver, or energy from another source controlled by the driver, or a combination of these various kinds of energy.
- 2.5. 'Transmission' means the combination of components comprised between the control and the brake and linking them functionally. The transmission may be mechanical, hydraulic, pneumatic, electric or mixed. Where the braking power is derived from or assisted by a source of energy independent of the driver, the reserve of energy in the system is likewise part of the transmission.

The transmission is divided into two independent functions: the control transmission and the energy transmission. Whenever the term 'transmission' is used alone in this Regulation, it means both the 'control transmission' and the 'energy transmission':
- 2.5.1. 'Control transmission' means the combination of the components of the transmission which control the operation of the brakes, including the control function and the necessary reserve(s) of energy;
- 2.5.2. 'Energy transmission' means the combination of the components which supply to the brakes the necessary energy for their function, including the reserve(s) of energy necessary for the operation of the brakes.
- 2.6. 'Brake' means the part in which the forces opposing the movement of the vehicle develop. It may be a friction brake (when the forces are generated by friction between two parts of the vehicle moving relatively to one another); an electrical brake (when the forces are generated by electro-magnetic action between two parts of the vehicle moving relatively to but not in contact with one another); a fluid brake (when the forces are generated by the action of a fluid situated between two parts of the vehicle moving relatively to one another); or an engine brake (when the forces are derived from an artificial increase in the braking action, transmitted to the wheels, of the engine).
- 2.7. 'Different types of braking equipment' means equipment which differ in such essential respects as:
 - 2.7.1. components having different characteristics;
 - 2.7.2. a component made of materials having different characteristics, or a component differing in shape or size;
 - 2.7.3. a different assembly of the components.
- 2.8. 'Component of the braking equipment' means one of the individual parts which, when assembled, constitute the braking equipment.
- 2.9. 'Progressive and graduated braking' means braking during which, within the normal operating range of the device, and during actuation of the brakes (see paragraph 2.16 below):

- 2.9.1. the driver can at any moment increase or decrease the braking force by acting on the control;
- 2.9.2. the braking force varies proportionally as the action on the control (monotonic function);
- 2.9.3. the braking force can be easily regulated with sufficient precision.
- 2.10. 'Laden vehicle' means, except where otherwise stated, a vehicle so laden as to attain its 'maximum mass'.
- 2.11. 'Maximum mass' means the maximum mass stated by the vehicle manufacturer to be technically permissible (this mass may be higher than the 'permissible maximum mass' laid down by the national administration).
- 2.12. 'The distribution of mass among the axles' means the distribution of the effect of the gravity on the mass of the vehicle and/or its contents among the axles.
- 2.13. 'Wheel/axle load' means the vertical static reaction (force) of the road surface in the contact area on the wheel/wheels of the axle.
- 2.14. 'Maximum stationary wheel/axle load' means the stationary wheel/axle load achieved under the condition of the laden vehicle.
- 2.15. 'Hydraulic braking equipment with stored energy' means a braking equipment where energy is supplied by a hydraulic fluid under pressure, stored in one or more accumulator(s) fed from one or more pressure pump(s), each fitted with a means of limiting the pressure to a maximum value. This value shall be specified by the manufacturer.
- 2.16. 'Actuation' means both application and release of the control.
- 2.17. 'Electric regenerative braking' means a braking system which, during deceleration, provides for the conversion of vehicle kinetic energy into electrical energy.
- 2.17.1. 'Electric regenerative braking control' means a device which modulates the action of the electric regenerative braking system;
- 2.17.2. 'Electric regenerative braking system of category A' means an electric regenerative braking system which is not part of the service braking system;
- 2.17.3. 'Electric regenerative braking system of category B' means an electric regenerative braking system which is part of the service braking system;
- 2.17.4. 'Electric state of charge' means the instantaneous ratio of electric quantity of energy stored in the traction battery relative to the maximum quantity of electric energy which could be stored in this battery;
- 2.17.5. 'Traction battery' means an assembly of accumulators constituting the storage of energy used for powering the traction motor(s) of the vehicle.
- 2.18. 'Phased braking' is a means which may be used where two or more sources of braking are operated from a common control, whereby one source may be given priority by phasing back the other source(s) so as to make increased control movement necessary before they begin to be brought into operation.
- 2.19. 'Nominal value' definitions for braking reference performance are required to put a value on the transfer function of the braking system, relating output to input for vehicles individually.

- 2.19.1. 'Nominal value' is defined as the characteristic which can be demonstrated at type approval and which relates the braking rate of the vehicle on its own to the level of the braking input variable.
- 2.20. 'Automatically commanded braking' means a function within a complex electronic control system where actuation of the braking system(s) or brakes of certain axles is made for the purpose of generating vehicle retardation with or without a direct action of the driver, resulting from the automatic evaluation of on-board initiated information.
- 2.21. 'Selective braking' means a function within a complex electronic control system where actuation of individual brakes is made by automatic means in which vehicle retardation is secondary to vehicle behaviour modification.
- 2.22. 'Braking signal': logic signal indicating brake activation as specified in paragraph 5.2.22.
- 2.23. 'Emergency braking signal': logic signal indicating emergency braking as specified in paragraph 5.2.23.
- 2.24. 'Ackerman steer angle' means the angle whose tangent is the wheelbase divided by the radius of the turn at a very low speed.
- 2.25. 'Electronic Stability Control System' or 'ESC System' means a system that has all of the following attributes:
- 2.25.1. That improves vehicle directional stability by at least having the ability to automatically control individually the braking torques of the left and right wheels on each axle⁽²⁾ to induce a correcting yaw moment based on the evaluation of actual vehicle behaviour in comparison with a determination of vehicle behaviour demanded by the driver;
- 2.25.2. That is computer controlled with the computer using a closed-loop algorithm to limit vehicle oversteer and to limit vehicle understeer based on the evaluation of actual vehicle behaviour in comparison with a determination of vehicle behaviour demanded by the driver;
- 2.25.3. That has a means to determine directly the value of the vehicle's yaw rate and to estimate its side-slip or side-slip derivative with respect to time;
- 2.25.4. That has a means to monitor driver steering inputs; and
- 2.25.5. That has an algorithm to determine the need, and a means to modify propulsion torque, as necessary, to assist the driver in maintaining control of the vehicle.
- 2.26. 'Lateral acceleration' means the component of the acceleration vector of a point in the vehicle perpendicular to the vehicle x axis (longitudinal) and parallel to the road plane.
- 2.27. 'Oversteer' means a condition in which the vehicle's yaw rate is greater than the yaw rate that would occur at the vehicle's speed as a result of the Ackerman steer angle.
- 2.28. 'Side-slip or side-slip angle' means the arctangent of the ratio of the lateral velocity to the longitudinal velocity of the centre of gravity of the vehicle.
- 2.29. 'Understeer' means a condition in which the vehicle's yaw rate is less than the yaw rate that would occur at the vehicle's speed as a result of the Ackerman steer angle.

⁽²⁾ An axle group shall be treated as a single axle and dual wheels shall be treated as a single wheel.

- 2.30. 'Yaw rate' means the rate of change of the vehicle's heading angle measured in degrees/second of rotation about a vertical axis through the vehicle's centre of gravity.
- 2.31. 'Peak braking coefficient (PBC)': means the measure of tyre to road surface friction based on the maximum deceleration of a rolling tyre.
- 2.32. 'Common space' means an area on which more than one tell-tale, indicator, identification symbol, or other message may be displayed but not simultaneously.
- 2.33. 'Static stability factor' means one-half the track width of a vehicle divided by the height of its center of gravity, also expressed as $SSF = T/2H$, where: T = track width (for vehicles with more than one track width the average is used; for axles with dual wheels, the outer wheels are used when calculating 'T') and H = height of the center of gravity of the vehicle.
- 2.34. 'Brake Assist System (BAS)' means a function of the braking system that deduces an emergency braking event from a characteristic of the driver's brake demand and, under such conditions:
- (a) assists the driver to deliver the maximum achievable braking rate, or
 - (b) is sufficient to cause full cycling of the Anti-lock Braking System.
- 2.34.1. 'Category A Brake Assist System' means a system which detects an emergency braking condition based on the brake pedal force applied by the driver;
- 2.34.2. 'Category B Brake Assist System' means a system which detects an emergency braking condition based on the brake pedal speed applied by the driver;
- 2.34.3. 'Category C Brake Assist System' means a system which detects an emergency braking condition based on multiple criteria, one of which must be the rate at which the brake pedal is applied.
3. APPLICATION FOR APPROVAL
- 3.1. The application for approval of a vehicle type with regard to braking shall be submitted by the vehicle manufacturer or by his duly accredited representative.
- 3.2. It shall be accompanied by the under-mentioned documents in triplicate and by the following particulars:
- 3.2.1. a description of the vehicle type with regard to the items specified in paragraph 2.2 above. The numbers and/or symbols identifying the vehicle type and the engine type shall be specified;
 - 3.2.2. a list of the components, duly identified, constituting the braking equipment;
 - 3.2.3. a diagram of assembled braking equipment and an indication of the position of its components on the vehicle;
 - 3.2.4. detailed drawings of each component to enable it to be easily located and identified.
- 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 paragraphs 5 and 6 below, approval of that vehicle type shall be granted.
- 4.2. An approval number shall be assigned to each type approved, its first two digits 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 the same vehicle type equipped with another type of braking equipment, or to another vehicle type.
- 4.3. Notice of approval or of refusal 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 form conforming to the model in Annex 1 to this Regulation and of a summary of the information contained in the documents referred to in paragraphs 3.2.1 to 3.2.4 above, the drawings supplied by the applicant for approval being 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, 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 ⁽³⁾, and of
- 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 above.
- 4.4.3. In the case of a vehicle complying with the Electronic Stability Control and Brake Assist System requirements of Annex 9 to this Regulation, the additional letters 'ESC' shall be placed immediately to the right of the letter 'R' mentioned in paragraph 4.4.2.
- 4.4.4. In the case of vehicles complying with the Vehicle Stability Function requirements of Annex 21 to Regulation No 13 and the Brake Assist System requirements of Annex 9 to this Regulation, the additional letters 'VSF' shall be placed immediately to the right of the letter 'R' mentioned in paragraph 4.4.2.
- 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 above, 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 4.4.1 above.
- 4.6. The approval mark shall be clearly legible and be indelible.

⁽³⁾ 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, 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, 53 for Thailand, 54 and 55 (vacant) and 56 for Montenegro. 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.

- 4.7. The approval mark shall be placed close to or on the vehicle data plate.
- 4.8. Annex 2 to this Regulation gives examples of arrangements of approval marks.
5. SPECIFICATIONS
- 5.1. General
- 5.1.1. Braking equipment
- 5.1.1.1. The braking equipment shall be so designed, constructed and fitted as to enable the vehicle in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Regulation.
- 5.1.1.2. In particular, the braking equipment shall be so designed, constructed and fitted as to be able to resist the corroding and ageing phenomena to which it is exposed.
- 5.1.1.3. Brake linings shall not contain asbestos.
- 5.1.1.4. The effectiveness of the braking equipment shall not be adversely affected by magnetic or electrical fields. (This shall be demonstrated by compliance with Regulation No 10, 02 series of amendments.)
- 5.1.1.5. A failure detection signal may interrupt momentarily (< 10 ms) the demand signal in the control transmission, provided that the braking performance is thereby not reduced.
- 5.1.2. Functions of the braking equipment
- The braking equipment defined in paragraph 2.3 must fulfil the following functions:
- 5.1.2.1. Service braking system
- The service braking system must make it possible to control the movement of the vehicle and to halt it safely, speedily and effectively, whatever its speed and load, on any up or down gradient. It must be possible to graduate this braking action. The driver must be able to achieve this braking action from his driving seat without removing his hands from the steering control.
- 5.1.2.2. Secondary braking system
- The secondary braking system must make it possible by application of the service brake control to halt the vehicle within a reasonable distance in the event of failure of the service braking system. It must be possible to graduate this braking action. The driver must be able to obtain this braking action from his driving seat without removing his hands from the steering control. For the purposes of these provisions it is assumed that not more than one failure of the service braking system can occur at one time.
- 5.1.2.3. Parking braking system
- The parking braking system must make it possible to hold the vehicle stationary on an up or down gradient even in the absence of the driver, the working parts being then held in the locked position by a purely mechanical device. The driver must be able to achieve this braking action from his driving seat.
- 5.1.3. The requirements of Annex 8 shall be applied to the safety aspects of all complex electronic vehicle control systems which provide or form part of the control transmission of the braking function including those which utilize the braking system(s) for automatically commanded braking or selective braking.

However, systems or functions, which use the braking system as the means of achieving a higher level objective, are subject to Annex 8 only insofar as they have a direct effect on the braking system. If such systems are provided, they must not be deactivated during type approval testing of the braking system.

5.1.4. Provisions for the periodic technical inspection of braking systems

5.1.4.1. It shall be possible to assess the wear condition of the components of the service brake that are subject to wear e.g. friction linings and drums/discs (in the case of drums or discs, wear assessment may not necessarily be carried out at the time of periodic technical inspection). The method by which this may be realized is defined in paragraph 5.2.11.2 of this Regulation.

5.1.4.2. It shall be possible to verify, in a simple way, the correct operational status of those complex electronic systems which have control over braking. If special information is needed, this shall be made freely available.

5.1.4.2.1. At the time of type approval, the means implemented to protect against simple unauthorized modification of the operation to the verification means chosen by the manufacturer (e.g. warning signal) shall be confidentially outlined. Alternatively, this protection requirement is fulfilled when a secondary means of checking the correct operational status is available.

5.1.4.3. It shall be possible to generate maximum braking forces under static conditions on a rolling road or roller brake tester.

5.2. Characteristics of braking systems

5.2.1. The set of braking systems with which a vehicle is equipped must satisfy the requirements laid down for service, secondary and parking braking systems.

5.2.2. The systems providing service, secondary and parking braking may have common components so long as they fulfil the following conditions:

5.2.2.1. there must be at least two controls, independent of each other and readily accessible to the driver from his normal driving position. Every brake control shall be designed such that it returns to the fully off position when released. This requirement shall not apply to a parking brake control when it is mechanically locked in an applied position;

5.2.2.2. the control of the service braking system must be independent of the control of the parking braking system;

5.2.2.3. the effectiveness of the linkage between the control of the service braking system and the different components of the transmission systems must not be liable to diminish after a certain period of use;

5.2.2.4. the parking braking system must be so designed that it can be actuated when the vehicle is in motion. This requirement may be met by the actuation of the vehicle's service braking system, even partially, by means of an auxiliary control;

5.2.2.5. without prejudice to the requirements of paragraph 5.1.2.3 of this Regulation, the service braking system and the parking braking system may use common components in their transmission(s), provided that in the event of a failure in any part of the transmission(s) the requirements for secondary braking are still ensured;

- 5.2.2.6. in the event of breakage of any component other than the brakes (as defined in paragraph 2.6 above) and the components referred to in paragraph 5.2.2.10 below, or of any other failure of the service braking system (malfunction, partial or total exhaustion of an energy reserve), that part of the service braking system which is not affected by the failure, must be able to bring the vehicle to a halt in the conditions prescribed for secondary braking;
- 5.2.2.7. if service braking is ensured by the action of the driver's muscular energy assisted by one or more energy reserves, secondary braking must, in the event of failure of that assistance, be capable of being ensured by the driver's muscular energy assisted by the energy reserves, if any, which are unaffected by the failure, the force applied to the service brake control not exceeding the prescribed maximum;
- 5.2.2.8. if the service braking force and transmission depend exclusively on the use, controlled by the driver, of an energy reserve, there must be at least two completely independent energy reserves, each provided with its own transmission, likewise independent; each of them may act on the brakes of only two or more wheels so selected as to be capable of ensuring by themselves the prescribed degree of secondary braking without endangering the stability of the vehicle during braking; in addition, each of the aforesaid energy reserves must be equipped with a warning device as defined in paragraph 5.2.14 below;
- 5.2.2.9. if the service braking force and transmission depend exclusively on the use of an energy reserve, one energy reserve for the transmission is deemed to be sufficient, provided that the prescribed secondary braking is ensured by the action of the driver's muscular energy acting on the service brake control and the requirements of paragraph 5.2.5 are met;
- 5.2.2.10. certain parts, such as the pedal and its bearing, the master cylinder and its piston or pistons, the control valve, the linkage between the pedal and the master cylinder or the control valve, the brake cylinders and their pistons, and the lever-and-cam assemblies of brakes, shall not be regarded as liable to breakage if they are amply dimensioned, are readily accessible for maintenance, and exhibit safety features at least equal to those prescribed for other essential components (such as the steering linkage) of the vehicle. Any such part as aforesaid whose failure would make it impossible to brake the vehicle with a degree of effectiveness at least equal to that prescribed for secondary braking must be made of metal or of a material with equivalent characteristics and must not undergo notable distortion in normal operation of the braking systems.
- 5.2.3. The failure of a part of a hydraulic transmission system shall be signalled to the driver by a device comprising a red tell-tale signal lighting up before or upon application of a differential pressure of not more than 15,5 bar between the active and failed brake equipment, measured at the master cylinder outlet and remaining lit as long as the failure persists and the ignition (start) switch is in the 'on' (run) position. However, a device comprising a red tell-tale signal lighting up when the fluid in the reservoir is below a certain level specified by the manufacturer is permitted. The tell-tale signal must be visible even by daylight; the satisfactory condition of the signal must be easily verifiable by the driver from the driver's seat. The failure of a component of the device must not entail total loss of the braking equipment's effectiveness. Application of the parking brake must also be indicated to the driver. The same tell-tale signal may be used.
- 5.2.4. Where use is made of energy other than the muscular energy of the driver, there need not be more than one source of such energy (hydraulic pump, air compressor, etc.), but the means by which the device constituting that source is driven must be as safe as practicable.

- 5.2.4.1. In the event of failure in any part of the transmission of a braking system, the feed to the part not affected by the failure must continue to be ensured if required for the purpose of halting the vehicle with the degree of effectiveness prescribed for secondary braking. This condition must be met by means of devices which can easily be actuated when the vehicle is stationary, or by automatic means.
- 5.2.4.2. Furthermore, storage devices located down-circuit of this device must be such that in the case of a failure in the energy supply after four full-stroke actuations of the service brake control, under the conditions prescribed in paragraph 1.2 of Annex 4 to this Regulation, it is still possible to halt the vehicle at the fifth application, with the degree of effectiveness prescribed for secondary braking.
- 5.2.4.3. However, for hydraulic braking systems with stored energy, these provisions can be considered to be met provided that the requirements of paragraph 1.3 of Annex 4 to this Regulation, are satisfied.
- 5.2.5. The requirements of paragraphs 5.2.2, 5.2.3 and 5.2.4 above must be met without the use of any automatic device of a kind such that its ineffectiveness might pass unnoticed through the fact that parts normally in a position of rest come into action only in the event of failure in the braking system.
- 5.2.6. The service braking system shall act on all wheels of the vehicle and shall distribute its action appropriately among the axles.
- 5.2.7. In the case of vehicles equipped with electric regenerative braking systems of category B, the braking input from other sources of braking, may be suitably phased to allow the electric regenerative braking system alone to be applied, provided that both the following conditions are met:
- 5.2.7.1. Intrinsic variations in the torque output of the electrical regenerative braking system (e.g. as a result of changes in the electric state of charge in the traction batteries) are automatically compensated by appropriate variation in the phasing relationship as long as the requirements ⁽⁴⁾ of one of the following annexes to this Regulation are satisfied:
- Annex 3, paragraph 1.3.2, or
- Annex 6, section 5.3 (including the case with the electric motor engaged), and
- 5.2.7.2. Wherever necessary, to ensure that braking rate ⁽⁵⁾ remains related to the driver's braking demand, having regard to the available tyre/road adhesion, braking shall automatically be caused to act on all wheels of the vehicle.
- 5.2.8. The action of the service braking system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle.
- Compensation and functions, such as anti-lock, which may cause deviations from this symmetrical distribution shall be declared.
- 5.2.8.1. Compensation by the electric control transmission for deterioration or defect within the braking system shall be indicated to the driver by means of the yellow warning signal specified in paragraph 5.2.21.1.2 below. This requirement shall apply for all conditions of loading when compensation exceeds the following limits:

⁽⁴⁾ The Authority, which is to grant approval, shall have the right to check the service braking system by additional vehicle test procedures.

⁽⁵⁾ See footnote 3.

- 5.2.8.1.1. a difference in transverse braking pressures on any axle:
- (a) of 25 per cent of the higher value for vehicle decelerations $\geq 2 \text{ m/sec}^2$,
 - (b) a value corresponding to 25 per cent at 2 m/sec^2 for decelerations below this rate.
- 5.2.8.1.2. an individual compensating value on any axle:
- (a) > 50 per cent of the nominal value for vehicle decelerations $\geq 2 \text{ m/sec}^2$,
 - (b) a value corresponding to 50 per cent of the nominal value at 2 m/sec^2 for decelerations below this rate.
- 5.2.8.2. Compensation as defined above, is permitted only when the initial brake application is made at vehicle speeds greater than 10 km/h.
- 5.2.9. Malfunctions of the electric control transmission shall not apply the brakes contrary to the driver's intentions.
- 5.2.10. The service, secondary and parking braking systems must act on braking surfaces connected to the wheels through components of adequate strength.

Where braking torque for a particular axle or axles is provided by both a friction braking system and an electrical regenerative braking system of category B, disconnection of the latter source is permitted, providing that the friction braking source remains permanently connected and able to provide the compensation referred to in paragraph 5.2.7.1.

However, in the case of short disconnection transients, incomplete compensation is accepted, but within 1s, this compensation shall have attained at least 75 per cent of its final value.

Nevertheless, in all cases, the permanently connected friction braking source shall ensure that both the service and secondary braking systems continue to operate with the prescribed degree of effectiveness.

Disconnection of the braking surfaces of the parking braking system shall be permitted only on condition that the disconnection is controlled exclusively by the driver from his driving seat, by a system incapable of being brought into action by a leak.

- 5.2.11. Wear of the brakes must be capable of being easily taken up by means of a system of manual or automatic adjustment. In addition, the control and the components of the transmission and of the brakes must possess a reserve of travel and, if necessary, suitable means of compensation such that, when the brakes become heated, or the brake linings have reached a certain degree of wear, effective braking is ensured without immediate adjustment being necessary.
- 5.2.11.1. Wear adjustment shall be automatic for the service brakes. Automatic wear adjustment devices shall be such that after heating followed by cooling of the brakes, effective braking is still ensured. In particular the vehicle shall remain capable of normal running after the tests conducted in accordance with Annex 3, paragraph 1.5 (Type-I test).
- 5.2.11.2. Checking the wear of the service brake friction components
- 5.2.11.2.1. It shall be possible to easily assess this wear on service brake linings from the outside or underside of the vehicle, without the removal of the wheels, by the provision of appropriate inspection holes or by some other means. This may be achieved by utilizing simple standard workshop tools or common inspection equipment for vehicles.

Alternatively, a sensing device per wheel (twin wheels are considered as a single wheel), which will warn the driver at his driving position when lining replacement is necessary, is acceptable. In the case of an optical warning, the yellow warning signal specified in paragraph 5.2.21.1.2 below may be used.

5.2.11.2.2. Assessment of the wear condition of the friction surfaces of brake discs or drums may only be performed by direct measurement of the actual component or examination of any brake disc or drum wear indicators, which may necessitate some level of disassembly. Therefore, at the time of type approval, the vehicle manufacturer shall define the following:

- (a) The method by which wear of the friction surfaces of drums and discs may be assessed, including the level of disassembly required and the tools and process required to achieve this.
- (b) Information defining the maximum acceptable wear limit at the point at which replacement becomes necessary.

This information shall be made freely available, e.g. vehicle handbook or electronic data record.

5.2.12. In hydraulic-transmission braking systems, the filling ports of the fluid reservoirs must be readily accessible; in addition, the receptacles containing the reserve fluid must be so designed and constructed that the level of the reserve fluid can be easily checked without the receptacles having to be opened, and the minimum total reservoir capacity is equivalent to the fluid displacement resulting when all the wheel cylinders or calliper pistons serviced by the reservoirs move from a new lining, fully retracted position to a fully worn, fully applied position. If these latter conditions are not fulfilled, the red warning signal specified in paragraph 5.2.21.1.1 below shall draw the driver's attention to any fall in the level of reserve fluid liable to cause a failure of the braking system.

5.2.13. The type of fluid to be used in hydraulic transmission braking systems shall be identified by the symbol in accordance with figure 1 or 2 of Standard ISO 9128-1987 and the appropriate DOT marking (e.g. DOT 3). The symbol and the marking must be affixed in a visible position in indelible form within 100 mm of the filling ports of the fluid reservoirs; additional information may be provided by the manufacturer.

5.2.14. Warning device

5.2.14.1. Any vehicle fitted with a service brake actuated from an energy reservoir must, where the prescribed secondary braking performance cannot be obtained by means of this brake without the use of the stored energy, be provided with a warning device, giving an optical or acoustic signal when the stored energy, in any part of the system, falls to a value at which without recharging of the reservoir and irrespective of the load conditions of the vehicle, it is possible to apply the service brake control a fifth time after four full-stroke actuations and obtain the prescribed secondary braking performance (without faults in the service brake transmission device and with the brakes adjusted as closely as possible). This warning device must be directly and permanently connected to the circuit. When the engine is running under normal operating conditions and there are no faults in the braking system, as is the case in type approval tests, the warning device must give no signal except during the time required for charging the energy reservoir(s) after start-up of the engine. The red warning signal specified in paragraph 5.2.21.1.1 below shall be used as the optical warning signal.

- 5.2.14.2. However, in the case of vehicles which are only considered to comply with the requirements of paragraph 5.2.4.1 of this Regulation by virtue of meeting the requirements of paragraph 1.3 of Annex 4 to this Regulation, the warning device shall consist of an acoustic signal in addition to an optical signal. These devices need not operate simultaneously, provided that each of them meets the above requirements and the acoustic signal is not actuated before the optical signal. The red warning signal specified in paragraph 5.2.21.1.1 below shall be used as the optical warning signal.
- 5.2.14.3. This acoustic device may be rendered inoperative while the parking brake is applied and/or, at the choice of the manufacturer, in the case of automatic transmission the selector is in the 'Park' position.
- 5.2.15. Without prejudice to the requirements of paragraph 5.1.2.3 above, where an auxiliary source of energy is essential to the functioning of a braking system, the reserve of energy must be such as to ensure that, if the engine stops or in the event of a failure of the means by which the energy source is driven, the braking performance remains adequate to bring the vehicle to a halt in the prescribed conditions. In addition, if the muscular effort applied by the driver to the parking braking system is reinforced by a servo device, the actuation of parking braking must be ensured in the event of a failure of the servo device, if necessary by using a reserve of energy independent of that normally supplying the servo device. This reserve of energy may be that intended for the service braking system.
- 5.2.16. The pneumatic/hydraulic auxiliary equipment must be supplied with energy in such a way that during its operation the prescribed deceleration values can be reached and that even in the event of damage to the source of energy the operation of the auxiliary equipment cannot cause the reserves of energy feeding the braking systems to fall below the level indicated in paragraph 5.2.14 above.
- 5.2.17. In the case of a motor vehicle equipped to tow a trailer with electric service brakes, the following requirements shall be met:
- 5.2.17.1. the power supply (generator and battery) of the motor vehicle shall have a sufficient capacity to provide the current for an electric braking system. With the engine running at the idling speed recommended by the manufacturer and all electrical devices supplied by the manufacturer as standard equipment of the vehicle switched on, the voltage in the electrical lines shall at maximum current consumption of the electrical braking system (15 A) not fall below the value of 9,6 V measured at the connection. The electrical lines shall not be capable of short circuiting even when overloaded;
- 5.2.17.2. in the event of a failure in the motor vehicle's service braking system, where that system consists of at least two independent units, the unit or units not affected by the failure shall be capable of partially or fully actuating the brakes of the trailer;
- 5.2.17.3. the use of the stop-lamp switch and circuit for actuating the electrical braking system is permissible only if the actuating line is connected in parallel with the stop-lamp and the existing stop-lamp switch and circuit are capable of taking the extra load.
- 5.2.18. Additional requirements for vehicles equipped with electric regenerative braking systems.
- 5.2.18.1. Vehicles fitted with an electric regenerative braking system of category A.
- 5.2.18.1.1. the electric regenerative braking shall only be activated by the accelerator control and/or the gear neutral position.

- 5.2.18.2. Vehicles fitted with an electric regenerative braking system of category B.
- 5.2.18.2.1. it must not be possible to disconnect, partially or totally, one part of the service braking system other than by automatic means. This should not be construed as a departure from the requirements of paragraph 5.2.10;
- 5.2.18.2.2. the service braking system must have only one control device;
- 5.2.18.2.3. the service braking system must not be adversely affected by the disengagement of the motor(s) or by the gear ratio used;
- 5.2.18.2.4. if the operation of the electric component of braking is ensured by a relation established between information coming from the control of the service brake and the braking force to the wheels which of it results, a failure of this relation leading to the non-respect of the prescriptions of distribution of braking among the axles (Annex 5 or 6, which is applicable) must be warned to the driver by an optical warning signal at the latest when the control is actuated and having to remain lit as long as this defect exists and that the switch of 'contact' is in the position 'go'.
- 5.2.18.3. For vehicles fitted with an electric regenerative braking system of either category, all the relevant prescriptions shall apply except paragraph 5.2.18.1.1 above. In this case, the electric regenerative braking may be actuated by the accelerator control and/or the gear neutral position. Additionally, the action on the service braking control must not reduce the above braking effect generated by the release of the accelerator control.
- 5.2.18.4. The operation of the electric braking must not be adversely affected by magnetic or electric fields.
- 5.2.18.5. For vehicles equipped with an anti-lock device, the anti-lock device must control the electric braking system.
- 5.2.18.6. The state of charge of the traction batteries is determined by the method set out in Appendix 1 to Annex 3 to this Regulation ⁽⁶⁾.
- 5.2.19. Special additional requirements for the electric transmission of the parking braking system:
- 5.2.19.1. In the case of a failure within the electric transmission, any unintended actuation of the parking braking system shall be prevented;
- 5.2.19.2. In the case of an electrical failure in the control or a break in the wiring within the electric control transmission between the control and the ECU directly connected with it, excluding the energy supply, it shall remain possible to apply the parking braking system from the driver's seat and thereby be capable of holding the laden vehicle stationary on an 8 per cent up or down gradient. Alternatively, in this case, an automatic actuation of the parking brake is allowed when the vehicle is stationary, provided that the above performance is achieved and, once applied, the parking brake remains engaged independently of the status of the ignition (start) switch. In this alternative, the parking brake shall be automatically released as soon as the driver starts to set the vehicle in motion again. The engine/manual transmission or the automatic transmission (park position) may be used to achieve or assist in achieving the above performance.

⁽⁶⁾ By agreement with the Technical Service, state of charge assessment will not be required for vehicles, which have an on-board energy source for charging the traction batteries and the means for regulating their state of charge.

- 5.2.19.2.1. A break in the wiring within the electrical transmission, or an electrical failure in the control of the parking braking system shall be signalled to the driver by the yellow warning signal specified in paragraph 5.2.21.1.2. When caused by a break in the wiring within the electrical control transmission of the parking braking system, this yellow warning signal shall be signalled as soon as the break occurs.

In addition, such an electrical failure in the control or break in the wiring external to the electronic control unit(s) and excluding the energy supply shall be signalled to the driver by flashing the red warning signal specified in paragraph 5.2.21.1.1 as long as the ignition (start) switch is in the 'on' (run) position including a period of not less than 10 seconds thereafter and the control is in the 'on' (activated) position.

However, if the parking braking system detects correct clamping of the parking brake, the flashing of the red warning signal may be suppressed and the non-flashing red signal shall be used to indicate 'parking brake applied'.

Where actuation of the parking brake is normally indicated by a separate red warning signal, satisfying all the requirements of paragraph 5.2.21.2, this signal shall be used to satisfy the above requirement for a red signal.

- 5.2.19.3. Auxiliary equipment may be supplied with energy from the electric transmission of the parking braking system provided that the supply of energy is sufficient to allow the actuation of the parking braking system in addition to the vehicle electrical load under non-fault conditions. In addition, where the energy reserve is also used by the service braking system, the requirements of paragraph 5.2.20.6 shall apply.
- 5.2.19.4. After the ignition/start switch which controls the electrical energy for the braking equipment has been switched off and/or the key removed, it shall remain possible to apply the parking braking system, whereas releasing shall be prevented.
- 5.2.20. Special additional requirements for service braking systems with electric control transmission:
- 5.2.20.1. With the parking brake released, the service braking system shall be able to generate a static total braking force at least equivalent to that required by the prescribed Type-0 test, even when the ignition/start switch has been switched off and/or the key has been removed. It should be understood that sufficient energy is available in the energy transmission of the service braking system.
- 5.2.20.2. In the case of a single temporary failure (< 40 ms) within the electric control transmission, excluding its energy supply, (e.g. non-transmitted signal or data error) there shall be no distinguishable effect on the service braking performance.
- 5.2.20.3. A failure within the electric control transmission⁽⁷⁾, not including its energy reserve, that affects the function and performance of systems addressed in this Regulation shall be indicated to the driver by the red or yellow warning signal specified in paragraphs 5.2.21.1.1 and 5.2.21.1.2, respectively, as appropriate. When the prescribed service braking performance can no longer be achieved (red warning signal), failures resulting from a loss of electrical continuity (e.g. breakage, disconnection) shall be signalled to the driver as soon as they occur, and the prescribed secondary braking performance shall be fulfilled by operating the service braking control in accordance with paragraph 2.2 of Annex 3 to this Regulation.

⁽⁷⁾ Until uniform test procedures have been agreed, the manufacturer shall provide the Technical Service with an analysis of potential failures within the control transmission and their effects. This information shall be subject to discussion and agreement between the Technical Service and the vehicle manufacturer.

- 5.2.20.4. In the event of a failure of the energy source of the electric control transmission, starting from the nominal value of the energy level, the full control range of the service braking system shall be guaranteed after twenty consecutive full stroke actuations of the service braking control. During the test, the braking control shall be fully applied for 20 seconds and released for 5 seconds on each actuation. It should be understood that during the above test sufficient energy is available in the energy transmission to ensure full actuation of the service braking system. This requirement shall not be construed as a departure from the requirements of Annex 4.
- 5.2.20.5. When the battery voltage falls below a value nominated by the manufacturer at which the prescribed service braking performance can no longer be guaranteed and/or which precludes at least two independent service braking circuits from each achieving the prescribed secondary braking performance, the red warning signal specified in paragraph 5.2.21.1.1 shall be activated. After the warning signal has been activated, it shall be possible to apply the service braking control and obtain at least the secondary performance prescribed in paragraph 2.2 of Annex 3 to this Regulation. It should be understood that sufficient energy is available in the energy transmission of the service braking system.
- 5.2.20.6. If auxiliary equipment is supplied with energy from the same reserve as the electric control transmission, it shall be ensured that, with the engine running at a speed not greater than 80 per cent of the maximum power speed, the supply of energy is sufficient to fulfil the prescribed deceleration values by either provision of an energy supply which is able to prevent discharge of this reserve when all auxiliary equipment is functioning or by automatically switching off pre-selected parts of the auxiliary equipment at a voltage above the critical level referred to in paragraph 5.2.20.5 of this Regulation such that further discharge of this reserve is prevented. Compliance may be demonstrated by calculation or by a practical test. This paragraph does not apply to vehicles where the prescribed deceleration values can be reached without the use of electrical energy.
- 5.2.20.7. If the auxiliary equipment is supplied with energy from the electric control transmission, the following requirements shall be fulfilled:
- 5.2.20.7.1. In the event of a failure in the energy source, whilst the vehicle is in motion, the energy in the reservoir shall be sufficient to actuate the brakes when the control is applied;
- 5.2.20.7.2. In the event of a failure in the energy source, whilst the vehicle is stationary and the parking braking system applied, the energy in the reservoir shall be sufficient to actuate the lights even when the brakes are applied.
- 5.2.21. The general requirements for optical warning signals whose function is to indicate to the driver certain specified failures (or defects) within the braking equipment of the motor vehicle, are set out in the following subparagraphs. Other than as described in paragraph 5.2.21.5 below, these signals shall be used exclusively for the purposes prescribed by this Regulation.
- 5.2.21.1. Motor vehicles shall be capable of providing optical brake failure and defect warning signals, as follows:
- 5.2.21.1.1. A red warning signal, indicating failures defined elsewhere in this Regulation within the vehicle braking equipment which preclude achievement of the prescribed service braking performance and/or which preclude the functioning of at least one of two independent service braking circuits;
- 5.2.21.1.2. Where applicable, a yellow warning signal indicating an electrically detected defect within the vehicle braking equipment, which is not indicated by the red warning signal described in paragraph 5.2.21.1.1 above.

- 5.2.21.2. The warning signals shall be visible, even by daylight; the satisfactory condition of the signals shall be easily verifiable by the driver from the driver's seat; the failure of a component of the warning devices shall not entail any loss of the braking system's performance.
- 5.2.21.3. Except where stated otherwise:
- 5.2.21.3.1. a specified failure or defect shall be signalled to the driver by the above-mentioned warning signal(s) not later than on actuation of the relevant braking control;
- 5.2.21.3.2. the warning signal(s) shall remain displayed as long as the failure/defect persists and the ignition (start) switch is in the 'on' (run) position; and
- 5.2.21.3.3. the warning signal shall be constant (not flashing).
- 5.2.21.4. The warning signal(s) mentioned above shall light up when the electrical equipment of the vehicle (and the braking system) is energised. With the vehicle stationary, the braking system shall verify that none of the specified failures or defects are present before extinguishing the signals. Specified failures or defects which should activate the warning signals mentioned above, but which are not detected under static conditions, shall be stored upon detection and be displayed at start-up and at all times when the ignition (start) switch is in the 'on' (run) position, as long as the failure or defect persists.
- 5.2.21.5. Non specified failures (or defects), or other information concerning the brakes and/or running gear of the power-driven vehicle, may be indicated by the yellow signal specified in paragraph 5.2.21.1.2 above, provided that all the following conditions are fulfilled:
- 5.2.21.5.1. the vehicle is stationary;
- 5.2.21.5.2. after the braking equipment is first energised and the signal has indicated that, following the procedures detailed in paragraph 5.2.21.4 above, no specified failures (or defects) have been identified; and
- 5.2.21.5.3. non-specified faults or other information shall be indicated only by the flashing of the warning signal. However, the warning signal shall be extinguished by the time when the vehicle first exceeds 10 km/h.
- 5.2.22. Generation of a braking signal to illuminate stop lamps.
- 5.2.22.1. Activation of the service braking system by the driver shall generate a signal that will be used to illuminate the stop lamps.
- 5.2.22.2. Activation of the service braking system by 'automatically commanded braking' shall generate the signal mentioned above. However, when the retardation generated is less than $0,7 \text{ m/s}^2$, the signal may be suppressed ⁽⁸⁾.
- 5.2.22.3. Activation of part of the service braking system by 'selective braking' shall not generate the signal mentioned above ⁽⁹⁾.
- 5.2.22.4. Electric regenerative braking systems, which produce a retarding force upon release of the throttle pedal, shall not generate a signal mentioned above.

⁽⁸⁾ At the time of type approval, compliance with this requirement shall be confirmed by the vehicle manufacturer.

⁽⁹⁾ During a 'selective braking' event, the function may change to 'automatically commanded braking'.

5.2.23. When a vehicle is equipped with the means to indicate emergency braking, activation and de-activation of the emergency braking signal shall meet the specifications below:

5.2.23.1. The signal shall be activated by the application of the service braking system at a deceleration of or above 6 m/s^2 ;

The signal shall be de-activated at the latest when the deceleration has fallen below $2,5 \text{ m/s}^2$.

5.2.23.2. The following conditions may also be used:

(a) The signal may be activated by the application of the service braking system in such a manner that it would produce, in an unladen condition and engine disconnected, under the test conditions of Type-0 as described in Annex 3, a deceleration of or above 6 m/s^2 ;

The signal shall be de-activated at the latest when the deceleration has fallen below $2,5 \text{ m/s}^2$.

or

(b) The signal may be activated when the service braking system is applied at a speed above 50 km/h and the antilock system is fully cycling (as defined in paragraph 2 of Annex 6).

The signal shall be deactivated when the antilock system is no longer fully cycling.

5.2.24. Subject to the requirements of paragraphs 12.2 to 12.3, any vehicle fitted with an ESC system complying with the definition of paragraph 2.25 shall meet the equipment, performance and test requirements contained in Part A of Annex 9 to this Regulation.

5.2.24.1. As an alternative to the requirement of paragraph 5.2.24, vehicles of categories M1 and N1 with a mass in running order $> 1\,735 \text{ kg}$ may be equipped with a vehicle stability function which includes roll-over control and directional control and meets the technical requirements of Annex 21 to Regulation No 13.

5.2.25. Power-driven vehicles of category M1 and N1 equipped with temporary-use spare wheels/tyres shall satisfy the relevant technical requirements of Annex 3 to Regulation No 64.

6. TESTS

Braking tests which the vehicles submitted for approval are required to undergo, and the braking performance required, are described in Annex 3 to this Regulation.

7. MODIFICATION OF VEHICLE TYPE OR BRAKING SYSTEM AND EXTENSION OF APPROVAL

7.1. Every modification of the vehicle type or of its braking system shall be notified to the Administrative Department which approved the vehicle type. That department may then either:

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

7.1.2. require a further report from the Technical Service responsible for carrying out the tests.

7.2. Notice of confirmation, extension, or refusal of approval shall be communicated by the procedure specified in paragraph 4.3 above, to the Parties to the Agreement which apply this Regulation.

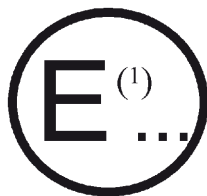
- 7.3. The Competent Authority issuing the extension of approval shall assign a series of numbers to each communication form drawn up for such an extension.
8. CONFORMITY OF PRODUCTION
- The conformity of production procedures shall comply with those set out in the Agreement, Appendix 2 (E/ECE/324-E/ECE/TRANS/505/Rev.2) with the following requirements:
- 8.1. 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 above.
- 8.2. 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.
9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION
- 9.1. The approval granted in respect of a vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 8.1 above are not complied with.
- 9.2. 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 copy of the communication form conforming to the model in Annex 1 to this Regulation.
10. 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 Agreement applying this Regulation by means of copies of a communication form conforming to the model in Annex 1 to this Regulation.
11. NAMES AND ADDRESSES OF THE TECHNICAL SERVICES CONDUCTING APPROVAL TESTS, AND OF ADMINISTRATIVE DEPARTMENTS
- The 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.
12. TRANSITIONAL PROVISIONS
- 12.1. Until 24 months after the date of entry into force of Supplement 5 to the original version of this Regulation, Contracting Parties applying this Regulation may continue to grant ECE approvals to the un-amended Regulation.
- 12.2. As from 1 November 2011, Contracting Parties applying this Regulation may refuse to grant national or regional type approval if the vehicle type does not meet the requirements of this Regulation as amended by Supplement 9 and is not fitted with an Electronic Stability Control System and a Brake Assist System, both meeting the requirements of Annex 9 to this Regulation.
- 12.3. As from 1 November 2013, Contracting Parties applying this Regulation may refuse first national registration of a vehicle which does not meet the requirements of this Regulation as amended by Supplement 9 and is not fitted with an Electronic Stability Control System and a Brake Assist System, both meeting the requirements of Annex 9 to this Regulation.

- 12.4. As from the official date of entry into force of Supplement 9 to the original version of this Regulation, Contracting Parties applying this Regulation:
- (a) shall not refuse to grant approval under this Regulation to a vehicle complying with the requirements as amended by Supplement 9 to the original version of this Regulation.
 - (b) shall refuse to grant approval under this Regulation as amended by Supplement 7 to the original version of this Regulation.
- 12.5. Contracting Parties applying this Regulation shall continue to grant approvals to those types of vehicles which comply with the requirements of this Regulation as amended by Supplement 6 to the original version of 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 braking, pursuant to Regulation No 13-H

Approval No Extension No

1. Trade name or mark of the vehicle
2. Vehicle type
3. Manufacturer's name and address
4. If applicable, name and address of manufacturer's representative

5. Mass of vehicle
- 5.1. Maximum mass of vehicle
- 5.2. Minimum mass of vehicle
6. Distribution of mass of each axle (maximum value)
7. Make and type of brake linings
- 7.1. Brake linings tested to all relevant prescriptions of Annex 3
- 7.2. Alternative brake linings tested to Annex 7
8. Engine type
9. Number and ratios of gears
10. Final drive ratio(s)
11. If applicable, maximum mass of trailer which may be coupled
- 11.1. Unbraked trailer
12. Tyre dimension
- 12.1. Temporary-use spare wheel/tyre dimensions
- 12.2. Vehicle meets the technical requirements of Annex 3 to Regulation No 64: Yes/No ⁽²⁾
13. Maximum design speed
14. Brief description of braking equipment

(*) At the request of (an) applicant(s) for Regulation No 90 approval, the information shall be provided by the Type Approval Authority as contained in Appendix 1 to this annex. However, this information shall not be provided for purposes other than Regulation No 90 approvals.

15. Mass of vehicle when tested:

	Laden (kg)	Unladen (kg)
Axle No 1		
Axle No 2		
Total		

16. Result of the tests:

Test Speed (km/h)	Measured performance	Measured force applied to control (daN)

- 16.1. Type-0 tests:

engine disconnected
service braking (laden)
service braking (unladen)
secondary braking (laden)
secondary braking (unladen)

- 16.2. Type-0 tests:

engine connected
service braking (laden)
service braking (unladen)
(in accordance with paragraph 2.1.1(B) of Annex 3)

- 16.3. Type-I tests:

preliminary snubs (to determine pedal force)
hot performance (1st stop)
hot performance (2nd stop)
recovery performance

- 16.4. Dynamic parking brake performance

17. Result of the Annex 5 performance tests

18. Vehicle is/is not ⁽²⁾ equipped to tow a trailer with electrical braking systems.

19. Vehicle is/is not ⁽²⁾ equipped with an anti-lock system.

- 19.1. The vehicle fulfils the requirement of Annex 6: Yes/No ⁽²⁾

- 19.2. Category of anti-lock system: category 1/2/3 ⁽²⁾

20. Adequate documentation according to Annex 8 was supplied in respect of the following system(s):
..... Yes/No/Not applicable ⁽²⁾

21. The vehicle is equipped with an ESC system: Yes/No

If yes: The ESC system has been tested according to and fulfils the requirements of Annex 9
..... Yes/No

or: The vehicle stability function has been tested according to and fulfils the requirements of Annex 21 to
Regulation No 13 Yes/No

22. The vehicle is/is not 2 fitted with a Brake Assist System meeting the requirements of Part B of Annex 9.
- 22.1. Category of Brake Assist System A/B/C ⁽²⁾
- 22.1.1. For category A systems, define the force threshold at which the ratio between pedal force and brake pressure increases ⁽²⁾;
- 22.1.2. For category B systems, define the brake pedal speed which must be achieved in order to activate the Brake Assist System (e.g. pedal stroke speed (mm/s) during a given time interval) ⁽²⁾;
- 22.1.3. For category C systems, define the input variables affecting the decision to activate the Brake Assist System, the relationship between them and the pedal application required to activate the Brake Assist System for the tests described in Part B of Annex 9 ⁽²⁾.
23. Vehicle submitted for approval on
24. Technical Service responsible for conducting approval
25. Date of report issued by that Service
26. Number of report issued by that Service
27. Approval granted/refused/extended/withdrawn ⁽²⁾
28. Position of approval mark on the vehicle
29. Place
30. Date
31. Signature
32. The summary referred to in paragraph 4.3 of this Regulation is annexed to this communication

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

⁽²⁾ Strike out what does not apply.

APPENDIX 1

List of vehicle data for the purpose of Regulation No 90 approvals

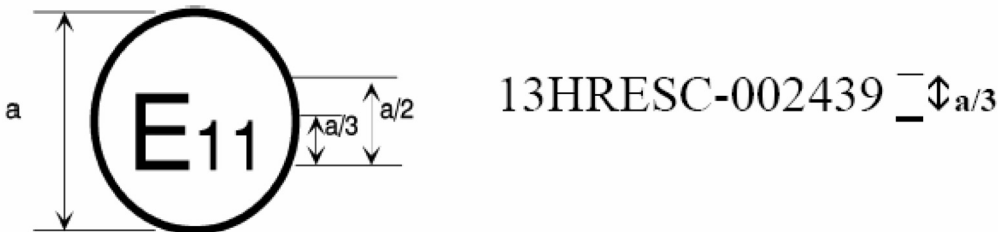
1. Description of the vehicle type
 - 1.1. Trade name or mark of the vehicle, if available
 - 1.2. Vehicle category
 - 1.3. Vehicle type according to Regulation No 13-H approval
 - 1.4. Models or trade names of vehicles constituting the vehicle type, if available
.....
 - 1.5. Manufacturer's name and address
 2. Make and type of brake linings
 - 2.1. Brake linings tested to all relevant prescriptions of Annex 3
 - 2.2. Brake linings tested to Annex
 3. Minimum mass of vehicle
 - 3.1. Distribution of mass of each axle (maximum value)
 4. Maximum mass of vehicle
 - 4.1. Distribution of mass of each axle (maximum value)
 5. Maximum vehicle speed
 6. Tyre and wheel dimensions
 7. Brake circuit configuration (e.g. front/rear or diagonal split)
 8. Declaration of which is the secondary braking system
 9. Specifications of brake valves (if applicable)
 - 9.1. Adjustment specifications of the load sensing valve
 - 9.2. Setting of pressure valve
 10. Designed brake force distribution
 11. Specification of brake
 - 11.1. Disc brake type (e.g. number of pistons with diameter(s), ventilated or solid disc)
.....
 - 11.2. Drum brake type (e.g. duo servo, with piston size and drum dimensions)
.....
 - 11.3. In case of compressed air brake systems, e.g. type and size of chambers, levers, etc.
.....
 12. Master cylinder type and size
 13. Booster type and size
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ANNEX 2

ARRANGEMENTS OF APPROVAL MARKS

MODEL A

(See paragraph 4.4 of this Regulation)

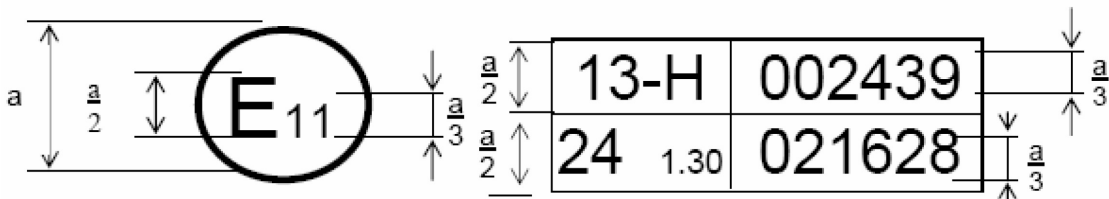


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to braking, been approved in the United Kingdom (E11) pursuant to Regulation No 13-H 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 13-H in its original form. The additional marking 'ESC' indicates that the vehicle meets the Electronic Stability Control and Brake Assist System requirements of Annex 9 to this Regulation.

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 United Kingdom (E11) pursuant to Regulations No 13-H and No 24 ⁽¹⁾. (In the case of the latter Regulation the corrected absorption coefficient is 1,30 m⁻¹). The approval numbers indicate that, at the dates when the respective approvals were given, Regulation No 13-H was in its original form and Regulation No 24 included the 02 series of amendments.

⁽¹⁾ This number is given merely as an example.

ANNEX 3

BRAKING TESTS AND PERFORMANCE OF BRAKING SYSTEMS

1. BRAKING TESTS

1.1. General

1.1.1. The performance prescribed for braking systems is based on the stopping distance and the mean fully developed deceleration. The performance of a braking system shall be determined by measuring the stopping distance in relation to the initial speed of the vehicle and/or by measuring the mean fully developed deceleration during the test.

1.1.2. The stopping distance shall be the distance covered by the vehicle from the moment when the driver begins to actuate the control of the braking system until the moment when the vehicle stops; the initial speed shall be the speed at the moment when the driver begins to actuate the control of the braking system; the initial speed shall not be less than 98 per cent of the prescribed speed for the test in question.

The mean fully developed deceleration (d_m) shall be calculated as the deceleration averaged with respect to distance over the interval v_b to v_e , according to the following formula:

$$d_m = \frac{v_b^2 - v_e^2}{25,92 (s_e - s_b)}$$

where:

v_o = initial vehicle speed in km/h,

v_b = vehicle speed at 0,8 v_o in km/h,

v_e = vehicle speed at 0,1 v_o in km/h,

s_b = distance travelled between v_o and v_b in metres,

s_e = distance travelled between v_o and v_e in metres.

The speed and distance shall be determined using instrumentation having an accuracy of ± 1 per cent at the prescribed speed for the test. The d_m may be determined by other methods than the measurement of speed and distance; in this case, the accuracy of the d_m shall be within ± 3 per cent.

1.2. For the approval of any vehicle, the braking performance shall be measured during road tests conducted in the following conditions:

1.2.1. The vehicle's condition as regards mass must be as prescribed for each type of test and be specified in the test report;

1.2.2. The test must be carried out at the speeds prescribed for each type of test; if the maximum design speed of a vehicle is lower than the speed prescribed for a test, the test shall be performed at the vehicle's maximum speed;

1.2.3. During the tests, the force applied to the brake control in order to obtain the prescribed performance must not exceed the maximum force laid down;

1.2.4. The road must have a surface affording good adhesion, unless specified otherwise in the relevant annexes;

1.2.5. The tests must be performed when there is no wind liable to affect the results;

1.2.6. At the start of the tests, the tyres must be cold and at the pressure prescribed for the load actually borne by the wheels when the vehicle is stationary;

- 1.2.7. The prescribed performance must be obtained without locking of the wheels at speeds exceeding 15 km/h, without deviation of the vehicle from a 3,5 m wide lane, without exceeding a yaw angle of 15° and without abnormal vibrations;
- 1.2.8. For vehicles powered completely or partially by an electric motor (or motors), permanently connected to the wheels, all tests must be carried out with these motor(s) connected;
- 1.2.9. For vehicles as described in paragraph 1.2.8 above, fitted with an electric regenerative braking system of category A, behaviour tests defined in paragraph 1.4.3.1 of this annex shall be carried out on a track with a low adhesion coefficient (as defined in paragraph 5.2.2 of Annex 6);
 - 1.2.9.1. Moreover, for vehicles fitted with an electric regenerative braking system of category A, transient conditions as gear changes or accelerator control release must not affect the behaviour of the vehicle in condition described in paragraph 1.2.9;
- 1.2.10. In the tests provided in paragraphs 1.2.9 and 1.2.9.1 wheel locking is not allowed. However, steering correction is permitted if the angular rotation of the steering control is within 120° during the initial 2 seconds and not more than 240° in all;
- 1.2.11. For a vehicle with electrically actuated service brakes powered from traction batteries (or an auxiliary battery) which receive(s) energy only from an independent external charging system, these batteries shall, during braking performance testing, be at an average of not more than 5 per cent above that state of charge at which the brake failure warning prescribed in paragraph 5.2.20.5 is required to be given.

If this warning is given, the batteries may receive some recharge during the tests, to keep them in the required state of charge range.

- 1.3. Behaviour of the vehicle during braking
 - 1.3.1. In braking tests, and in particular in those at high speed, the general behaviour of the vehicle during braking must be checked.
 - 1.3.2. Behaviour of the vehicle during braking on a road on which adhesion is reduced must meet the relevant requirements of Annex 5 and/or Annex 6 to this Regulation.
 - 1.3.2.1. In the case of a braking system according to paragraph 5.2.7 where the braking for a particular axle (or axles) is comprised of more than one source of braking torque, and any individual source can be varied with respect to the other(s), the vehicle shall satisfy the requirements of Annex 5, or alternatively, Annex 6 under all relationships permitted by its control strategy ⁽¹⁾.
- 1.4. Type-0 test (ordinary performance test with cold brakes)
 - 1.4.1. General
 - 1.4.1.1. The average temperature of the service brakes on the hottest axle of the vehicle, measured inside the brake linings or on the braking path of the disc or drum, is between 65 and 100 °C prior to any brake application.
 - 1.4.1.2. The test must be conducted in the following conditions:
 - 1.4.1.2.1. the vehicle must be laden, the distribution of its mass among the axles being that stated by the manufacturer; where provision is made for several arrangements of the load on the axles the distribution of the maximum mass among the axles must be such that the mass on each axle is proportional to the maximum permissible mass for each axle;

⁽¹⁾ The manufacturer shall provide the Technical Service with the family of braking curves permitted by the automatic control strategy. These curves may be verified by the Technical Service.

1.4.1.2.2. every test must be repeated on the unladen vehicle; there may be, in addition to the driver, a second person on the front seat who is responsible for noting the results of the test;

1.4.1.2.3. in the case of a vehicle equipped with an electric regenerative braking system, the requirements depend on the category of this system:

Category A. Any separate electric regenerative braking control which is provided, shall not be used during the Type-0 tests.

Category B. The contribution of the electric regenerative braking system to the braking force generated shall not exceed that minimum level guaranteed by the system design.

This condition is deemed to be satisfied if the state of charge of the batteries is in one of the following conditions:

- (a) at the maximum charge level recommended by the manufacturer, as listed in the vehicle specification,
- (b) at a level not less than 95 per cent of the full charge level, where the manufacturer has made no specific recommendation,
- (c) at a maximum level resulting from automatic charge control on the vehicle.

1.4.1.2.4. the limits prescribed for minimum performance, both for tests with the vehicle unladen and for tests with the vehicle laden, shall be those laid down hereunder; the vehicle must satisfy both the prescribed stopping distance and the prescribed mean fully developed deceleration, but it may not be necessary to actually measure both parameters;

1.4.1.2.5. the road must be level; unless otherwise specified each test may comprise up to six stops including any needed for familiarization.

1.4.2. Type-0 test with engine disconnected, service braking in accordance with paragraph 2.1.1(A) of this annex.

The test must be carried out at the speed prescribed, the figures prescribed in this connection being subject to a certain margin of tolerance. The minimum performance prescribed must be attained.

1.4.3. Type-0 test with engine connected, service braking in accordance with paragraph 2.1.1(B) of this annex.

1.4.3.1. The test shall be carried out with the engine connected, from the speed prescribed in paragraph 2.1.1(B) of this annex. The minimum performance prescribed shall be attained. This test is not run if the maximum speed of the vehicle is ≤ 125 km/h.

1.4.3.2. The maximum practical performance figures shall be measured, and the behaviour of the vehicle shall be in accordance with paragraph 1.3.2 of this annex. However, if the maximum speed of the vehicle is greater than 200 km/h, the test speed shall be 160 km/h.

1.5. Type-I test (fade and recovery test)

1.5.1. Heating procedure

- 1.5.1.1. The service brakes of all vehicles must be tested by successively applying and releasing the brakes a number of times, the vehicle being laden, in the conditions shown in the table below:

Conditions			
v_1 (km/h)	v_2 (km/h)	Δt (sec)	n
80 % $v_{\max}$ ≤ 120	0,5 v_1	45	15

where:

v_1 = initial speed, at beginning of braking

v_2 = speed at end of braking

$v_{\max}$ = maximum speed of the vehicle

n = number of brake applications

Δt = duration of a braking cycle: time elapsing between the initiation of one brake application and the initiation of the next.

- 1.5.1.2. If the characteristics of the vehicle make it impossible to abide by the duration prescribed for Δt , the duration may be increased; in any event, in addition to the time necessary for braking and accelerating the vehicle, a period of 10 seconds must be allowed in each cycle for stabilizing the speed v_1 .
- 1.5.1.3. In these tests, the force applied to the control must be so adjusted as to attain a mean deceleration of 3 m/s² during every brake application; two preliminary tests may be carried out to determine the appropriate control force.
- 1.5.1.4. During brake applications, the highest gear ratio (excluding overdrive, etc.) must be continuously engaged.
- 1.5.1.5. For regaining speed after braking, the gearbox must be used in such a way as to attain the speed v_1 in the shortest possible time (maximum acceleration allowed by the engine and gearbox).
- 1.5.1.6. For vehicles not having sufficient autonomy to carry out the cycles of heating of the brakes, the tests shall be carried out by achieving the prescribed speed before the first braking application and thereafter by using the maximum acceleration available to regain speed and then braking successively at the speed reached at the end of each 45 second cycle duration.
- 1.5.1.7. For vehicles equipped with an electric regenerative braking system of category B, the condition of the vehicle batteries at the start of the test, shall be such that the braking force contribution provided by the electric regenerative braking system does not exceed the minimum guaranteed by the system design. This requirement is deemed to be satisfied if the batteries are at one of the state of charge conditions as listed in paragraph 1.4.1.2.3 above.
- 1.5.2. Hot performance
- 1.5.2.1. At the end of the Type-I test (described in paragraph 1.5.1 of this annex) the hot performance of the service braking system must be measured in the same conditions (and in particular at a mean control force no greater than the mean force actually used) as for the Type-0 test with the engine disconnected (the temperature conditions may be different).
- 1.5.2.2. This hot performance must not be less than 75 ⁽¹⁾ per cent of that prescribed, nor less than 60 per cent of the figure recorded in the Type-0 test with the engine disconnected.
- 1.5.2.3. For vehicles fitted with an electric regenerative braking system of category A, during brake applications, the highest gear must be continuously engaged and the separate electric braking control, if any, not used.

⁽¹⁾ This corresponds to a stopping distance of $0,1 v + 0,0080 v^2$ and a mean fully developed deceleration of 4,82 m/s².

- 1.5.2.4. In the case of vehicles equipped with an electric regenerative braking system of category B, having carried out the heating cycles according to paragraph 1.5.1.6 of this annex, the hot performance test shall be carried out at the maximum speed which can be reached by the vehicle at the end of the brake heating cycles, unless the speed specified in paragraph 2.1.1(A) of this annex can be reached.

For comparison, a later Type-0 test with cold brakes shall be repeated from this same speed and with a similar electric regenerative braking contribution, as set by an appropriate state of battery charge, as was available during the hot performance test.

Following the recovery process and test, further reconditioning of the linings shall be permitted before the test is made to compare this second cold performance with that achieved in the hot test, against the criteria of paragraphs 1.5.2.2 or 1.5.2.5 of this annex.

- 1.5.2.5. In the case of a vehicle which satisfies the 60 per cent requirement specified in paragraph 1.5.2.2 of this annex, but which cannot comply with the 75 ⁽¹⁾ per cent requirement of paragraph 1.5.2.2 of this annex, a further hot performance test may be carried out using a control force not exceeding that specified in paragraph 2 of this annex. The results of both tests shall be entered in the report.

1.5.3. Recovery procedure

Immediately after the hot performance test, make four stops from 50 km/h with the engine connected, at a mean deceleration of 3 m/s². Allow an interval of 1,5 km between the start of successive stops. Immediately after each stop, accelerate at maximum rate to 50 km/h and maintain that speed until making the next stop.

- 1.5.3.1. Vehicles equipped with an electrical regenerative braking system of category B may have their batteries re-charged or replaced by a charged set, in order to complete the recovery procedure.

1.5.4. Recovery performance

At the end of the recovery procedure, the recovery performance of the service braking system must be measured in the same conditions as for the Type-0 test with the engine disconnected (the temperature conditions may be different), using a mean force on the control, which is not more than the mean control force used in the corresponding Type-0 test.

This recovery performance must not be less than 70 per cent, nor more than 150 per cent, of the figure recorded in the Type-0 test with the engine disconnected.

- 1.5.4.1. For vehicles equipped with an electrical regenerative braking system of category B, the recovery test shall be made with no regenerative braking component, i.e. under the conditions of paragraph 1.5.4 above.

After the further reconditioning of the linings, a second repeat Type-0 test shall be made from the same speed and with no electric regenerative braking contribution as in the recovery test with the engine/motors disconnected, and comparison shall be made between these test results.

The recovery performance must not be less than 70 per cent, nor more than 150 per cent of the figure recorded in this final repeat Type-0 test.

2. PERFORMANCE OF BRAKING SYSTEMS

2.1. Service braking system

- 2.1.1. The service brakes shall be tested under the conditions shown in the following table:

(A) Type-0 test with engine disconnected	v $s \leq$ $d_m \geq$	100 km/h $0,1 v + 0,0060 v^2$ (m) 6,43 m/s ²
(B) Type-0 test with engine connected	v $s \leq$ $d_m \geq$	80 % $v_{max} \leq 160$ km/h $0,1 v + 0,0067 v^2$ (m) 5,76 m/s ²
	f	6,5 – 50 daN

⁽¹⁾ This corresponds to a stopping distance of $0,1 v + 0,0080 v^2$ and a mean fully developed deceleration of 4,82 m/s².

where:

v = test speed, in km/h

s = stopping distance, in metres

d_m = mean fully developed deceleration, in m/s^2

f = force applied to foot control, in daN

v_{max} = maximum speed of the vehicle, in km/h

- 2.1.2. In the case of a motor vehicle authorized to tow an unbraked trailer, the minimum Type-0 performance of the combination shall not be less than $5,4 m/s^2$ in both the laden and unladen conditions.

The combination performance shall be verified by calculations referring to the maximum braking performance actually achieved by the motor vehicle alone (laden) during the Type-0 test with the engine disconnected, using the following formula (no practical tests with a coupled unbraked trailer are required):

$$d_{M+R} = d_M \cdot \frac{P_M}{P_M + P_R}$$

where:

d_{M+R} = calculated mean fully developed deceleration of the motor vehicle when coupled to an unbraked trailer, in m/s^2

d_M = maximum mean fully developed deceleration of the motor vehicle alone achieved during the Type-0 test with engine disconnected, in m/s^2

P_M = mass of the motor vehicle (laden)

P_R = maximum mass of an unbraked trailer which may be coupled, as declared by the motor vehicle manufacturer.

- 2.2. Secondary braking system

- 2.2.1. The performance of the secondary braking system shall be tested by the Type-0 test with the engine disconnected from an initial vehicle speed of 100 km/h and a force applied to the service brake control not less than 6,5 daN and not exceeding 50 daN.

- 2.2.2. The secondary braking system must give a stopping distance not exceeding the following value:

$$0,1 v + 0,0158 v^2 \text{ (m)}$$

and a mean fully developed deceleration not less than $2,44 m/s^2$ (corresponding to the second term of the above formula).

- 2.2.3. The secondary braking effectiveness test shall be conducted by simulating the actual failure conditions in the service braking system.

- 2.2.4. For vehicles employing electric regenerative braking systems, the braking performance shall additionally be checked under the two following failure conditions:

- 2.2.4.1. For a total failure of the electric component of the service braking output.

- 2.2.4.2. In the case where the failure condition causes the electric component to deliver its maximum braking force.
 - 2.3. Parking braking system
 - 2.3.1. The parking braking system must be capable of holding the laden vehicle stationary on a 20 per cent up or down gradient.
 - 2.3.2. On vehicles to which the coupling of a trailer is authorized, the parking braking system of the motor vehicle must be capable of holding the combination of vehicles stationary on a 12 per cent up or down gradient.
 - 2.3.3. If the control device is manual, the force applied to it must not exceed 40 daN.
 - 2.3.4. If it is a foot control device, the force exerted on the control must not exceed 50 daN.
 - 2.3.5. A parking braking system which has to be actuated several times before it attains the prescribed performance is admissible.
 - 2.3.6. To check compliance with the requirement specified in paragraph 5.2.2.4 of this Regulation, a Type-0 test must be carried out, with the engine disconnected, at an initial test speed of 30 km/h. The mean fully developed deceleration on application of the control of the parking brake system and the deceleration immediately before the vehicle stops, shall not be less than 1,5 m/s². The test shall be carried out with the laden vehicle. The force exerted on the braking control device shall not exceed the specified values.
 - 3. RESPONSE TIME
 - 3.1. Where a vehicle is equipped with a service braking system which is totally or partially dependent on a source of energy other than the muscular effort of the driver, the following requirements must be satisfied:
 - 3.1.1. in an emergency manoeuvre, the time elapsing between the moment when the control device begins to be actuated and the moment when the braking force on the least favourable placed axle reaches the level corresponding to the prescribed performance must not exceed 0,6 seconds;
 - 3.1.2. in the case of vehicles fitted with hydraulic braking systems, the requirements of paragraph 3.1.1 above are considered to be satisfied if, in an emergency manoeuvre, the deceleration of the vehicle or the pressure at the least favourable brake cylinder, reaches a level corresponding to the prescribed performance within 0,6 seconds.
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APPENDIX

PROCEDURE FOR MONITORING THE STATE OF BATTERY CHARGE

This procedure is applicable to vehicle batteries used for traction and regenerative braking.

The procedure requires the use of a bi-directional DC Watt-hour meter.

1. PROCEDURE

- 1.1. If the batteries are new or have been subject to extended storage, they shall be cycled as recommended by the manufacturer. A minimum 8-hour soak period at ambient temperature shall be allowed after completion of cycling.
 - 1.2. A full charge shall be established using the manufacturer's recommended charging procedure.
 - 1.3. When the braking tests of paragraphs 1.2.11, 1.4.1.2.3, 1.5.1.6, 1.5.1.7 and 1.5.2.4 of Annex 3 are conducted the watt-hours consumed by the traction motors and supplied by the regenerative braking system shall be recorded as a running total which shall then be used to determine the state of charge existing at the beginning or end of a particular test.
 - 1.4. To replicate a level of state of charge in the batteries for comparative tests, such as those of paragraph 1.5.2.4, the batteries shall be either recharged to that level or charged to above that level and discharged into a fixed load at approximately constant power until the required state of charge is reached. Alternatively, for vehicles with battery powered electric traction only, the state of charge may be adjusted by running the vehicle. Tests conducted with a battery partially charged at their start shall be commenced as soon as possible after the desired state of charge has been reached.
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ANNEX 4

Provisions relating to energy sources and energy storage devices (energy accumulators)**Hydraulic braking systems with stored energy**

1. CAPACITY OF ENERGY STORAGE DEVICES (ENERGY ACCUMULATORS)
 - 1.1. General
 - 1.1.1. Vehicles on which the braking equipment requires the use of stored energy provided by hydraulic fluid under pressure shall be equipped with energy storage devices (energy accumulators) of a capacity meeting the requirements of paragraphs 1.2 or 1.3 of this annex;
 - 1.1.2. However, the energy storage devices shall not be required to be of a prescribed capacity if the braking system is such that in the absence of any energy reserve it is possible with the service brake control to achieve a braking performance at least equal to that prescribed for the secondary braking system;
 - 1.1.3. In verifying compliance with the requirements of paragraphs 1.2, 1.3 and 2.1 of this annex, the brakes shall be adjusted as closely as possible and, for paragraph 1.2 of this annex, the rate of full-stroke actuations must be such as to provide an interval of at least 60 seconds between each actuation.
 - 1.2. Vehicles equipped with a hydraulic braking system with stored energy shall meet the following requirements:
 - 1.2.1. After eight full-stroke actuations of the service brake control, it shall still be possible to achieve, on the ninth application, the performance prescribed for the secondary braking system.
 - 1.2.2. Testing shall be performed in conformity with the following requirements:
 - 1.2.2.1. Testing shall commence at a pressure that may be specified by the manufacturer but is not higher than the cut-in pressure ⁽¹⁾;
 - 1.2.2.2. The energy storage device(s) shall not be fed; in addition, any energy storage device(s) for auxiliary equipment shall be isolated.
 - 1.3. Vehicles equipped with a hydraulic braking system with stored energy which cannot meet the requirements of paragraph 5.2.4.1 of this Regulation shall be deemed to satisfy that paragraph if the following requirements are met:
 - 1.3.1. After any single transmission failure it shall still be possible after eight full-stroke actuations of the service brake control, to achieve, at the ninth application, at least the performance prescribed for the secondary braking system.
 - 1.3.2. Testing shall be performed in conformity with the following requirements:
 - 1.3.2.1. With the energy source stationary or operating at a speed corresponding to the engine idling speed, any transmission failure may be induced. Before inducing such a failure, the energy storage device(s) shall be at a pressure that may be specified by the manufacturer but not exceeding the cut-in pressure;
 - 1.3.2.2. The auxiliary equipment and its energy storage devices, if any, shall be isolated.
2. CAPACITY OF HYDRAULIC FLUID ENERGY SOURCES
 - 2.1. The energy sources shall meet the requirements set out in the following paragraphs.

⁽¹⁾ The initial energy level shall be stated in the approval document.

2.1.1. Definitions

2.1.1.1. 'p₁' represents the maximum system operational pressure (cut-out pressure) in the energy storage device(s) specified by the manufacturer.

2.1.1.2. 'p₂' represents the pressure after four full-stroke actuations with the service brake control, starting at p₁, without having fed the energy storage device(s).

2.1.1.3. 't' represents the time required for the pressure to rise from p₂ to p₁ in the energy storage device(s) without application of the brake control.

2.1.2. Conditions of measurement

2.1.2.1. During the tests to determine the time t, the feed rate of the energy source shall be that obtained when the engine is running at the speed corresponding to its maximum power or at the speed allowed by the over-speed governor.

2.1.2.2. During the test to determine the time t, energy storage device(s) for auxiliary equipment shall not be isolated other than automatically.

2.1.3. Interpretation of results

2.1.3.1. In the case of all vehicles, the time t shall not exceed 20 seconds.

3. CHARACTERISTICS OF WARNING DEVICES

With the engine stationary and commencing at a pressure that may be specified by the manufacturer but does not exceed the cut-in pressure, the warning device shall not operate following two full-stroke actuations of the service brake control.

ANNEX 5

DISTRIBUTION OF BRAKING AMONG THE AXLES OF VEHICLES

1. GENERAL

Vehicles which are not equipped with an anti-lock system as defined in Annex 6 to this Regulation shall meet all the requirements of this annex. If a special device is used, this must operate automatically.

2. SYMBOLS

I = axle index ($i = 1$, front axle;

$i = 2$, rear axle)

P_i = normal reaction of road surface on axle i under static conditions

N_i = normal reaction of road surface on axle i under braking

T_i = force exerted by the brakes on axle i under normal braking conditions on the road

$f_i = T_i/N_i$, adhesion utilized by axle i ⁽¹⁾

J = deceleration of the vehicle

g = acceleration due to gravity: $g = 9,81 \text{ m/s}^2$

z = braking rate of vehicle = J/g

P = mass of vehicle

h = height of centre of gravity specified by the manufacturer and agreed by the Technical Services conducting the approval test

E = wheelbase

k = theoretical coefficient of adhesion between tyre and road

3. REQUIREMENTS

3.1.(A) For all states of load of the vehicle, the adhesion utilization curve of the rear axle shall not be situated above that for the front axle ⁽²⁾:

for all braking rates between 0,15 and 0,8:

3.1.(B) For k values between 0,2 and 0,8 ⁽²⁾:

$z \geq 0,1 + 0,7 (k - 0,2)$ (see diagram 1 of this annex)

3.2. In order to verify the requirements of paragraph 3.1 of this annex, the manufacturer shall provide the adhesion utilization curves for the front and rear axles calculated by the formulae:

⁽¹⁾ 'Adhesion utilisation curves' of a vehicle means curves showing, for specified load conditions, the adhesion utilized by each axle i plotted against the braking rate of the vehicle.

⁽²⁾ The provisions of paragraph 3.1 do not affect the requirements of Annex 3 to this Regulation relating to the braking performance. However, if, in tests made under the provisions of paragraph 3.1., braking performances are obtained which are higher than those prescribed in Annex 3, the provisions relating to the adhesion utilization curves shall be applied within the areas of diagram 1 of this annex defined by the straight lines $k = 0,8$ and $z = 0,8$.

$$f_1 = \frac{T_1}{N_1} = \frac{T_1}{P_1 + z \cdot \frac{h}{E} \cdot P \cdot g}$$

$$f_2 = \frac{T_2}{N_2} = \frac{T_2}{P_2 - z \cdot \frac{h}{E} \cdot P \cdot g}$$

The curves shall be plotted for both the following load conditions:

- 3.2.1. unladen, in running order with the driver on board;
- 3.2.2. laden; where provision is made for several possibilities of load distribution, the one whereby the front axle is the most heavily laden shall be the one considered;
- 3.2.3. for vehicles fitted with an electric regenerative braking system of category B, where the electric regenerative braking capacity is influenced by the electric state of charge, the curves shall be plotted by taking account of the electric braking component under the minimal and maximum conditions of delivered braking force. This requirement is not applicable if the vehicle is equipped with an anti-lock device which controls the wheels connected to the electric braking then the requirements of Annex 6 to this Regulation shall apply.

4. REQUIREMENTS TO BE MET IN CASE OF FAILURE OF THE BRAKING DISTRIBUTION SYSTEM

When the requirements of this annex are fulfilled by means of a special device (e.g. controlled mechanically by the suspension of the vehicle), it shall be possible, in the event of the failure of its control, (e.g. by disconnecting the control linkage), to stop the vehicle under the conditions of the Type-0 test with the engine disconnected to give a stopping distance not exceeding $0,1 v + 0,0100 v^2$ (m) and a mean fully developed deceleration not less than $3,86 \text{ m/s}^2$.

5. VEHICLE TESTING

During the type-approval testing of a vehicle, the technical inspection authority shall verify conformity with the requirements contained in the present annex, by carrying out the following tests:

5.1. Wheel-lock sequence test (see Appendix 1)

If the wheel-lock sequence test confirms that the front wheels lock before or simultaneously with the rear wheels, conformity with paragraph 3 of this annex has been verified and testing is complete.

5.2. Additional tests

If the wheel-lock sequence test indicates that the rear wheels lock before the front wheels, then the vehicle:

(a) will be subjected to additional testing, as follows:

(i) additional wheel-lock sequence tests; and/or

(ii) torque wheel tests (see Appendix 2) to determine brake factors to generate adhesion utilization curves; these curves must satisfy the requirements in paragraph 3.1(A) of this annex.

(b) may be refused type-approval.

5.3. The results of the practical tests shall be appended to the type-approval report.

6. CONFORMITY OF PRODUCTION

- 6.1. When checking vehicles for conformity of production, the Technical Services should follow the same procedures as for type-approval.

- 6.2. The requirements shall also be the same as for type-approval, except that in the test described in paragraph 5.2(a)(ii) of this annex, the rear axle curve must lie below the line $z = 0,9 k$ for all braking rates between 0,15 and 0,8 (instead of meeting the requirement in paragraph 3.1(A) (see diagram 2).

DIAGRAM 1

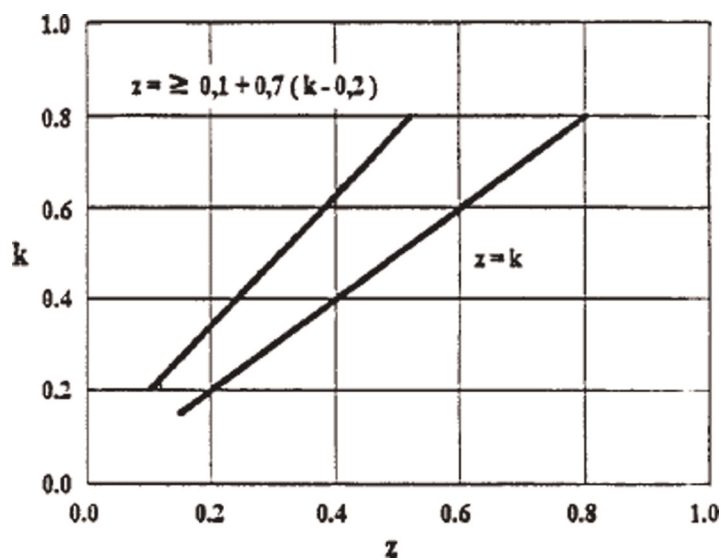
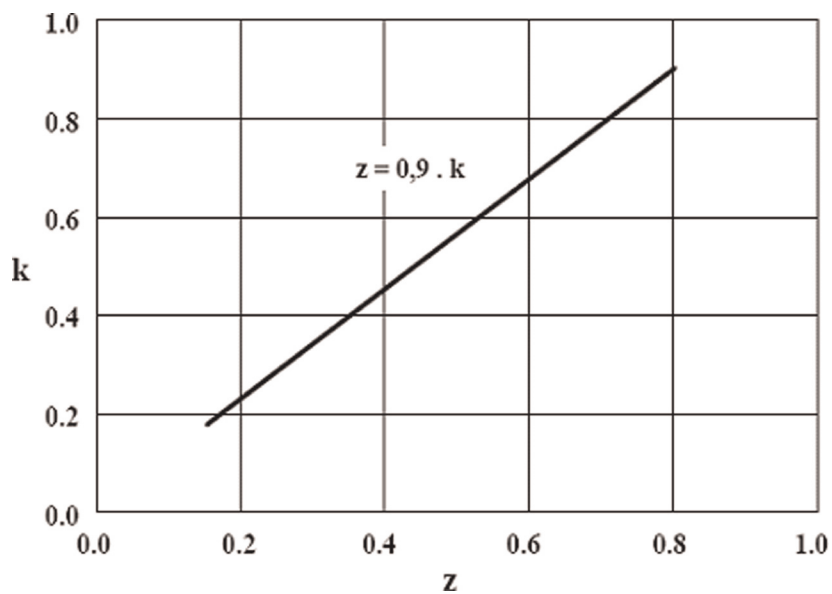


DIAGRAM 2



APPENDIX 1

WHEEL-LOCK SEQUENCE TEST PROCEDURE**1. GENERAL INFORMATION**

- (a) The purpose of this test is to ensure that lockup of both front wheels occurs at a lower deceleration rate than the lockup of both rear wheels when tested on road surfaces on which wheel lockup occurs at braking rates between 0,15 and 0,8.
- (b) A simultaneous lockup of the front and rear wheels refers to the condition when the time interval between the lockup of the last (second) wheel on the rear axle and the last (second) wheel on the front axle is $< 0,1$ seconds for vehicle speeds > 30 km/h.

2. VEHICLE CONDITIONS

- (a) Vehicle load: Laden and unladen
- (b) Transmission position: Engine disconnected

3. TEST CONDITIONS AND PROCEDURES

- (a) Initial brake temperature: Between 65°C and 100°C average on the hottest axle.
- (b) Test speed: 65 km/h for a braking rate $\leq 0,50$;
100 km/h for a braking rate $> 0,50$.
- (c) Pedal force:
 - (i) Pedal force is applied and controlled by a skilled driver or by a mechanical brake pedal actuator.
 - (ii) Pedal force is increased at a linear rate such that the first axle lockup occurs no less than one-half (0,5) second and no more than one and one-half (1,5) seconds after the initial application of the pedal.
 - (iii) The pedal is released when the second axle locks, or when the pedal force reaches 1 kN, or 0,1 seconds after the first lockup, whichever occurs first.
- (d) Wheel lockup: Only wheel lockups above a vehicle speed of 15 km/h are considered.
- (e) Test surface: This test is conducted on road test surfaces on which wheel lockup occurs at braking rates between 0,15 and 0,8.
- (f) Data to be recorded: The following information must be automatically recorded in phase continuously throughout each test run such that values of the variables can be cross referenced in real time:
 - (i) Vehicle speed;
 - (ii) Instantaneous vehicle braking rate (e.g. by differentiation of vehicle speed);
 - (iii) Brake pedal force (or hydraulic line pressure);
 - (iv) Angular velocity at each wheel.
- (g) Each test run shall be repeated once to confirm the wheel lockup sequence: if one of these two results indicates a failure to comply, then a third test run under the same conditions will be decisive.

4. PERFORMANCE REQUIREMENTS

- (a) Both rear wheels shall not reach a locked condition prior to both front wheels being locked – at vehicle braking rates between 0,15 and 0,8.
 - (b) If, when tested to the procedure specified above, and at vehicle braking rates between 0,15 and 0,8 the vehicle meets one of the following criteria, then it passes this wheel lockup sequence requirement:
 - (i) No wheels lock;
 - (ii) Both wheels on the front axle and one or no wheels on the rear axle lock;
 - (iii) Both axles simultaneously lock.
 - (c) If wheel lockup commences at a braking rate less than 0,15 and more than 0,8 then the test is invalid and should be repeated on a different road surface.
 - (d) If, either laden or unladen, at a braking rate between 0,15 and 0,8 both wheels on the rear axle and one or no wheels on the front axle lock, then it fails the wheel lockup sequence test. In this latter case, the vehicle must be submitted to the 'torque wheels' test procedure to determine the objective brake factors for calculation of the adhesion utilization curves.
-

APPENDIX 2

TORQUE WHEEL TEST PROCEDURE**1. GENERAL INFORMATION**

The purpose of this test is to measure the brake factors and thus determine the adhesion utilization of the front and rear axles over a range of braking rates between 0,15 and 0,8.

2. VEHICLE CONDITIONS

- (a) Vehicle load: Laden and unladen
- (b) Transmission position: Engine disconnected

3. TEST CONDITIONS AND PROCEDURES

- (a) Initial brake temperature: Between 65 °C and 100 °C average on the hottest axle.
- (b) Test speeds: 100 km/h and 50 km/h.
- (c) Pedal force: Pedal force is increased at a linear rate between 100 and 150 N/sec for the 100 km/h test speed, or between 100 and 200 N/sec for the 50 km/h test speed, until the first axle locks or until a pedal force of 1 kN is reached, whichever occurs first.
- (d) Brake cooling: Between brake applications, the vehicle is driven at speeds up to 100 km/h until the initial brake temperature specified in paragraph 3(a) above is reached.
- (e) Number of runs: With the vehicle unladen, run five stops from a speed of 100 km/h and five stops from a speed of 50 km/h, while alternating between the two test speeds after each stop. With the vehicle laden, repeat the five stops at each test speed while alternating between the two test speeds.
- (f) Test surface: This test is conducted on a road test surface affording good adhesion.
- (g) Data to be recorded: The following information must be automatically recorded in phase continuously throughout each test run such that values of the variables can be cross referenced in real time:
 - (i) Vehicle speed
 - (ii) Brake pedal force
 - (iii) Angular velocity of each wheel
 - (iv) Brake torque at each wheel
 - (v) Hydraulic line pressure in each brake circuit, including transducers on at least one front wheel and one rear wheel downstream of any operative proportioning or pressure limiting valve(s)
 - (vi) Vehicle deceleration
- (h) Sample rate: All data acquisition and recording equipment shall support a minimum sample rate of 40 Hz on all channels.
- (i) Determination of front versus rear brake pressure: Determine the front versus rear brake pressure relationship over the entire range of line pressures. Unless the vehicle has a variable brake proportioning system, this determination is made by static tests. If the vehicle has a variable brake proportioning system, dynamic tests are run with the vehicle both laden and unladen. Fifteen snubs from 50 km/h are made for each of the two load conditions, using the same initial conditions specified in this appendix.

4. DATA REDUCTION

- (a) The data from each brake application prescribed in paragraph 3(e) above is filtered using a five-point, on-centre moving average for each data channel.
- (b) For each brake application prescribed in paragraph 3(e) above, determine the slope (brake factor) and pressure axis intercept (brake hold-off pressure) of the linear least squares equation best describing the measured torque output at each braked wheel as a function of measured line pressure applied at the same wheel. Only torque output values obtained from data collected when the vehicle deceleration is within the range of 0,15 g to 0,80 g are used in the regression analysis.
- (c) Average the results of paragraph (b) above to calculate the average brake factor and brake hold-off pressure for all brake applications for the front axle.
- (d) Average the results of paragraph (b) above to calculate the average brake factor and brake hold-off pressure for all brake applications for the rear axle.
- (e) Using the relationship between front and rear brake line pressure determined in paragraph 3(i) above and the dynamic tyre rolling radius, calculate the braking force at each axle as a function of front brake line pressure.
- (f) Calculate the braking rate of the vehicle as a function of the front brake line pressure using the following equation:

$$z = \frac{T_1 + T_2}{P \cdot g}$$

where

z = braking rate at a given front brake line pressure

T_1, T_2 = braking forces at the front and rear axles respectively, corresponding to the same front brake line pressure

P = vehicle mass

- (g) Calculate the adhesion utilized at each axle as a function of braking rate using the following formulae:

$$f_1 = \frac{T_1}{P_1 + \frac{z \cdot h \cdot P \cdot g}{E}}$$

$$f_2 = \frac{T_2}{P_2 - \frac{z \cdot h \cdot P \cdot g}{E}}$$

The symbols are defined in paragraph 2 of this annex.

- (h) Plot f_1 and f_2 as a function of z , for both laden and unladen load conditions. These are the adhesion utilization curves for the vehicle, which must satisfy the requirements in paragraph 5.2(a)(ii) of this annex (or, in the case of Conformity of Production checks, these curves must satisfy the requirements in paragraph 6.2 of this annex).

ANNEX 6 (*)

Test requirements for vehicles fitted with anti-lock systems

1. GENERAL

- 1.1. This annex defines the required braking performance for road vehicles fitted with anti-lock systems.
- 1.2. The anti-lock systems known at present comprise a sensor or sensors, a controller or controllers and a modulator or modulators. Any device of a different design which may be introduced in the future, or where an anti-lock braking function is integrated into another system, shall be deemed to be an anti-lock braking system within the meaning of this annex and Annex 5 to this Regulation, if it provides performance equal to that prescribed by this annex.

2. DEFINITIONS

- 2.1. An 'anti-lock system' is a part of a service braking system which automatically controls the degree of slip, in the direction of rotation of the wheel(s), on one or more wheels of the vehicle during braking.
- 2.2. 'Sensor' means a component designed to identify and transmit to the controller the conditions of rotation of the wheel(s) or the dynamic conditions of the vehicle.
- 2.3. 'Controller' means a component designed to evaluate the data transmitted by the sensor(s) and to transmit a signal to the modulator.
- 2.4. 'Modulator' means a component designed to vary the braking force(s) in accordance with the signal received from the controller.
- 2.5. 'Directly controlled wheel' means a wheel whose braking force is modulated according to data provided at least by its own sensor⁽¹⁾.
- 2.6. 'Indirectly controlled wheel' means a wheel whose braking force is modulated according to data provided by the sensor(s) of other wheel(s)⁽¹⁾.
- 2.7. 'Full cycling' means that the anti-lock system is repeatedly modulating the brake force to prevent the directly controlled wheels from locking. Brake applications where modulation only occurs once during the stop shall not be considered to meet this definition.

3. TYPES OF ANTI-LOCK SYSTEMS

- 3.1. A vehicle is deemed to be equipped with an anti-lock system within the meaning of paragraph 1 of Annex 5 to this Regulation, if one of the following systems is fitted:

3.1.1. Category 1 anti-lock system

A vehicle equipped with a category 1 anti-lock system shall meet all the requirements of this annex.

3.1.2. Category 2 anti-lock system

A vehicle equipped with a category 2 anti-lock system shall meet all the requirements of this annex, except those of paragraph 5.3.5.

3.1.3. Category 3 anti-lock system

A vehicle equipped with a category 3 anti-lock system shall meet all the requirements of this annex, except those of paragraphs 5.3.4 and 5.3.5. On such vehicles, any individual axle which does not include at least one directly controlled wheel must fulfil the conditions of adhesion utilization and the wheel-locking sequence of Annex 5 to this Regulation, instead of the adhesion utilization requirements prescribed in paragraph 5.2 of this annex. However, if the relative positions of the adhesion utilization curves do not meet the requirements of paragraph 3.1 of Annex 5 to this Regulation, a check shall be made to ensure that the wheels on at least one of the rear axles do not lock before those of the front axle or axles under the conditions prescribed in paragraph 3.1 of Annex 5 to this Regulation, with regard to the braking rate and the load respectively. These requirements may be checked on high- and low-adhesion road surfaces (about 0,8 and 0,3 maximum) by modulating the service braking control force.

(*) All footnotes to Annex 6 can be found at the end of this annex.

4. GENERAL REQUIREMENTS

- 4.1. Any electrical failure or sensor anomaly that affects the system with respect to the functional and performance requirements in this annex, including those in the supply of electricity, the external wiring to the controller(s), the controller(s) ⁽²⁾ and the modulator(s) shall be signalled to the driver by a specific optical warning signal. The yellow warning signal specified in paragraph 5.2.21.1.2 of this Regulation shall be used for this purpose.
- 4.1.1. Sensor anomalies, which cannot be detected under static conditions, shall be detected not later than when the vehicle speed exceeds 10 km/h ⁽³⁾. However, to prevent erroneous fault indication when a sensor is not generating a vehicle speed output, due to non-rotation of a wheel, verification may be delayed but detected not later than when the vehicle speed exceeds 15 km/h.
- 4.1.2. When the anti-lock braking system is energized with the vehicle stationary, electrically controlled pneumatic modulator valve(s) shall cycle at least once.
- 4.2. In the event of a single electrical functional failure which only affects the anti-lock function, as indicated by the above-mentioned yellow warning signal, the subsequent service braking performance must not be less than 80 per cent of the prescribed performance according to the Type-0 test with the engine disconnected. This corresponds to a stopping distance of $0,1 v + 0,0075 v^2$ (m) and a mean fully developed deceleration of $5,15 \text{ m/s}^2$.
- 4.3. The operation of the anti-lock system must not be adversely affected by magnetic or electrical fields ⁽⁴⁾. (This shall be demonstrated by compliance with Regulation No 10, 02 series of amendments).
- 4.4. A manual device may not be provided to disconnect or change the control mode ⁽⁵⁾ of the anti-lock system.

5. SPECIAL PROVISIONS

5.1. Energy consumption

Vehicles equipped with anti-lock systems must maintain their performance when the service braking control device is fully applied for long periods. Compliance with this requirement shall be verified by means of the following tests:

5.1.1. Test procedure

- 5.1.1.1. The initial energy level in the energy storage device(s) shall be that specified by the manufacturer. This level shall be at least such as to ensure the efficiency prescribed for service braking when the vehicle is laden. The energy storage device(s) for pneumatic auxiliary equipment must be isolated.
- 5.1.1.2. From an initial speed of not less than 50 km/h, on a surface with a coefficient of adhesion of 0,3 ⁽⁶⁾ or less, the brakes of the laden vehicle shall be fully applied for a time t , during which time the energy consumed by the indirectly controlled wheels shall be taken into consideration and all directly controlled wheels must remain under control of the anti-lock system.
- 5.1.1.3. The vehicle's engine shall then be stopped or the supply to the energy transmission storage device(s) cut off.
- 5.1.1.4. The service braking control shall then be fully actuated four times in succession with the vehicle stationary.
- 5.1.1.5. When the brakes are applied for the fifth time, it must be possible to brake the vehicle with at least the performance prescribed for secondary braking of the laden vehicle.
- 5.1.2. Additional requirements
- 5.1.2.1. The coefficient of adhesion of the road surface shall be measured with the vehicle under test, by the method described in paragraph 1.1 of Appendix 2 to this annex.
- 5.1.2.2. The braking test shall be conducted with the engine disconnected and idling, and with the vehicle laden.

5.1.2.3. The braking time t shall be determined by the formula:

$$t = \frac{V_{\max}}{7}$$

(but not less than 15 seconds)

where t is expressed in seconds and $v_{\max}$ represents the maximum design speed of the vehicle expressed in km/h, with an upper limit of 160 km/h.

5.1.2.4. If the time t cannot be completed in a single braking phase, further phases may be used, up to a maximum of four in all.

5.1.2.5. If the test is conducted in several phases, no fresh energy shall be supplied between the phases of the test.

From the second phase, the energy consumption corresponding to the initial brake application may be taken into account, by subtracting one full brake application from the four full applications prescribed in paragraph 5.1.1.4 (and 5.1.1.5 and 5.1.2.6) of this annex for each of the second, third and fourth phases used in the test prescribed in paragraph 5.1.1 of this annex as applicable.

5.1.2.6. The performance prescribed in paragraph 5.1.1.5 of this annex shall be deemed to be satisfied if, at the end of the fourth application, with the vehicle stationary, the energy level in the storage device(s) is at or above that required for secondary braking with the laden vehicle.

5.2. Utilization of adhesion

5.2.1. The utilization of adhesion by the anti-lock system takes into account the actual increase in braking distance beyond the theoretical minimum. The anti-lock system shall be deemed to be satisfactory when the condition $\epsilon \geq 0,75$ is satisfied, where ϵ represents the adhesion utilized, as defined in paragraph 1.2 of Appendix 2 to this annex.

5.2.2. The adhesion utilization ϵ shall be measured on road surfaces with a coefficient of adhesion of 0,3 ⁽⁶⁾ or less, and of about 0,8 (dry road), with an initial speed of 50 km/h. To eliminate the effects of differential brake temperatures it is recommended that z_{AL} be determined prior to the determination of k .

5.2.3. The test procedure to determine the coefficient of adhesion (k) and the formulae for calculation of the adhesion utilization (ϵ) shall be those laid down in Appendix 2 to this annex.

5.2.4. The utilization of adhesion by the anti-lock system shall be checked on complete vehicles equipped with anti-lock systems of categories 1 or 2. In the case of vehicles equipped with category 3 anti-lock systems, only the axle(s) with at least one directly controlled wheel must satisfy this requirement.

5.2.5. The condition $\epsilon \geq 0,75$ shall be checked with the vehicle both laden and unladen ⁽⁷⁾.

The laden test on the high adhesion surface may be omitted if the prescribed force on the control device does not achieve full cycling of the anti-lock system.

For the unladen test, the control force may be increased up to 100 daN if no cycling is achieved with its full force value ⁽⁸⁾. If 100 daN is insufficient to make the system cycle, then this test may be omitted.

5.3. Additional checks

The following additional checks shall be carried out with the engine disconnected, with the vehicle laden and unladen:

5.3.1. The wheels directly controlled by an anti-lock system must not lock when the full force ⁽⁸⁾ is suddenly applied on the control device, on the road surfaces specified in paragraph 5.2.2 of this annex, at an initial speed of $v = 40$ km/h and at a high initial speed $v = 0,8 v_{\max} \leq 120$ km/h ⁽⁹⁾;

- 5.3.2. When an axle passes from a high-adhesion surface (k_H) to a low-adhesion surface (k_L), where $k_H \geq 0,5$ and $k_H/k_L \geq 2$ ⁽¹⁰⁾, with the full force ⁽⁸⁾ applied on the control device, the directly controlled wheels must not lock. The running speed and the instant of applying the brakes shall be so calculated that, with the anti-lock system fully cycling on the high-adhesion surface, the passage from one surface to the other is made at high and at low speed, under the conditions laid down in paragraph 5.3.1 ⁽⁹⁾;
- 5.3.3. When a vehicle passes from a low-adhesion surface (k_L) to a high-adhesion surface (k_H) where $k_H \geq 0,5$ and $k_H/k_L \geq 2$ ⁽¹⁰⁾, with the full force ⁽⁸⁾ applied on the control device, the deceleration of the vehicle must rise to the appropriate high value within a reasonable time and the vehicle must not deviate from its initial course. The running speed and the instant of applying the brake shall be so calculated that, with the anti-lock system fully cycling on the low-adhesion surface, the passage from one surface to the other occurs at approximately 50 km/h;
- 5.3.4. The provisions of this paragraph shall only apply to vehicles equipped with anti-lock systems of categories 1 or 2. When the right and left wheels of the vehicle are situated on surfaces with differing coefficients of adhesion (k_H and k_L), where $k_H \geq 0,5$ and $k_H/k_L \geq 2$ ⁽¹⁰⁾, the directly controlled wheels must not lock when the full force ⁽⁸⁾ is suddenly applied on the control device at a speed of 50 km/h;
- 5.3.5. Furthermore, laden vehicles equipped with anti-lock systems of category 1 shall, under the conditions of paragraph 5.3.4 of this annex satisfy the prescribed braking rate in Appendix 3 to this annex;
- 5.3.6. However, in the tests provided in paragraphs 5.3.1, 5.3.2, 5.3.3, 5.3.4 and 5.3.5 of this annex, brief periods of wheel-locking shall be allowed. Furthermore, wheel-locking is permitted when the vehicle speed is less than 15 km/h; likewise, locking of indirectly controlled wheels is permitted at any speed, but stability and steerability must not be affected and the vehicle must not exceed a yaw angle of 15° or deviate from a 3,5 m wide lane;
- 5.3.7. During the tests provided in paragraphs 5.3.4 and 5.3.5 of this annex, steering correction is permitted, if the angular rotation of the steering control is within 120° during the initial 2 seconds, and not more than 240° in all. Furthermore, at the beginning of these tests the longitudinal median plane of the vehicle must pass over the boundary between the high- and low-adhesion surfaces and during these tests no part of the outer tyres must cross this boundary ⁽⁷⁾.

⁽¹⁾ Anti-lock systems with select-high control are deemed to include both directly and indirectly controlled wheels; in systems with select-low control, all sensed wheels are deemed to be directly controlled wheels.

⁽²⁾ The manufacturer shall provide the Technical Service with documentation relating to the controller(s) which follows the format set out in Annex 8.

⁽³⁾ The warning signal may light up again while the vehicle is stationary, provided that it is extinguished before the vehicle speed reaches 10 km/h or 15 km/h, as appropriate, when no defect is present.

⁽⁴⁾ Until uniform test procedures have been agreed, the manufacturers shall provide the Technical Services with their test procedures and results.

⁽⁵⁾ It is understood that devices changing the control mode of the anti-lock system are not subject to paragraph 4.4 if in the changed control mode condition all requirements to the category of anti-lock systems, with which the vehicle is equipped, are fulfilled.

⁽⁶⁾ Until such test surfaces become generally available, tyres at the limit of wear, and higher values up to 0.4 may be used at the discretion of the Technical Service. The actual value obtained and the type of tyres and surface shall be recorded.

⁽⁷⁾ Until a uniform test procedure is established, the tests required by this paragraph may have to be repeated for vehicles equipped with electrical regenerative braking systems, in order to determine the effect of different braking distribution values provided by automatic functions on the vehicle.

⁽⁸⁾ 'Full force' means the maximum force laid down in Annex 3 to this Regulation; a higher force may be used if required to activate the anti-lock system.

⁽⁹⁾ The purpose of these tests is to check that the wheels do not lock and that the vehicle remains stable; it is not necessary, therefore, to make complete stops and bring the vehicle to a halt on the low-adhesion surface.

⁽¹⁰⁾ k_H is the high-adhesion surface coefficient

k_L is the low-adhesion surface coefficient

k_H and k_L are measured as laid down in Appendix 2 to this annex.

APPENDIX 1

SYMBOLS AND DEFINITIONS

Table

Symbols and definitions

SYMBOL	NOTES
E	wheelbase
ε	the adhesion utilized of the vehicle; quotient of the maximum braking rate with the anti-lock system operative (z_{AL}) and the coefficient of adhesion (k)
ε_i	the ε – value measured on axle i (in the case of a motor vehicle with a category 3 anti-lock system)
ε_H	the ε – value on the high-adhesion surface
ε_L	the ε – value on the low-adhesion surface
F	force (N)
F_{dyn}	normal reaction of road surface under dynamic conditions with the anti-lock system operative
F_{idyn}	F_{dyn} on axle i in case of power-driven vehicles
F_i	normal reaction of road surface on axle i under static conditions
F_M	total normal static reaction of road surface on all wheels of power-driven vehicle
$F_{Mnd} (*)$	total normal static reaction of road surface on the unbraked and non-driven axles of the power-driven vehicle
$F_{Md} (*)$	total normal static reaction of road surface on the unbraked and driven axles of the power-driven vehicle
$F_{WM} (*)$	$0,01 F_{Mnd} + 0,015 F_{Md}$
g	acceleration due to gravity ($9,81 \text{ m/s}^2$)
h	height of centre of gravity specified by the manufacturer and agreed by the Technical Service conducting the approval test
k	coefficient of adhesion between tyre and road
k_f	k – factor of one front axle
k_H	k – value determined on the high-adhesion surface
k_i	k – value determined on axle i for a vehicle with a category 3 anti-lock system
k_L	k – value determined on the low-adhesion surface
k_{lock}	value of adhesion for 100 per cent slip
k_M	k – factor of the power-driven vehicle
k_{peak}	maximum value of the curve 'adhesion versus slip'

SYMBOL	NOTES
k_r	k – factor of one rear axle
P	mass of individual vehicle (kg)
R	ratio of k_{peak} to k_{lock}
t	time interval (s)
t_m	mean value of t
t_{min}	minimum value of t
z	braking rate
z_{AL}	braking rate z of the vehicle with the anti-lock system operative
z_m	mean braking rate
z_{max}	maximum value of z
z_{MALS}	z_{AL} of the power-driven vehicle on a 'split surface'
(*) F_{Mnd} and F_{Md} in case of two-axled motor vehicles: these symbols may be simplified to corresponding F_i – symbols.	

APPENDIX 2

UTILIZATION OF ADHESION

1. METHOD OF MEASUREMENT

1.1. Determination of the coefficient of adhesion (k)

1.1.1. The coefficient of adhesion (k) shall be determined as the quotient of the maximum braking forces without locking the wheels and the corresponding dynamic load on the axle being braked.

1.1.2. The brakes shall be applied on only one axle of the vehicle under test, at an initial speed of 50 km/h. The braking forces shall be distributed between the wheels of the axle to reach maximum performance. The anti-lock system shall be disconnected, or inoperative, between 40 km/h and 20 km/h.

1.1.3. A number of tests at increments of line pressure shall be carried out to determine the maximum braking rate of the vehicle ($z_{\max}$). During each test, a constant input force shall be maintained and the braking rate will be determined by reference to the time taken (t) for the speed to reduce from 40 km/h to 20 km/h using the formula:

$$z = \frac{0,566}{t}$$

$z_{\max}$ is the maximum value of z; t is in seconds.

1.1.3.1. Wheel lock may occur below 20 km/h.

1.1.3.2. Starting from the minimum measured value of t, called $t_{\min}$, then select three values of t comprised within $t_{\min}$ and $1,05 t_{\min}$ and calculate their arithmetical mean value t_m .

then calculate:

$$Z_m = \frac{0,566}{t_m}$$

If it is demonstrated that for practical reasons the three values defined above cannot be obtained, then the minimum time $t_{\min}$ may be utilized. However, the requirements of paragraph 1.3 shall still apply.

1.1.4. The braking forces shall be calculated from the measured braking rate and the rolling resistance of the unbraked axle which is equal to 0,015 and 0,010 of the static axle load for a driven axle and a non-driven axle, respectively.

1.1.5. The dynamic load on the axle shall be that given by the formulae in Annex 5 to this Regulation.

1.1.6. The value of k shall be rounded to three decimal places.

1.1.7. Then, the test will be repeated for the other axle(s) as defined in paragraphs 1.1.1 to 1.1.6 above.

1.1.8. For example, in the case of a two-axle rear-wheel drive vehicle, with the front axle (1) being braked, the coefficient of adhesion (k) is given by:

$$k_f = \frac{Z_m \cdot P \cdot g - 0,015 F_2}{F_1 + \frac{h}{E} \cdot Z_m \cdot P \cdot g}$$

The other symbols (P, h, E) are defined in Annex 5 to this Regulation.

1.1.9. One coefficient will be determined for the front axle k_f and one for the rear axle k_r .

1.2. Determination of the adhesion utilized (ϵ)

1.2.1. The adhesion utilized (ϵ) is defined as the quotient of the maximum braking rate with the anti-lock system operative (z_{AL}) and the coefficient of adhesion (k_M) i.e.,

$$\epsilon = \frac{Z_{AL}}{K_M}$$

1.2.2. From an initial vehicle speed of 55 km/h, the maximum braking rate (z_{AL}) shall be measured with full cycling of the anti-lock braking system and based on the average value of three tests, as in paragraph 1.1.3 of this appendix, using the time taken for the speed to reduce from 45 km/h to 15 km/h, according to the following formula:

$$Z_{AL} = \frac{0,849}{t_m}$$

1.2.3. The coefficient of adhesion k_M shall be determined by weighting with the dynamic axle loads.

$$k_M = \frac{k_f \cdot F_{fdyn} + K_r \cdot F_{rdyn}}{P \cdot g}$$

where:

$$F_{fdyn} = F_f + \frac{h}{E} \cdot Z_{AL} \cdot P \cdot g$$

$$F_{rdyn} = F_r - \frac{h}{E} \cdot Z_{AL} \cdot P \cdot g$$

1.2.4. The value of ϵ shall be rounded to two decimal places.

1.2.5. In the case of a vehicle equipped with an anti-lock system of categories 1 or 2, the value of z_{AL} will be based on the whole vehicle, with the anti-lock system in operation, and the adhesion utilized (ϵ) is given by the same formula quoted in paragraph 1.2.1 of this appendix.

1.2.6. In the case of a vehicle equipped with an anti-lock system of category 3, the value of z_{AL} will be measured on each axle which has at least one directly controlled wheel. For example, for a two-axle rear-wheel drive vehicle with an anti-lock system acting only on the rear axle (2), the adhesion utilized (ϵ) is given by:

$$\epsilon_2 = \frac{Z_{AL} \cdot P \cdot g - 0,010F_1}{k_2(F_2 - \frac{h}{E} \cdot Z_{AL} \cdot P \cdot g)}$$

This calculation shall be made for each axle having at least one directly controlled wheel.

1.3. If $\epsilon > 1,00$, the measurements of coefficients of adhesion shall be repeated. A tolerance of 10 % is accepted.

APPENDIX 3

PERFORMANCE ON DIFFERING ADHESION SURFACES

1. The prescribed braking rate referred to in paragraph 5.3.5 of this annex may be calculated by reference to the measured coefficient of adhesion of the two surfaces on which this test is carried out. These two surfaces must satisfy the conditions prescribed in paragraph 5.3.4 of this annex.
2. The coefficient of adhesion (k_H and k_L) of the high- and low-adhesion surfaces, respectively, shall be determined in accordance with the provisions in paragraph 1.1 of Appendix 2 to this annex.
3. The braking rate (z_{MALS}) for laden vehicles shall be:

$$Z_{\text{MALS}} \geq 0,75 \left(\frac{4k_L + k_H}{5} \right) \text{ and } Z_{\text{MALS}} \geq k_L$$

APPENDIX 4

METHOD OF SELECTION OF THE LOW ADHESION SURFACE

1. Details of the coefficient of adhesion of the surface selected, as defined in paragraph 5.1.1.2 of this annex, must be given to the Technical Service.
- 1.1. These data must include a curve of the coefficient of adhesion versus slip (from 0 to 100 per cent slip) for a speed of approximately 40 km/h.
- 1.1.1. The maximum value of the curve will represent k_{peak} and the value at 100 per cent slip will represent k_{lock} .
- 1.1.2. The ratio R shall be determined as the quotient of the k_{peak} and k_{lock} .

$$R = \frac{k_{\text{peak}}}{k_{\text{lock}}}$$

- 1.1.3. The value of R shall be rounded to one decimal place.
- 1.1.4. The surface to be used must have a ratio R between 1,0 and 2,0 ⁽¹⁾.
2. Prior to the tests, the Technical Service shall ensure that the selected surface meets the specified requirements and shall be informed of the following:
 - test method to determine R,
 - type of vehicle,
 - axle load and tyres (different loads and different tyres have to be tested and the results shown to the Technical Service which will decide if they are representative for the vehicle to be approved).
- 2.1. The value of R shall be mentioned in the test report.

The calibration of the surface has to be carried out at least once a year with a representative vehicle to verify the stability of R.

⁽¹⁾ Until such test surfaces become generally available, a ratio R up to 2,5 is acceptable, subject to discussion with the Technical Service.

ANNEX 7

INERTIA DYNAMOMETER TEST METHOD FOR BRAKE LININGS**1. GENERAL**

- 1.1. The procedure described in this annex may be applied in the event of a modification of vehicle type resulting from the fitting of brake linings of another type to vehicles which have been approved in accordance with this Regulation.
- 1.2. The alternative types of brake linings shall be checked by comparing their performance with that obtained from the brake linings with which the vehicle was equipped at the time of approval and conforming to the components identified in the relevant information document, a model of which is given in Annex 1 to this Regulation.
- 1.3. The Technical Authority responsible for conducting approval tests may at its discretion require comparison of the performance of the brake linings to be carried out in accordance with the relevant provisions contained in Annex 3 to this Regulation.
- 1.4. Application for approval by comparison shall be made by the vehicle manufacturer or by his duly accredited representative.
- 1.5. In the context of this annex 'vehicle' shall mean the vehicle type approved according to this Regulation and for which it is requested that the comparison shall be considered satisfactory.

2. TEST EQUIPMENT

- 2.1. A dynamometer having the following characteristics shall be used for the tests:
 - 2.1.1. it shall be capable of generating the inertia required by paragraph 3.1 of this annex, and have the capacity to meet the requirements prescribed by paragraph 1.5 of Annex 3 to this Regulation with respect to the Type-I fade test;
 - 2.1.2. the brakes fitted shall be identical with those of the original vehicle type concerned;
 - 2.1.3. air cooling, if provided, shall be in accordance with paragraph 3.4 of this annex;
 - 2.1.4. the instrumentation for the test shall be capable of providing at least the following data:
 - 2.1.4.1. a continuous recording of disc or drum rotational speed;
 - 2.1.4.2. number of revolutions completed during a stop, to resolution not greater than one eighth of a revolution;
 - 2.1.4.3. stop time;
 - 2.1.4.4. a continuous recording of the temperature measured in the centre of the path swept by the lining or at mid-thickness of the disc or drum or lining;
 - 2.1.4.5. a continuous recording of brake application control line pressure or force;
 - 2.1.4.6. a continuous recording of brake output torque.

3. TEST CONDITIONS

- 3.1. The dynamometer shall be set as close as possible, with ± 5 per cent tolerance, to the rotary inertia equivalent to that part of the total inertia of the vehicle braked by the appropriate wheel(s) according to the following formula:

$$I = M R^2$$

where:

I = rotational inertia (kgm^2)

R = dynamic tyre rolling radius (m)

M = that part of the maximum mass of the vehicle braked by the appropriate wheel(s). In the case of a single-ended dynamometer, this part shall be calculated from the design braking distribution when deceleration corresponds to the appropriate value given in paragraph 2.1.1(A) of Annex 3 to this Regulation.

- 3.2. The initial rotational speed of the inertia dynamometer shall correspond to the linear speed of the vehicle as prescribed in paragraph 2.1.1(A) of Annex 3 to this Regulation and shall be based on the dynamic rolling radius of the tyre.
- 3.3. Brake linings shall be at least 80 per cent bedded and shall not have exceeded a temperature of 180 °C during the bedding procedure, or alternatively, at the vehicle manufacturer's request, be bedded in accordance with his recommendations.
- 3.4. Cooling air may be used, flowing over the brake in a direction perpendicular to its axis of rotation. The velocity of the cooling air flowing over the brake shall be not greater than 10 km/h. The temperature of the cooling air shall be the ambient temperature.

4. TEST PROCEDURE

- 4.1. Five sample sets of the brake lining shall be subjected to the comparison test; they shall be compared with five sets of linings conforming to the original components identified in the information document concerning the first approval of the vehicle type concerned.
- 4.2. Brake lining equivalence shall be based on a comparison of the results achieved using the test procedures prescribed in this annex and in accordance with the following requirements.
- 4.3. Type-0 cold performance test
- 4.3.1. Three brake applications shall be made when the initial temperature is below 100 °C. The temperature shall be measured in accordance with the provisions of paragraph 2.1.4.4 of this annex.
- 4.3.2. Brake applications shall be made from an initial rotational speed equivalent to that given in paragraph 2.1.1(A) of Annex 3 to this Regulation, and the brake shall be applied to achieve a mean torque equivalent to the deceleration prescribed in that paragraph. In addition, tests shall also be carried out at several rotational speeds, the lowest being equivalent to 30 per cent of the maximum speed of the vehicle and the highest being equivalent to 80 per cent of that speed.
- 4.3.3. The mean braking torque recorded during the above cold performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15 per cent of the mean braking torque recorded with the brake linings conforming to the component identified in the relevant application for vehicle type approval.
- 4.4. Type-I test (fade test)
- 4.4.1. Heating procedure
- 4.4.1.1. Brake linings shall be tested according to the procedure given in paragraph 1.5.1 of Annex 3 to this Regulation.

4.4.2. Hot performance

4.4.2.1. On completion of the tests required under paragraph 4.4.1 of this annex, the hot braking performance test specified in paragraph 1.5.2 of Annex 3 to this Regulation shall be carried out.

4.4.2.2. The mean braking torque recorded during the above hot performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15 per cent of the mean braking torque recorded with the brake linings conforming to the component identified in the relevant application for vehicle type approval.

5. INSPECTION OF BRAKE LININGS

5.1. Brake linings shall be visually inspected on completion of the above tests to check that they are in satisfactory condition for continued use in normal service.

ANNEX 8

Special requirements to be applied to the safety aspects of complex electronic vehicle control systems

1. GENERAL

This annex defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of Complex Electronic Vehicle Control Systems (definition 2.3 below) as far as this Regulation is concerned.

This annex may also be called, by special paragraphs in this Regulation, for safety related functions which are controlled by electronic system(s).

This annex does not specify the performance criteria for 'The System' but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes.

This information shall show that 'The System' respects, under normal and fault conditions, all the appropriate performance requirements specified elsewhere in this Regulation.

2. DEFINITIONS

For the purposes of this annex,

- 2.1. 'Safety concept' is a description of the measures designed into the system, for example within the electronic units, so as to address system integrity and thereby ensure safe operation even in the event of an electrical failure.

The possibility of a fall-back to partial operation or even to a back-up system for vital vehicle functions may be a part of the safety concept.

- 2.2. 'Electronic control system' means a combination of units, designed to cooperate in the production of the stated vehicle control function by electronic data processing.

Such systems, often controlled by software, are built from discrete functional components such as sensors, electronic control units and actuators and connected by transmission links. They may include mechanical, electro-pneumatic or electro-hydraulic elements.

'The System', referred to herein, is the one for which type approval is being sought.

- 2.3. 'Complex electronic vehicle control systems' are those electronic control systems which are subject to a hierarchy of control in which a controlled function may be over-ridden by a higher level electronic control system/function.

A function which is over-ridden becomes part of the complex system.

- 2.4. 'Higher-level control' systems/functions are those which employ additional processing and/or sensing provisions to modify vehicle behaviour by commanding variations in the normal function(s) of the vehicle control system.

This allows complex systems to automatically change their objectives with a priority which depends on the sensed circumstances.

- 2.5. 'Units' are the smallest divisions of system components which will be considered in this annex, since these combinations of components will be treated as single entities for purposes of identification, analysis or replacement.

- 2.6. 'Transmission links' are the means used for inter-connecting distributed units for the purpose of conveying signals, operating data or an energy supply.

This equipment is generally electrical but may, in some part, be mechanical, pneumatic, hydraulic or optical.

2.7. 'Range of control' refers to an output variable and defines the range over which the system is likely to exercise control.

2.8. 'Boundary of functional operation' defines the boundaries of the external physical limits within which the system is able to maintain control.

3. DOCUMENTATION

3.1. Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of 'The System' and the means by which it is linked to other vehicle systems or by which it directly controls output variables.

The function(s) of 'The System' and the safety concept, as laid down by the manufacturer, shall be explained.

Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved.

For periodic technical inspections, the documentation shall describe how the current operational status of 'The System' can be checked.

3.1.1. Documentation shall be made available in 2 parts:

- (a) The formal documentation package for the approval, containing the material listed in Section 3 (with the exception of that of paragraph 3.4.4) which shall be supplied to the technical service at the time of submission of the type approval application. This will be taken as the basic reference for the verification process set out in paragraph 4 of this annex.
- (b) Additional material and analysis data of paragraph 3.4.4, which shall be retained by the manufacturer, but made open for inspection at the time of type approval.

3.2. Description of the functions of 'The System'

A description shall be provided which gives a simple explanation of all the control functions of 'The System' and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

3.2.1. A list of all input and sensed variables shall be provided and the working range of these defined.

3.2.2. A list of all output variables which are controlled by 'The System' shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle system. The range of control (paragraph 2.7) exercised on each such variable shall be defined.

3.2.3. Limits defining the boundaries of functional operation (paragraph 2.8) shall be stated where appropriate to system performance.

3.3. System layout and schematics

3.3.1. Inventory of components

A list shall be provided, collating all the units of 'The System' and mentioning the other vehicle systems which are needed to achieve the control function in question.

An outline schematic showing these units in combination, shall be provided with both the equipment distribution and the interconnections made clear.

3.3.2. Functions of the units

The function of each unit of 'The System' shall be outlined and the signals linking it with other Units or with other vehicle systems shall be shown. This may be provided by a labelled block diagram or other schematic, or by a description aided by such a diagram.

3.3.3. Interconnections

Interconnections within 'The System' shall be shown by a circuit diagram for the electrical transmission links, by an optical-fiber diagram for optical links, by a piping diagram for pneumatic or hydraulic transmission equipment and by a simplified diagrammatic layout for mechanical linkages.

3.3.4. Signal flow and priorities

There shall be a clear correspondence between these transmission links and the signals carried between units.

Priorities of signals on multiplexed data paths shall be stated, wherever priority may be an issue affecting performance or safety as far as this Regulation is concerned.

3.3.5. Identification of units

Each unit shall be clearly and unambiguously identifiable (e.g. by marking for hardware and marking or software output for software content) to provide corresponding hardware and documentation association.

Where functions are combined within a single Unit or indeed within a single computer, but shown in multiple blocks in the block diagram for clarity and ease of explanation, only a single hardware identification marking shall be used.

The manufacturer shall, by the use of this identification, affirm that the equipment supplied conforms to the corresponding document.

3.3.5.1. The identification defines the hardware and software version and, where the latter changes such as to alter the function of the unit as far as this Regulation is concerned, this identification shall also be changed.

3.4. Safety concept of the manufacturer

3.4.1. The manufacturer shall provide a statement which affirms that the strategy chosen to achieve 'The System' objectives will not, under non-fault conditions, prejudice the safe operation of systems which are subject to the prescriptions of this Regulation.

3.4.2. In respect of software employed in 'The System', the outline architecture shall be explained and the design methods and tools used shall be identified. The manufacturer shall be prepared, if required, to show some evidence of the means by which they determined the realisation of the system logic, during the design and development process.

3.4.3. The Manufacturer shall provide the technical authorities with an explanation of the design provisions built into 'The System' so as to generate safe operation under fault conditions. Possible design provisions for failure in 'The System' are for example:

- (a) Fall-back to operation using a partial system.
- (b) Change-over to a separate back-up system.
- (c) Removal of the high level function.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the Ignition (run) switch to 'off', or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

- 3.4.3.1. If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.
- 3.4.3.2. If the chosen provision selects a second (back-up) means to realise the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.
- 3.4.3.3. If the chosen provision selects the removal of the higher level function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.
- 3.4.4. The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any one of those specified faults which will have a bearing on vehicle control performance or safety.

This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations.

The chosen analytical approach(es) shall be established and maintained by the manufacturer and shall be made open for inspection by the technical service at the time of the type approval.

- 3.4.4.1. This documentation shall itemise the parameters being monitored and shall set out, for each fault condition of the type defined in paragraph 3.4.4 above, the warning signal to be given to the driver and/or to service/technical inspection personnel.

4. VERIFICATION AND TEST

- 4.1. The functional operation of 'The System', as laid out in the documents required in paragraph 3, shall be tested as follows:

- 4.1.1. Verification of the function of 'The System'

As the means of establishing the normal operational levels, verification of the performance of the vehicle system under non-fault conditions shall be conducted against the manufacturer's basic benchmark specification unless this is subject to a specified performance test as part of the approval procedure of this or another Regulation.

- 4.1.2. Verification of the safety concept of paragraph 3.4.

The reaction of 'The System' shall, at the discretion of the type approval authority, be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit.

- 4.1.2.1. The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed as being adequate.

ANNEX 9

ELECTRONIC STABILITY CONTROL AND BRAKE ASSIST SYSTEMS**A. REQUIREMENTS FOR ELECTRONIC STABILITY CONTROL SYSTEMS, WHERE FITTED****1. GENERAL REQUIREMENTS**

Vehicles equipped with an ESC system shall meet the functional requirements specified in paragraph 2 and the performance requirements in paragraph 3 under the test procedures specified in paragraph 4 and under the test conditions specified in paragraph 5 of this section.

2. FUNCTIONAL REQUIREMENTS

Each vehicle to which this annex applies shall be equipped with an electronic stability control system that:

- 2.1. Is capable of applying braking torques individually to all four wheels ⁽¹⁾ and has a control algorithm that utilizes this capability;
- 2.2. Is operational over the full speed range of the vehicle, during all phases of driving including acceleration, coasting, and deceleration (including braking), except:
 - 2.2.1. When the driver has disabled ESC;
 - 2.2.2. When the vehicle speed is below 20 km/h;
 - 2.2.3. While the initial start-up self test and plausibility checks are completed, not to exceed 2 minutes when driven under the conditions of paragraph 5.10.2;
 - 2.2.4. When the vehicle is being driven in reverse.
- 2.3. Remains capable of activation even if the antilock braking system or traction control system is also activated.

3. PERFORMANCE REQUIREMENTS

During each test performed under the test conditions of paragraph 4 and the test procedure of paragraph 5.9, the vehicle with the ESC system engaged shall satisfy the directional stability criteria of paragraphs 3.1 and 3.2, and it shall satisfy the responsiveness criterion of paragraph 3.3 during each of those tests conducted with a commanded steering wheel angle of 5 A or greater but limited as per paragraph 5.9.4, where A is the steering wheel ⁽²⁾ angle computed in paragraph 5.6.1.

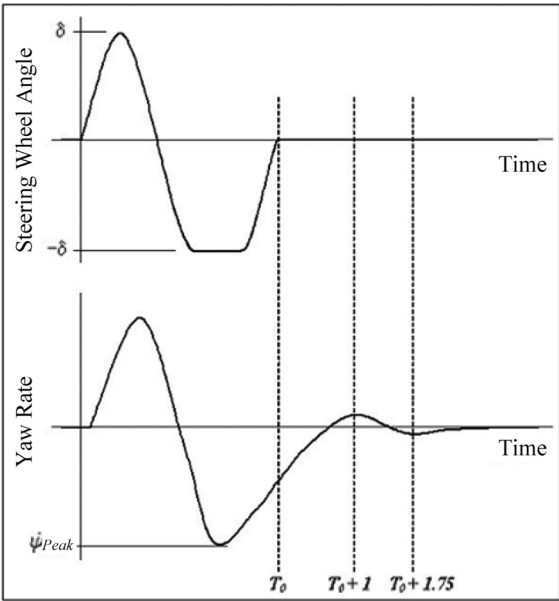
Where a vehicle has been physically tested in accordance with paragraph 4, the compliance of versions or variants of that same vehicle type may be demonstrated by a computer simulation, which respects the test conditions of paragraph 4 and the test procedure of paragraph 5.9. The use of the simulator is defined in Appendix 1 to this annex.

- 3.1. The yaw rate measured 1 second after completion of the Sine with Dwell steering input (time $T_0 + 1$ in Figure 1) shall not exceed 35 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks) (ψ_{peak} in Figure 1) during the same test run.

⁽¹⁾ An axle group shall be treated as a single axle and dual wheels shall be treated as a single wheel.

⁽²⁾ The text in this annex assumes that the vehicle steering is controlled by means of a steering wheel. Vehicles using other types of steering control may also be approved to this annex provided the manufacturer is able to demonstrate to the technical service that the performance requirements of this annex can be met using equivalent steering inputs to the steering inputs stipulated under paragraph 5. of this section.

Figure 1
Steering wheel position and yaw velocity information used to assess lateral stability



- 3.2. The yaw rate measured 1,75 seconds after completion of the Sine with Dwell steering input shall not exceed 20 percent of the first peak value of yaw rate recorded after the steering wheel angle changes sign (between first and second peaks) during the same test run.
- 3.3. The lateral displacement of the vehicle centre of gravity with respect to its initial straight path shall be at least 1,83 m for vehicles with a GVM of 3 500 kg or less, and 1,52 m for vehicles with a maximum mass greater than 3 500 kg when computed 1,07 seconds after the Beginning of Steer (BOS). BOS is defined in paragraph 5.11.6.
- 3.3.1. The computation of lateral displacement is performed using double integration with respect to time of the measurement of lateral acceleration at the vehicle centre of gravity, as expressed by the formula:

Lateral Displacement = $\iint a_{y\,C.G.} dt$

An alternative measuring method may be allowed for type approval testing, provided it demonstrates at least an equivalent level of precision as the double integration method.

- 3.3.2. Time t = 0 for the integration operation is the instant of steering initiation, known as the Beginning of Steer (BOS). BOS is defined in paragraph 5.11.6.

3.4. ESC malfunction detection

The vehicle shall be equipped with a tell-tale that provides a warning to the driver of the occurrence of any malfunction that affects the generation or transmission of control or response signals in the vehicle's electronic stability control system.

- 3.4.1. The ESC malfunction tell-tale:
 - 3.4.1.1. Shall be displayed in direct and clear view of the driver, while in the driver's designated seating position with the driver's seat belt fastened;
 - 3.4.1.2. Shall appear perceptually upright to the driver while driving;

- 3.4.1.3. Shall be identified by the symbol shown for 'ESC Malfunction Tell-tale' below or the text 'ESC':



- 3.4.1.4. Shall be yellow or amber in colour;
- 3.4.1.5. When illuminated must be sufficiently bright to be visible to the driver under both daylight and night-time driving conditions, when the driver has adapted to the ambient roadway light conditions;
- 3.4.1.6. Except as provided in paragraph 3.4.1.7, the ESC malfunction tell-tale shall illuminate when a malfunction exists and shall remain continuously illuminated under the conditions specified in paragraph 3.4 for as long as the malfunction exists, whenever the ignition locking system is in the 'On' ('Run') position;
- 3.4.1.7. Except as provided in paragraph 3.4.2, each ESC malfunction tell-tale shall be activated as a check of lamp function either when the ignition locking system is turned to the 'On' ('Run') position when the engine is not running, or when the ignition locking system is in a position between 'On' ('Run') and 'Start' that is designated by the manufacturer as a check position;
- 3.4.1.8. Shall extinguish at the next ignition cycle after the malfunction has been corrected in accordance with paragraph 5.10.4;
- 3.4.1.9. May also be used to indicate the malfunction of related systems/functions, including traction control, trailer stability assist, corner brake control, and other similar functions that use throttle and/or individual torque control to operate and share common components with ESC.
- 3.4.2. The ESC malfunction tell-tale need not be activated when a starter interlock is in operation.
- 3.4.3. The requirement of paragraph 3.4.1.7 does not apply to tell-tales shown in a common space.
- 3.4.4. The manufacturer may use the ESC malfunction tell-tale in a flashing mode to indicate ESC operation.
- 3.5. ESC Off and other system controls

The manufacturer may include an 'ESC Off' control, which shall be illuminated when the vehicle's headlamps are activated, and which has a purpose to place the ESC system in a mode in which it will no longer satisfy the performance requirements of paragraphs 3, 3.1, 3.2 and 3.3. Manufacturers may also provide controls for other systems that have an ancillary effect upon ESC operation. Controls of either kind that place the ESC system in a mode in which it may no longer satisfy the performance requirements of paragraphs 3, 3.1, 3.2 and 3.3 are permitted, provided that the system also meets the requirements of paragraphs 3.5.1, 3.5.2 and 3.5.3.

- 3.5.1. The vehicle's ESC system shall always return to the manufacturer's original default mode that satisfies the requirements of paragraphs 2 and 3 at the initiation of each new ignition cycle, regardless of what mode the driver had previously selected. However, the vehicle's ESC system need not return to a mode that satisfies the requirements of paragraphs 3 through 3.3 at the initiation of each new ignition cycle if:
- 3.5.1.1. The vehicle is in a four-wheel drive configuration which has the effect of locking the drive gears at the front and rear axles together and providing an additional gear reduction between the engine speed and vehicle speed of at least 1,6, selected by the driver for low-speed, off-road driving; or
- 3.5.1.2. The vehicle is in a four-wheel drive configuration selected by the driver that is designed for operation at higher speeds on snow-, sand-, or dirt-packed roads and that has the effect of locking the drive gears at the front and rear axles together, provided that in this mode the vehicle meets the stability performance requirements of paragraphs 3.1 and 3.2 under the test conditions specified in paragraph 4. However, if the system has more than one ESC mode that satisfies the requirements of paragraphs 3.1 and 3.2 within the drive configuration selected for the previous ignition cycle, the ESC shall return to the manufacturer's original default ESC mode for that drive configuration at the initiation of each new ignition cycle.

- 3.5.2. A control, whose only purpose is to place the ESC system in a mode in which it will no longer satisfy the performance requirements of paragraphs 3, 3.1, 3.2 and 3.3, shall be identified by the symbol shown for 'ESC Off' below or the text 'ESC OFF'.



- 3.5.3. A control for an ESC system whose purpose is to place the ESC system in different modes, at least one of which may no longer satisfy the performance requirements of paragraphs 3, 3.1, 3.2, and 3.3, shall be identified by the symbol below with the text 'OFF' adjacent to the control position for this mode.



Alternatively, in the case where the ESC system mode is controlled by a multi-functional control, the driver display shall identify clearly to the driver the control position for this mode using either the symbol in paragraph 3.5.2 or the text 'ESC OFF'.

- 3.5.4. A control for another system that has the ancillary effect of placing the ESC system in a mode in which it no longer satisfies the performance requirements of paragraphs 3, 3.1, 3.2 and 3.3 need not be identified by the 'ESC OFF' symbol of paragraph 3.5.2.

3.6. ESC OFF tell-tale

If the manufacturer elects to install a control to turn off or reduce the performance of the ESC system under paragraph 3.5, the tell-tale requirements of paragraphs 3.6.1 to 3.6.4 shall be met in order to alert the driver to the inhibited or reduced state of ESC system functionality. This requirement does not apply for the driver-selected mode referred to in paragraph 3.5.1.2.

- 3.6.1. The vehicle manufacturer shall provide a tell-tale indicating that the vehicle has been put into a mode that renders it unable to satisfy the requirements of paragraphs 3, 3.1, 3.2 and 3.3, if such a mode is provided.

3.6.2. The 'ESC OFF' tell-tale:

- 3.6.2.1. Shall be displayed in direct and clear view of the driver while in the driver's designated seating position with the driver's seat belt fastened;

- 3.6.2.2. Shall appear perceptually upright to the driver while driving;

- 3.6.2.3. Shall be identified by the symbol shown for 'ESC OFF' below or the text 'ESC OFF',



or

Shall be identified with the English word 'OFF' adjacent to either the control referred to in paragraph 3.5.2 or 3.5.3 or the illuminated malfunction tell-tale;

- 3.6.2.4. Shall be yellow or amber in colour;

- 3.6.2.5. When illuminated, shall be sufficiently bright to be visible to the driver under both daylight and night time driving conditions, when the driver has adapted to the ambient roadway light conditions;

- 3.6.2.6. Shall remain continuously illuminated for as long as the ESC is in a mode that renders it unable to satisfy the requirements of paragraphs 3, 3.1, 3.2 and 3.3;

- 3.6.2.7. Except as provided in paragraphs 3.6.3 and 3.6.4 each 'ESC Off' tell-tale shall be activated as a check of lamp function either when the ignition locking system is turned to the 'On' ('Run') position when the engine is not running, or when the ignition locking system is in a position between 'On' ('Run') and 'Start' that is designated by the manufacturer as a check position.
- 3.6.2.8. Shall extinguish after the ESC system has been returned to the manufacturer's original default mode.
- 3.6.3. The 'ESC OFF' tell-tale need not be activated when a starter interlock is in operation.
- 3.6.4. The requirement of paragraph 3.6.2.7 of this section does not apply to tell-tales shown in a common space.
- 3.6.5. The manufacturer may use the 'ESC OFF' tell-tale to indicate an ESC level of function other than the manufacturer's original default mode even if the vehicle would meet paragraphs 3, 3.1, 3.2 and 3.3 of this section at that level of ESC function.
- 3.7. ESC system technical documentation
- Further to the requirements defined in Annex 8 to this Regulation the documentation package shall, as confirmation that the vehicle is equipped with an ESC system that meets the definition of an 'ESC System' as in paragraph 2.25 to this Regulation, include the vehicle manufacturer's documentation as specified in paragraphs 3.7.1 to 3.7.4 below.
- 3.7.1. System diagram identifying all ESC system hardware. The diagram shall identify those components that are used to generate brake torques at each wheel, determine vehicle yaw rate, estimated side-slip or the side-slip derivative and driver steering inputs.
- 3.7.2. A brief written explanation sufficient to describe the ESC system's basic operational characteristics. This explanation shall include the outline description of the system's capability to apply braking torques at each wheel and how the system modifies propulsion torque during ESC system activation, and show that the vehicle yaw rate is directly determined. The explanation shall also specify the vehicle speed range and the driving phases (acceleration, deceleration, coasting, during activation of the ABS or traction control) under which the ESC system can activate.
- 3.7.3. Logic diagram. This diagram supports the explanation provided under paragraph 3.7.2.
- 3.7.4. Understeer information. An outline description of the pertinent inputs to the computer that control ESC system hardware and how they are used to limit vehicle understeer.
4. TEST CONDITIONS
- 4.1. Ambient conditions
- 4.1.1. The ambient temperature is between 0 °C and 45 °C.
- 4.1.2. The maximum wind speed is no greater than 10 m/s for vehicles with SSF > 1,25, and 5 m/s for vehicles with SSF ≤ 1,25.
- 4.2. Road test surface
- 4.2.1. Tests are conducted on a dry, uniform, solid-paved surface. Surfaces with irregularities and undulations, such as dips and large cracks, are unsuitable.
- 4.2.2. The road test surface has a nominal ⁽¹⁾ peak braking coefficient (PBC) of 0,9, unless otherwise specified, when measured using either:
- 4.2.2.1. The American Society for Testing and Materials (ASTM) E1136 standard reference test tyre, in accordance with ASTM Method E1337-90, at a speed of 40 mph; or

⁽¹⁾ The 'nominal' value is understood as being the theoretical target value.

- 4.2.2.2. The k-test method specified in Appendix 2 to Annex 6 of this Regulation.
- 4.2.3. The test surface has a consistent slope between level and 1 per cent.
- 4.3. Vehicle conditions
- 4.3.1. The ESC system is enabled for all testing.
- 4.3.2. Vehicle mass. The vehicle is loaded with the fuel tank filled to at least 90 per cent of capacity, and a total interior load of 168 kg comprised of the test driver, approximately 59 kg of test equipment (automated steering machine, data acquisition system and the power supply for the steering machine), and ballast as required to make up for any shortfall in the weight of test drivers and test equipment. Where required, ballast shall be placed on the floor behind the passenger front seat or if necessary in the front passenger foot well area. All ballast shall be secured in a way that prevents it from becoming dislodged during testing.
- 4.3.3. Tyres. The tyres are inflated to the vehicle manufacturer's recommended cold inflation pressure(s) e.g. as specified on the vehicle's placard or the tyre inflation pressure label. Tubes may be installed to prevent tyre de-beading.
- 4.3.4. Outriggers. Outriggers may be used for testing if deemed necessary for test drivers' safety. In this case, the following applies for vehicles with a Static Stability Factor (SSF) $\leq 1,25$:
- 4.3.4.1. Vehicles with a mass in running order under 1 588 kg shall be equipped with 'lightweight' outriggers. Lightweight outriggers shall be designed with a maximum mass of 27 kg and a maximum roll moment of inertia of $27 \text{ kg} \cdot \text{m}^2$.
- 4.3.4.2. Vehicles with a mass in running order between 1 588 kg and 2 722 kg shall be equipped with 'standard' outriggers. Standard outriggers shall be designed with a maximum mass of 32 kg and a maximum roll moment of inertia of $35,9 \text{ kg} \cdot \text{m}^2$.
- 4.3.4.3. Vehicles with a mass in running order equal to or greater than 2 722 kg shall be equipped with 'heavy' outriggers. Heavy outriggers shall be designed with a maximum mass of 39 kg and a maximum roll moment of inertia of $40,7 \text{ kg} \cdot \text{m}^2$.
- 4.3.5. Automated steering machine. A steering robot programmed to execute the required steering pattern shall be used in paragraphs 5.5.2, 5.5.3, 5.6 and 5.9. The steering machine shall be capable of supplying steering torques between 40 to 60 Nm. The steering machine shall be able to apply these torques when operating with steering wheel velocities up to 1 200 degrees per second.
5. TEST PROCEDURE
- 5.1. Inflate the vehicles' tyres to the manufacturer's recommended cold inflation pressure(s) e.g. as provided on the vehicle's placard or the tyre inflation pressure label.
- 5.2. Tell-tale bulb check. With the vehicle stationary and the ignition locking system in the 'Lock' or 'OFF' position, switch the ignition to the 'On' ('Run') position or, where applicable, the appropriate position for the lamp check. The ESC malfunction tell-tale shall be illuminated as a check of lamp function, as specified in paragraph 3.4.1.7, and if equipped, the 'ESC OFF' tell-tale shall also be illuminated as a check of lamp function, as specified in paragraph 3.6.2.7. The tell-tale bulb check is not required for a tell-tale shown in a common space as specified in paragraphs 3.4.3 and 3.6.4.
- 5.3. 'ESC OFF' control check. For vehicles equipped with an 'ESC OFF' control, with the vehicle stationary and the ignition locking system in the 'Lock' or 'OFF' position, switch the ignition locking system to the 'On' ('Run') position. Activate the 'ESC OFF' control and verify that the 'ESC OFF' tell-tale is illuminated, as specified in paragraph 3.6.4 Turn the ignition locking system to the 'Lock' or 'Off' position. Again, switch the ignition locking system to the 'On' ('Run') position and verify that the 'ESC Off' tell-tale has extinguished indicating that the ESC system has been restored as specified in paragraph 3.5.1.

5.4. Brake conditioning

Condition the vehicle brakes in the manner described in paragraphs 5.4.1 to 5.4.4.

5.4.1. Ten stops are performed from a speed of 56 km/h, with an average deceleration of approximately 0,5 g.

5.4.2. Immediately following the series of ten 56 km/h stops, three additional stops are performed from 72 km/h at higher deceleration.

5.4.3. When executing the stops in paragraph 5.4.2, sufficient force is applied to the brake pedal to bring the vehicle's antilock braking system (ABS) into operation for a majority of each braking event.

5.4.4. Following completion of the final stop in 5.4.2, the vehicle is driven at a speed of 72 km/h for five minutes to cool the brakes.

5.5. Tyre Conditioning

Condition the tyres using the procedure of paragraphs 5.5.1 to 5.5.3 to wear away mould sheen and achieve operating temperature immediately before beginning the test runs of paragraphs 5.6 and 5.9.

5.5.1. The test vehicle is driven around a circle 30 meters in diameter at a speed that produces a lateral acceleration of approximately 0,5 to 0,6 g for three clockwise laps followed by three anticlockwise laps.

5.5.2. Using a sinusoidal steering pattern at a frequency of 1 Hz, a peak steering wheel angle amplitude corresponding to a peak lateral acceleration of 0,5 to 0,6 g, and a vehicle speed of 56 km/h, the vehicle is driven through four passes performing 10 cycles of sinusoidal steering during each pass.

5.5.3. The steering wheel angle amplitude of the final cycle of the final pass shall be twice that of the other cycles. The maximum time permitted between each of the laps and passes is five minutes.

5.6. Slowly increasing steer procedure

The vehicle is subjected to two series of runs of the slowly increasing steer test using a constant vehicle speed of 80 ± 2 km/h and a steering pattern that increases by 13,5 degrees per second until a lateral acceleration of approximately 0,5 g is obtained. Three repetitions are performed for each test series. One series uses anti-clockwise steering, and the other series uses clockwise steering. The maximum time permitted between each test run is five minutes.

5.6.1. From the slowly increasing steer tests, the quantity 'A' is determined. 'A' is the steering wheel angle in degrees that produces a steady state lateral acceleration (corrected using the methods specified in paragraph 5.11.3) of 0,3 g for the test vehicle. Utilizing linear regression, A is calculated, to the nearest 0,1 degrees, from each of the six slowly increasing steer tests. The absolute value of the six A values calculated is averaged and rounded to the nearest 0,1 degrees to produce the final quantity, A, used below.

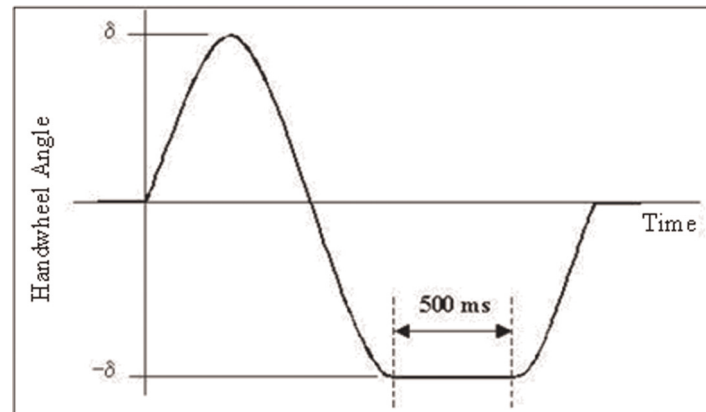
5.7. After the quantity A has been determined, without replacing the tyres, the tyre conditioning procedure described in paragraph 5.5 is performed again immediately prior to conducting the Sine with Dwell test of paragraph 5.9. Initiation of the first Sine with Dwell test series shall begin within two hours after completion of the slowly increasing steer tests of paragraph 5.6.

5.8. Check that the ESC system is enabled by ensuring that the ESC malfunction and 'ESC Off' (if provided) tell-tales are not illuminated.

5.9. Sine with Dwell test of oversteer intervention and responsiveness

The vehicle is subjected to two series of test runs using a steering pattern of a sine wave at 0,7 Hz frequency with a 500 ms delay beginning at the second peak amplitude as shown in Figure 2 (the Sine with Dwell tests). One series uses anticlockwise steering for the first half cycle, and the other series uses clockwise steering for the first half cycle. The vehicle is allowed to cool-down between each test runs for a period of 1,5 to 5 minutes, with the vehicle stationary.

Figure 2

Sine with Dwell

- 5.9.1. The steering motion is initiated with the vehicle coasting in high gear at 80 ± 2 km/h.
- 5.9.2. The steering amplitude for the initial run of each series is 1,5 A, where A is the steering wheel angle determined in paragraph 5.6.1.
- 5.9.3. In each series of test runs, the steering amplitude is increased from run to run, by 0,5 A, provided that no such run will result in a steering amplitude greater than that of the final run specified in paragraph 5.9.4.
- 5.9.4. The steering amplitude of the final run in each series is the greater of 6,5 A or 270 degrees, provided the calculated magnitude of 6,5 A is less than or equal to 300 degrees. If any 0,5 A increment, up to 6,5 A, is greater than 300 degrees, the steering amplitude of the final run shall be 300 degrees.
- 5.9.5. Upon completion of the two series of test runs, post processing of yaw rate and lateral acceleration data is done as specified in paragraph 5.11.
- 5.10. ESC malfunction detection
- 5.10.1. Simulate one or more ESC malfunction(s) by disconnecting the power source to any ESC component, or disconnecting any electrical connection between ESC components (with the vehicle power off). When simulating an ESC malfunction, the electrical connections for the tell-tale lamp(s) and/or optional ESC system control(s) are not to be disconnected.
- 5.10.2. With the vehicle initially stationary and the ignition locking system in the 'Lock' or 'OFF' position, switch the ignition locking system to the 'Start' position and start the engine. Drive the vehicle forward to obtain a vehicle speed of 48 ± 8 km/h. 30 seconds, at the latest, after the engine has been started and within the next two minutes at this speed, conduct at least one left and one right smooth turning manoeuvre without losing directional stability and one brake application. Verify that the ESC malfunction indicator illuminates in accordance with paragraph 3.4 by the end of these manoeuvres.
- 5.10.3. Stop the vehicle, switch the ignition locking system to the 'OFF' or 'Lock' position. After a five-minute period, switch the vehicle's ignition locking system to the 'Start' position and start the engine. Verify that the ESC malfunction indicator again illuminates to signal a malfunction and remains illuminated as long as the engine is running or until the fault is corrected.
- 5.10.4. Switch the ignition locking system to the 'Off' or 'Lock' position. Restore the ESC system to normal operation, switch the ignition system to the 'Start' position and start the engine. Re-perform the manoeuvre described in paragraph 5.10.2 and verify that the tell-tale has extinguished within this time or immediately afterwards.
- 5.11. Post data processing – calculations for performance metrics
- Yaw rate and lateral displacement measurements and calculations shall be processed utilizing the techniques specified in paragraphs 5.11.1 to 5.11.8.

- 5.11.1. Raw steering wheel angle data is filtered with a 12-pole phaseless Butterworth filter and a cut-off frequency of 10 Hz. The filtered data is then zeroed to remove sensor offset utilizing static pre-test data.
- 5.11.2. Raw yaw rate data is filtered with a 12-pole phaseless Butterworth filter and a cut-off frequency of 6 Hz. The filtered data is then zeroed to remove sensor offset utilizing static pre-test data.
- 5.11.3. Raw lateral acceleration data is filtered with a 12-pole phaseless Butterworth filter and a cut-off frequency of 6 Hz. The filtered data is then zeroed to remove sensor offset utilizing static pre-test data. The lateral acceleration data at the vehicle centre of gravity is determined by removing the effects caused by vehicle body roll and by correcting for sensor placement via the use of coordinate transformation. For data collection, the lateral accelerometer shall be located as close as possible to the position of the vehicle's longitudinal and lateral centres of gravity.
- 5.11.4. Steering wheel velocity is determined by differentiating the filtered steering wheel angle data. The steering wheel velocity data is then filtered with a moving 0,1 second running average filter.
- 5.11.5. Lateral acceleration, yaw rate and steering wheel angle data channels are zeroed utilizing a defined 'zeroing range.' The methods used to establish the zeroing range are defined in paragraphs 5.11.5.1 and 5.11.5.2.
- 5.11.5.1. Using the steering wheel rate data calculated using the methods described in paragraph 5.11.4, the first instant that the steering wheel rate exceeds 75 deg/sec is identified. From this point, steering wheel rate shall remain greater than 75 deg/sec for at least 200 ms. If the second condition is not met, the next instant that the steering wheel rate exceeds 75 deg/sec is identified and the 200 ms validity check applied. This iterative process continues until both conditions are ultimately satisfied.
- 5.11.5.2. The 'zeroing range' is defined as the 1,0 second time period prior to the instant the steering wheel rate exceeds 75 deg/sec (i.e., the instant the steering wheel velocity exceeds 75 deg/sec defines the end of the 'zeroing range').
- 5.11.6. The Beginning of Steer (BOS) is defined as the first instance when the filtered and zeroed steering wheel angle data reaches - 5 degrees (when the initial steering input is anticlockwise) or + 5 degrees (when the initial steering input is clockwise) after a time defining the end of the 'zeroing range.' The value for time at the BOS is interpolated.
- 5.11.7. The Completion of Steer (COS) is defined as the time the steering wheel angle returns to zero at the completion of the Sine with Dwell steering manoeuvre. The value for time at the zero degree steering wheel angle is interpolated.
- 5.11.8. The second peak yaw rate is defined as the first local yaw rate peak produced by the reversal of the steering wheel. The yaw rates at 1,000 and 1,750 seconds after COS are determined by interpolation.
- 5.11.9. Determine lateral velocity by integrating corrected, filtered and zeroed lateral acceleration data. Zero lateral velocity at the BOS point. Determine lateral displacement by integrating zeroed lateral velocity. Zero lateral displacement at the BOS point. The lateral displacement measurement is made at 1,07 seconds after BOS point and is determined by interpolation.

B. SPECIAL REQUIREMENTS TO BE APPLIED TO BRAKE ASSIST SYSTEMS, WHERE FITTED

1. GENERAL

The following requirements apply to vehicles fitted with Brake Assist Systems (BAS) as defined in paragraph 2.34 of this Regulation and declared in the Communication of Annex 1, paragraph 22 of this Regulation.

In addition to the requirements of this annex, Brake Assist Systems shall also be subject to any relevant requirements contained elsewhere within this Regulation.

In addition to the requirements of this annex, vehicles with BAS shall also be equipped with ABS in accordance with Annex 6.

1.1. General performance characteristics for category 'A' BAS systems

When an emergency condition has been sensed by a relatively high pedal force, the additional pedal force to cause full cycling of the ABS shall be reduced compared to the pedal force required without the BAS system in operation.

Compliance with this requirement is demonstrated if the provisions of paragraphs 3.1 to 3.3 of this section are met.

1.2. General performance characteristics for category 'B' and category 'C' BAS systems

When an emergency condition has been sensed, at least by a very fast application of the pedal, the BAS system shall raise the pressure to deliver the maximum achievable braking rate or cause full cycling of the ABS.

Compliance with this requirement is demonstrated if the provisions of paragraphs 4.1 to 4.3 of this section are met.

2. GENERAL TEST REQUIREMENTS

2.1. Variables

Whilst performing the tests described in part B of this annex, the following variables shall be measured:

2.1.1. Brake pedal force, F_p ;

2.1.2. Vehicle velocity, v_x ;

2.1.3. Vehicle deceleration, a_x ;

2.1.4. Brake temperature, T_d ;

2.1.5. Brake pressure, P , where applicable;

2.1.6. Brake pedal travel, S_p , measured at the centre of the pedal plate or at a position on the pedal mechanism where the displacement is proportional to the displacement at the centre of the pedal plate allowing simple calibration of the measurement.

2.2. Measuring equipment

2.2.1. The variables listed in paragraph 2.1 of this section shall be measured by means of appropriate transducers. Accuracy, operating ranges, filtering techniques, data processing and other requirements are described in ISO Standard 15037-1: 2006.

2.2.2. Accuracy of pedal force and disc temperature measurements shall be as follows:

Variable range system	Typical operating range of the transducers	Recommended maximum recording errors
Pedal force	0 to 2 000 N	± 10 N
Brake temperature	0 - 1 000 °C	± 5 °C
Brake pressure (*)	0 - 20 MPa (*)	± 100 kPa (*)

(*) Applicable as specified in paragraph 3.2.5.

2.2.3. Details on analogue and digital data processing of the BAS test procedures are described in Appendix 5 to this annex. A sampling rate for data acquisition of at least 500 Hz is required.

2.2.4. Alternative measuring methods to those referred to in paragraph 2.2.3 may be allowed, provided they demonstrate at least an equivalent level of precision.

- 2.3. Test conditions
- 2.3.1. Test vehicle loading condition: The vehicle shall be unladen. There may be, in addition to the driver, a second person on the front seat who is responsible for noting the results of the tests.
- 2.3.2. Braking tests shall be carried out on a dry surface affording good adhesion.
- 2.4. Test method
- 2.4.1. The tests as described in paragraphs 3 and 4 of this section shall be carried out from a test speed of 100 ± 2 km/h. The vehicle shall be driven at the test speed in a straight line.
- 2.4.2. The average temperature of the brakes shall be in accordance with paragraph 1.4.1.1 of Annex 3.
- 2.4.3. For the tests the reference time, t_0 , is defined as the moment when the brake pedal force reaches 20 N.
- Note: For vehicles equipped with a brake system assisted by an energy source, the applied pedal force necessary depends on the energy level that exists in the energy storage device. Therefore, sufficient energy level shall be ensured at the beginning of the test.

3. ASSESSMENT OF THE PRESENCE OF A CATEGORY 'A' BAS

A category 'A' BAS shall meet the test requirements contained in paragraphs 3.1 and 3.2.

- 3.1. Test 1: Reference test to determine F_{ABS} and a_{ABS} .
- 3.1.1. The reference values F_{ABS} and a_{ABS} shall be determined in accordance with the procedure described in Appendix 4 to this annex.
- 3.2. Test 2: For activation of BAS
- 3.2.1. Once an emergency braking condition has been detected, systems sensitive to pedal force shall show a significant increase in the ratio of:
- (a) brake line pressure to brake pedal force, where permitted by paragraph 3.2.5, or
- (b) vehicle deceleration to brake pedal force.
- 3.2.2. The performance requirements for a category 'A' BAS are met if a specific brake application characteristic can be defined that exhibits a decrease of between 40 per cent and 80 per cent in required brake pedal force for $(F_{ABS} - F_T)$ compared to $(F_{ABS \text{ extrapolated}} - F_T)$.
- 3.2.3. F_T and a_T are threshold force and threshold deceleration as shown in Figure 1. The values of F_T and a_T shall be supplied to the Technical Service at the time of submission of the type-approval application. The value of a_T shall be between $3,5 \text{ m/s}^2$ and $5,0 \text{ m/s}^2$.
- 3.2.4. A straight line is drawn from the origin through the point F_T, a_T (as shown in Figure 1a). The value of brake pedal force 'F', at the point of intersection between this line and a horizontal line defined by $a = a_{ABS}$, is defined as $F_{ABS, \text{ extrapolated}}$:

$$F_{ABS, \text{ extrapolated}} = \frac{F_T \cdot a_{ABS}}{a_T}$$

- 3.2.5. As an alternative, which can be selected by the manufacturer, in the case of vehicles of category N1, or M1 derived from those N1 vehicles, with a gross vehicle mass $GVM > 2\,500 \text{ kg}$, the pedal force figures for F_T , $F_{ABS, \text{ min}}$, $F_{ABS, \text{ max}}$ and $F_{ABS, \text{ extrapolated}}$ may be derived from the brake line pressure response characteristic instead of the vehicle deceleration characteristic. This shall be measured as the brake pedal force is increasing.
- 3.2.5.1. The pressure, at which ABS cycling commences, shall be determined by making five tests from $100 \pm 2 \text{ km/h}$ in which the brake pedal is applied up to the level which produces ABS operation and the five pressures at which this occurs as determined from front wheel pressure records, shall be recorded and the mean value obtained as p_{abs} .

- 3.2.5.2. The threshold pressure P_T shall be stated by the manufacturer and correspond to a deceleration in the range of 2,5 – 4,5 m/s².
- 3.2.5.3. Figure 1b shall be constructed in the manner set out in paragraph 3.2.4, but using line pressure measurements to define the parameters set out in paragraph 3.2.5 of this section where:

$$F_{ABS, extrapolated} = \frac{F_T \cdot P_{ABS}}{P_T}$$

Figure 1a

Pedal force characteristic needed in order to achieve maximum deceleration with category 'A' BAS

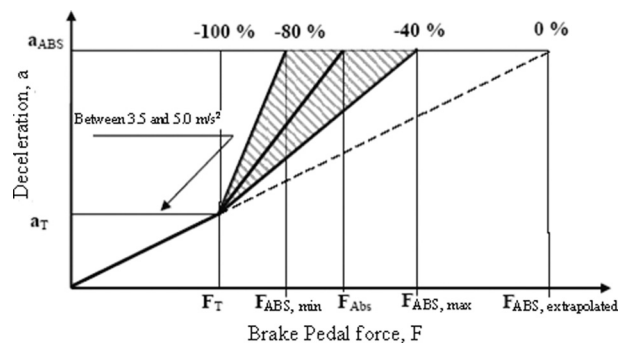
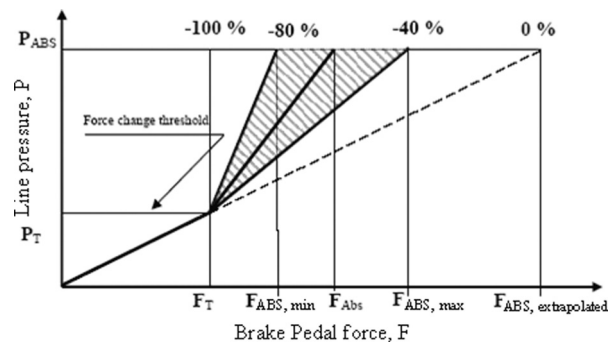


Figure 1b

Pedal force characteristic needed in order to achieve maximum deceleration with category 'A' BAS



3.3. Data evaluation

The presence of a category 'A' BAS is proven if

$$F_{ABS, min} \leq F_{ABS} \leq F_{ABS, max}$$

where:

$$F_{ABS, max} - F_T \leq (F_{ABS, extrapolated} - F_T) \cdot 0,6$$

and

$$F_{ABS, min} - F_T \geq (F_{ABS, extrapolated} - F_T) \cdot 0,2$$

4. ASSESSMENT OF THE PRESENCE OF A CATEGORY 'B' BAS

A category 'B' BAS shall meet the test requirements contained within paragraphs 4.1 and 4.2 of this section.

4.1. Test 1: Reference test to determine F_{ABS} and a_{ABS} .

4.1.1. The reference values F_{ABS} and a_{ABS} shall be determined in accordance with the procedure described in Appendix 4 to this annex.

4.2. Test 2: For activation of BAS

The vehicle shall be driven in a straight line at the test speed specified in paragraph 2.4 of this section. The driver shall apply the brake pedal quickly according to Figure 2, simulating emergency braking so that BAS is activated and ABS is fully cycling.

In order to activate BAS the brake pedal shall be applied as specified by the car manufacturer. The manufacturer shall notify the Technical Service of the required brake pedal input at the time of submission of the application for type-approval. It shall be demonstrated to the satisfaction of the Technical Service that the BAS activates under the conditions specified by the manufacturer in accordance with paragraph 22.1.2 or 22.1.3 of Annex 1.

After $t = t_0 + 0,8$ s and until the vehicle has slowed down to a speed of 15 km/h, the brake pedal force shall be maintained in a corridor between $F_{ABS, upper}$ and $F_{ABS, lower}$ where $F_{ABS, upper}$ is $0,7 F_{ABS}$ and $F_{ABS, lower}$ is $0,5 F_{ABS}$.

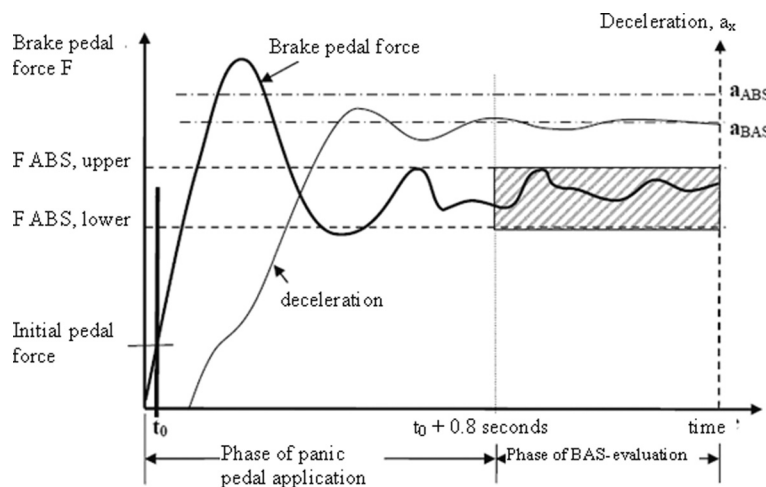
The requirements are also considered to be met if, after $t = t_0 + 0,8$ s, the pedal force falls below $F_{ABS, lower}$ provided the requirement of paragraph 4.3 is fulfilled.

4.3. Data evaluation

The presence of BAS 'B' is demonstrated if a mean deceleration (a_{BAS}) of at least $0,85 \cdot a_{ABS}$ is maintained from the time when $t = t_0 + 0,8$ s to the time when the vehicle speed has been reduced to 15 km/h.

Figure 2

Example of test 2 of a category 'B' BAS system



5. ASSESSMENT OF THE PRESENCE OF A CATEGORY 'C' BAS

5.1. A category 'C' BAS shall meet the test requirements of paragraphs 4.1 and 4.2 of this section.

5.2. Data evaluation

A category 'C' BAS shall meet the requirements of paragraph 4.3 of this section.

APPENDIX 1

USE OF THE DYNAMIC STABILITY SIMULATION

The effectiveness of the electronic stability control system may be determined by computer simulation.

1. USE OF THE SIMULATION

- 1.1. The vehicle stability function shall be demonstrated by the vehicle manufacturer to the Type Approval Authority or Technical Service by simulating the dynamic manoeuvres of paragraph 5.9 of Annex 9.
- 1.2. The simulation shall be a means whereby the vehicle stability performance shall be demonstrated with:
 - (a) The yaw rate, one second after completion of the Sine with Dwell steering input (time $T_0 + 1$);
 - (b) The yaw rate, 1,75 seconds after completion of the Sine with Dwell steering input;
 - (c) The lateral displacement of the vehicle centre of gravity with respect to its initial straight path.
- 1.3. The simulation shall be carried out with a validated modelling and simulation tool and using the dynamic manoeuvres of paragraph 5.9 of Annex 9 under the test conditions of paragraph 4 of Annex 9.

The method by which the simulation tool is validated is given in Appendix 2 to this annex.

APPENDIX 2

DYNAMIC STABILITY SIMULATION TOOL AND ITS VALIDATION**1. SPECIFICATION OF THE SIMULATION TOOL**

- 1.1. The simulation method shall take into account the main factors which influence the directional and roll motion of the vehicle. A typical model may include the following vehicle parameters in an explicit or implicit form:

- (a) Axle/wheel
- (b) Suspension
- (c) Tyre
- (d) Chassis/vehicle body
- (e) Power train/driveline, if applicable
- (f) Brake system
- (g) Payload

- 1.2. The Vehicle Stability Function shall be added to the simulation model by means of:

- (a) A subsystem (software model) of the simulation tool; or
- (b) The electronic control box in a hardware-in-the-loop configuration.

2. VALIDATION OF THE SIMULATION TOOL

- 2.1. The validity of the applied modelling and simulation tool shall be verified by means of comparisons with practical vehicle tests. The tests utilised for the validation shall be the dynamic manoeuvres of paragraph 5.9 of Annex 9.

During the tests, the following motion variables, as appropriate, shall be recorded or calculated in accordance with ISO 15037 Part 1:2005: General conditions for passenger cars or Part 2:2002: General conditions for heavy vehicles and buses (depending on the vehicle category):

- (a) Steering-wheel angle (δH)
- (b) Longitudinal velocity (v_X)
- (c) Sideslip angle (β) or lateral velocity (v_Y); (optional)
- (d) Longitudinal acceleration (a_X); (optional)
- (e) Lateral acceleration (a_Y)
- (f) Yaw velocity ($d\psi/dt$)
- (g) Roll velocity ($d\phi/dt$)
- (h) Pitch velocity ($d\vartheta/dt$)
- (i) Roll angle (ϕ)
- (j) Pitch angle (ϑ)

- 2.2. The objective is to show that the simulated vehicle behaviour and operation of the vehicle stability function is comparable with that seen in practical vehicle tests.

- 2.3. The simulator shall be deemed to be validated when its output is comparable to the practical test results produced by a given vehicle type during the dynamic manoeuvres of paragraph 5.9 of Annex 9. The relationship of activation and sequence of the vehicle stability function in the simulation and in the practical vehicle test shall be the means of making the comparison.

- 2.4. The physical parameters that are different between the reference vehicle and simulated vehicle configurations shall be modified accordingly in the simulation.
 - 2.5. A simulator test report shall be produced, a model of which is defined in Appendix 3 to this annex, and a copy attached to the vehicle approval report.
-

APPENDIX 3

VEHICLE STABILITY FUNCTION SIMULATION TOOL TEST REPORT

Test Report Number:

1. Identification

1.1. Name and address of the simulation tool manufacturer

1.2. Simulation tool identification: name/model/number (hardware and software)

2. Scope of application

2.1. Vehicle type:

2.2. Vehicle configurations:

3. Verifying vehicle test

3.1. Description of vehicle(s):

3.1.1. Vehicle(s) identification: make/model/VIN

3.1.2. Vehicle description, including suspension/wheels, engine and drive line, braking system(s), steering system, with name/model/number identification:

3.1.3. Vehicle data used in the simulation (explicit):

3.2. Description of location(s), road/test area surface conditions, temperature and date(s):

3.3. Results with the vehicle stability function switched on and off, including the motion variables referred to in Annex 9, Appendix 2, paragraph 2.1 as appropriate:

4. Simulation results

4.1. Vehicle parameters and the values used in the simulation that are not taken from the actual test vehicle (implicit):

4.2. Yaw stability and lateral displacement according to paragraphs 3.1 to 3.3 of Annex 9:

5. This test has been carried out and the results reported in accordance with Appendix 2 of Annex 9 to Regulation No 13-H, as last amended by the Supplement 7.

Technical Service conducting the test ⁽¹⁾

Signed: Date:

Approval Authority ⁽¹⁾

Signed: Date:

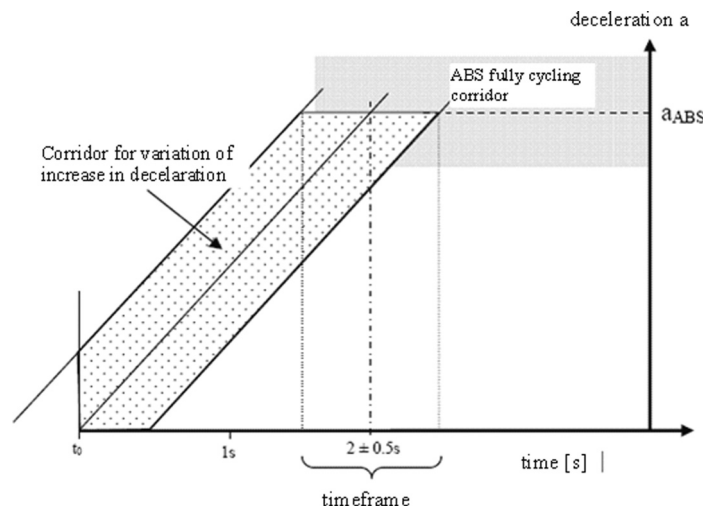
⁽¹⁾ To be signed by different persons if the Technical Service and the Approval Authority is the same organization.

APPENDIX 4

METHOD FOR DETERMINATION OF F_{ABS} AND a_{ABS}

- 1.1. The brake pedal force F_{ABS} is the minimum pedal force that has to be applied for a given vehicle in order to achieve maximum deceleration which indicates that ABS is fully cycling. a_{ABS} is the deceleration for a given vehicle during ABS deceleration as defined in paragraph 1.7.
- 1.2. The brake pedal shall be applied slowly (without activating the BAS in the case of category B or category C systems) providing a constant increase of deceleration until ABS is fully cycling (Figure 3).
- 1.3. The full deceleration must be reached within the timeframe of $2,0 \pm 0,5$ s. The deceleration curve, recorded against time, must be within a corridor of $\pm 0,5$ s around the centre line of the deceleration curve corridor. The example in Figure 3 has its origin at the time t_0 crossing the a_{ABS} line at 2 seconds. Once full deceleration has been achieved the pedal travel S_p shall not be decreased for at least 1 s. The time of full activation of the ABS system is defined as the time when pedal force F_{ABS} is achieved. The measurement shall be within the corridor for variation of increase in deceleration (see Figure 3).

Figure 3

Deceleration corridor for determination of F_{ABS} and a_{ABS} 

- 1.4. Five tests meeting the requirements of paragraph 1.3 shall be carried out. For each of these valid tests the vehicle deceleration shall be plotted as a function of the recorded brake pedal force. Only data recorded at speeds above 15 km/h shall be taken for the calculations described in the following paragraphs.
- 1.5. For the determination of a_{ABS} and F_{ABS} , a low pass filter of 2 Hz for vehicle deceleration as well as pedal force shall be applied.
- 1.6. The five individual 'deceleration versus brake pedal force' curves are averaged by calculating the mean deceleration of the five individual 'deceleration vs. brake pedal force' curves at increments of 1 N pedal force. The result is the mean deceleration versus brake pedal force curve, which will be referred to as the 'maF curve' in this appendix.
- 1.7. The maximum value for the vehicle deceleration is determined from the 'maF curve' and is named as ' a_{max} '.
- 1.8. All values of the 'maF curve' that are above 90 per cent of this deceleration value ' a_{max} ' are averaged. This value of ' a ' is the deceleration ' a_{ABS} ' referred to in this annex.
- 1.9. The minimum force on the pedal (F_{ABS}) sufficient to achieve the deceleration a_{ABS} is defined as the value of F corresponding to $a = a_{ABS}$ on the maF curve.

APPENDIX 5

DATA PROCESSING FOR THE BAS

(see paragraph 2.2.3 of section B of this annex)

1. ANALOGUE DATA PROCESSING

The bandwidth of the entire, combined transducer/recording system shall be no less than 30 Hz.

In order to execute the necessary filtering of signals, low-pass filters with order 4 or higher shall be employed. The width of the pass band (from 0 Hz to frequency f_o at -3 dB) shall not be less than 30 Hz. Amplitude errors shall be less than $\pm 0,5$ per cent in the relevant frequency range of 0 Hz to 30 Hz. All analogue signals shall be processed with filters having sufficiently similar phase characteristics to ensure that time delay differences due to filtering lie within the required accuracy for time measurement.

Note: During analogue filtering of signals with different frequency contents, phase shifts can occur. Therefore, a data processing method, as described in paragraph 2 of this appendix, is preferable.

2. DIGITAL DATA PROCESSING

2.1. General consideration

Preparation of analogue signals includes consideration of filter amplitude attenuation and sampling rate to avoid aliasing errors, and filter phase lags and time delays. Sampling and digitising considerations include pre-sampling amplification of signals to minimize digitising errors; number of bits per sample; number of samples per cycle; sample and hold amplifiers; and time-wise spacing of samples. Considerations for additional phaseless digital filtering include selection of pass bands and stop bands and the attenuation and allowable ripple in each; and correction of filter phase lags. Each of these factors shall be considered in order to achieve a relative overall data acquisition accuracy of $\pm 0,5$ per cent.

2.2. Aliasing errors

In order to avoid uncorrectable aliasing errors, the analogue signals shall be appropriately filtered before sampling and digitising. The order of the filters used and their pass band shall be chosen according to both the required flatness in the relevant frequency range and the sampling rate.

The minimum filter characteristics and sampling rate shall be such that:

- (a) Within the relevant frequency range of 0 Hz to $f_{\max} = 30$ Hz the attenuation is less than the resolution of the data acquisition system; and
- (b) At one-half the sampling rate (i.e. the Nyquist or 'folding' frequency) the magnitudes of all frequency components of signal and noise are reduced to less than the system resolution.

For 0,05 per cent resolution the filter attenuation shall be less than 0,05 per cent in the frequency range between 0 and 30 Hz, and the attenuation shall be greater than 99,95 per cent at all frequencies greater than one-half the sampling frequency.

Note: For a Butterworth filter the attenuation is given by:

$$A^2 = \frac{1}{1 + \left(\frac{f_{\max}}{f_0}\right)^{2n}} \text{ and } A^2 = \frac{1}{1 + \left(\frac{f_N}{f_0}\right)^{2n}}$$

where:

n is the order to filter;

$f_{\max}$ is the relevant frequency range (30 Hz);

f_o is the filter cut-off frequency;

f_N is the Nyquist or 'folding' frequency.

For a fourth order filter

for $A = 0,9995$: $f_o = 2,37 \cdot f_{\max}$

for $A = 0,0005$: $f_s = 2 \cdot (6,69 \cdot f_o)$, where f_s is the sampling frequency $= 2 \cdot f_N$.

2.3. Filter phase shifts and time delays for anti-aliasing filtering

Excessive analogue filtering shall be avoided, and all filters shall have sufficiently similar phase characteristics to ensure that time delay differences are within the required accuracy for the time measurement. Phase shifts are especially significant when measured variables are multiplied together to form new variables, because while amplitudes multiply, phase shifts and associated time delays add. Phase shifts and time delays are reduced by increasing f_o . Whenever equations describing the pre-sampling filters are known, it is practical to remove their phase shifts and time delays by simple algorithms performed in the frequency domain.

Note: In the frequency range in which the filter amplitude characteristics remain flat, the phase shift Φ of a Butterworth filter can be approximated by

$\Phi = 81 \cdot (f/f_o)$ degrees for second order

$\Phi = 150 \cdot (f/f_o)$ degrees for fourth order

$\Phi = 294 \cdot (f/f_o)$ degrees for eighth order

The time delay for all filter orders is: $t = (\Phi/360) \cdot (1/f_o)$

2.4. Data sampling and digitising

At 30 Hz the signal amplitude changes by up to 18 per cent per millisecond. To limit dynamic errors caused by changing analogue inputs to 0,1 per cent, sampling or digitising time shall be less than 32 μ s. All pairs or sets of data samples to be compared shall be taken simultaneously or over a sufficiently short time period.

2.5. System requirements

The data system shall have a resolution of 12 bits ($\pm 0,05$ per cent) or more and an accuracy of $\pm 0,1$ per cent (2 lbs). Anti-aliasing filters shall be of order 4 or higher and the relevant data range $f_{\max}$ shall be 0 Hz to 30 Hz.

For fourth order filters the pass-band frequency f_o (from 0 Hz to frequency f_o) shall be greater than $2,37 \cdot f_{\max}$ if phase errors are subsequently adjusted in digital data processing, and greater than $5 \cdot f_{\max}$ otherwise. For fourth order filters the data sampling frequency f_s shall be greater than $13,4 \cdot f_o$.

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/wp29fdocstts.html>

**Regulation No 17 of the Economic Commission for Europe of the United Nations (UN/ECE) —
Uniform provisions concerning the approval of vehicles with regard to the seats, their anchorages
and any head restraints**

Incorporating all valid text up to:

08 series of amendments: Date of entry into force: 22 July 2009

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ANNEXES

- Annex 1 — Communication concerning the approval or refusal or extension or withdrawal of approval or production definitely discontinued of a vehicle type with regard to the strength of the seats and their anchorages, in the case either of seats fitted or capable of being fitted with head restraints or of seats not capable of being fitted with such devices and the characteristics of head restraints pursuant to Regulation No 17
- Annex 2 — Arrangements of approval marks
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Annex 6 — Test procedure for checking energy dissipation

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Annex 9 — Test procedure for devices intended to protect the occupants against displacement of luggage

1. SCOPE

This Regulation applies to

- (a) Vehicles of categories M1 and N ⁽¹⁾ with regard to the strength of seats and their anchorages and with regard to their head restraints;
- (b) Vehicles of categories M2 and M3 ⁽¹⁾ with regard to seats not covered by Regulation No 80, in respect of the strength of seats and their anchorages, and in respect of their head restraints;
- (c) Vehicles of category M1 with regard to the design of the rear parts of seat backs and the design of devices intended to protect the occupants from the danger resulting from the displacement of luggage in a frontal impact.

It does not apply to vehicles with regard to side-facing or rearward-facing seats, or to any head restraint fitted to these seats.

2. DEFINITIONS

For the purposes of this Regulation

- 2.1. 'Approval of a vehicle' means the approval of a vehicle type with regard to the strength of the seats and their anchorages, the design of the rear parts of the seat-backs and the characteristics of their head restraints;
- 2.2. 'Vehicle type' means a category of motor vehicles which do not differ in such essential respects as:
 - 2.2.1. the structure, shape, dimensions, materials and the mass of the seats, although the seats may differ in covering and colour; differences not exceeding 5 per cent in the mass of the approved seat type shall not be considered significant;
 - 2.2.2. the type and dimensions of the adjustment, displacement and locking systems of the seat-back and seats and their parts;
 - 2.2.3. the type and dimensions of the seat anchorages;
 - 2.2.4. the dimensions, frame, materials and padding of head restraints, although they may differ in colour and covering;
 - 2.2.5. the type and dimensions of the attachments of the head restraint and the characteristics of the part of the vehicle to which the head restraint is attached, in the case of a separate head restraint;
- 2.3. '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. Depending on its orientation, a seat is defined as follows:

⁽¹⁾ As defined in Annex 7 to the Consolidated Resolution on the Construction of vehicles (R.E.3), document TRANS/WP.29/78/Rev.1/Amend.2, as last amended by Amendment 4.

- 2.3.1. 'Forward-facing seat' means a seat which can be used whilst the vehicle is in motion and which faces towards the front of the vehicle in such a manner that the vertical plane of symmetry of the seat forms an angle of less than $+10^{\circ}$ or -10° with the vertical plane of symmetry of the vehicle;
- 2.3.2. 'Rearward-facing seat' means a seat which can be used whilst the vehicle is in motion and which faces towards the rear of the vehicle in such a manner that the vertical plane of symmetry of the seat forms an angle of less than $+10^{\circ}$ or -10° with the vertical plane of symmetry of the vehicle;
- 2.3.3. 'Side-facing seat' means a seat which, with regard to its alignment with the vertical plane of symmetry of the vehicle, does not meet either of the definitions given in paragraph 2.3.1 or 2.3.2 above;
- 2.4. 'Bench seat' means a structure complete with trim, intended to seat more than one adult person;
- 2.5. 'Anchorage' means the system by which the seat assembly is secured to the vehicle structure, including the affected parts of the vehicle structure;
- 2.6. '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:
 - 2.6.1. longitudinal displacement;
 - 2.6.2. vertical displacement;
 - 2.6.3. angular displacement;
- 2.7. 'Displacement system' means a device by which the seat or one of its parts can be displaced and/or rotated, without a fixed intermediate position, to permit easy access of occupants to the space behind the seat concerned;
- 2.8. 'Locking system' means a device ensuring that the seat and its parts are maintained in the position of use;
- 2.9. 'Folding seat' means an auxiliary seat intended for occasional use and normally folded;
- 2.10. 'Transverse plane' means a vertical plane perpendicular to the median longitudinal plane of the vehicle;
- 2.11. 'Longitudinal plane' means a plane parallel to the median longitudinal plane of the vehicle;
- 2.12. 'Head restraint' means a device whose purpose is to limit the rearward displacement of an adult occupant's head in relation to his torso in order to reduce the danger of injury to the cervical vertebrae in the event of an accident;
 - 2.12.1. 'Integrated head restraint' means a head restraint formed by the upper part of the seat-back. Head restraints meeting the definitions of paragraphs 2.12.2 or 2.12.3 below but which can only be detached from the seat or the vehicle structure by the use of tools or by partial or complete removal of the seat covering, meet the present definition;
 - 2.12.2. 'Detachable head restraint' means a head restraint consisting of a component separable from the seat designed for insertion and positive retention in the seat-back structure;

- 2.12.3. 'Separate head restraint' means a head restraint consisting of a component separate from the seat, designed for insertion and/or positive retention in the structure of the vehicle;
 - 2.13. 'R point' means the seating reference point as defined in annex 3 to this Regulation;
 - 2.14. 'Reference line' means the line on the manikin reproduced in annex 3, appendix 1, figure 1, to this Regulation.
 - 2.15. 'Partitioning system' means parts or devices which, in addition to the seat-backs, are intended to protect the occupants from displaced luggage; in particular, a partitioning system may be constituted by netting or wire mesh located above the level of the seat-backs in their upright or folded down position. Head restraints fitted as standard equipment for vehicles equipped with such parts or devices shall be considered as part of the partitioning system. However, a seat equipped with a head restraint shall not be considered as being on its own a partitioning system.
3. APPLICATION FOR APPROVAL
- 3.1. The application for approval of a vehicle type shall be submitted by the vehicle manufacturer or by his duly accredited representative.
 - 3.2. It shall be accompanied by the following documents in triplicate and the following particulars:
 - 3.2.1. a detailed description of the vehicle type with regard to the design of the seats, their anchorages, and their adjustment, displacement and locking systems;
 - 3.2.1.1. A detailed description and/or drawings of the partitioning system, if applicable.
 - 3.2.2. drawings, on an appropriate scale and in sufficient detail, of the seats, their anchorages on the vehicle, and their adjustment, displacement and locking systems.
 - 3.2.3. In the case of a seat with a detachable head restraint:
 - 3.2.3.1. a detailed description of the head restraint, specifying in particular the nature of the padding material or materials;
 - 3.2.3.2. a detailed description of the location, the type of support and the attachments for mounting the head restraint on the seat.
 - 3.2.4. In the case of a separate head restraint:
 - 3.2.4.1. a detailed description of the head restraint, specifying in particular the nature of the padding material or materials;
 - 3.2.4.2. a detailed description of the location, and the attachments for fitting the head restraint to the structure of the vehicle.
 - 3.3. The following shall be submitted to the technical service responsible for the approval tests:
 - 3.3.1. a vehicle representative of the vehicle type to be approved or the parts of the vehicle which the technical service deems necessary for approval tests;
 - 3.3.2. an additional set of the seats with which the vehicle is equipped, with their anchorages.
 - 3.3.3. For vehicles with seats fitted or capable of being fitted with head restraints, in addition to the requirements set out in paragraphs 3.3.1 and 3.3.2:
 - 3.3.3.1. in the case of detachable head restraints: an additional set of seats, fitted with head restraints, with which the vehicle is equipped, together with their anchorages.

- 3.3.3.2. In the case of separate head restraints: an additional set of the seats with which the vehicle is equipped, with their anchorages, an additional set of the corresponding head restraints and the part of the vehicle structure to which the head restraint is fitted, or a complete structure.
4. APPROVAL
- 4.1. If the vehicle submitted for approval pursuant to this Regulation meets the relevant requirements (seats fitted with head restraints or capable of being fitted with head restraints), approval of the vehicle type shall be granted.
- 4.2. An approval number shall be assigned to each type approved. Its first two digits (at present 08, corresponding to the 08 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 either to the same vehicle type equipped with other types of seats or head restraints or with seats anchored differently on the vehicle (this applies both to seats with and to those without head restraints) or to another vehicle type.
- 4.3. Notice of approval or extension or refusal of approval of a vehicle type pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation by means of a form conforming to the model in annex 1 to this 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, followed by the letter 'R', a dash and the approval number, to the right of the circle prescribed in paragraph 4.4.1.
- 4.4.3. However, if the vehicle is equipped with one or more seats fitted or capable of being fitted with head restraints, approved as meeting the requirements under paragraphs 5.2 and 5.3 below, the number of this Regulation shall be followed by the letters 'RA'. The form conforming to the model in annex 1 to this Regulation shall indicate which seat(s) of the vehicle is (are) fitted or capable of being fitted with head restraints. The marking shall also indicate that any remaining seats in the vehicle, not fitted or capable of being fitted with head restraints, are approved and meet the requirements of paragraph 5.2 below of this Regulation.
- 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 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.

⁽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, 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, 53 for Thailand, 54 and 55 (vacant) and 56 for Montenegro. 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.

- 4.6. 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. Examples of arrangements of approval marks are given in annex 2 to this Regulation.
5. REQUIREMENTS
- 5.1. General requirements
- 5.1.1. The installation of side-facing seats shall be prohibited in vehicles of categories M1, N1, M2 (of class III or B) and M3 (of class III or B).
- 5.1.2. It does not apply to ambulances or to vehicles intended for use by the armed services, civil defence, fire services and forces responsible for maintaining public order.
- 5.1.3. It shall also not apply to vehicles of category M3 (of class III or B) of a technically permissible maximum laden mass exceeding 10 tonnes in which side facing seats are grouped together at the rear of the vehicle to form an integrated room of up to 10 seats. Such side-facing seats shall be fitted with, at least, a head restraint and a two-point belt with retractor type-approved in accordance with Regulation No 16. The anchorages for the safety belts shall comply with Regulation No 14.
- 5.2. General requirements applicable to all seats of vehicles of category M1 ⁽¹⁾
- 5.2.1. Every adjustment and displacement system provided shall incorporate a locking system, which shall operate automatically. Locking systems for armrests or other comfort devices are not necessary unless the presence of such devices will cause additional risk of injury to the occupants of a vehicle in the event of a collision.
- 5.2.2. The unlocking control for a device as referred to in paragraph 2.7 shall be placed on the outside of the seat close to the door. It shall be easily accessible, even to the occupant of the seat immediately behind the seat concerned.
- 5.2.3. The rear parts of seats situated in area 1, defined in paragraph 6.8.1.1 shall pass the energy dissipation test in accordance with the requirements of annex 6 to this Regulation.
- 5.2.3.1. This requirement is deemed to be met if in the tests carried out by the procedure specified in annex 6 the deceleration of the headform does not exceed 80 g continuously for more than 3 ms. Moreover, no dangerous edge shall occur during or remain after the test.
- 5.2.3.2. The requirements of paragraph 5.1.3 shall not apply to rearmost seats; to back-to-back seats or to seats that comply with the provisions of Regulation No 21 'Uniform Provisions concerning the Approval of Vehicles with regard to their Interior Fittings' (E/ECE/324 E/ECE/TRANS/505/Rev.1/Add.20/Rev.2, as last amended).
- 5.2.4. The surface of the rear parts of seats shall exhibit no dangerous roughness or sharp edges likely to increase the risk of severity of injury to the occupants. This requirement is considered as satisfied if the surface of the rear parts of seats tested in the conditions specified in paragraph 6.1 exhibit radii of curvature not less than:
- 2,5 mm in area 1,
- 5,0 mm in area 2,
- 3,2 mm in area 3.
- These areas are defined in paragraph 6.8.1.
- 5.2.4.1. This requirement does not apply to:

⁽¹⁾ Vehicles of category M2, which are approved to this Regulation as an alternative to Regulation No 80 (in line with paragraph 1.2 to that Regulation) shall also meet the requirements of this paragraph.

- 5.2.4.1.1. the parts of the different areas exhibiting a projection of less than 3,2 mm from the surrounding surface, which shall exhibit blunted edges, provided that the height of the projection is not more than half its width;
- 5.2.4.1.2. Rearmost seats, to back-to-back seats or to seats that comply with the provisions of Regulation No 21 'Uniform Provisions concerning the Approval of Vehicles with regard to their Interior Fittings' (E/ECE/324 E/ECE/TRANS/505/Rev.1/ Add.20/Rev.2, as last amended);
- 5.2.4.1.3. Rear parts of seats situated below a horizontal plane passing through the lowest R point in each row of seats. (Where rows of seats have different heights, starting from the rear, the plane shall be turned up or down forming a vertical step passing through the R point of the row of seats immediately in front);
- 5.2.4.1.4. parts such as 'flexible wire mesh'.
- 5.2.4.2. In area 2, defined in paragraph 6.8.1.2, surfaces may exhibit radii less than 5 mm, but not less than 2,5 mm provided that they pass the energy-dissipation test prescribed in annex 6 to this Regulation. Moreover, these surfaces must be padded to avoid direct contact of the head with the seat frame structure.
- 5.2.4.3. If the areas defined above contain parts covered with material softer than 50 Shore A hardness, the above requirements, with the exception of those relating to the energy-dissipation test in accordance with the requirements of annex 6, shall apply only to the rigid parts.
- 5.2.5. No failure shall be shown in the seat frame or in the seat anchorage, the adjustment and displacement systems or their locking devices during or after the tests prescribed in paragraphs 6.2 and 6.3. Permanent deformations, including ruptures, may be accepted, provided that these do not increase the risk of injury in the event of a collision and the prescribed loads were sustained.
- 5.2.6. No release of the locking systems shall occur during the tests described in paragraph 6.3 and in annex 9, paragraph 2.1.
- 5.2.7. After the tests, the displacement systems intended for permitting or facilitating the access of occupants must be in working order; they must be capable, at least once, of being unlocked and must permit the displacement of the seat or the part of the seat for which they are intended.

Any other displacement systems, as well as adjustment systems and their locking systems are not required to be in working order.

In the case of seats provided with head restraints, the strength of the seat-back and of its locking devices is deemed to meet the requirements set out in paragraph 6.2 when, after testing in accordance with paragraph 6.4.3.6, no breakage of the seat or seat-back has occurred; otherwise, it must be shown that the seat is capable of meeting the test requirements set out in paragraph 6.2.

In the case of seats (benches) with more places to sit than head restraints, the test described in paragraph 6.2 shall be carried out.

- 5.3. General specifications applicable to seats of vehicles of categories N1, N2 and N3 and to seats of vehicles of categories M2 and M3 not covered by Regulation No 80.

With the exception of the provisions of paragraph 5.1, the requirements also apply to side-facing seats of all categories of vehicles.

- 5.3.1. Seats and bench seats must be firmly attached to the vehicle.
- 5.3.2. Sliding seats and bench seats must be automatically lockable in all the positions provided.

- 5.3.3. Adjustable seat-backs must be lockable in all the positions provided.
- 5.3.4. All seats which can be tipped forward or have fold-on backs must lock automatically in the normal position. This requirement does not apply to seats fitted in the wheelchair spaces of vehicles of category M2 or M3 of class I, II or A.
- 5.4. Mounting of head restraints
 - 5.4.1. A head restraint shall be mounted on every outboard front seat in every vehicle of category M1. Seats fitted with head restraints, intended for fitment in other seating positions and in other categories of vehicles may also be approved to this Regulation.
 - 5.4.2. A head restraint shall be mounted on every outboard front seat in every vehicle of category M2 with a maximum mass not exceeding 3 500 kg and of category N1; head restraints mounted in such vehicles shall comply with the requirements of Regulation No 25, as amended by the 03 series of amendments.
- 5.5. Special requirements for seats fitted or capable of being fitted with head restraints
 - 5.5.1. The presence of the head restraint must not be an additional cause of danger to occupants of the vehicle. In particular, it shall not in any position of use exhibit any dangerous roughness or sharp edge liable to increase the risk or seriousness of injury to the occupants.
 - 5.5.2. Parts of the front and rear faces of the head restraints situated in area 1, as defined in paragraph 6.8.1.1.3 below shall pass the energy absorption test.
 - 5.5.2.1. This requirement is deemed to be met if in the tests carried out by the procedure specified in annex 6 the deceleration of the headform does not exceed 80 g continuously for more than 3 ms. Moreover, no dangerous edge shall occur during or remain after the test.
 - 5.5.3. Parts of the front and rear faces of head restraints situated in area 2, as defined in paragraph 6.8.1.2.2 below, shall be so padded as to prevent any direct contact of the head with the components of the structure and shall meet the requirements of paragraph 5.2.4 above applicable to the rear parts of seats situated in area 2.
 - 5.5.4. The requirements of paragraphs 5.5.2 and 5.5.3 above, shall not apply to parts of rear faces of head restraints designed to be fitted to seats behind which no seat is provided.
 - 5.5.5. The head restraint shall be secured to the seat or to the vehicle structure in such a way that no rigid and dangerous parts project from the padding of the head restraint or from its attachment to the seat-back as a result of the pressure exerted by the headform during the test.
 - 5.5.6. In the case of a seat fitted with a head restraint, the provisions of paragraph 5.1.3 may, after agreement of the technical service, be considered to be met if the seat fitted with its head restraint complies with the provisions of paragraph 5.5.2 above.
- 5.6. Height of head restraints
 - 5.6.1. The height of head restraints shall be measured as described in paragraph 6.5 below.
 - 5.6.2. For head restraints not adjustable for height, the height shall be not less than 800 mm in the case of front seats and 750 mm in the case of other seats.
 - 5.6.3. For head restraints adjustable for height:
 - 5.6.3.1. the height shall be not less than 800 mm in the case of front seats and 750 mm in the case of other seats; this value shall be obtained in a position between the highest and lowest positions to which adjustment is possible;
 - 5.6.3.2. there shall be no 'use position' resulting in a height of less than 750 mm;

- 5.6.3.3. in the case of seats other than the front seats the head restraints may be such that they can be displaced to a position resulting in a height of less than 750 mm, provided that such position is clearly recognizable to the occupant as not being included for the use of the head restraint;
- 5.6.3.4. in the case of front seats head restraints may be such that they can be automatically displaced when the seat is not occupied, to a position resulting in a height of less than 750 mm, provided that they automatically return to the position of use when the seat is occupied.
- 5.6.4. The dimensions mentioned in paragraphs 5.6.2 and 5.6.3.1 above may be less than 800 mm in the case of front seats and 750 mm in the case of other seats to leave adequate clearance between the head restraint and the interior surface of the roof, the windows or any part of the vehicle structure; however, the clearance shall not exceed 25 mm. In the case of seats fitted with displacement and/or adjustment systems, this shall apply to all seat positions. Furthermore, by derogation to paragraph 5.6.3.2 above, there shall not be any 'use position' resulting in a height lower than 700 mm.
- 5.6.5. By derogation to the height requirements mentioned in paragraphs 5.6.2 and 5.6.3.1 above, the height of any head restraint designed to be provided in rear centre seats or seating positions shall be not less than 700 mm.
- 5.7. In the case of a seat capable of being fitted with a head restraint, the provisions of paragraphs 5.1.3 and 5.4.2 above shall be verified.
- 5.7.1. The height of the part of the device on which the head rests, measured as described in paragraph 6.5 below, shall in the case of a head restraint adjustable for height be not less than 100 mm.
- 5.8. There shall be no gap of more than 60 mm between the seat-back and the head restraint in the case of a device not adjustable for height. If the head restraint is adjustable for height it shall, in its lowest position, be not more than 25 mm from the top of the seat-back. In the case of seats or bench seats adjustable in height provided with separate head restraints, this requirement shall be verified for all the positions of the seat or bench seat.
- 5.9. In the case of head restraints integral with the seat-back, the area to be considered is:
- above a plane perpendicular to the reference line at 540 mm from the R point.
- Between two vertical longitudinal planes passing at 85 mm on either side of the reference line. In this area, one or more gaps which regardless of their shape can show a distance 'a' of more than 60 mm when measured as described in paragraph 6.7 below, are permitted provided that, after the additional test under paragraph 6.4.3.3.2 below, the requirements of paragraph 5.11 below are still met.
- 5.10. In the case of head restraints adjustable for height one or more gaps, which regardless of their shape can show a distance 'a' of more than 60 mm when measured as described in paragraph 6.7 below, are permitted on the part of the device serving as a head restraint provided that, after the additional test under paragraph 6.4.3.3.2 below, the requirements of paragraph 5.12 below are still met.
- 5.11. The width of the head restraint shall be such as to provide appropriate support for the head of a person normally seated. As determined according to the procedure described in paragraph 6.6 below, the head restraint shall cover an area extending not less than 85 mm to each side of the vertical median plane of the seat for which the head restraint is intended.
- 5.12. The head restraint and its anchorage shall be such that the maximum backward displacement X of the head permitted by the head restraint and measured in conformity with the static procedure laid down in paragraph 6.4.3 below, is less than 102 mm.

- 5.13. The head restraint and its anchorage shall be strong enough to bear without breakage the load specified in paragraph 6.4.3.6 below. In the case of head restraints integral with the seat-back, the requirements of this paragraph shall apply to the part of the seat-back structure situated above a plane perpendicular to the reference line at 540 mm from the R point.
- 5.14. If the head restraint is adjustable, it shall not be possible to raise it beyond the maximum operational height except by deliberate action on the part of the user distinct from any act necessary for its adjustment.
- 5.15. The strength of the seat-back and of its locking devices is deemed to meet the requirements set out in paragraph 6.2 below when, after testing in accordance with paragraph 6.4.3.6 below, no breakage of the seat or seat-back has occurred; otherwise, it shall be shown that the seat is capable of meeting the test requirements set out in paragraph 6.2 below.
- 5.16. Special requirements regarding the protection of occupants from displaced luggage
- 5.16.1. Seat-backs

Seat-backs and/or head restraints located such that they constitute the forward boundary of the luggage compartment, all seats being in place and in the normal position of use as indicated by the manufacturer, shall have sufficient strength to protect the occupants from displaced luggage in a frontal impact. This requirement is deemed to be met if, during and after the test described in annex 9, the seat-backs remain in position and the locking mechanisms remain in place. However, the deformation of the seat-backs and their fastenings during the test is permitted, provided that the forward contour of the parts of the tested seat-back and/or head restraints, that are harder than 50 Shore A, does not move forward of a transverse vertical plane which passes through:

- (a) a point of 150 mm forward of the R point of the seat in question, for the parts of the head restraint;
- (b) a point of 100 mm forward of the R point of the seat in question, for parts of the seat-back;

excluding the rebound phases of the test blocks.

For integrated head restraints, the limit between the head restraint and the seat-back is defined by the plane perpendicular to the reference line 540 mm from the R point.

All measurements shall be taken in the longitudinal median plane of the corresponding seat or seating position for each seating position constituting the forward boundary of the luggage compartment.

During the test described in annex 9, the test blocks shall remain behind the seat-back(s) in question.

5.16.2. Partitioning systems

At the request of the vehicle manufacturer, the test described in annex 9 may be carried out with the partitioning systems in place, if these systems are fitted as standard equipment for the particular type of vehicle.

Partitioning systems, netting wire mesh located above the seat-backs in their normal position of use, shall be tested according to paragraph 2.2 of annex 9.

This requirement is deemed to be met if, during the test, the partitioning systems remain in position. However, the deformation of the partitioning systems during the test is permitted, provided that the forward contour of the partitioning (including parts of the tested seat-back(s) and/or head restraint(s) that are harder than 50 Shore A does not move forward of a transverse vertical plane which passes through:

- (a) a point of 150 mm forward of the R point of the seat in question, for parts of the head restraint;

- (b) a point of 100 mm forward of the R point of the seat in question, for parts of the seat-back and part of the partitioning system others than the head restraint.

For integrated head restraint, the limit between the head restraint and the seat-back is the one defined in paragraph 5.16.1.

All measurements shall be taken in the longitudinal median plane of the corresponding seat or seating position for each seating position constituting the forward boundary of the luggage compartment.

After the test, no sharp or rough edges likely to increase the danger or severity of injuries of the occupants shall be present.

- 5.16.3. The requirements mentioned in paragraphs 5.15.1 and 5.15.2 above shall not apply to luggage retention systems which are activated automatically in case of an impact. The manufacturer shall demonstrate to the satisfaction of the technical service that the protection offered by such systems is equivalent to that described in paragraphs 5.16.1 and 5.16.2.

6. TESTS

6.1. General specifications applicable to all tests

- 6.1.1. The seat-back, if adjustable, shall be locked in a position corresponding to a rearward inclination as close as possible to 25° from the vertical of the torso reference line of the manikin described in annex 3, unless otherwise specified by the manufacturer.

- 6.1.2. When a seat, its locking mechanism and its installation are identical or symmetrical with respect to another seat on the vehicle, the technical service may test only one such seat.

- 6.1.3. In the case of seats with adjustable head restraints, the tests shall be conducted with the head restraints placed in the most unfavourable position (generally, the highest position) allowed by its adjusting system.

6.2. Test of strength of the seat-back and its adjustment systems

- 6.2.1. A force producing a moment of 53 daNm in relation to the R point shall be applied longitudinally and rearwards to the upper part of the seat-back frame through a component simulating the back of the manikin shown in annex 3 to this Regulation. In the case of a bench seat, where part or all of the supporting frame (including that of the head restraints) is common to more than one seating position, the test shall be conducted simultaneously for all those seating positions.

6.3. Test of strength of the seat anchorage and the adjustment, locking and displacement systems

- 6.3.1. A longitudinal horizontal deceleration or, at the choice of the applicant, acceleration of not less than 20 g shall be applied for 30 milliseconds in a direction to the whole shell of the vehicle imitating a frontal collision, in accordance with the requirements of Annex 7, paragraph 1. At the request of the manufacturer the test pulse described in Annex 9 - appendix may be used alternatively.

- 6.3.2. A longitudinal deceleration or, at the choice of the applicant, acceleration in accordance with the requirements of paragraph 6.3.1 shall be applied imitating a rear collision.

- 6.3.3. The requirements of paragraphs 6.3.1 and 6.3.2 above shall be verified for all positions of the seat. In the case of seats fitted with an adjustable head restraint, the test shall be conducted with the head restraints placed in the most unfavourable position (generally the highest position) allowed by its adjusting system. During the test the seat shall be so positioned that no external factor shall prevent the release of the locking systems.

These conditions shall be considered to be met if the seat is tested after being adjusted in the following positions:

the longitudinal adjustment is fixed one notch or 10 mm rearward of the most forward normal driving position or position of use as indicated by the manufacturer (for seats with independent vertical adjustment, the cushion shall be placed in its highest position);

the longitudinal adjustment is fixed one notch or 10 mm forward of the most rearward normal driving position or position of use as indicated by the manufacturer (for seats with independent vertical adjustment, the cushion shall be placed in its lowest position), and, where appropriate, in accordance with the requirements of paragraph 6.3.4 below.

6.3.4. In cases where the arrangement of the locking systems is such that, in a seat position other than those defined in paragraph 6.3.3 above, the distribution of the forces on the locking devices and seat anchorages would be less favourable than with either configuration defined in paragraph 6.3.3, the tests shall be conducted for that less favourable seating position.

6.3.5. The test conditions of paragraph 6.3.1 shall be considered to be satisfied if, at the request of the manufacturer, they are replaced by a collision test of the complete vehicle in running order against a rigid barrier as laid down in paragraph 2 of annex 7 to this Regulation. In this case, the seat shall be adjusted for the least favourable conditions of distribution of stresses in the anchorage system as provided for in paragraphs 6.1.1, 6.3.3 and 6.3.4 above.

6.4. Test of the performance of the head restraint

6.4.1. If the head restraint is adjustable, it shall be placed in the most unfavourable position (generally the highest position) allowed by its adjustment system.

6.4.2. In the case of a bench seat, where part or all of the supporting frame (including that of the head restraints) is common to more than one seating position, the test shall be conducted simultaneously for all those seating positions.

6.4.3. Test

6.4.3.1. All lines, including the projections of the reference line, shall be drawn in the vertical median plane of the seat or seating position concerned (see annex 5 to this Regulation).

6.4.3.2. The displaced reference line is determined by applying to the part simulating the back of the manikin referred to in annex 3 to this Regulation an initial force producing a rearward moment of 37,3 daNm about the R point.

6.4.3.3. By means of a spherical headform 165 mm in diameter an initial force producing a moment of 37,3 daNm about the R point is applied at right angles to the displaced reference line at a distance of 65 mm below the top of the head restraint, the reference line being kept in its displaced position in accordance with paragraph 6.4.3.2.

6.4.3.3.1. If the presence of gaps prevents the application of the force prescribed in paragraph 6.4.3.3 at 65 mm from the top of the head restraint, the distance may be reduced so that the axis of the force passes through the centre line of the frame element nearest to the gap.

6.4.3.3.2. In the cases described in paragraphs 5.9 and 5.10 above, the test shall be repeated by applying to each gap, using a sphere of 165 mm in diameter, a force:

passing through the centre of gravity of the smallest of the sections of the gap, along transversal planes parallel to the reference line, and

reproducing a moment of 37,3 daNm about the R point.

6.4.3.4. The tangent Y to the spherical headform, parallel to the displaced reference line, is determined.

6.4.3.5. The distance X, provided for in paragraph 5.12 above, between the tangent Y and the displaced reference line is measured.

- 6.4.3.6. To check the effectiveness of the head restraint, the initial load specified in paragraphs 6.4.3.3 and 6.4.3.3.2 is increased to 89 daN unless the breakage of the seat or seat-back occurs earlier.
- 6.5. Determination of the height of the head restraint
- 6.5.1. All lines, including the projection of the reference line, shall be drawn in the vertical median plane of the seat or seating position concerned, the intersection of such plane with the seat determining the contour of the head restraint and of the seat-back (see figure 1 of annex 4 to this Regulation).
- 6.5.2. The manikin described in annex 3 to this Regulation shall be placed in a normal position on the seat.
- 6.5.3. The projection of the reference line of the manikin shown in annex 3 to this Regulation is then, in the seat concerned, drawn in the plane specified in paragraph 6.4.3.1 above.
- The tangent S to the top of the head restraint is drawn perpendicular to the reference line.
- 6.5.4. The distance 'h' from the R point to the tangent S is the height to be taken into consideration in implementing the requirements of paragraph 5.6 above.
- 6.6. Determination of the width of the head restraint
- (see figure 2 of annex 4 to this Regulation)
- 6.6.1. The plane S1, perpendicular to the reference line and situated 65 mm below the tangent S defined in paragraph 6.5.3 above, determines a section in the head restraint bounded by the outline C.
- 6.6.2. The width of the head restraint to be taken into consideration in implementing the requirements of paragraph 5.11 above, is the distance 'L' measured in the plane S1 between the vertical longitudinal planes P and P'.
- 6.6.3. The width of the head restraint shall if necessary also be determined in the plane perpendicular to the reference line 635 mm above the R point of the seat, this distance being measured along the reference line.
- 6.7. Determination of distance 'a' of head restraint gaps
- (see annex 8 to this Regulation)
- 6.7.1. The distance 'a' shall be determined for each gap and in relation to the front face of the head restraint, by means of a sphere having a diameter of 165 mm.
- 6.7.2. The sphere shall be put into contact with the gap in a point of the gap area which allows the maximum sphere intrusion, considering no load is to be applied.
- 6.7.3. The distance between the two points of contact of the sphere with the gap will constitute the distance 'a' to be considered for the evaluation of the provisions under paragraphs 5.9 and 5.10 above.
- 6.8. Tests for checking energy dissipation on the seat-back and head restraint
- 6.8.1. The surfaces of the rear parts of seats to be checked are those situated in the areas defined below which can be contacted by a 165 mm diameter sphere when the seat is mounted in the vehicle.
- 6.8.1.1. Area 1

- 6.8.1.1.1. In the case of separate seats without head restraints, this area shall include the rear part of the seat-back between the longitudinal vertical planes situated at 100 mm on either side of the longitudinal median plane of the seat centre line, and above a plane perpendicular to the reference line 100 mm below the top of the seat-back.
- 6.8.1.1.2. In the case of bench seats without head restraints, this area shall extend between the longitudinal vertical planes situated at 100 mm on either side of the longitudinal median plane of each designated outboard seating position defined by the manufacturer and above a plane perpendicular to the reference line 100 mm below the top of the seat-back.
- 6.8.1.1.3. In the case of seats or bench seats with head restraints, this area shall extend between the longitudinal vertical planes, on either side of and 70 mm from the longitudinal median plane of the seat or of the seating position concerned and situated above the plane perpendicular to the reference line 635 mm from the R point. For the test, the head restraint, if adjustable shall be placed in the most unfavourable position (generally the highest) permitted by its adjustment system.
- 6.8.1.2. Area 2
- 6.8.1.2.1. In the case of seats or bench seats without head restraints and seats or bench seats with detachable or separate head restraints, area 2 shall extend above a plane perpendicular to the reference line 100 mm distant from the top of the seat-back, other than parts of area 1.
- 6.8.1.2.2. In the case of seats or bench seats with integrated head restraints, area 2 shall extend above a plane perpendicular to the reference line 440 mm distant from the R point of the seat or of the seating position concerned, other than parts of area 1.
- 6.8.1.3. Area 3
- 6.8.1.3.1. Area 3 is defined as the part of the back of the seat or the bench seats situated above the horizontal planes defined in paragraph 5.2.4.1.3 above, excluding parts situated in area 1 and area 2.
- 6.9. Equivalent test methods
- If a test method other than those specified in paragraphs 6.2, 6.3, 6.4 above and annex 6 is used, its equivalence shall be proved.
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. Every vehicle approved pursuant to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set out in paragraph 5 above. However, in the case of head restraints as defined in paragraph 2.12.2 and 2.12.3 above, nothing shall prevent the vehicle from conforming to the vehicle type approved, even if it is marketed with seats not fitted with head restraints.
- 7.2. The competent authority which granted type approval may at any time verify the conformity control methods applied for each production unit. The authority may also carry out random checks on serially-manufactured vehicles in respect to the requirements set out in paragraph 5 above.
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 7.1 above are not complied with or if the vehicles fail in the checks prescribed in paragraph 7 above.

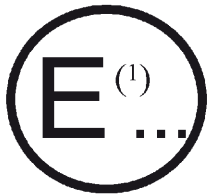
- 8.2. If a Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation by means of a communication form conforming to the model in annex 1 to this Regulation.
9. MODIFICATIONS OF THE VEHICLE TYPE AND EXTENSION OF APPROVAL WITH RESPECT TO THE SEATS, THEIR ANCHORAGES AND/OR THEIR HEAD RESTRAINTS
- 9.1. Every modification of the vehicle type with respect to the seats, their anchorages and/or their head restraints shall be notified to the administrative department which approved the vehicle type. The department may then either:
- 9.1.1. consider that the modifications made are unlikely to have an appreciable adverse effect, and that in any event the vehicle still complies with the requirements; or
- 9.1.2. consider that the modifications are sufficiently unimportant for the results specified in paragraph 6.2, 6.3 and 6.4 above to be verified by calculations based on the approval test results; or
- 9.1.3. require a further report from the technical service responsible for conducting the tests.
- 9.2. Confirmation or refusal of approval, specifying the modifications, shall be communicated to the Parties to the Agreement applying this Regulation by means of the procedure laid down in paragraph 4.3 above.
- 9.3. 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.
10. PRODUCTION DEFINITELY DISCONTINUED
- 10.1. If the holder of the approval completely ceases to manufacture a device 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.
11. INSTRUCTIONS FOR USE
- 11.1. For seats fitted with adjustable head restraints, the manufacturers shall provide instructions on how to operate, adjust, lock and, where applicable, remove the head restraints.
12. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS AND OF ADMINISTRATIVE DEPARTMENTS
- The 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.
13. TRANSITIONAL PROVISIONS
- 13.1. 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.
- 13.2. As from 1 October 1999, Contracting Parties applying this Regulation shall grant ECE approvals only if the requirements of this Regulation, as amended by the 06 series of amendments, are satisfied.

- 13.3. As from 1 October 2001, 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.
 - 13.4. As from the official date of entry into force of the 07 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approvals under this Regulation as amended by the 07 series of amendments.
 - 13.5. As from 24 months after the date of entry into force of the 07 series of amendments, Contracting Parties applying this Regulation shall grant ECE approval only if the vehicle type to be approved complies with the requirements of this Regulation as amended by the 07 series of amendments.
 - 13.6. As from 48 months after the date of entry into force of the 07 series of amendments, existing approvals to this Regulation shall cease to be valid, except in the case of vehicle types which comply with the requirements of this Regulation as amended by the 07 series of amendments.
 - 13.7. As from the official date of entry into force of the 08 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approvals under this Regulation as amended by the 08 series of amendments.
 - 13.8. As from 24 months after the date of entry into force of the 08 series of amendments, Contracting Parties applying this Regulation shall grant ECE approvals only if the requirements of this Regulation, as amended by the 08 series of amendments, are satisfied.
 - 13.9. As from 36 months after the date of entry into force of the 08 series of amendments, Contracting Parties applying this Regulation may refuse to recognize approvals which were not granted in accordance with the 08 series of amendments to this Regulation.
 - 13.10. Notwithstanding paragraphs 13.8 and 13.9, approvals of the vehicle categories which are not affected by the 08 series of amendments shall remain valid and Contracting Parties applying the Regulation shall continue to accept them.
 - 13.11. As long as there are no requirements forbidding side-facing seats in their national requirements at the time of acceding to this Regulation, Contracting Parties may continue to allow the fitting of side-facing seats for the purpose of national approval and in this case these bus categories cannot be type approved under this Regulation
 - 13.12. The exemption referred to in paragraph 5.1.3 shall cease to have effect on 20 October 2010. It may be extended if reliable accident statistics are available and there has been further development of restraint systems.
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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 the strength of the seats and their anchorages, in the case either of seats fitted or capable of being fitted with head restraints or of seats not capable of being fitted with such devices and the characteristics of head restraints pursuant to Regulation No 17

Approval No Extension No

1. Trade name or mark of the motor vehicle
2. Vehicle type
3. Manufacturer's name and address
4. If applicable, name and address of the manufacturer's representative

5. Description of seats
6. Number of seats fitted or capable of being fitted with head restraints, adjustable or not adjustable

7. Description of the adjustment, displacement and locking systems of the seat or of its parts and a description of occupant protection system against displacement of luggage
8. Description of seat anchorage
9. Longitudinal position of the seats during the tests
10. Type of device: deceleration/acceleration ⁽²⁾
11. Vehicle submitted for approval on
12. Technical service responsible for conducting approval tests
13. Date of report issued by that service
14. No of report issued by that service
15. Remarks
16. Approval is granted/refused/extended/withdrawn ⁽²⁾

17. Reason(s) of extension (if applicable)
18. Position of approval mark on the vehicle
19. Place
20. Date
21. Signature
22. The following documents, bearing the approval number shown above, are annexed to this communication:
- ... drawings, diagrams and plans of the seats, their anchorage on the vehicle, the adjustment and displacement systems of the seats and their parts, and their locking devices
 - ... photographs of the seats, their anchorages, the adjustment and displacement systems of the seats and their parts, and their locking devices, and of additional occupant protection system against displacement of luggage.

Note: In the case of seats fitted with head restraints as defined in paragraphs 2.12.2 and 2.12.3 of this Regulation, the head restraint shall be shown on all drawings, diagrams and photographs.

⁽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

ARRANGEMENTS OF APPROVAL MARKS

MODEL A

(see paragraphs 4.4, 4.4.1, 4.4.2 and 4.4.3 of this Regulation)

Vehicle with at least one seat fitted or capable of being fitted with a head restraint



a = 8 mm min.

The above approval mark when affixed to a vehicle shows that the vehicle type concerned, with regard to the strength of the seats fitted or capable of being fitted with head restraints and with regard to characteristics of the head restraints, has been approved in the Netherlands (E4) pursuant to Regulation No 17, under the approval number 082439. The first two digits of the approval number indicate that the Regulation already contained the 08 series of amendments at the time of approval. The above approval mark also shows that the vehicle type was approved pursuant to Regulation No 17 with regard to the strength of any seats on the vehicle which are not fitted or capable of being fitted with head restraints.

MODEL B

(see paragraphs 4.4, 4.4.1 and 4.4.2 of this Regulation)

Vehicle with seats not fitted or not capable of being fitted with head restraints



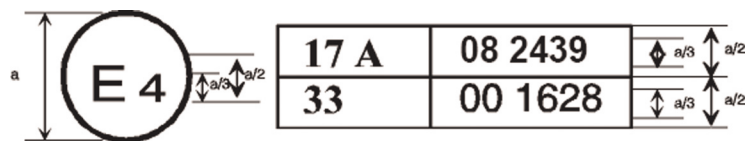
a = 8 mm min.

The above approval mark when affixed to a vehicle shows that the vehicle type has seats not fitted or capable of being fitted with head restraints, and has, with regard to the strength of the seats and their anchorages, been approved in the Netherlands (E4) pursuant to Regulation No 17 under the approval number 082439. The first two digits of the approval number indicate that the Regulation already contained the 08 series of amendments at the time of approval.

MODEL C

(see paragraph 4.5 of this Regulation)

Vehicle with at least one seat fitted or capable of being fitted with a head restraint



a = 8 mm min.

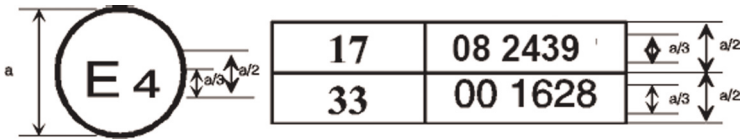
The above approval mark when affixed to a vehicle shows that the vehicle type has at least one seat fitted or capable of being fitted with a head restraint, and was approved in the Netherlands (E4) pursuant to Regulations No 17 and No 33 ⁽¹⁾.

The approval numbers indicate that, on the dates when approval was granted, Regulation No 17 included the 08 series of amendments but Regulation No 33 was still in its original form. The above approval mark also shows that the vehicle type was approved pursuant to Regulation No 17 with regard to the strength of any seats on the vehicle which are not fitted or capable of being fitted with head restraints.

MODEL D

(see paragraph 4.5 of this Regulation)

Vehicle with seats not fitted or not capable of being fitted with head restraints



a = 8 mm min.

The above approval mark when affixed to a vehicle shows that the vehicle type has seats not fitted or capable of being fitted with head restraints, and was approved in the Netherlands (E4) pursuant to Regulations No 17 and No 33 ⁽¹⁾. The approval numbers indicate that, on the dates when approval was granted, Regulation No 17 included the 08 series of amendments but Regulation No 33 was still in its original form.

⁽¹⁾ The second number is given merely as an example.

ANNEX 3

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 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 measured 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. 'Centre plane 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 centre plane of the seat coincides with the centre plane of the occupant. For other seats, the centre plane 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 degree 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 reaches 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 minutes 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 be then 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 the 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.

- 4.5. Place the seat and back assembly of the 3-D H machine so that the centre plane of the occupant (C/LO) coincides with the centre plane 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 centre plane 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 centre plane 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 centre plane 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.

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

- 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 degrees arc (5 degrees to each side of the vertical centre plane) 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 minutes 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

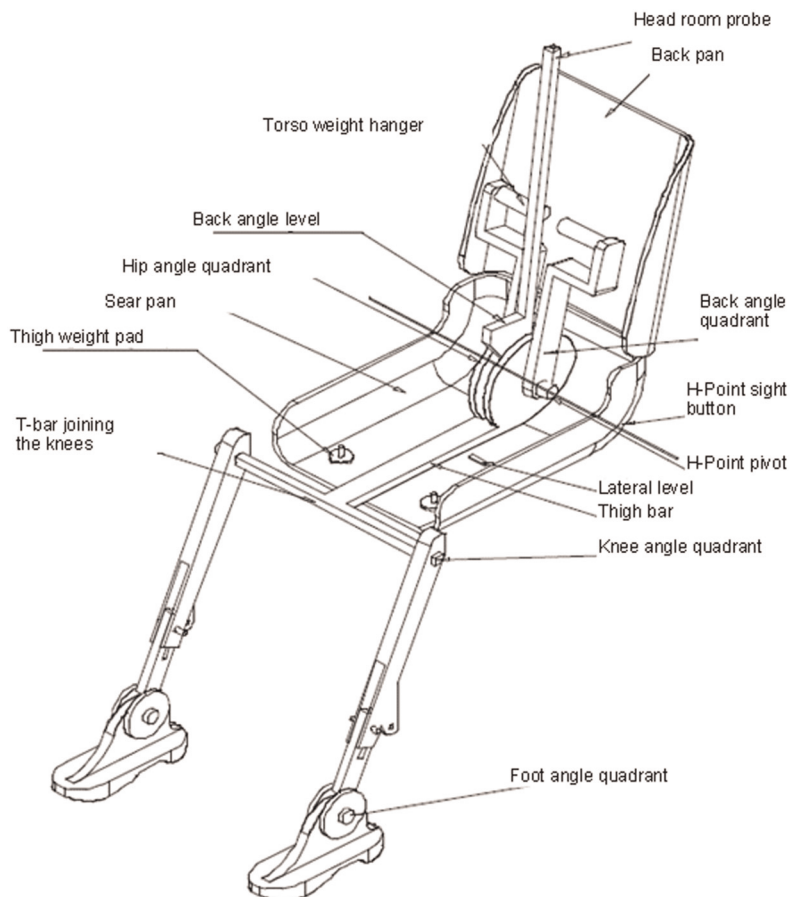
The back and seat pans are constructed of reinforced plastic and metal; they simulate the human torso and thigh and are mechanically hinged at the 'H' point. A quadrant is fastened to the probe hinged at the 'H' point to measure the actual torso angle. An adjustable thigh bar, attached to the seat pan,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

Figure 1

3-D H machine elements designation

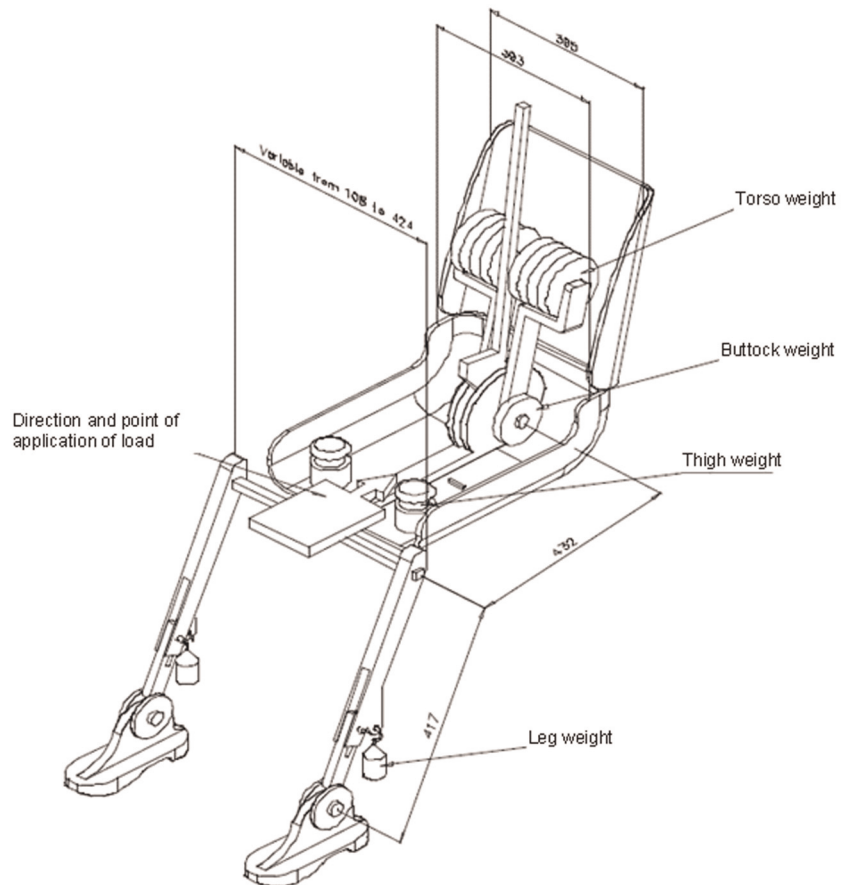


(*) For details of the construction of the 3-D H machine refer to Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, Pennsylvania 15096, United States of America.
The machine corresponds to that described in ISO Standard 6549 : 1980.

Figure 2

Dimensions of the 3-D H machine elements and load distribution

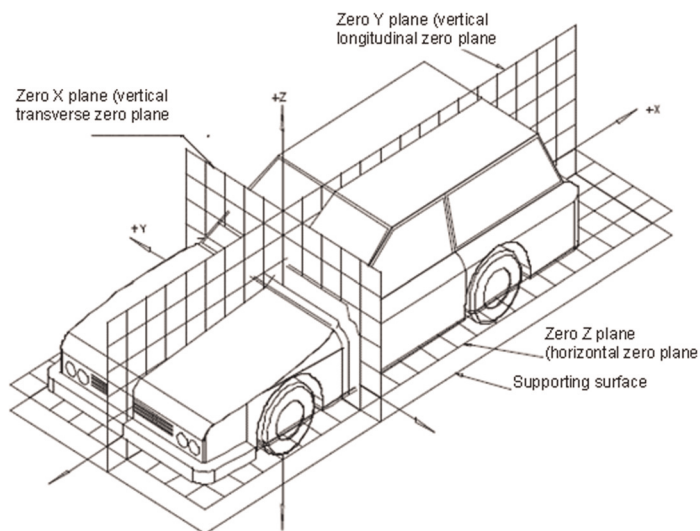
(Dimensions in millimeters)



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 ISO standard 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. Specification for seat adjustment (*)

horizontal:

vertical:

angular:

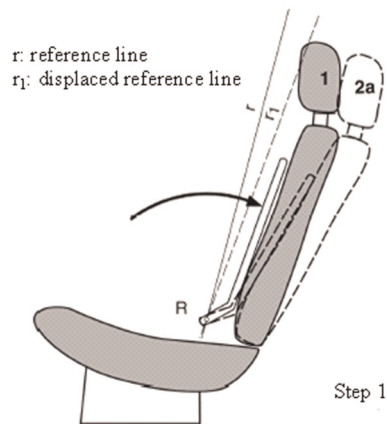
torso angle:

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

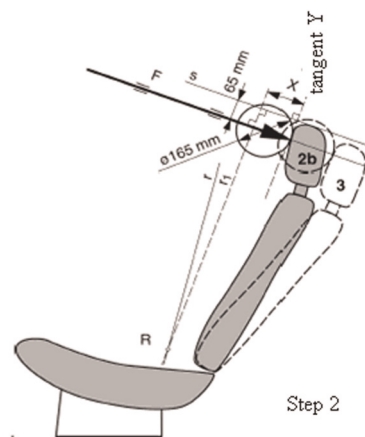
(*) Strike out what does not apply.

ANNEX 5

DETAILS OF LINES AND MEASUREMENTS TAKEN DURING TESTS



1. Original unloaded position.
- 2a. Displaced position by applying to the manikin's back a moment of 373 Nm about the R point, defining the position of the displaced reference line r₁.
- 2b. Displaced position by applying to the 165 mm sphere a force F producing a moment of 373 Nm about the R point, keeping the displaced reference line r₁ in place.
3. Position after displacement by the force F increased to 890 N.



ANNEX 6

TEST PROCEDURE FOR CHECKING ENERGY DISSIPATION**1. INSTALLATION, TEST APPARATUS, RECORDING INSTRUMENTS AND PROCEDURE****1.1. Setting up**

The seat, as mounted in the vehicle, shall be firmly secured to the test bench with the attachment parts provided by the manufacturer, so as to remain stationary when the impact is applied.

The seat-back, if adjustable, shall be locked in the position specified in paragraph 6.1.1 of this Regulation.

If the seat is fitted with a head restraint, the head restraint shall be mounted on the seat-back as in the vehicle. Where the head restraint is separate, it shall be secured to the part of the vehicle structure to which it is normally attached.

If the head restraint is adjustable, it shall be placed in the most unfavourable position allowed by its adjusting systems.

1.2. Test apparatus

1.2.1. This apparatus consists of a pendulum whose pivot is supported by ball-bearings and whose reduced mass (*) at its centre of percussion is 6,8 kg. The lower extremity of the pendulum consists of a rigid headform 165 mm in diameter whose centre is identical with the centre of percussion of the pendulum.

1.2.2. The headform shall be fitted with two accelerometers and a speed-measuring device, all capable of measuring values in the direction of impact.

1.3. Recording instruments

The recording instruments used shall be such that measurements can be made with the following degrees of accuracy:

1.3.1. Acceleration:

accuracy = $\pm 5\%$ of the actual value;

frequency class of data channel: class 600 corresponding to ISO Standard 6487 (1980);

cross-axis sensitivity = $< 5\%$ of the lowest point on the scale.

1.3.2. Speed:

accuracy: $\pm 2,5\%$ of the actual value;

sensitivity: 0,5 km/h.

1.3.3. Time recording:

the instrumentation shall enable the action to be recorded throughout its duration and readings to be made to within one one-thousandth of a second;

the beginning of the impact at the moment of first contact between the headform and the item being tested shall be detected on the recordings used for analysing the test.

(*) The relationship of the reduced mass 'm_r' of the pendulum to the total mass 'm' of the pendulum at a distance 'a' between the centre of percussion and the axis of rotation and at a distance 'l' between the centre of gravity and the axis of rotation is given by the formula:

$$m_r = m \frac{l}{a}$$

1.4. Test procedure

1.4.1. Tests on the seat-back

With the seat installed as indicated in paragraph 1.1 of this annex, the direction of impact from the rear towards the front shall be situated in a longitudinal plane at an angle of 45° from the vertical.

The impact points shall be selected by the test laboratory in area 1 as defined in paragraph 6.8.1.1 of this Regulation, or if necessary in area 2 as defined in paragraph 6.8.1.2 of this Regulation, on surfaces exhibiting radii of curvature less than 5 mm.

1.4.2. Tests on the head restraint

The head restraint shall be fitted and adjusted as indicated in paragraph 1.1 of this annex. Impacts shall be performed on points selected by the test laboratory in area 1 as defined in paragraph 6.8.1.1 of this Regulation, and possibly in area 2 as defined in paragraph 6.8.1.2 of this Regulation, on surfaces exhibiting radii of curvature less than 5 mm.

1.4.2.1. For the rear face, the direction of impact from the rear towards the front shall be in a longitudinal plane at an angle of 45° from the vertical.

1.4.2.2. For the front face, the direction of impact from the front towards the rear shall be horizontal in a longitudinal plane.

1.4.2.3. The front and rear zones are respectively bounded by the horizontal plane tangential to the top of the head restraint as determined in paragraph 6.5 of this Regulation.

1.4.3. The headform shall strike the test item at a speed of 24,1 km/h: this speed shall be achieved either by the mere energy of propulsion or by using an additional impelling device.

2. RESULTS

The deceleration rate shall be taken as the average of the readings on the two accelerometers.

3. EQUIVALENT PROCEDURES (see paragraph 6.9 of this Regulation).

ANNEX 7

Method for testing the strength of seat anchorages and their adjustment, locking and displacement systems**1. TEST OF RESISTANCE TO INERTIA EFFECTS**

- 1.1. The seats to be tested shall be mounted on the vehicle body for which they are designed. This vehicle body shall be firmly anchored on a test trolley as prescribed in the following paragraphs.
- 1.2. The method used for anchoring the vehicle body on the test trolley shall not result in a reinforcement of the seat anchorages.
- 1.3. The seats and their parts shall be adjusted and locked as prescribed in paragraph 6.1.1 and in one of the positions described in paragraph 6.3.3 or 6.3.4 of this Regulation.
- 1.4. If the seats of a group do not present essential differences in the sense of paragraph 2.2 of this Regulation, the tests prescribed in paragraphs 6.3.1 and 6.3.2 of this Regulation may be carried out with one seat adjusted to its foremost position and the other seat adjusted to its rearmost position.
- 1.5. The trolley deceleration or acceleration is measured with data channels of frequency class (CFC) 60 corresponding to the characteristics of International Standard ISO 6487 (2002).

2. COLLISION TEST OF THE COMPLETE VEHICLE AGAINST A RIGID BARRIER

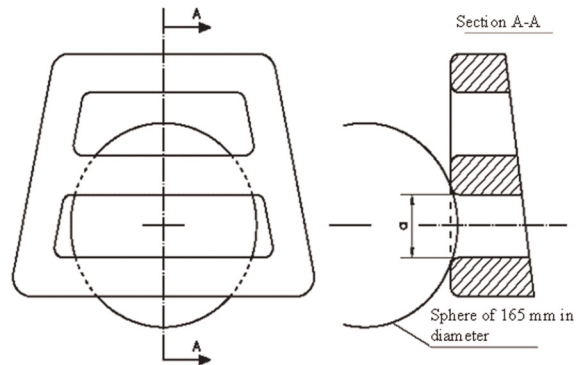
- 2.1. The barrier shall consist of a block of reinforced concrete of not less than 3 m width, not less than 1,5 m height and not less than 0,6 m thickness. The front face shall be perpendicular to the final part of the run-up track and shall be covered with plywood boards 19 ± 1 mm thick. At least 90 tonnes of earth shall be compressed behind the block of reinforced concrete. The barrier of reinforced concrete and earth may be replaced by obstacles having the same front surface, provided that they give equivalent results.
 - 2.2. At the moment of impact the vehicle shall run free. It shall reach the obstacle on a course perpendicular to the collision wall; the maximum lateral misalignment allowed between the vertical median line of the front of the vehicle and the vertical median line of the collision wall shall be ± 30 cm; at the moment of impact the vehicle shall no longer be subjected to the action of any additional steering or propelling device. The speed on impact shall be between 48,3 km/h and 53,1 km/h.
 - 2.3. The fuel feed system shall be filled to at least 90 per cent of its capacity with fuel or an equivalent liquid.
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ANNEX 8

DETERMINATION OF DIMENSION 'a' OF HEAD RESTRAINT GAPS

Figure 1

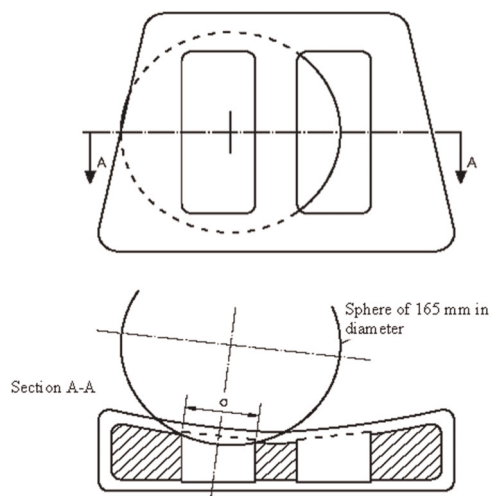
Example of horizontal gaps



Note: Section A-A is to be made in a point of the gap area which allows the maximum sphere intrusion, without exerting any load.

Figure 2

Example of vertical gaps



Note: Section A-A is to be made in a point of the gap area which allows the maximum sphere intrusion, without exerting any load.

ANNEX 9

TEST PROCEDURE FOR DEVICES INTENDED TO PROTECT THE OCCUPANTS AGAINST DISPLACEMENT OF LUGGAGE**1. TEST BLOCKS**

Rigid blocks, with the centre of inertia in the geometric centre.

Type 1

Dimensions: 300 mm × 300 mm × 300 mm
all edges and corners rounded to 20 mm

Mass: 18 kg

Type 2

Dimensions: 500 mm × 350 mm × 125 mm
all edges and corners rounded to 20 mm

Mass: 10 kg

2. TEST PREPARATION**2.1. Test of seat-backs (see figure 1)****2.1.1. General requirements**

2.1.1.1. At the option of the car manufacturer, parts whose hardness is lower than 50 Shore A can be removed from the tested seat and head restraint for the tests.

2.1.1.2. Two type 1 test blocks shall be placed on the floor of the luggage compartment. In order to determine the location of the test blocks in the longitudinal direction, they shall first be positioned such that their front side contacts that part of the vehicle which constitutes the forward boundary of the luggage compartment and that their lower side rests on the floor of the luggage compartment. They shall then be moved backwards and parallel to the longitudinal median plane of the vehicle until their geometrical centre has traversed a horizontal distance of 200 mm. If the dimensions of the luggage compartment do not allow a distance of 200 mm and if the rear seats are horizontally adjustable, these seats shall be moved forward to the limit of the adjustment range intended for normal occupant use, or to the position resulting in a distance of 200 mm, whichever is less. In other cases, the test blocks shall be placed as far as possible behind the rear seats. The distance between the longitudinal median plane of the vehicle and the inward facing side of each test block shall be 25 mm to obtain a distance of 50 mm between both blocks.

2.1.1.3. During the test, the seats must be adjusted to ensure that the locking system cannot be released by external factors. If applicable, the seats shall be adjusted as follows:

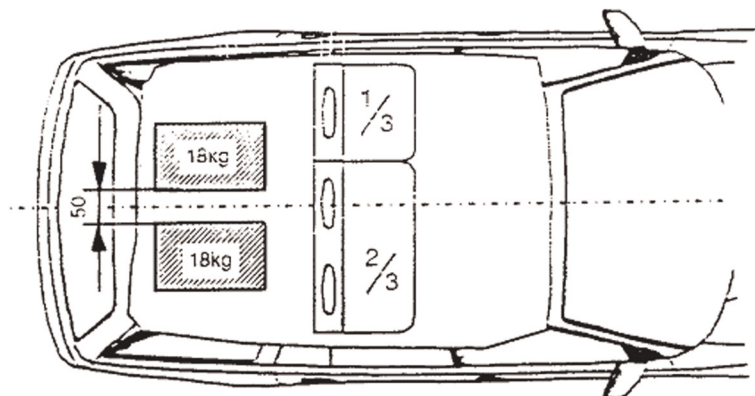
The longitudinal adjustment shall be secured one notch or 10 mm in front of the rearmost possible position of use specified by the manufacturer (for seats with independent vertical adjustment, the cushion shall be placed to its lowest possible position). The test shall be carried out with the seat-backs in their normal position of use.

2.1.1.4. If the seat-back is fitted with a head restraint, the test must be carried out with the head restraint placed in the highest position, if adjustable.

2.1.1.5. If the back(s) of the rear seat(s) can be folded down, they shall be secured in their upright normal position by the standard locking mechanism.

2.1.1.6. Seats behind which the type 1 blocks cannot be installed are exempted from this test

Figure 1

Positions of test blocks before test of rear seat-backs

2.1.2. Vehicles with more than two rows of seats

2.1.2.1. If the rearmost row of seats is removable and/or can be folded down by the user according to the manufacturer's instructions in order to increase the luggage compartment area, then the seat row immediately in front of this rearmost row shall also be tested.

2.1.2.2. However, in this case, the Technical Service, after consultation with the manufacturer, may decide not to test one of the two rearmost rows of seats if the seats and their attachments are of similar design and if the test requirement of 200 mm is respected.

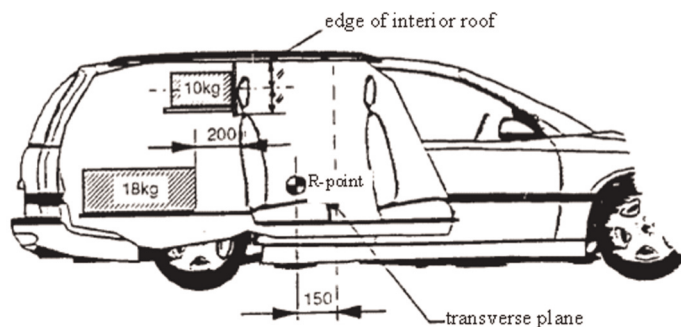
2.1.3. When there is a gap, allowing sliding of one type 1 block past the seats, then the test loads (two type 1 blocks) shall be installed behind the seats after agreement between the Technical Service and the manufacturer.

2.1.4. The exact test configuration shall be noted in the test report.

2.2. Test of partitioning systems

For the test of the partitioning systems above the seat-backs, the vehicle shall be fitted with a fixed raised test floor having a load surface that locates the centre of gravity of the test block centrally between the top edge of the bordering seat-back (without taking into account the head restraints) and the bottom edge of the roof lining. A type 2 test block is placed on the raised test floor with its largest surface 500×350 mm, centrally in relation to the longitudinal axis of the vehicle and with its surface 500×125 mm to the front. Partitioning systems behind which the type 2 test block cannot be installed are exempted from this test. The test block is placed directly in contact with the partitioning system. In addition, two type 1 test blocks are positioned in accordance with paragraph 2.1 in order to perform a simultaneous test on the seat-backs (see figure 2).

Figure 2

Testing of a partitioning system above the backrest

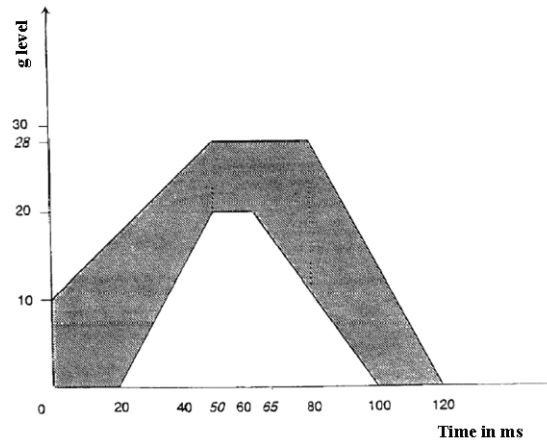
2.2.1. If the seat-back is fitted with a head restraint, the test must be carried out with the head restraint placed in the highest position, if adjustable.

3. DYNAMIC TESTING OF SEAT-BACKS AND PARTITIONING SYSTEMS USED AS LUGGAGE RESTRAINT SYSTEMS
 - 3.1. The body of the passenger car shall be anchored securely to a test sled, and this anchorage shall not act as reinforcement for seat-backs and the partitioning system. After the installation of the test blocks as described in paragraph 2.1 or 2.2, the passenger car body shall be decelerated or, at the choice of the applicant, accelerated such that the curve remains within the area of the graph in Annex 9, Appendix, and the total velocity change ΔV is $50 \pm 0/-2$ km/h. With the agreement of the manufacturer, the above described test pulse corridor can be used alternatively to fulfil the test of the seat strength according to paragraph 6.3.1.
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APPENDIX

Corridor of sled's deceleration or acceleration as a function of time

(Simulation of frontal impact)



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/wp29docstts.html>

Regulation No 43 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles

Incorporating all valid text up to:

Supplement 12 to the original version of the Regulation — Date of entry into force: 24 October 2009

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1. SCOPE

This Regulation applies to:

(a) safety glazing materials intended for installation as windscreens or other panes, or as partitioning, on vehicles of category L, M, N, O, and T ⁽¹⁾;

(b) vehicles of category M, N and O with regard to the installation of these materials;

in both cases, to the exclusion of glazing for lighting and light-signalling devices and instrument panels, of special bullet-proof glazing and of double-windows.

2. DEFINITIONS

For the purpose of this Regulation:

2.1. 'Toughened-glass pane' means a glass pane consisting of a single layer of glass which has been subjected to special treatment to increase its mechanical strength and to condition its fragmentation after shattering;

2.2. 'Laminated-glass pane' means a glass pane consisting of two or more layers of glass held together by one or more interlayers of plastics material; it may be:

2.2.1. 'ordinary', when none of the layers of glass of which it is composed has been treated; or

⁽¹⁾ As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), (document TRANS/WP.29/78/Rev.1/Amend.2 as last amended by Amend.4).

- 2.2.2. 'treated', when at least one of the layers of glass of which it is composed has been specially treated to increase its mechanical strength and to condition its fragmentation after shattering;
- 2.3. 'Safety-glass pane faced with plastics material' means a glass pane as defined in paragraphs 2.1 or 2.2 with a layer of plastics material on its inner face;
- 2.4. 'Glass-plastics pane' means a pane of laminated glass having one layer of glass and one or more layers of plastics material, at least one of which acts as interlayer. The plastics layer(s) shall be on the inner face when the glazing is fitted on the vehicle;
- 2.5. 'Plastic glazing' is a glazing material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state and, at some stage in its manufacture or processing into finished articles, can be shaped by flow;
- 2.5.1 'Rigid plastic glazing' means a plastic glazing material which does not deflect vertically more than 50 mm in the flexibility test (annex 3, paragraph 12);
- 2.5.2. 'Flexible plastic glazing' means a plastic glazing material which deflects vertically more than 50 mm in the flexibility test (annex 3, paragraph 12).
- 2.6. 'Double window' means an assembly of two glazing panes separately installed within the same opening of the vehicle;
- 2.7. 'Double-glazed unit' means an assembly of two glazing panes permanently assembled in manufacture and separated by a uniform gap;
- 2.7.1. 'Symmetrical double-glazing' means a double-glazed unit where the two component glazings are of the same type (toughened glass, laminated glass, rigid plastic) and have the same principal and/or secondary characteristics;
- 2.7.2. 'Asymmetrical double-glazing' means a double-glazed unit where the two component glazings are of different type (toughened glass, laminated glass, rigid plastic) or have different principal and/or secondary characteristics;
- 2.8. 'Principal characteristic' means a characteristic which appreciably modifies the optical and/or mechanical properties of a safety glazing material in a way not without significance to the function which it is intended to perform in a vehicle. The term also covers the trade names or marks as specified by the holder of the approval;
- 2.9. 'Secondary characteristic' means a characteristic capable of modifying the optical and/or mechanical properties of a safety glazing material in a way which is of significance to the function which it is intended to perform in a vehicle. The extent of such modification is assessed in relation to the indices of difficulty.
- 2.10. The term 'Indices of difficulty' covers a two-stage grading system applying to the variations observed in practice in each secondary characteristic. A change from index '1' to index '2' indicates the need for additional tests;
- 2.11. 'Developed area of windscreen' means the minimum rectangular area of glass from which a windscreen can be manufactured;
- 2.12. 'Inclination angle of a windscreen' means the angle included between on the one hand a vertical line and on the other hand a straight line passing through the top and bottom edges of the windscreen, both lines being contained in a vertical plane containing the longitudinal axis of the vehicle;
- 2.12.1. Measurement of the inclination angle shall be performed on a vehicle standing on level ground, and in the case of a passenger-transport vehicle the vehicle shall be in running order, shall be fully charged with fuel, coolant and lubricant, and shall be equipped with tools and the spare wheel or wheels (if they are provided as standard equipment by the vehicle manufacturer); allowance shall be made for the mass of the driver, and also, in the case of a passenger-transport vehicle, for that of one front-seat passenger, the mass of the driver and that of the passenger each being deemed to be 75 ± 1 kg;

- 2.12.2. Vehicles equipped with hydropneumatic, hydraulic or pneumatic suspension or with a device for automatic adjustment of ground clearance according to load shall be tested in the normal running conditions specified by the manufacturer;
- 2.13. 'Group of windscreens' means a group comprising windscreens of differing sizes and shapes subjected to an examination of their mechanical properties, their mode of fragmentation and their behaviour in environmental-aggression resistance tests;
 - 2.13.1. 'Flat windscreen' means a windscreen exhibiting no normal curvature resulting in a height of segment greater than 10 mm per linear metre;
 - 2.13.2. 'Curved windscreen' means a windscreen exhibiting a normal curvature resulting in a height of segment greater than 10 mm per linear metre.
- 2.14. 'Height of segment "h"' means the maximum distance, measured at right angles approximately to the glass pane, separating the inner surface of the pane from a plane passing through the ends of the pane (see annex 17, figure 1);
- 2.15. 'Type of safety glazing material' means a glazing as defined in paragraphs 2.1 to 2.7 not exhibiting any essential differences, with respect, in particular, to the principal and secondary characteristics defined in annexes 4 to 12 and 14 to 16;
 - 2.15.1. Although a change in the principal characteristics implies that the product is of a new type, it is recognised that in certain cases a change in shape and dimension does not necessarily require a complete set of tests to be carried out. For certain of the tests prescribed in the individual annexes, glazings may be grouped if it is evident that they have similar principal characteristics;
 - 2.15.2. Types of glazing exhibiting differences only as regards their secondary characteristics may be deemed to be of the same type; certain tests may however be carried out on samples of such glazings if the performance of those tests is explicitly stipulated in the test condition.
- 2.16. 'Curvature "r"' means the approximate value of the smallest radius of arc of the windscreen as measured in the most curved area.
- 2.17. 'HIC' (Head Injury Criteria) value means a value for the characteristics of skull-brain injury arising from the deceleration forces which result from a blunt perpendicular impact with the glazing.
- 2.18. 'Safety glazing material requisite for driver visibility'
 - 2.18.1. 'Safety glazing material requisite for the driver's forward field of vision' means all the glazing situated in front of a plane passing through the driver's R point and perpendicular to the longitudinal median plane of the vehicle through which the driver can view the road when driving or manoeuvring the vehicle.
 - 2.18.2. 'Safety glazing material requisite for the driver's rearward vision' means all glazing situated behind a plane passing through the driver's R point perpendicular to the longitudinal median plane of the vehicle through which the driver can view the road when driving or manoeuvring the vehicle.

- 2.19. 'Opaque obscuration' means any area of the glazing preventing light transmission.
- 2.20. 'Shade band' means any area of the glazing with a reduced regular transmittance.
- 2.21. 'Transparent area' means the whole glazing area, excluding any opaque obscuration and any shade band.
- 2.22. 'Daylight opening' means the whole glazing area, excluding any opaque obscuration but including any shade band.
- 2.23. 'Interlayer' means any material used to hold together the component layers of laminated glazing.
- 2.24. 'Type of vehicle', as regards the installation of safety glazing, means vehicles belonging to the same category which do not differ in at least the following essential respects:

The manufacturer;

The manufacturer's type designation;

Essential aspects of construction and design.

- 2.25. 'Seat back angle' means the design torso angle as defined in annex 19 of this Regulation.

3. APPLICATION FOR APPROVAL

3.1. Approval for a type of glazing

The application for approval of a type of glazing shall be submitted by the manufacturer or by his duly accredited representative in the country where the application is made.

- 3.2. For each type of glazing the application shall be accompanied by the undermentioned documents in triplicate and by the following particulars:

- 3.2.1. A technical description comprising all principal and secondary characteristics, and

- 3.2.1.1. In the case of glazings other than windscreens, diagrams in a format not exceeding A4 or folded to that format showing:

the maximum area,

the smallest angle between two adjacent sides of the piece,

the greatest height of segment, where applicable.

- 3.2.1.2. in the case of windscreens,

- 3.2.1.2.1. a list of the models of windscreens for which approval is sought, specifying the name of the vehicle manufacturer and the type and category of the vehicle.

- 3.2.1.2.2. drawings on a scale 1:1 for M1 category and 1:1 or 1:10 for all other categories, and diagrams of the windscreen and its positioning in the vehicle in sufficient detail to show:

- 3.2.1.2.2.1. the position of the windscreen relative to the R point of the driver's seat, where applicable,

- 3.2.1.2.2.2. the inclination angle of the windscreen,

- 3.2.1.2.2.3. the inclination angle of the seat-back,

- 3.2.1.2.2.4. the position and size of the zones in which the optical qualities are verified and, where appropriate, the area subjected to differential toughening,

- 3.2.1.2.2.5. the developed area of the windscreen,
- 3.2.1.2.2.6. the maximum height of segment of the windscreen,
- 3.2.1.2.2.7. the minimum radius curvature of the windscreen (for windscreen-grouping purposes only).
- 3.2.1.3. In the case of double-glazed units, diagrams in a format not exceeding A4 or folded to that format, showing, in addition to the information referred to in paragraph 3.2.1.1:
 - the type of each component pane,
 - the type of sealing,
 - the nominal width of the gap between the two panes.
- 3.3. In addition, the applicant for approval shall submit a sufficient number of test pieces and samples of the finished pieces of the models considered, the number being if necessary determined by agreement with the technical service responsible for conducting the tests.
- 3.4. Approval for a type of vehicle

The application for approval of a vehicle type with regard to the installation of its safety glazing shall be submitted by the vehicle manufacturer or by his duly accredited representative.
- 3.5. It shall be accompanied by the under mentioned documents in triplicate and the following particulars:
 - 3.5.1. Drawings of the vehicle on an appropriate scale showing:
 - 3.5.1.1. The position of the windscreen relative to the R point of the vehicle,
 - 3.5.1.2. The inclination angle of the windscreen,
 - 3.5.1.3. The inclination angle of the seat back;
 - 3.5.2. Technical details concerning the windscreen and all other glazings, in particular:
 - 3.5.2.1. The materials used,
 - 3.5.2.2. Approval numbers,
 - 3.5.2.3. Any additional markings, as described in paragraph 5.5.
- 3.6. A vehicle representative of the vehicle type to be approved shall be submitted to the technical service responsible for conducting the approval tests.
- 4. MARKINGS
 - 4.1. Every piece of safety glazing material, including the samples and test pieces submitted for approval, shall bear a trade name or mark as listed under item 3 of annex 1. Manufactured parts must bear the ECE Regulation No 43 number allocated to the prime manufacturer. The marking shall be clearly legible and indelible.
- 5. APPROVAL
 - 5.1. Approval for a type of glazing

If the samples submitted for approval meet the requirements of paragraphs 6 to 8 of this Regulation, approval of the pertinent type of safety glazing material shall be granted.

- 5.2. An approval number shall be assigned to each type as defined in annexes 5, 7, 11, 12, 14, 15 and 16 or, in the case of windscreens, to each group approved. Its first two digits (at present 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 may not assign the same number to another type or group of safety glazing material.
- 5.3. Notice of approval or extension of approval or refusal of approval of a type of safety glazing material pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in annex 1 — and its appendices — to this Regulation.
- 5.3.1. In the case of windscreens, the notice of approval shall be accompanied by a document listing every windscreen model in the approved group, together with the characteristics of the group pursuant to annex 1, appendix 8.
- 5.4. There shall be affixed conspicuously to every piece of glazing and double-glazed unit conforming to a type approved under this Regulation, in addition to the marking prescribed in paragraph 4.1, an international approval mark. Any specific approval mark assigned to each pane forming a double-glazed unit may also be affixed. This approval mark shall consist of:
- 5.4.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ⁽²⁾;
- 5.4.2. 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 5.4.1.
- 5.5. The following additional symbols shall be affixed near the above approval mark:
- 5.5.1. in the case of a windscreen:
- I for toughened glass (I/P if faced) ⁽³⁾
- II for ordinary laminated glass (II/P if faced) ⁽³⁾
- III for treated laminated glass (III/P if faced) ⁽³⁾
- IV for glass-plastics glazing.
- 5.5.2. V in the case of safety glazing having a regular light transmittance less than 70 per cent.
- 5.5.3. VI in the case of double-glazed unit
- 5.5.4. VII in the case of uniformly-toughened glass panes which can be used as windscreens for slow-moving vehicles which, by construction, cannot exceed 40 km/h.

⁽²⁾ 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, 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, 53 for Thailand, 54 and 55 (vacant) and 56 for Montenegro. 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.

⁽³⁾ As defined in paragraph 2.3.

- 5.5.5. VIII In the case of rigid plastic glazing. In addition the appropriate application will be signified by:

- /A for forward facing panels
- /B for side, rear and roof glazing
- /C in locations where there is little or no chance of head impact

In addition, for plastic glazing which has been submitted to the abrasion resistance tests described in annex 3, paragraph 4, the following markings shall also be applied as appropriate:

- /L for panes with a light scatter not exceeding 2 per cent after 1 000 cycles on the outer surface and 4 per cent after 100 cycles on the inner surface (see annexes 14 and 16, paragraph 6.1.3.1)
- /M for panes with a light scatter not exceeding 10 per cent after 500 cycles on the outer surface and 4 per cent after 100 cycles on the inner surface (see annexes 14 and 16, paragraph 6.1.3.2)

- 5.5.6. IX in the case of flexible-plastic glazing

- 5.5.7. X in the case of a rigid plastic double-glazed unit. In addition, the appropriate application will be signified by:

- /A for forward facing panels
- /B for side, rear and roof glazings
- /C in locations where there is little or no chance of head impact

For plastic glazing which has been submitted to the abrasion resistance test described in annex 3, paragraph 4, the following markings shall also be applied as appropriate:

- /L for panes with a light scatter not exceeding 2 per cent after 1 000 cycles on the outer surface and 4 per cent after 100 cycles on the inner surface (see annex 6, paragraph 6.1.3.1)
- /M for panes with a light scatter not exceeding 10 per cent after 500 cycles on the outer surface and 4 per cent after 100 cycles on the inner surface (see annex 16, paragraph 6.1.3.2).

- 5.5.8. XI in the case of a laminated glass pane other than windscreen.

- 5.6. The approval mark and symbol shall be clearly legible and be indelible. Additional symbols must be combined within the approval marking.

- 5.7. Annex 2 to this Regulation gives examples of arrangements of approval marks.

- 5.8. Approval for a type of vehicle

If the vehicle submitted for approval pursuant to this Regulation meets the requirements of annex 21 to this Regulation, approval of that vehicle type shall be granted.

- 5.9. An approval number shall be assigned to each type approved. Its first two digits (at present 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 number to another vehicle type as defined in paragraph 2.24 above.
- 5.10. 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 1A to this Regulation.
- 5.11. 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:
- 5.11.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ⁽⁴⁾;
- 5.11.2. 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 5.11.1.
- 5.12. 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 5.11.1 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 5.11.1.
- 5.13. The approval mark shall be clearly legible and be indelible.
- 5.14. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 5.15. Annex 2A to this Regulation gives examples of arrangements of approval marks.
6. GENERAL REQUIREMENTS
- 6.1. All glazing materials, including glazing material for the manufacture of windscreens, shall be such that, in the event of shattering, the danger of bodily injury is reduced as far as possible. The glazing material shall be sufficiently resistant to the incidents likely to occur in normal traffic, and to atmospheric and temperature conditions, chemical action, combustion and abrasion.
- 6.2. Safety glazing materials shall in addition be sufficiently transparent, shall not cause any noticeable distortions of objects as seen through the windscreen, and shall not give rise to any confusion between the colours used in road-traffic signs and signals. In the event of the windscreen's shattering, the driver must still be able to see the road clearly enough to be able to brake and stop his vehicle safely.
7. PARTICULAR REQUIREMENTS
- All types of safety glazing shall, depending on the category to which they belong, comply with the following particular requirements:
- 7.1. as regards toughened-glass windscreens, the requirements contained in annex 4;
- 7.2. as regards uniformly-toughened glass panes, the requirements contained in annex 5;

⁽⁴⁾ See footnote 2 of para. 5.4.1.

- 7.3. as regards ordinary laminated-glass windscreens, the requirements contained in annex 6;
- 7.4. as regards ordinary laminated-glass panes other than windscreens, the requirements contained in annex 7;
- 7.5. as regards treated laminated-glass windscreens, the requirements contained in annex 8;
- 7.6. as regards safety-glass panes faced with plastics material, in addition to the relevant requirements listed above, the requirements contained in annex 9;
- 7.7. as regards glass-plastics windscreens, the requirements contained in annex 10;
- 7.8. as regards glass-plastics panes other than windscreens, the requirements contained in annex 11;
- 7.9. as regards double-glazed units, the requirements contained in annex 12.
- 7.10. as regards rigid plastic glazings, the requirements contained in annex 14.
- 7.11. as regards flexible plastic glazings, the requirements contained in annex 15.
- 7.12. as regards rigid plastic double-glazed units, the requirements contained in annex 16.
- 8. TESTS
- 8.1. The following tests are prescribed in this Regulation:
 - 8.1.1. Fragmentation test

The purpose of this test is:

 - 8.1.1.1. to verify that the fragments and splinters produced by fracture of the glass pane are such as to minimize the risk of injury, and
 - 8.1.1.2. in the case of windscreens, to check residual visibility after shattering.
 - 8.1.2. Mechanical strength test
 - 8.1.2.1. Ball-impact test

There are two forms of tests, one using a 227 g ball and one using a 2 260 g ball.

 - 8.1.2.1.1. — 227 g ball test: The purpose of this test is to assess the adhesion of the interlayer of laminated glass and the mechanical strength of uniformly-toughened glass and plastic glazings.
 - 8.1.2.1.2. — 2 260 g ball test: The purpose of this test is to assess ball-penetration resistance of laminated glass.
 - 8.1.2.2. Headform test

The purpose of this test is to verify the compliance of glazing with the requirements relating to the limitation of injury in the event of impact of the head against the windscreen, laminated glass and panes of glass-plastic and rigid plastic other than windscreens, together with the double-glazed units used in the side windows.
 - 8.1.3. Test of resistance to the environment
 - 8.1.3.1. Test of resistance to abrasion

The purpose of this test is to determine whether the resistance of a safety glazing to abrasion exceeds a specified value.
 - 8.1.3.2. Test of resistance to high temperature

The purpose of this test is to verify that no bubbles or other defects occur in the interlayer in laminated glass or glass-plastics glazing when exposed to high temperatures over an extended period of time.

8.1.3.3. Resistance-to-radiation test

The purpose of this test is to determine whether the light transmittance of laminated-glass panes, glass-plastics panes or glass panes faced with plastics material when exposed to radiation over an extended period of time is significantly reduced thereby or whether the glazing is significantly discoloured.

8.1.3.4. Resistance-to-humidity test

The purpose of this test is to determine whether laminated-glass panes, glass-plastic panes, glass panes faced with plastic material and rigid plastic material will withstand, without significant deterioration, the effects of prolonged exposure to atmospheric humidity.

8.1.3.5. Resistance-to-temperature-changes test

The purpose of this test is to check that plastics material(s) used in safety glazing as defined in paragraphs 2.3 and 2.4 above will withstand the effects of prolonged exposure to extremes of temperature without significant deterioration.

8.1.3.6. Resistance to simulated weathering test

The purpose of this test is to verify that plastic safety glazing is resistant to simulated weathering conditions.

8.1.3.7. Cross cut test

The purpose of this test is to examine whether any abrasive resistant coating of a rigid plastic glazing has sufficient adherence.

8.1.4. Optical qualities

8.1.4.1. Light-transmission test

The purpose of this test is to determine whether the regular transmittance of safety glazing exceeds a specified value.

8.1.4.2. Optical-distortion test

The purpose of this test is to verify that the distortion of objects as seen through the wind-screen is not of such extent as to be likely to confuse the driver.

8.1.4.3. Secondary-image-separation test

The purpose of this test is to verify that the angular separation of the secondary image from the primary image does not exceed a specified value.

8.1.4.4. Identification-of-colours test

The purpose of this test is to verify that there is no risk of confusion of colours as seen through a windscreen.

8.1.5. Burning-behaviour (fire-resistance) test

The purpose of this test is to verify that a safety glazing material as defined in paragraphs 2.3, 2.4 and 2.5 above has a sufficiently low burn rate.

8.1.6. Test of resistance to chemicals

The purpose of this test is to determine whether the safety glazing material as defined in paragraphs 2.3, 2.4 and 2.5 above will withstand the effects of exposure to chemicals likely to be normally present or used within the vehicle (e.g. cleaning compounds) without significant deterioration.

8.1.7. Flexibility and fold test

The purpose of this test is to determine whether a plastic glazing material falls within the rigid or flexible category.

8.2. Tests prescribed for glazing materials of the categories defined in paragraphs 2.1 to 2.5 of this Regulation

8.2.1. Safety glazing materials shall be subjected to the tests listed in the following tables: 8.2.1.1 and 8.2.1.2.

8.2.1.1. Safety glass panes shall be subjected to the tests listed in the following table:

Tests	Windscreen							Glass panes other than windscreens		
	Toughened glass		Ordinary laminated glass		Treated laminated glass		Glass-plastics	Toughened glass	Laminated glass	Glass-plastics
	I	I-P	II	II-P	III	III-P	IV			
Fragmentation:	A4/2	A4/2	—	—	A8/4	A8/4	—	A5/2	—	—
Mechanical strength										
— 227 g ball	—	—	A6/4.3	A6/4.3	A6/4.3	A6/4.3	A6/4.3	A5/3.1	A7/4	A7/4
— 2 260 g ball	—	—	A6/4.2	A6/4.2	A6/4.2	A6/4.2	A6/4.2	—	—	—
Head formtest ⁽¹⁾	A4/3	A4/3	A6/3	A6/3	A6/3	A6/3	A10/3	—	A7/3	A11/3
Abrasion										
Outer face	—	—	A6/5.1	A6/5.1	A6/5.1	A6/5.1	A6/5.1	—	A6/5.1	A6/5.1
Inner face	—	A9/2	—	A9/2	—	A9/2	A9/2	A9/2 ⁽²⁾	A9/2 ⁽²⁾	A9/2
High temperature	—	—	A3/5	A3/5	A3/5	A3/5	A3/5	—	A3/5	A3/5
Radiation	—	A3/6	A3/6	A3/6	A3/6	A3/6	A3/6	—	A3/6	A3/6
Humidity	—	A3/7	A3/7	A3/7	A3/7	A3/7	A3/7	A3/7 ⁽²⁾	A3/7	A3/7
Light transmission	A3/9.1	A3/9.1	A3/9.1	A3/9.1	A3/9.1	A3/9.1	A3/9.1	A3/9.1	A3/9.1	A3/9.1
Optical distortion	A3/9.2	A3/9.2	A3/9.2	A3/9.2	A3/9.2	A3/9.2	A3/9.2	A3/9.2 ⁽³⁾	—	—
Secondary image	A3/9.3	A3/9.3	A3/9.3	A3/9.3	A3/9.3	A3/9.3	A3/9.3	A3/9.3 ⁽³⁾	—	—
Identification of colours	A3/9.4	A3/9.4	A3/9.4	A3/9.4	A3/9.4	A3/9.4	A3/9.4	—	—	—
Resistance to temperature changes	—	A3/8	—	A3/8		A3/8	A3/8	A3/8 ⁽²⁾	A3/8 ⁽²⁾	A3/8
Fire resistance	—	A3/10	—	A3/10	—	A3/10	A3/10	A3/10 ⁽²⁾	A3/10 ⁽²⁾	A3/10
Resistance to chemicals	—	A3/11.2.1	—	A3/11.2.1		A3/11.2.1	A3/11.2.1	A3/11.2.1 ⁽²⁾	A3/11.2.1 ⁽²⁾	A3/11.2.1

⁽¹⁾ Furthermore this test shall be carried out on double-glazed units pursuant to annex 12, paragraph 3 (A12/3).

⁽²⁾ If coated on the inner side with plastics material.

⁽³⁾ This test shall only be carried out on uniformly-toughened glass-panes to be used as windscreens of slow-moving vehicles which, by construction, cannot exceed 40 km/h.

Note: A reference such as A4/3 in the table indicates the annex 4 and paragraph 3 of that annex, where the relevant test is described and the acceptance requirements are specified.

8.2.1.2. Plastic glazing materials shall be subjected to the tests listed in the following table:

Test	Plastics other than windscreens				
	Rigid plastics		Double glazing		Flexible plastics
	Motorised vehicles	Trailers and unoccupied vehicles	Motorised vehicles	Trailers and unoccupied vehicles	
Flexibility	A3/12	A3/12	A3/12	A3/12	A3/12
227 g ball	A14/5	A14/5	A16/5	A16/5	A15/4
Headform ⁽¹⁾	A14/4	—	A16/4	—	—
Light transmission ⁽²⁾	A3/9.1	—	A3/9.1	—	A3/9.1
Fire resistance	A3/10	A3/10	A3/10	A3/10	A3/10
Chemical resistance	A3/11	A3/11	A3/11	A3/11	A3/11.2.1
Abrasion	A14/6.1	—	A16/6.1	—	—
Weathering	A3/6.4	A3/6.4	A3/6.4	A3/6.4	A3/6.4
Humidity	A14/6.4	A14/6.4	A16/6.4	A16/6.4	—
Cross-cut ⁽²⁾	A3/13	—	A3/13	—	—

⁽¹⁾ Test requirements are dependant on the location of the glazing within the vehicle.

⁽²⁾ Applies only if the glazing is to be used in a location requisite for driving visibility.

8.2.2. A safety glazing material shall be approved if it meets all the requirements prescribed in the relevant provisions referred to in the tables: 8.2.1.1 and 8.2.1.2.

9. MODIFICATION OR EXTENSION OF APPROVAL OF A TYPE OF SAFETY GLAZING MATERIAL

9.1. Every modification of a type of safety glazing material, or in the case of windscreens every addition of a windscreen to a group, shall be notified to the administrative department which approved the type of safety glazing material. The department may then either:

9.1.1. consider that the modifications made are unlikely to have an appreciable adverse effect and, in the case of windscreens, that the new type comes within the approved group of windscreens, and that in any case the safety glazing material still complies with the requirements; or

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

9.2. Communication

9.2.1. Confirmation or refusal of approval (or extension of approval) shall be communicated by the procedure specified in paragraph 5.3 above to the Parties to the Agreement applying this Regulation.

9.2.2. The competent authority which has granted an extension of approval shall enter a serial number on each communication of extension.

10. CONFORMITY OF PRODUCTION

10.1. 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:

10.2. Special provisions

The checks referred to in paragraph 2.2 of appendix 2 of the Agreement shall include compliance with the requirements of annex 20 to this Regulation.

10.3. The normal frequency of inspection as referred to in paragraph 2.4 of appendix 2 of the Agreement shall be one per year.

11. PENALTIES FOR NON-CONFORMITY OF PRODUCTION
 - 11.1. The approval granted in respect of a type of safety glazing material pursuant to this Regulation may be withdrawn if the requirement laid down in paragraph 10.1 above is not complied with.
 - 11.2. If a Party to the Agreement which applies this Regulation withdraws an approval it had previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation thereof by means of a copy of a communication form conforming to the model in annex 1 to this Regulation.
 12. TRANSITIONAL PROVISIONS
 - 12.1. As from the date of entry into force of Supplement 8 to this Regulation in its original form, no Contracting Party applying this Regulation shall refuse an application for approval under this Regulation as amended by Supplement 8 to the Regulation in its original form.
 - 12.2. As from 24 months after the official date of the entry into force of Supplement 8, the Contracting Parties applying this Regulation may refuse to recognize the approval of safety glazing not bearing the symbols prescribed in paragraph 5.5 of this Regulation.
 - 12.3. As from the official date of entry into force of Supplement 12 to this Regulation, no Contracting Party applying this Regulation shall refuse to grant approval under this Regulation as amended by Supplement 12 to the Regulation in its original form.
 - 12.4. As from 24 months after the date of entry into force, Contracting Parties applying this Regulation shall grant approvals only if the type of component or separate unit to be approved meets the requirements of Supplement 12 to the Regulation.
 - 12.5. As from 24 months after the date of entry into force of Supplement 12, the Contracting Parties applying this Regulation may refuse to recognize the approval of safety glazing not bearing the symbols prescribed in paragraph 5.5 of this Regulation.
 13. PRODUCTION DEFINITELY DISCONTINUED

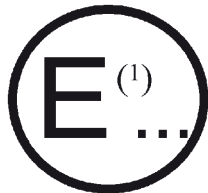
If the holder of the approval completely ceases to manufacture a type of safety glazing material approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication, that authority shall inform thereof the other Parties to the Agreement which apply this Regulation by means of a copy of a communication form conforming to the model in annex 1 to this Regulation.
 14. 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 and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.
 15. The technical services responsible for conducting approval tests shall comply with the harmonized standards concerning the operation of testing laboratories (ISO/CEI Guide 25). In addition they should be designated by the approval authority for which they carry out the approval tests.
-

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 safety glazing material pursuant to Regulation No 43.

Approval No Extension No

1. Class of safety glazing material:
2. Description of the type of glazing: please refer to appendices 1, 2, 3, 4, 5, 6, 7, 8, and 9 ⁽²⁾, and in the case of windscreens, the list conforming to appendix 10.
3. Trade names or marks
4. Manufacturer's name and address
5. If applicable, name and address of manufacturer's representative
6. Submitted for approval on:
7. Technical service responsible for conducting approval tests:
8. Date of report issued by that service:
9. Number of report issued by that service:
10. Approval is granted/refused/extended/withdrawn ⁽²⁾
11. Reason(s) for extension of approval:
12. Remarks:
13. Place
14. Date
15. Signature
16. The list of documents filed with the administrative service which has granted approval and available on request is annexed to this communication.

⁽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.

APPENDIX 1

TOUGHENED-GLASS WINDSCREENS

(Principal and secondary characteristics as defined in annex 4 or annex 9 to Regulation No 43)

Approval No Extension No

Principal characteristics

Shape category:

Thickness category:

Nominal thickness of the windscreen:

Nature and type of plastics coating(s):

Nominal thickness of plastics coating(s):

Secondary characteristics

Nature of the material (plate, float, sheet glass):

Colouring of glass:

Colouring of plastics coating(s):

Conductors incorporated (yes/no):

Opaque obscuration incorporated (yes/no):

Remarks**Documents attached: list of windscreens (see appendix 10)**

APPENDIX 2

UNIFORMLY-TOUGHENED GLASS PANES

(Principal and secondary characteristics as defined in annex 5 or annex 9 to Regulation No 43)

Approval No Extension No

Principal characteristics

Other than windscreens (yes/no):

Windscreen(s) for slow moving vehicles:

Shape category:

Nature of toughening process:

Thickness category:

Nature and type of plastics coating(s):

Nominal thickness of plastic coating(s):

Secondary characteristics

Nature of the material (plate, float, sheet glass):

Colouring of glass:

Colouring of plastics coating(s):

Conductors incorporated (yes/no):

Opaque obscuration incorporated (yes/no):

Approved criteria

Greatest area (flat glass):

Smallest angle:

Greatest developed area (curved glass):

Greatest height of segment:

Remarks**Documents attached: list of windscreens (if applicable) (see appendix 10)**

APPENDIX 3

LAMINATED-GLASS WINDSCREENS

(Principal and secondary characteristics as defined in annexes 6, 8 or 9 to Regulation No 43)

Approval No Extension No

Principal characteristics

Number of layers of glass:

Number of layers of interlayer:

Nominal thickness of the windscreen:

Nominal thickness of interlayer(s):

Special treatment of glass:

Nature and type of interlayer(s):

Nature and type of plastics coating(s):

Nominal thickness of plastic coating(s):

Colouring of interlayer (total/partial):

Secondary characteristics

Nature of the material (plate, float, sheet glass):

Colouring of glass (colourless/tinted):

Colouring of plastics coating(s):

Conductors incorporated (yes/no):

Opaque obscuration incorporated (yes/no):

Remarks**Documents attached: list of windscreens (see appendix 10)**

APPENDIX 4

LAMINATED-GLASS PANES OTHER THAN WINDSCREENS

(Principal and secondary characteristics as defined in annex 7 or annex 9 to Regulation No 43)

Approval No Extension No

Principal characteristics

Number of layers of glass:

Number of layers of interlayer:

Thickness category:

Nominal thickness of interlayer(s):

Special treatment of glass:

Nature and type of interlayer(s):

Nature and type of plastics coating(s):

Nominal thickness of plastics coating(s):

Secondary characteristics

Nature of the material (plate, float, sheet glass):

Colouring of interlayer (total/partial):

Colouring of glass:

Colouring of plastics coating(s):

Conductors incorporated (yes/no):

Opaque obscuration incorporated (yes/no):

Remarks

APPENDIX 5

GLASS-PLASTICS WINDSCREENS

(Principal and secondary characteristics as defined in annex 10 to Regulation No 43)

Approval No Extension No

Principal characteristics

Shape category:

Number of layers of plastics:

Normal thickness of glass:

Treatment of the glass (yes/no):

Nominal thickness of the windscreen:

Nominal thickness of the layer(s) of plastics acting as interlayer:

Nature and type of layer(s) of plastics acting as interlayer:

Nature and type of the outer layer of plastics:

Secondary characteristics

Nature of the material (plate, float, sheet glass):

Colouring of glass:

Colouring of the layer(s) of plastics (total/partial):

Conductors incorporated (yes/no):

Opaque obscuration incorporated (yes/no):

Remarks**Documents attached: list of windscreens (see appendix 10)**

APPENDIX 6

GLASS-PLASTICS PANES OTHER THAN WINDSCREENS

(Principal and secondary characteristics as defined in annex 11 to Regulation No 43)

Approval No Extension No

Principal characteristics

Number of layers of plastics:

Thickness of the glass component:

Treatment of the glass component (yes/no):

Nominal thickness of the pane:

Nominal thickness of the layer(s) of plastics acting as interlayer:

Nature and type of layer(s) of plastics acting as interlayer:

Nature and type of the outer layer of plastics:

Secondary characteristics

Nature of the material (plate, float, sheet glass):

Colouring of glass (colourless/tinted):

Colouring of the layer(s) of plastics (total/partial):

Conductors incorporated (yes/no):

Opaque obscuration incorporated (yes/no):

Remarks

APPENDIX 7

DOUBLE GLAZED UNITS

(Principal and secondary characteristics as defined in annex 12 or annex 16 to Regulation No 43)

Approval No Extension No

Principal characteristics

Composition of double-glazed units (symmetrical/asymmetrical):

Nominal thickness of the gap:

Method of assembly:

Type of each glazing component as defined in annexes 5, 7, 9, 11 or 14:

Documents attached

One form for the two panes of a symmetrical double-glazed unit in accordance with the annex under which the panes have been tested or approved.

One form for each pane of an asymmetrical double-glazed unit in accordance with the annexes under which these panes have been tested or approved.

Remarks

APPENDIX 8

RIGID PLASTICS PANES OTHER THAN WINDSCREENS

(Principal and secondary characteristics in accordance with annex 14)

Approval No Extension No

Principal characteristics

Chemical designation of the material:

The classification of the material by the manufacturer:

Process of manufacture:

Shape and dimensions:

Nominal thickness:

Colouring of the rigid plastic material:

Nature and type of surface coating:

Secondary characteristics

Conductors incorporated (yes/no):

Remarks

APPENDIX 9

PANES OF FLEXIBLE PLASTICS OTHER THAN WINDSCREENS

(Principal and secondary characteristics in accordance with annex 15)

Approval No Extension No

Principal characteristics

Chemical designation of the material:

Process of manufacture:

Nominal thickness:

Colouring of the plastic product:

Nature and type of surface coating:

Secondary characteristics

No secondary characteristic is involved.

Remarks

APPENDIX 10

CONTENTS OF THE LIST OF WINDSCREENS ⁽¹⁾

For each of the windcreens covered by this approval, at least the following particulars shall be provided:

Vehicle manufacturer

Type of vehicle

Vehicle category

Developed area (F)

Height of segment (h)

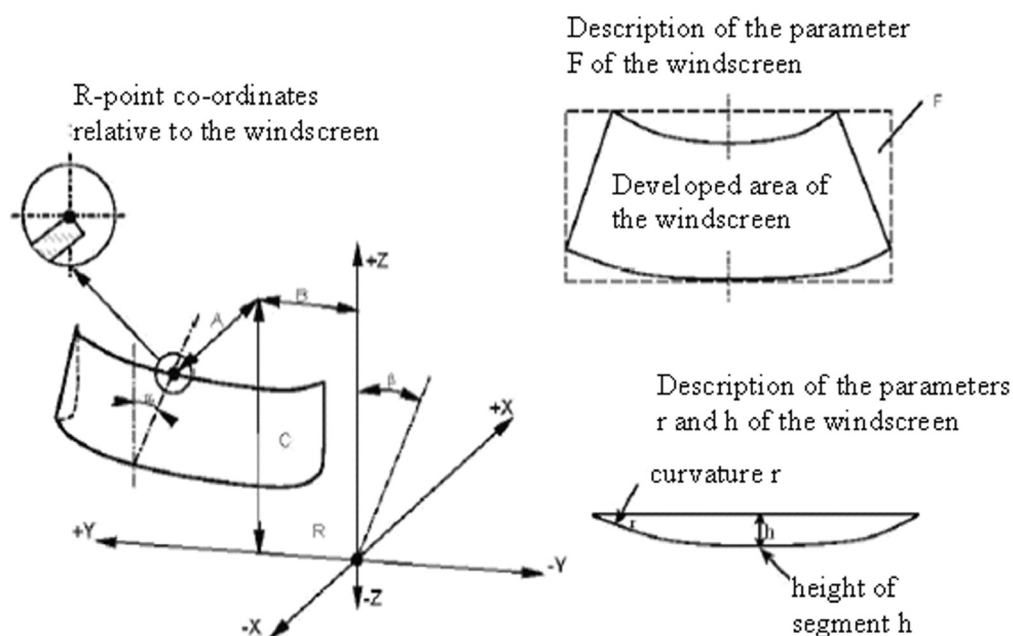
Curvature (r)

Installation angle (α)

Seat-back angle (β)

R-point coordinates (A, B, C) relative

to the centre of the upper edge of the windscreen.

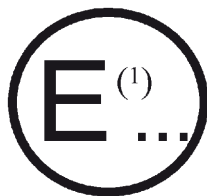


⁽¹⁾ These particulars shall be attached to appendices 1, 2 (if applicable), 3 and 5 to this annex.

ANNEX 1A

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 its safety glazing pursuant to Regulation No 43.

Approval No Extension No

1. Make (name of manufacturer) of vehicle:
2. Type, where appropriate, and trade description of vehicle:

3. Name and address of manufacturer:
4. Name and address of manufacturer's representative where applicable:

5. Description of the type of glazing used:
 - 5.1. in the case of windscreens:
 - 5.2.1. in the case of front side windows:
 - 5.2.2. in the case of rear side windows:
 - 5.3. in the case of rear windows:
 - 5.4. in the case of opening roofs:
 - 5.5. in the case of glazing other than the above:
6. ECE component type approval mark for a windscreen:
7. ECE component type approval mark(s) for:
 - 7.1. front side windows:
 - 7.2. rear side windows:
 - 7.3. rear windows:
 - 7.4. opening roofs:
 - 7.5. other glazing:
8. The fitting requirements have/have not ⁽²⁾ been met.
9. Vehicle submitted for approval on:
10. Technical service responsible for conducting approval tests:

11. Date of report issued by that service:

12. Number of report issued by that service:
 13. Approval is granted/refused/extended/withdrawn ⁽²⁾
 14. Reason(s) for extension of approval:
.....
 15. Remarks:
 16. Place
 17. Date
 18. Signature
 19. The list of documents deposited with the Administration Service which has granted approval is annexed to the communication and may be obtained upon request.
- _____

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

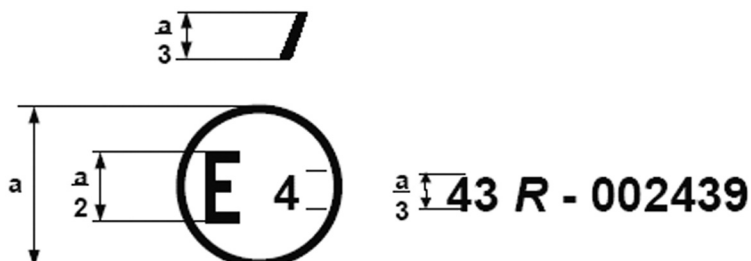
⁽²⁾ Strike out what does not apply.

ANNEX 2

ARRANGEMENTS OF APPROVAL MARKS FOR COMPONENTS

(See paragraph 5.5 of this Regulation)

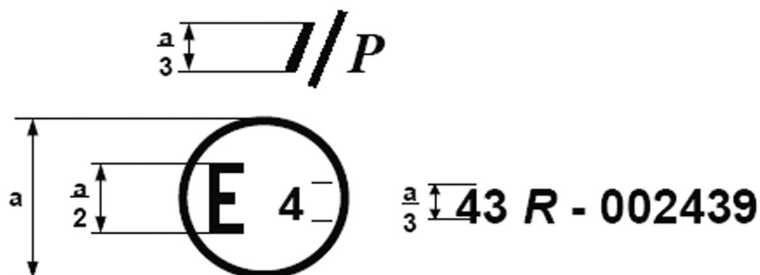
Toughened-glass windscreens



a = 8 mm min.

The above approval mark affixed to a toughened-glass windscreen shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval number 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

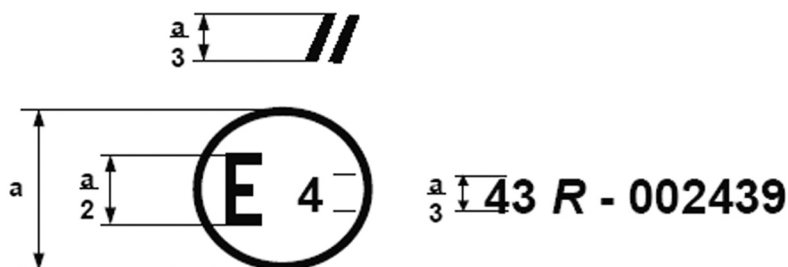
Toughened-glass windscreens faced with plastics material



a = 8 mm min.

The above approval mark affixed to a toughened-glass windscreen faced with plastics material shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

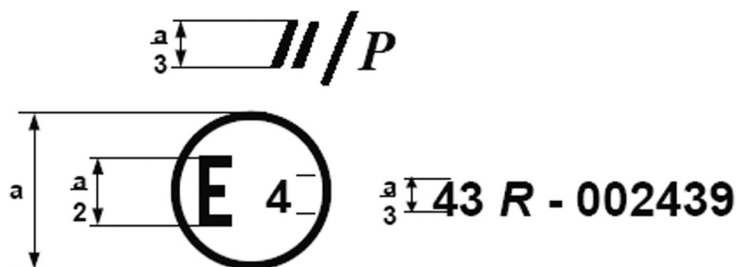
Ordinary laminated-glass windscreens



a = 8 mm min.

The above approval mark affixed to an ordinary laminated-glass windscreen shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

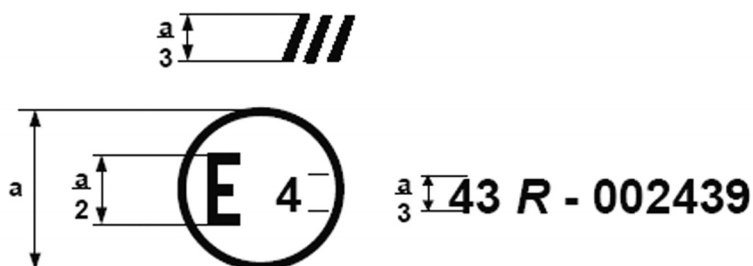
Ordinary laminated-glass windscreens faced with plastics material



a = 8 mm min.

The above approval mark affixed to an ordinary laminated-glass windscreen faced with plastics material shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

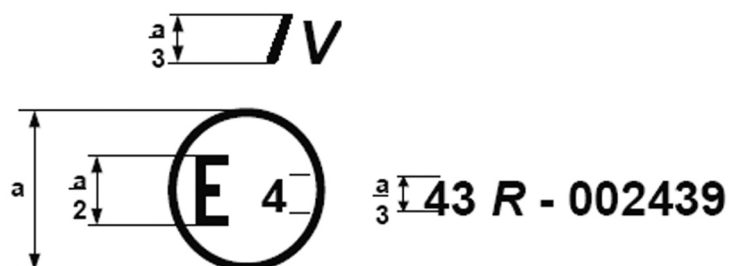
Treated laminated-glass windscreens



a = 8 mm min.

The above approval mark affixed to a treated laminated-glass windscreen shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

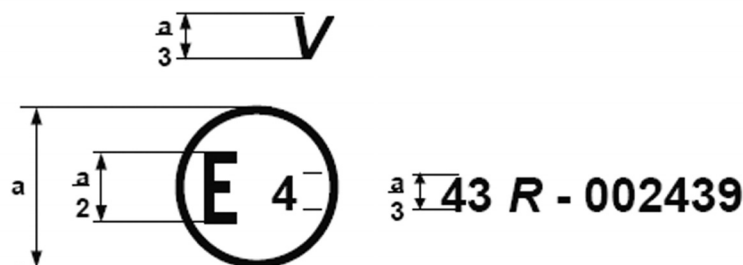
Glass-plastics windscreens



a = 8 mm min.

The above approval mark affixed to a glass-plastics windscreen shows that the component concerned has been approved in the Netherlands (E4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

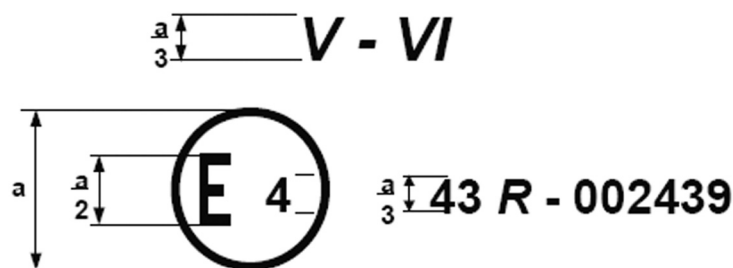
Glass panes other than windscreens having a regular light transmittance < 70 per cent



a = 8 mm min.

The above approval mark affixed to a glass pane other than a windscreen to which the requirements of annex 3, paragraph 9.1.4, are applicable shows that the component concerned has been approved in the Netherlands (E4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

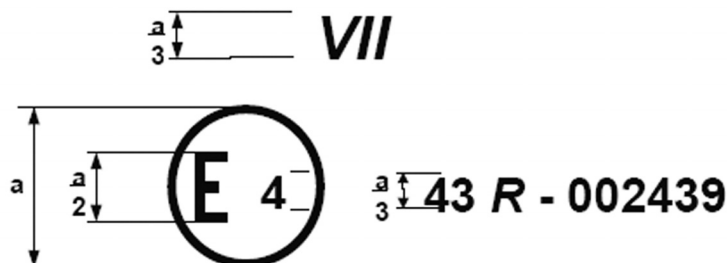
Double-glazed units having a regular light transmittance < 70 per cent



a = 8 mm min.

The above approval mark affixed to a double-glazed unit shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

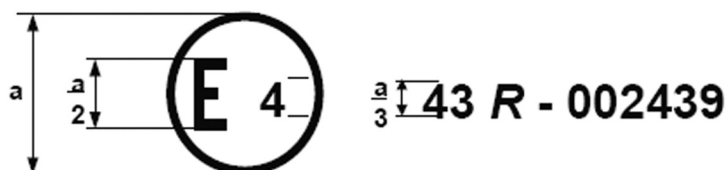
Uniformly-toughened glass panes to be used as windscreen for slow-moving vehicles which by construction cannot exceed 40 km/h



a = 8 mm min.

The above approval mark affixed to a uniformly-toughened glass pane shows that the component concerned intended to be used as a windscreen on a slow-moving vehicle which, by construction, cannot exceed 40 km/h, has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

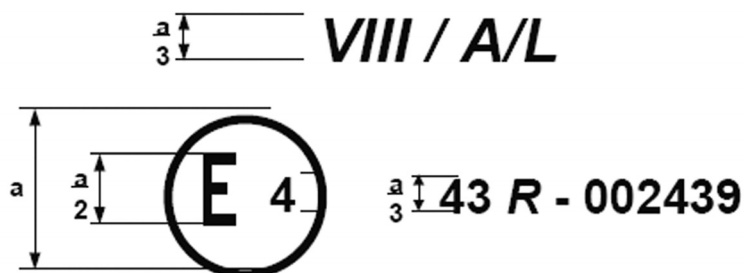
Glass panes other than windscreens having a regular light transmittance ≥ 70 per cent



$a = 8$ mm min.

The above approval mark affixed to a glass pane other than a windscreen to which the requirements of annex 3, paragraph 9.1.4.1, are applicable shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

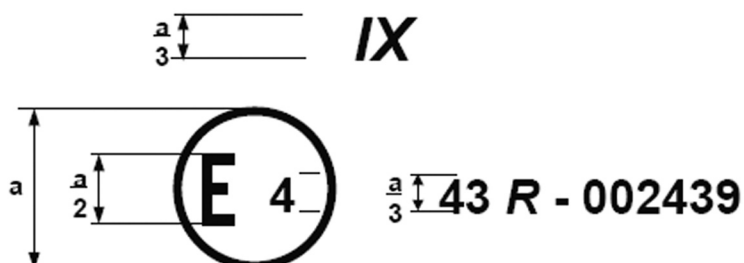
Rigid plastic glazings other than windscreens



$a = 8$ mm min.

The above approval mark affixed to a rigid plastic glazing pane for forward facing panels with a light scatter not exceeding 2 per cent after 1 000 cycles on the outer surface and 4 per cent after 100 cycles on the inner surface shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

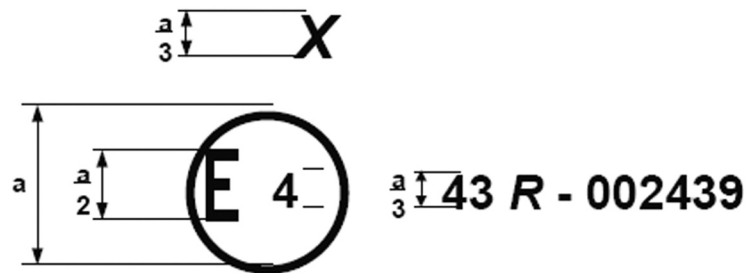
Flexible plastic glazings other than windscreens



$a = 8$ mm min.

The above approval mark affixed to a flexible plastic glazing pane shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

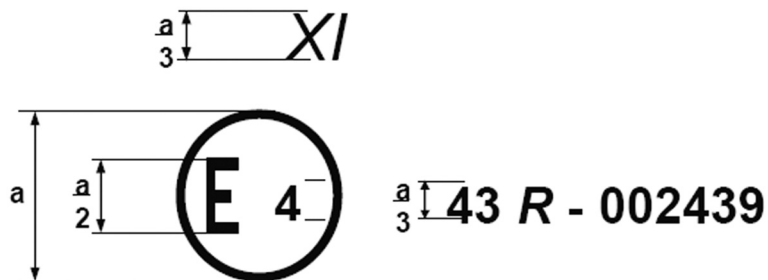
Rigid plastic double glazed units



a = 8 mm min.

The above approval mark affixed to a rigid plastic double glazed unit shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

Laminated glass panels other than windscreens



a = 8 mm min.

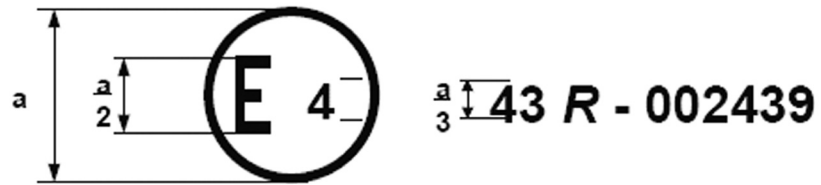
The above approval mark affixed to a laminated glass pane other than a windscreen, shows that the component concerned has been approved in the Netherlands (E 4) pursuant to Regulation No 43 under approval No 002439. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

ANNEX 2A

ARRANGEMENTS OF APPROVAL MARKS FOR VEHICLES

MODEL A

(see paragraph 5.11 of this Regulation)

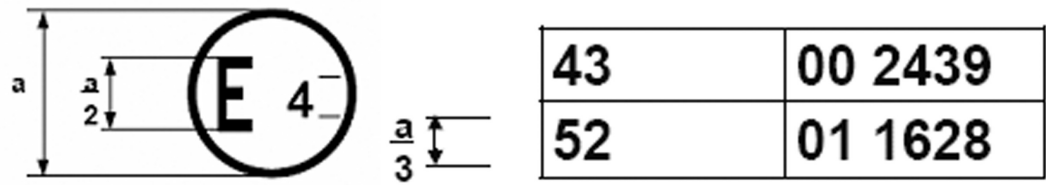


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to installation of glazing, been approved in the Netherlands (E 4) pursuant to Regulation No 43. The approval number indicates that the approval was granted in accordance with the requirements of Regulation No 43.

MODEL B

(see paragraph 5.12 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 (E 4) pursuant to Regulations No 43 and No 52 ⁽¹⁾. The approval numbers indicate that, at the date when the respective approvals were given, Regulation No 43 was in its original form and Regulation No 52 included the 01 series of amendments.

⁽¹⁾ The second number is given only as an example.

ANNEX 3

GENERAL TEST CONDITIONS

1. FRAGMENTATION TEST
 - 1.1. The glass pane to be tested shall not be rigidly secured; it may however be fastened on an identical glass pane by means of adhesive tape applied all round the edge.
 - 1.2. To obtain fragmentation, a hammer of about 75 g or some other appliance giving equivalent results shall be used. The radius of curvature of the point shall be $0,2 \pm 0,05$ mm.
 - 1.3. One test shall be carried out at each prescribed point of impact.
 - 1.4. The examination of the fragments shall be made using any method validated on its accuracy of the counting itself and on its ability to find the correct location where the minimum and the maximum counting shall be done.

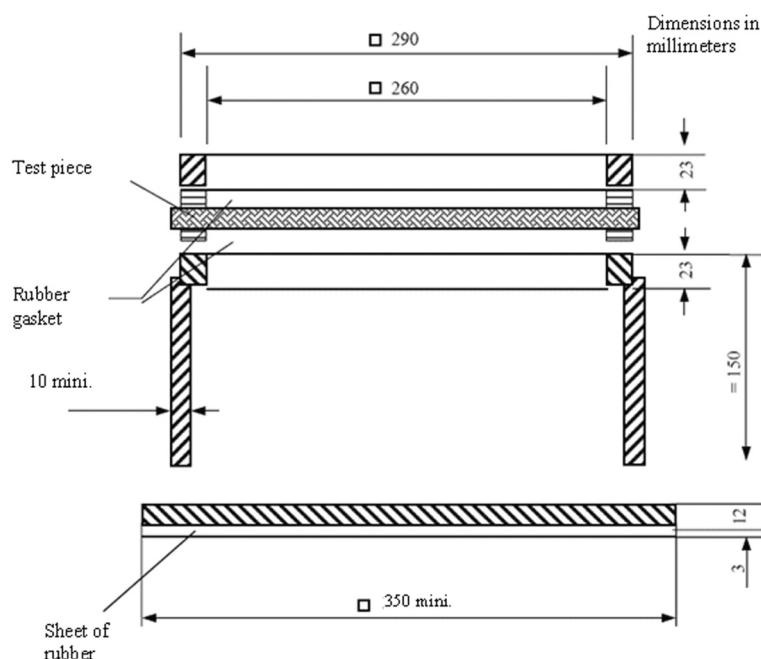
Permanent recording of the fragmentation pattern must start within 10 seconds and must end within 3 minutes after the impact. The technical service shall keep the permanent recordings of the fragmentation pattern.

2. BALL-IMPACT TESTS
 - 2.1. 227 g ball test
 - 2.1.1. Apparatus
 - 2.1.1.1. Hardened-steel ball with a mass of 227 ± 2 g and a diameter of approximately 38 mm.
 - 2.1.1.2. Means for dropping the ball freely from a height to be specified, or a means for giving the ball a velocity equivalent to that obtained by the free fall. When a device to project the ball is used, the tolerance on velocity shall be ± 1 per cent of the velocity equivalent to that obtained by the free fall.
 - 2.1.1.3. Supporting fixture, such as that shown in figure 1, composed of steel frames, with machined borders 15 mm wide, fitting one over the other and faced with rubber gaskets about 3 mm thick and 15 mm wide and of hardness 50 IRHD.

The lower frame rests on a steel box about 150 mm high. The test piece is held in place by the upper frame, the mass of which is about 3 kg. The supporting frame is welded onto a sheet of steel of about 12 mm thick resting on the floor with an interposed sheet of rubber about 3 mm thick and of hardness 50 IRHD.

Figure 1

Support for ball tests



2.1.2. Test conditions

Temperature: $20 \pm 5^\circ\text{C}$

Pressure: 860 to 1 060 mbar

Relative humidity: 60 ± 20 per cent

2.1.3. Test piece

The test piece shall be a flat square of side $300 + 10/-0$ mm or shall be cut from the flattest part of a windscreen or other curved pane of safety glazing.

Alternatively a curved pane of safety glazing may be tested. In this case care shall be taken to ensure adequate contact between the safety glazing and the support.

2.1.4. Procedure

Condition the test piece at the specified temperature for at least four hours immediately preceding the test.

Place the test piece in the fixture (paragraph 2.1.1.3). The plane of the test piece shall be perpendicular, within 3° , to the incident direction of the ball.

In the case of flexible plastic glazing the test piece shall be clamped to the support.

The point of impact shall be within 25 mm of the geometric centre of the test piece for a drop height less than or equal to 6 m, and within 50 mm of the centre of the test piece for a drop height greater than 6 m. The ball shall strike that face of the test piece which represents the outside face of the safety-glazing pane when mounted on the vehicle. The ball shall be allowed to make only one impact.

2.2. 2 260 g ball test

2.2.1. Apparatus

2.2.1.1. Hardened-steel ball with a mass of $2\,260 \pm 20$ g and a diameter of approximately 82 mm.

2.2.1.2. Means for dropping the ball freely from height to be specified, or means for giving the ball a velocity equivalent to that obtained by the free fall. When a device to project the ball is used, the tolerance on velocity shall be ± 1 per cent of the velocity equivalent to that obtained by the free fall.

2.2.1.3. The supporting fixture shall be as shown in figure 1 and identical with that described in paragraph 2.1.1.3.

2.2.2. Test conditions

Temperature: $20 \pm 5^\circ$

Pressure: 860 to 1 060 mbar

Relative humidity: 60 ± 20 per cent.

2.2.3. Test piece

The test piece shall be a flat square of side $300 + 10/-0$ mm or shall be cut out from the flattest part of a windscreen or other curved pane of safety glazing.

Alternatively, the whole windscreen or other curved pane of safety glazing may be tested. In this case care shall be taken to ensure adequate contact between the safety glazing pane and the support.

2.2.4. Procedure

Condition the test piece at the specified temperature for at least four hours immediately preceding the test.

Place the test piece in the fixture (paragraph 2.1.1.3). The plane of the test piece shall be perpendicular, within 3° , to the incident direction of the ball.

In the case of glass-plastics glazing the test piece shall be clamped to the support.

The point of impact shall be within 25 mm of the geometric centre of the test piece.

The ball shall strike that face of the test piece which represents the inward face of the safety-glass pane when the latter is mounted on the vehicle.

The ball shall be allowed to make only one impact.

3. HEADFORM TEST

3.1. Headform test without deceleration measurement

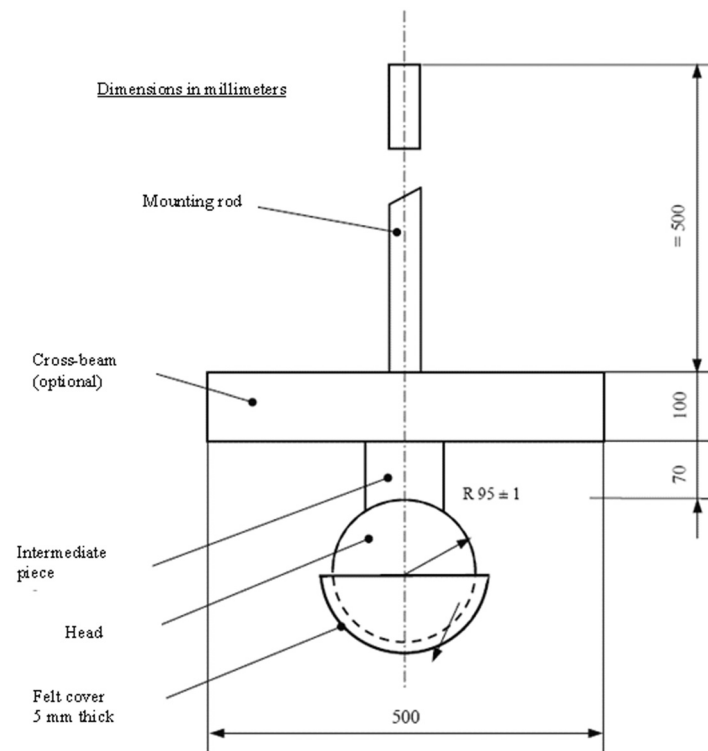
3.1.1. Apparatus

Headform weight with a spherical or semi-spherical headform made of laminated hardwood covered with replaceable felt and with or without a cross-beam made of wood. There is a neck-shaped intermediate piece between the spherical part and the cross-beam and a mounting rod on the other side of the cross-beam.

The dimensions shall be in accordance with figure 2. The total mass of the apparatus shall be $10 \pm 0,2$ kg.

Figure 2

Headform weight



3.1.2. Means for dropping the headform weight freely from a height to be specified, or means for giving the weight a velocity equivalent to that obtained by the free fall. When a device to project the headform weight is used, the tolerance on velocity shall be ± 1 per cent of the velocity equivalent to that obtained by the free fall.

3.1.3. Supporting fixture, as shown in figure 3, for testing flat test pieces. The fixture is composed of two steel frames, with machined borders 50 mm wide, fitting one over the other and faced with rubber gaskets about 3 mm thick and 15 ± 1 mm wide and of hardness 70 IRHD. The upper frame is held pressed against the lower frame by at least eight bolts.

3.1.4. Test conditions

Temperature: 20 ± 5 °C

Pressure: 860 to 1 060 mbar

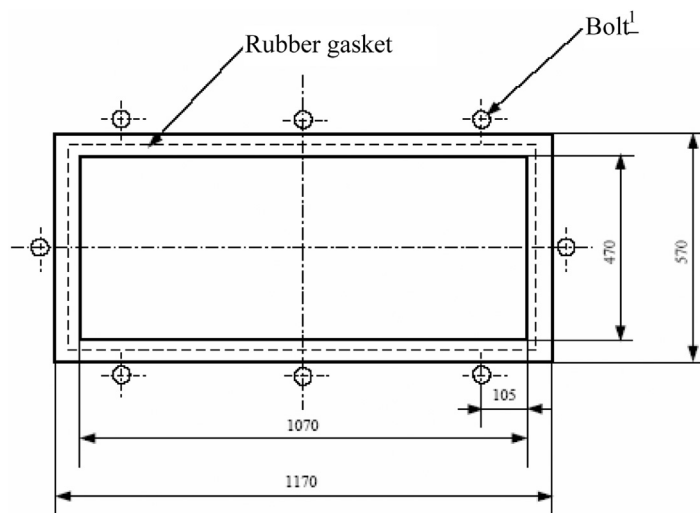
Relative humidity: 60 ± 20 per cent.

3.1.5. Procedure

3.1.5.1. Test on a flat test piece

The flat test piece, having a length of $1\,100 \pm 5$ mm and a width of 500 ± 5 mm, shall be kept at a constant temperature of 20 ± 5 °C for at least four hours immediately preceding the test.

Figure 3

Support for headform tests

Dimensions in millimeters

- (1) The minimum recommended torque for M 20 is 30 Nm.

Fix the test piece in the supporting frames (paragraph 3.1.3); the torque on the bolts shall ensure that the movement of the test piece during the test will not exceed 2 mm. The plane of the test piece shall be substantially perpendicular to the incident direction of the weight. The weight shall strike the test piece within 40 mm of its geometric centre on that face which represents the inward face of the safety-glass pane when the latter is mounted on the vehicle, and shall be allowed to make only one impact.

The impact surface of the felt cover shall be replaced after 12 tests.

3.1.5.2. Tests on a complete windscreen (used only for a drop height of less than or equal to 1,5 m)

Place the windscreen freely on a support with an interposed strip of rubber of hardness 70 IRHD and thickness about 3 mm, the width of contact over the whole perimeter being about 15 mm.

The support shall consist of a rigid piece corresponding to the shape of the windscreen so that the headform weight strikes the internal surface. If necessary the windscreen shall be clamped to the support.

The support shall rest on a rigid stand with an interposed sheet of rubber of hardness 70 IRHD and thickness about 3 mm. The surface of the windscreen shall be substantially perpendicular to the incident direction of the headform weight.

The headform weight shall strike the windscreen at a point within 40 mm of its geometric centre on that face which represents the inward face of the safety-glass pane when the latter is mounted on the vehicle, and shall be allowed to make only one impact.

The impact surface of the felt cover shall be replaced after 12 tests.

3.2. Headform test with deceleration measurement

3.2.1. Apparatus

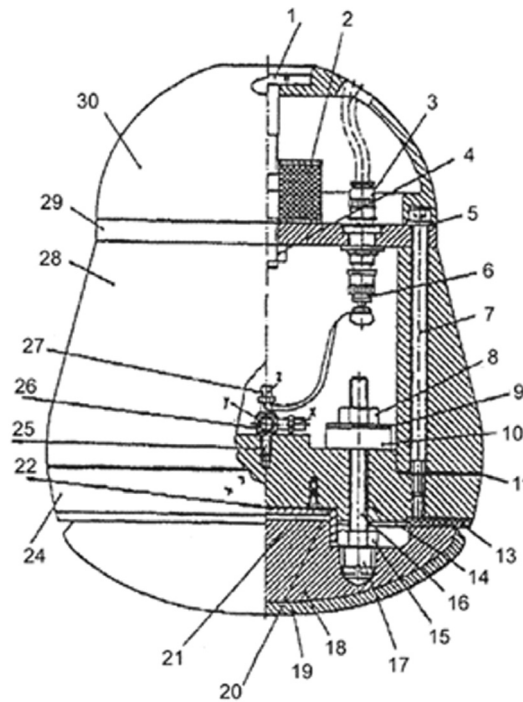
In the case of headform tests with simultaneous determination of HIC-values the drop body is the phantom head as in figure 2.1. The total mass of the phantom head should be $10,0 \pm 0,2$ – 0,0 kg.

In the middle of the base plate (24) the triaxial mounting block (26) is mounted in the centre of gravity to receive the acceleration gauges (27). The acceleration gauges should be arranged vertically to each other.

The basin (18) and cover (19) situated under the base plate (24) share, to a great extent, the elastic properties of the human skull. The elastic properties of the phantom head on impact are determined by the hardness and the thickness of the intermediate ring (13) and the basin.

Figure 2.1

10 kg Headform



List of pieces for the 10 kg headform concerning figure 2.1

Position No	Number of Pieces	Standard notation	Material	Remarks
1	1	Magnetic holding device	Steel DIN 17100	—
2	1	Vibration damper	Rubber / Steel	Diameter: 50 mm Thickness: 30 mm Thread: M10
3	4	HF connector BNC	—	—
4	1	Hexagonal nut DIN 985	—	—
5	6	Disc DIN 125	—	—
6	3	Transition piece	—	—
7	6	Cylinder screw DIN 912	—	—
8	3	Hexagonal nut	—	—
9	3	Disc	Steel DIN 17100	Hole Diameter: 8 mm Outer Diameter: 35 mm Thickness: 1,5 mm

Position No	Number of Pieces	Standard notation	Material	Remarks
10	3	Rubber ring	Rubber, hardness 60 IRHD	Hole Diameter: 8 mm Outer Diameter: 30 mm Thickness: 10 mm
11	1	Damping ring	Packing with paper	Hole Diameter: 120 mm Outer Diameter: 199 mm Thickness: 0,5 mm
12	—	—	—	—
13	1	Intermediate ring	Butadien-rubber, hardness IRHD about 80	Hole Diameter: 129 mm Outer Diameter: 192 mm Thickness: 4 mm
14	3	Guide tube	Polytetra-fluorethen (PTFE)	Inner Diameter: 8 mm Outer Diameter: 10 mm Length: 40 mm
15	3	Hexagonal nut	—	—
16	3	Threaded bolt DIN 976	—	—
17	3	Screwed insert	Cast alloy DIN 1709-GD-CuZn 37Pb	—
18	1	Basin	Polyamid 12	—
19	1	Cover	Butadien-rubber	Thickness: 6 mm Rib on one side
20	1	Guide bush	Steel DIN 17100	—
21	4	Counter sunk screw	—	—
22	1	Damping disc	Packing with paper	Diameter: 65 mm Thickness: 0,5 mm
23	—	—	—	—
24	1	Base plate	Steel DIN 17100	—
25	1	Set screw with hexagonal socket	Class of strength 45H	—
26	1	Triaxial mounting block	—	—
27	3	Acceleration gauge	—	—
28	1	Wood component	Hornbeam, glued in layers	—
29	1	Cover plate	Alloy (AlMg5)	—
30	1	Protective cap	Polyamid 12	—

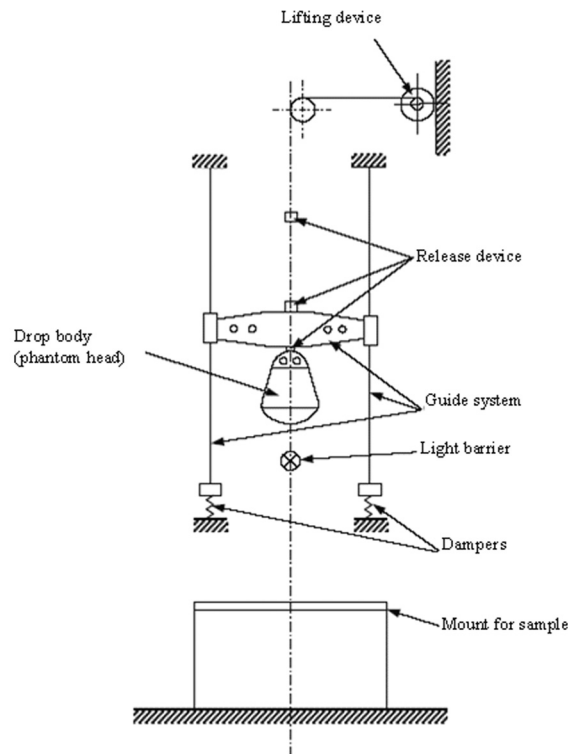
3.2.2. Adjustment and calibration

To perform the headform test the phantom head is fixed to the cross arm of the guide system (figure 2.2) and moved to the required drop height by means of a lifting device. During the headform test the cross arm with the phantom head is released. After passing the height adjustable light barrier the phantom head is released from the cross arm, the cross arm's fall is dampened and the phantom head falls onto the sample.

No impulse may be given to the phantom head by the drop appliance or by the measuring cable, so that it is accelerated only by gravity and falls vertically.

Figure 2.2

Test apparatus for the headform experiment with deceleration measurement



3.2.2.1. Measuring device which allows to determine HIC-values with the headform described under paragraph 3.2.1.

3.2.2.2. Equipment to calibrate the phantom head

The drop appliance must allow drop heights between 50 mm and 254 mm to be adjusted exactly to within 1 mm. A guide system is not necessary for these small drop heights.

A steel impact plate which is made of steel is 600 mm × 600 mm in size and at least 50 mm thick. The impact surface must be polished:

surface roughness $R_{\max} = 1 \text{ m}$, flatness tolerance $t = 0,05 \text{ mm}$.

3.2.2.3. Calibration and adjustment of the phantom head

Before each test series and no later than each 50 tests within a series, the phantom head must be calibrated and adjusted if necessary.

The impact plate must be clean and dry and during the test must lie non-positively on a concrete base.

The phantom head is allowed to hit the impact plate vertically. The drop heights (measured from the lowest point of the phantom head to the surface of the impact plate) are 50, 100, 150 and 254 mm. The deceleration curves should be recorded.

The greatest deceleration a_z from the various drop heights on the z-axis must lie within the limits given in the table:

Drop height mm	Greatest deceleration a_z as a multiple of acceleration due to gravity g
50	64 ± 5
100	107 ± 5
150	150 ± 7
254	222 ± 12

The deceleration curves should be based on a unimodal vibration. The deceleration curve of the drop height of 254 mm must run at least 1,2 ms and at most 1.5 ms over 100 g.

If the requirements given in paragraph 3.2.2.3 are not met, the elastic properties of the phantom head must be adjusted by varying the thickness of the intermediate ring (13) in the base plate (24). Corrections can be carried out by adjusting the three self-locking hexagonal nuts (8) on the threaded bolts (16) with which the basin (18) is fixed to the base plate (24). The rubber rings (10) under the hexagon nuts (8) should not be brittle or cracked.

The cover (19) of the impact surface and the intermediate ring (13) should always be replaced immediately if damaged, especially when the phantom head can no longer be adjusted.

- 3.2.3. Supporting fixture for testing flat test pieces is as described in paragraph 3.1.3.
- 3.2.4. Test conditions are specified in paragraph 3.1.4.
- 3.2.5. Tests on complete panes (used for a drop height between 1,5 m and 3 m). Place the pane freely on a support with an interposed strip of rubber of hardness 70 IRHD and thickness of about 3 mm.

The pane shall be clamped to the supporting structure by means of appropriate devices. The surface of the pane shall be substantially perpendicular to the incident direction of the headform weight. The headform weight shall strike the pane at a point within 40 mm of its geometric centre on that face which represents the inward face of the plastic pane when the latter is mounted on the vehicle, and shall be allowed to make only one impact.

Starting from a selected initial drop height, the drop heights should be raised by 0,5 m respectively in each further experiment. The deceleration curves occurring on impact on the sample for a_x , a_y and a_z should be recorded according to time t .

After the headform test, it should be checked whether a glazing edge has moved more than 2 mm in the mount and whether the requirement for the point of impact was met. The acceleration components a_x and a_y should be smaller for vertical impact than 0,1 a_z .

3.2.6. Evaluation

The deceleration curves should be evaluated as follows:

The resulting deceleration $a_{res}(t)$ in the centre of gravity according to equation (1) from the measured deceleration curves $a_x(t)$, $a_y(t)$ and $a_z(t)$ is to be compounded as multiples of the acceleration due to gravity.

$$(1) \ a_{res}(t) = (a_x^2(t) + a_y^2(t) + a_z^2(t))^{1/2}$$

The time for which a deceleration of 80 g with a_{res} is continually exceeded and the greatest deceleration of a_{res} should be determined. The HIC-value should be calculated as a measurement of the danger of blunt skull-brain-injuries using the following equation (2):

$$(2) \ HIC = (t_2 - t_1)^{-1.5} \left(\int_{t_1}^{t_2} a_{res}(t) dt \right)^{2.5}$$

The integral limits t_1 and t_2 should be selected in such a way that the integral takes a maximal value.

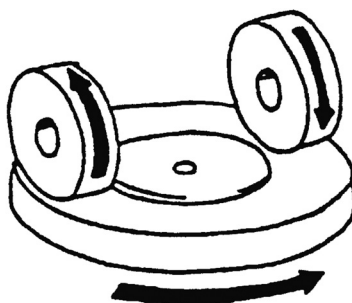
4. TEST OF RESISTANCE TO ABRASION

4.1. Apparatus

- 4.1.1. Abrading instrument ⁽¹⁾ shown diagrammatically in figure 4 and consisting of: A horizontal turntable, with centre clamp, which revolves counter-clockwise at 65 to 75 rev/min.;

Figure 4

Diagram of abrading instrument



Two weighted parallel arms each carrying a special abrasive wheel freely rotating on a ball-bearing horizontal spindle; each wheel rests on the test specimen under the pressure exerted by a mass of 500 g.

The turntable of the abrading instrument shall rotate regularly, substantially in one plane (the deviation from this plane shall not be greater than $\pm 0,05$ mm at a distance of 1,6 mm from the turntable periphery).

The wheels shall be mounted in such a way that when they are in contact with the rotating test piece they rotate in opposite directions so as to exert, twice during each rotation of the test piece, a compressive and abrasive action along curved lines over an annular area of about 30 cm².

- 4.1.2. Abrasive wheels ⁽²⁾, each 45 to 50 mm in diameter and 12,5 mm thick, composed of a special finely-screened abrasive embedded in a medium-hard rubber. The wheels shall have a hardness of 72 ± 5 IRHD, as measured at four points equally spaced on the centreline of the abrading surface, the pressure being applied vertically along a diameter of the wheel and the readings being taken 10 seconds after full application of the pressure.

The abrasive wheels shall be prepared for use by very slow rotation against a sheet of flat glass to ensure that their surface is completely even.

- 4.1.3. Light source consisting of an incandescent lamp with its filament contained within a parallelepiped measuring 1,5 mm $\times$ 1,5 mm $\times$ 3 mm. The voltage at the lamp filament shall be such that the colour temperature is $2\,856 \pm 50$ K. This voltage shall be stabilized within $\pm 1/1\,000$. The instrument used to check the voltage shall be of appropriate accuracy.
- 4.1.4. Optical system consisting of a lens with a focal length f of at least 500 mm and corrected for chromatic aberrations. The full aperture of the lens shall not exceed $f/20$. The distance between the lens and the light source shall be adjusted in order to obtain a light beam which is substantially parallel. A diaphragm shall be inserted to limit the diameter of the light beam to 7 ± 1 mm. This diaphragm shall be situated at a distance of 100 ± 50 mm from the lens on the side remote from the light source.
- 4.1.5. Equipment for measuring scattered light (see figure 5), consisting of a photoelectric cell with an integrating sphere 200 to 250 mm in diameter. The sphere shall be equipped with entrance and exit ports for the light. The entrance port shall be circular and have a diameter at least twice that of the light beam. The exit port of the sphere shall be provided with either a light trap or a reflectance standard, according to the procedure described in paragraph 4.4.3 below. The light trap shall absorb all the light when no test piece is inserted in the light beam.

⁽¹⁾ A suitable abrading instrument is supplied by Teledyne Taber (United States of America).

⁽²⁾ Suitable abrasive wheels may be obtained from Teledyne Taber (United States of America).

The axis of the light beam shall pass through the centre of the entrance and exit ports. The diameter b of the light-exit port shall be equal to $2 a \tan 4^\circ$, where a is the diameter of the sphere. The photoelectric cell shall be mounted in such a way that it cannot be reached by light coming directly from the entrance port or from the reflectance standard.

The surfaces of the interior of the integrating sphere and the reflectance standard shall be of substantially equal reflectance and shall be matt and non-selective.

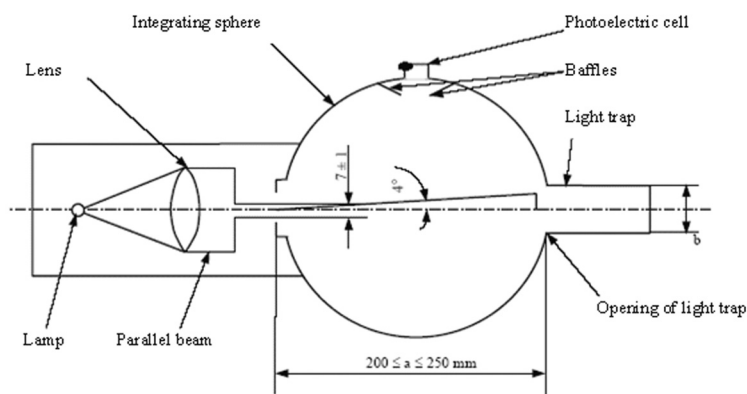
The output of the photoelectric cell shall be linear within ± 2 per cent over the range of luminous intensities used. The design of the instrument shall be such that there is no galvanometer deflection when the sphere is dark.

The whole apparatus shall be checked at regular intervals by means of calibration standards of defined haze.

If haze measurements are made using equipment or methods differing from those defined above, the results shall be corrected, if necessary, to bring them into agreement with those obtained by the apparatus described above.

Figure 5

Hazemeter



4.2. Test conditions

Temperature: $20 \pm 5^\circ\text{C}$

Pressure: 860 to 1 060 mbar

Relative humidity: 60 ± 20 per cent.

4.3. Test pieces

The test pieces shall be flat squares of side 100 mm having both surfaces substantially plane and parallel and having a fixing hole $6,4^{+0.2}_{-0}$ mm in diameter drilled in the center, if necessary.

4.4. Procedure

The abrasion test shall be carried out on that surface of the test piece which represents the outside face of the pane when the latter is mounted on the vehicle and also on the inner face if of plastics material.

4.4.1. Immediately before and after the abrasion, clean the test pieces in the following manner:

- (a) wipe with a linen cloth under clear running water,
- (b) rinse with distilled or demineralized water,
- (c) blow dry with oxygen or nitrogen,

- (d) remove possible traces of water by dabbing softly with a damp linen cloth. If necessary, dry by pressing lightly between two linen cloths.

Any treatment with ultrasonic equipment shall be avoided. After cleaning, the test pieces shall be handled only by their edges and shall be stored to prevent damage to, or contamination of, their surfaces.

- 4.4.2. Condition the test pieces for a minimum time of 48 hours at $20 \pm 5^\circ\text{C}$ and 60 ± 20 per cent relative humidity.
- 4.4.3. Immediately place the test piece against the entrance port of the integrating sphere. The angle between the normal (perpendicular) to the surface of the test piece and the axis of the light beam shall not exceed 8° .

Take four readings as indicated in the following table:

Reading	With test piece	With light-trap	With reflectance standard	Quantity represented
T_1	No	No	Yes	Incident light
T_2	Yes	No	Yes	Total light transmitted by test-piece
T_3	No	Yes	No	Light scattered by instrument
T_4	Yes	Yes	No	Light scattered by instrument and test piece

Repeat readings for T_1 , T_2 , T_3 , and T_4 with other specified positions of the test piece to determine uniformity.

Calculate the total transmittance $T_t = T_2/T_1$.

Calculate the diffuse transmittance T_d as follows:

$$T_d = \frac{T_4 - T_3(T_2/T_1)}{T_1 - T_3}$$

Calculate the percentage haze, or light, or both, scattered, as follows:

$$\text{Haze, or light, or both, scattered,} = \frac{T_d}{T_t} \times 100 \%$$

Measure the initial haze of the test piece at a minimum of four equally-spaced points in the unabraded area in accordance with the formula above. Average the results for each test piece. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/sec or more.

For each type of safety glazing, carry out three tests with the same load. Use the haze as a measure of the subsurface abrasion, after the test piece has been subjected to the abrasion test.

Measure the light scattered by the abraded track at a minimum of four equally-spaced points along the track in accordance with the formula above. Average the results for each test piece. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/sec or more.

- 4.5. The abrasion test will be carried out only at the discretion of the laboratory conducting the test with due regard to the information already at its disposal.

Except for glass-plastics materials, changes in the interlayer or materials thickness will not normally necessitate further testing.

4.6. Indices of difficulty of the secondary characteristics

No secondary characteristics are involved.

5. TEST OF RESISTANCE TO HIGH TEMPERATURE

5.1. Procedure

Heat to 100 °C three samples or three square test pieces of at least 300 × 300 mm which have been cut by the laboratory from three windscreens or three glass panes other than windscreens as the case may be, one edge of which corresponds to the upper edge of the glazing. Maintain this temperature for a period of two hours, then allow the samples or test pieces to cool to room temperature. If the safety-glass pane has both external surfaces of inorganic material, the test may be carried out by immersing the sample vertically in boiling water for the specified period of time, care being taken to avoid undue thermal shock. If samples are cut from windscreens, one edge of each such sample shall be part of an edge of the windscreen.

5.2. Indices of difficulty of the secondary characteristics

	Colourless	Tinted
Colouring of the interlayer	1	2

The other secondary characteristics are not involved.

5.3. Interpretation of results

5.3.1. The test for resistance to high temperature shall be considered to give a positive result if bubbles or other defects are not formed more than 15 mm from an uncut edge or 25 mm from a cut edge of the test piece or sample or more than 10 mm away of any cracks which may occur during the test.

5.3.2. A set of test pieces or samples submitted for approval shall be considered satisfactory from the point of view of the test for resistance to high temperature if either of the following conditions is fulfilled:

5.3.2.1. All the tests give a satisfactory result; or

5.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces or samples gives satisfactory results.

6. RESISTANCE-TO-RADIATION TEST

6.1 Test method

6.1.1. Apparatus

6.1.1.1. Radiation source consisting of a medium-pressure mercury-vapour arc lamp with a tubular quartz bulb of ozone-free type; the bulb axis shall be vertical. The nominal dimensions of the lamp shall be 360 mm in length by 9,5 mm in diameter. The arc length shall be 300 ± 4 mm. The lamp shall be operated at 750 ± 50 W.

Any other source of radiation which produces the same effect as the lamp specified above may be used. To check that the effects of another source are the same, a comparison shall be made by measuring the amount of energy emitted within a wavelength range of 300 to 450 nanometers, all other wavelengths being removed by the use of suitable filters. The alternative source shall then be used with these filters.

In the case of safety-glass panes for which there is no satisfactory correlation between this test and the conditions of use it will be necessary to review the test conditions.

6.1.1.2. Power-supply transformer and capacitor capable of supplying to the lamp (paragraph 6.1.1.1) a starting peak voltage of 1 100 V minimum and an operating voltage of 500 ± 50 V.

- 6.1.1.3. Device for mounting and rotating the test pieces at 1 to 5 rev/min about the centrally-located radiation source in order to ensure even exposure.

- 6.1.2. Test pieces

- 6.1.2.1. The size of the test pieces shall be 76 × 300 mm.

- 6.1.2.2. The test pieces shall be cut by the laboratory from the upper part of the glass panes in such a way that:

In the case of glass panes other than windscreens, the upper edge of the test piece coincides with the upper edge of the glass pane.

In the case of windscreens, the upper edge of the test piece coincides with the upper limit of the zone in which regular transmittance shall be measured, determined in accordance with paragraph 9.1.2.2 of this annex.

- 6.1.3. Procedure

Check the regular light transmittance, determined according to paragraphs 9.1.1 to 9.1.2 of this annex, of three test pieces before exposure. Protect a portion of each test piece from the radiation, and then place the test pieces in the test apparatus 230 mm from and parallel lengthwise to the lamp axis. Maintain the temperature of the test pieces at 45 ± 5 °C throughout the test.

That face of each test piece which would constitute a glazed exterior part of the vehicle shall face the lamp. For the type of lamp specified in paragraph 6.1.1.1 the exposure time shall be 100 hours. After exposure, measure the regular light transmittance again in the exposed area of each test piece.

- 6.1.4. Each test piece or sample (total number 3 pieces) shall be subjected, in accordance with the procedure above, to radiation such that the radiation on each point of the test piece or sample produces on the interlayer used the same effect as that which would be produced by solar radiation of 1 400 W/m² for 100 hours.

- 6.2. Indices of difficulty of the secondary characteristics

	Colourless	Tinted
Colouring of glass	2	1
Colouring of interlayer	1	2

The other secondary characteristics are not involved.

- 6.3. Interpretation of results

- 6.3.1. The test for resistance to radiation shall be deemed to have given a positive result if the following conditions are fulfilled:

- 6.3.1.1. The total light transmittance when measured pursuant to paragraphs 9.1.1 and 9.1.2 of this annex does not fall below 95 per cent of the original value before irradiation and in any event does not fall:

- 6.3.1.1.1. below 70 per cent in the case of glass panes other than windscreens which are required to comply with the specifications regarding the driver's field of view in all directions;

- 6.3.1.1.2. below 70 per cent in the case of a windscreen in the zone where the regular light transmittance is measured as defined in paragraph 9.1.2.2 below.

- 6.3.1.2. The test piece or sample may however show a slight coloration after irradiation when examined against a white background, but no other defect may be apparent.

- 6.3.2. A set of test pieces or samples submitted for approval shall be considered satisfactory from the point of view of the resistance-to-radiation test if one of the following conditions is fulfilled:

6.3.2.1. All the tests give a satisfactory result;

6.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces or samples gives satisfactory results.

6.4. Resistance to simulated weathering

6.4.1. Test method

6.4.1.1. Apparatus

6.4.1.1.1. Long arc xenon lamp

The exposure apparatus ⁽¹⁾ shall utilize a long arc xenon lamp as the source of irradiation, but other methods giving the required level of ultraviolet radiant exposure shall be allowed. The long arc xenon lamp is advantageous in that it can, when correctly filtered and maintained, yield a spectrum most closely approximating that of natural sunlight. To this end, the quartz xenon burner tube shall be fitted with suitable borosilicate glass optical filter(s) ⁽²⁾ The xenon lamps employed shall be operated from a suitable 50 or 60 Hz power supply, suitable reactance transformers and electrical equipment.

The exposure apparatus shall include equipment necessary for measuring and/or controlling the following:

- Irradiance
- Black standard temperature
- Water spray
- Operating schedule or cycle

The exposure apparatus shall be made from inert materials which do not contaminate the water employed in the test.

Irradiance shall be measured at the test specimen surface and shall be controlled according to the recommendations of the exposure apparatus manufacturer.

Total ultraviolet ⁽³⁾ radiant exposure (Joules per square metre) shall be measured or computed and shall be considered the primary measure of test specimen exposure.

6.4.1.2. Test specimens

The dimensions of the test specimen shall normally be those specified in the appropriate test method for the property or properties to be measured after exposure.

The number of control and test specimens for each test condition or exposure stage shall be determined, in addition to those required for visual evaluations by the number required by the test methods.

It is recommended that visual evaluations be conducted on the largest test specimens tested.

6.4.1.3. Procedure

Measure, according to paragraph 9.1 of this annex the luminous transmission of the test specimen(s) to be exposed. Measure, according to paragraph 4 of this annex, the resistance to abrasion of the surface(s) of the control specimen(s). That face of each test specimen, which would represent the surface glazed to the exterior of the road vehicle, shall face the lamp. Other exposure conditions shall be as follows:

6.4.1.3.1. The irradiance shall not vary more than $\pm 10\%$ over the whole test specimen area.

6.4.1.3.2. At appropriate intervals, clean lamp filters by washing with detergent and water. Xenon arc filters shall be replaced according to the recommendations of the equipment manufacturer.

⁽¹⁾ Such as Atlas Ci Series, Heraeus Xenotest Series, or Suga WEL-X Series.

⁽²⁾ Such as Corning 7 740 Pyrex or Heraeus Suprax.

⁽³⁾ Total ultraviolet is considered to be all radiation of wavelength less than 400 nm.

- 6.4.1.3.3. The temperature within the exposure apparatus during the dry portion of the cycle shall be controlled by circulation of sufficient air to maintain a constant black standard temperature.

In the xenon arc exposure apparatus, this temperature shall be 70 ± 3 °C as indicated by a Black standard thermometer or equivalent.

The black panel thermometer shall be mounted in the test specimen rack and readings shall be taken at the point where maximum heat is developed due to light exposure.

- 6.4.1.3.4. The relative humidity within the exposure apparatus shall be controlled at 50 ± 5 % during the dry portions of the cycle.

- 6.4.1.3.5. The deionized water used in the spray cycle shall contain less than 1 ppm silicon dioxide solids and shall leave no permanent deposit or residue on the test specimens which would interfere with subsequent measurements.

- 6.4.1.3.6. The pH of the water shall be between 6,0 and 8,0, and the conductivity shall be less than 5 microsiemens.

- 6.4.1.3.7. The temperature of the water in the line where it enters the exposure apparatus shall be the ambient water temperature.

- 6.4.1.3.8. The water shall strike the test specimens in the form of a fine spray in sufficient volume to wet the test specimens uniformly, immediately upon impact.

Water spray will be directed only against the test specimen surface facing the light source. No recirculation of the spray water or immersion of the test specimens in the water shall be permitted.

- 6.4.1.3.9. The test specimens shall be rotated about the arc in order to provide uniform distribution of the light. All positions in the exposure apparatus shall be filled with test specimens or surrogates to ensure that a uniform temperature distribution is maintained. Test specimens shall be held in frames with backs exposed to the cabinet environment. However, reflections from cabinet walls shall not be permitted to strike the back surface of specimens. If necessary, samples may be backed to block such reflections so long as free circulation of air at the specimen surface is not impeded.

- 6.4.1.3.10. The exposure apparatus shall be operated to provide continuous light and intermittent water spray in 2 h cycles. Each 2 h cycle shall be divided into periods during which the test specimens are exposed to light without water spray for 102 minutes and to light with water spray for 18 minutes.

- 6.4.1.4. Evaluation

After exposure, the test specimens may be cleaned, if necessary, by a practice recommended by their manufacturer to remove any residues present.

Evaluate the exposed test specimens visually with respect to the following properties:

- Bubbles
- Colour
- Haze
- Noticeable decomposition

Measure the luminous transmission of the exposed specimens.

- 6.4.1.5. Expression of results

Report visual evaluations of exposed test specimens, comparing the appearance of each with that of the unexposed control.

The regular light transmittance measured shall not differ from the original test on unexposed samples by more than 5 per cent and shall not fall below:

70 per cent in the case of a windscreen and other glazing that is located in a position requisite for driving visibility.

7. RESISTANCE-TO-HUMIDITY TEST

7.1. Procedure

Keep three samples or three square test pieces of at least 300 × 300 mm in a vertical position for two weeks in a closed container in which the temperature is maintained at 50 ± 2 °C and the relative humidity at 95 ± 4 per cent. In the case of rigid plastic glazings and rigid plastic double glazed units, the number of samples shall be ten.

The test pieces shall be prepared in such a way that:

- at least one edge of the test pieces coincides with an original edge of the glass pane,
- if several test pieces are tested at the same time, adequate spacing shall be provided between them.

Precautions shall be taken to prevent condensate from the walls or ceiling of the test chamber from falling on the test pieces.

7.2. Indices of difficulty of the secondary characteristics

	Colourless	Tinted
Colouring of interlayer	1	2

The other secondary characteristics are not involved.

7.3. Interpretation of results

7.3.1. Safety glazing shall be deemed to be satisfactory from the point of view of resistance to humidity if no significant change is observed more than 10 mm from the uncut edges and more than 15 mm from the cut edges after ordinary and treated laminated glass panes have been maintained for two hours in the ambient atmosphere, and plastics-faced and glass-plastics panes have been maintained for 48 hours in the ambient atmosphere.

7.3.2. A set of test pieces or samples submitted for approval shall be considered satisfactory from the point of view of the resistance-to-humidity test if one of the following conditions is fulfilled:

7.3.2.1. All the tests give a satisfactory result;

7.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of samples gives satisfactory results.

8. TEST OF RESISTANCE TO TEMPERATURE CHANGES

8.1. Test method

Two test pieces 300 × 300 mm shall be placed in an enclosure at a temperature of -40 ± 5 °C for a period of 6 hours; they shall then be placed in the open air at a temperature of 23 ± 2 °C for one hour or until temperature equilibrium has been reached by the test pieces. These shall then be placed in circulating air at a temperature of 72 ± 2 °C for 3 hours. After being placed again in the open air at 23 ± 2 °C and cooled to that temperature, the test pieces shall be examined.

8.2. Indices of difficulty of secondary characteristics

	Colourless	Tinted
Colouring of the interlayer or of the plastics coating	1	2

The other secondary characteristics are not involved.

8.3. Interpretation of results

The test for resistance to temperature changes shall be considered to have given a satisfactory result if the test pieces do not show any evidence of cracking, clouding, separation of layers or other apparent deterioration.

9. OPTICAL QUALITIES

9.1. Light transmission test

9.1.1. Apparatus

9.1.1.1. Light source consisting of an incandescent lamp with its filament contained within a parallelepiped measuring 1,5 mm × 1,5 mm × 3 mm. The voltage at the lamp filament shall be such that the colour temperature is $2\,856 \pm 50$ K. This voltage shall be stabilized within $\pm 1/1\,000$. The instrument used to check the voltage shall be of appropriate accuracy.

9.1.1.2. Optical system consisting of a lens with a focal length f of at least 500 mm and corrected for chromatic aberrations. The full aperture of the lens shall not exceed $f/20$. The distance between the lens and the light source shall be adjusted in order to obtain a light beam which is substantially parallel. A diaphragm shall be inserted to limit the diameter of the light beam to 7 ± 1 mm. This diaphragm shall be situated at a distance of 100 ± 50 mm from the lens on the side remote from the light source. The point of measurement shall be taken at the centre of the light beam.

9.1.1.3. Measuring equipment

The receiver shall have a relative spectral sensitivity in substantial agreement with the relative spectral luminous efficiency for the ICI ⁽¹⁾ standard photometric observer for photopic vision. The sensitive surface of the receiver shall be covered with a diffusing medium and shall have at least twice the cross-section of the light beam emitted by the optical system. If an integrating sphere is used, the aperture of the sphere shall have a cross-sectional area at least twice that of the parallel portion of the beam.

The linearity of the receiver and the associated indicating instrument shall be better than 2 per cent of the effective part of the scale.

The receiver shall be centred on the axis of the light beam.

9.1.2. Procedure

The sensitivity of the measuring system shall be adjusted in such a way that the instrument indicating the response of the receiver indicates 100 divisions when the safety-glass pane is not inserted in the light path. When no light is falling on the receiver, the instrument shall read zero.

Place the safety-glass pane at a distance from the receiver equal to approximately five times the diameter of the receiver. Insert the safety-glass pane between the diaphragm and the receiver and adjust its orientation in such a way that the angle of incidence of the light beam is equal to $0 \pm 5^\circ$. The regular transmittance shall be measured on the safety-glass pane, and for every point measured the number of divisions, n , shown on the indicating instrument, shall be read. The regular transmittance τ is equal to $n/100$.

⁽¹⁾ International Commission on Illumination.

9.1.2.1. In the case of windscreens, alternative test methods may be applied using either a test piece cut from the flattest part of a windscreen or a specifically-prepared flat square with material and thickness characteristics identical to those of the actual windscreen, the measurements being taken normal (perpendicular) to the glass pane.

9.1.2.2. For the windscreens of M1 vehicles ⁽¹⁾

the test shall be carried out in test area B defined in Annex 18, paragraph 2.3, excluding any opaque obscuration impinging on it.

For the windscreens of N1 vehicles, the manufacturer may request that the same test may be carried out either in test area B defined in Annex 18, paragraph 2.3, excluding any opaque obscuration impinging on it, or in the zone I defined in paragraph 9.2.5.2.3 of this annex.

For windscreens of other categories of vehicles, the test shall be carried out in the zone I defined in paragraph 9.2.5.2.3 of this annex.

However, for agricultural and forestry tractors and for construction-site vehicles for which it is not possible to determine zone I, the test shall be carried out in zone I' as defined in paragraph 9.2.5.3 of this annex.

9.1.3. Indices of difficulty of the secondary characteristics

	Colourless	Tinted
Colouring of the glass	1	2
Colouring of the interlayer (in the case of laminated windscreens)	1	2
	not included	included
Shade and/or opaque obscuration	1	2

The other secondary characteristics are not involved.

9.1.4. Interpretation of results

The regular light transmittance shall be measured according to Paragraph 9.1.2 of this annex and the result shall be recorded. In the case of a windscreen, it shall not be less than 70 per cent. In the case of glazing other than a windscreen, the requirements are specified in Annex 21.

9.2. Optical distortion test

9.2.1. Scope

The method specified is a projection method which permits evaluation of the optical distortion of a safety-glass pane.

9.2.1.1. Definitions

9.2.1.1.1. Optical deviation: The angle between the true and the apparent direction of a point viewed through the safety-glass pane, the magnitude of the angle being a function of the angle of incidence of the line of sight, the thickness and inclination of the glass pane, and the radius of curvature at the point of incidence.

9.2.1.1.2. Optical distortion in a direction M-M': The algebraic difference in angular deviation measured between two points M and M' on the surface of the glass pane, the distance between the two points being such that their projections in a plane at right angles to the direction of vision are separated by a given distance x (see figure 6).

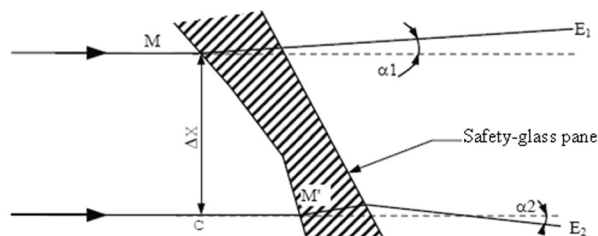
Anti-clockwise deviation should be regarded as positive and clockwise deviation as negative.

⁽¹⁾ As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), (document TRANS/WP.29/78/Rev.1/Amend.2 as last amended by Amend.4.

9.2.1.1.3. Optical distortion at a point M: The optical-distortion maximum for all directions M-M' from the point M.

Figure 6

Diagrammatic representation of optical distortion



NOTES:

$\Delta\alpha = \alpha_1 - \alpha_2$, i.e. the optical distortion in the direction M-M'.

$\Delta x = MC$ i.e. the distance between two straight lines parallel to the direction of vision and passing through the points M and M'.

9.2.1.2. Apparatus

This method entails the projection of an appropriate slide (raster) onto the display screen through the safety-glass pane being tested. The change caused in the shape of the projected image by the insertion of the safety-glass pane in the line of light provides a measure of the distortion.

The apparatus shall comprise the following items, arranged as shown in figure 9.

9.2.1.2.1. Projector, of good quality, with a high-intensity point light source, having for example the following characteristics:

focal length at least 90 mm,

aperture approximately 1/2,5,

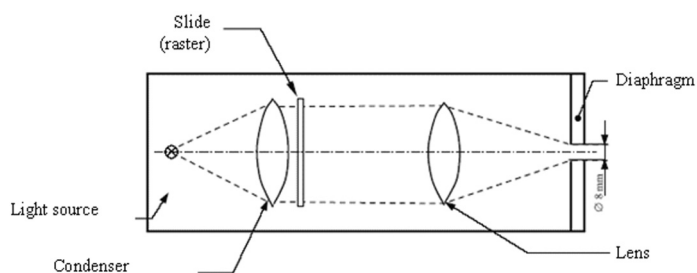
150-W quartz halogen lamp (if used without a filter),

250-W quartz halogen lamp (if a green filter is used).

The projector is shown schematically in figure 7. A diaphragm of 8 mm in diameter is positioned approximately 10 mm from the front lens.

Figure 7

Optical arrangement of the projector



- 9.2.1.2.2. Slides (rasters) consisting, for example, of an array of bright circular shapes on a dark background (see figure 8). The slides shall be of sufficiently high quality and contrast to enable measurement to be carried out with an error of less than 5 per cent.

In the absence of the safety-glass pane to be examined, the dimensions of the circular shapes shall be such that when the circular shapes are projected they form an array of circles of diameter

$$\frac{R_1 + R_2}{R_1} \cdot \Delta x, \text{ where } \Delta x = 4 \text{ mm (see figures 6 and 9).}$$

Figure 8

Enlarged section of the slide

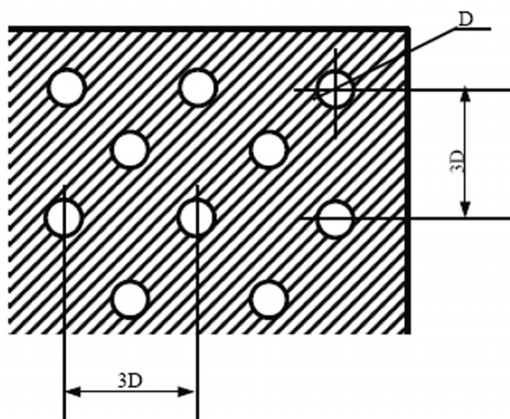
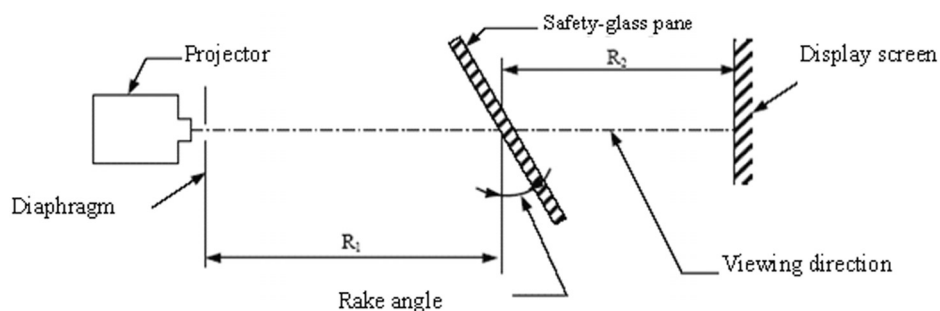


Figure 9

Arrangement of the apparatus for the optical distortion test



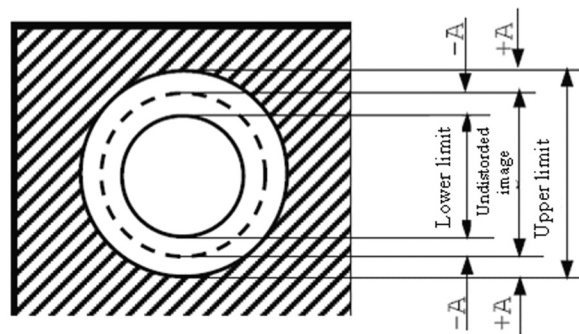
$$R_1 = 4 \text{ m}$$

$$R_2 = 2 \text{ to } 4 \text{ m (4 m preferred)}$$

- 9.2.1.2.3. Support stand, preferably one permitting vertical and horizontal scanning, as well as rotation of the safety-glass pane.

- 9.2.1.2.4. Checking template for measuring changes in dimensions where a rapid assessment is required. A suitable design is shown in figure 10.

Figure 10

Design for a suitable checking template

9.2.1.3. Procedure

9.2.1.3.1. General

Mount the safety-glass pane on the support stand (paragraph 9.2.1.2.3) at the designed rake angle. Project the test image through the area being examined. Rotate the safety-glass pane or move it either horizontally or vertically in order to examine the whole of the specified area.

9.2.1.3.2. Assessment using a checking template

When a rapid assessment with a possible margin of error of up to 20 per cent is sufficient, calculate the value of A (see figure 10) from the limit value l for the change in deviation and the value of R_2 , the distance from the safety-glass pane to the display screen:

$$A = 0,145 \Delta\alpha_l - R_2$$

The relationship between the change in diameter of the projected image d and the change in angular deviation is given by

$$\Delta d = 0,29 \Delta\alpha \cdot R_2$$

where:

Δd is in millimetres,

A is in millimetres,

$\Delta\alpha_l$ is in minutes of arc,

$\Delta\alpha$ is in minutes of arc,

R_2 is in metres.

9.2.1.3.3. Measurement using a photoelectric device

Where a precise measurement with a possible margin of error of less than 10 per cent of the limit value is required, measure d on the projection axis, the value of the spot width being taken at the point where the luminance is 0,5 times the maximum spot-luminance value.

9.2.1.4. Expression of results

Evaluate the optical distortion of the safety-glass panes by measuring d at any point of the surface and in all directions in order to find $d_{\max}$.

9.2.1.5. Alternative method

In addition, a strioscopic technique is permitted as an alternative to the projection techniques, provided that the accuracy of the measurements given in paragraphs 9.2.1.3.2 and 9.2.1.3.3 is maintained.

9.2.1.6. The distance x shall be 4 mm.

9.2.1.7. The windscreen shall be mounted at the same angle of inclination as on the vehicle.

9.2.1.8. The projection axis in the horizontal plane shall be maintained approximately normal to the trace of the windscreen in that plane.

9.2.2. The measurements shall be performed:

9.2.2.1. For vehicle category M1 in test area A, extended to the median plane of the vehicle, and in the corresponding part of the windscreen symmetrical to it about the longitudinal median plane of the vehicle, and also in the reduced test area B according to paragraph 2.4 of Annex 18.

9.2.2.2. For vehicles of categories M and N other than M1:

(a) in zone I as defined in paragraph 9.2.5.2 of this annex for M2, M3, N2 and N3 vehicles;

(b) either in zone I as defined in paragraph 9.2.5.2 of this annex or in test area A, extended to the median plane of the vehicle, and in the corresponding part of the windscreen symmetrical to it about the longitudinal median plane of the vehicle, and also in the reduced test area B according to paragraph 2.4 of Annex 18 for N1 vehicles.

9.2.2.3. For agricultural and forestry tractors and for construction-site vehicles for which it is not possible to determine zone I, in zone I' as defined in paragraph 9.2.5.3 of this annex.

9.2.2.4. Vehicle type

The test shall be repeated if the windscreen is to be fitted to a vehicle of a type in which the forward field of vision differs from that of the vehicle type for which the windscreen has already been approved.

9.2.3. Indices of difficulty of the secondary characteristics

9.2.3.1. Nature of the material

Polished (plate) glass

Float glass

Sheet glass

1

1

2

9.2.3.2. Other secondary characteristics

No other secondary characteristics are involved.

9.2.4. Number of samples

Four samples shall be submitted for testing.

9.2.5. Definitions of zones

9.2.5.1. Zones A and B of windscreens for vehicle category M1 and N1 are defined in Annex 18 to this Regulation.

9.2.5.2. Zones of windscreens for vehicles of categories M and N other than M1 are defined on the basis of:

9.2.5.2.1. the eye point, which is the point located 625 mm above the point R of the driver's seat in the vertical plane parallel to the longitudinal median plane of the vehicle for which the windscreen is intended, passing through the axis of the steering wheel. The eye point is hereunder designated '0';

9.2.5.2.2. the straight line OQ which is the horizontal straight line passing through the eye point 0 and perpendicular to the median longitudinal plane of the vehicle.

9.2.5.2.3. Zone I is the windscreen zone determined by the intersection of the windscreen with the four planes defined below:

P1 — a vertical plane passing through 0 and forming an angle of 15° to the left of the median longitudinal plane of the vehicle;

P2 — a vertical plane symmetrical to P1 about the median longitudinal plane of the vehicle.

If this is not possible (in the absence of a symmetrical median longitudinal plane, for instance) P2 shall be the plane symmetrical to P1 about the longitudinal plane of the vehicle passing through point 0.

P3 — a plane passing through the straight line OQ and forming an angle of 10° above the horizontal plane;

P4 — a plane passing through the straight line OQ and forming an angle of 8° below the horizontal plane.

9.2.5.3. For agricultural and forestry tractors and for construction-site vehicles for which it is not possible to determine zone I, zone I' consists in the whole surface of the windscreen.

9.2.6. Interpretation of results

A windscreen type shall be considered satisfactory with respect to optical distortion if, in the four samples submitted for testing, optical distortion does not exceed the values given below for each zone.

Vehicle category	Zone	Maximum values of optical distortion
M1 and N1	A - extended according to para. 9.2.2.1.	2' of arc
	B - reduced according to para. 2.4 of annex 18	6' of arc
M and N categories other than M1	I	2' of arc
Other categories of vehicles	I'	2' of arc

9.2.6.1. For vehicles of categories M and N, no measurements shall be made in a peripheral area 25 mm wide.

9.2.6.2. For agricultural and forestry tractors and for construction-site vehicles, no measurements shall be made in a peripheral area 100 mm wide.

9.2.6.3. In the case of split windscreens, no measurements shall be made in a strip 35 mm from the edge of the pane which is to be adjacent to the dividing pillar.

9.2.6.4. A maximum value of 6' of arc is permitted for all portions of zone I or zone A which are less than 100 mm from the edge of the windscreen.

9.2.6.5. Slight deviations from the requirements may be allowed in the reduced test area B according to paragraph 2.4 of annex 18 provided they are localized and recorded in the report.

9.3. Secondary-image-separation test

9.3.1. Scope

Two test methods are recognized:

target test, and

collimation-telescope test.

These test methods may be used for approval, quality-control or product-evaluation purposes, as appropriate.

9.3.1.1. Target test

9.3.1.1.1. Apparatus

This method involves viewing an illuminated target through the safety-glass pane. The target may be designed in such a way that the test can be carried out on a simple 'go-no go' basis.

The target shall preferably be of one of the following types; that is to say, either

- (a) an illuminated 'ring' target whose outer diameter, D , subtends an angle of n minutes of arc at a point situated at x metres (figure 11(a)), or
- (b) an illuminated 'ring and spot' target whose dimensions are such that the distance D from a point on the edge of the spot to the nearest point on the inside of the circle subtends an angle of n minutes of arc at a point situated at x metres (figure 11(b)), where

n is the limit value of secondary-image separation,

x is the distance from the safety-glass pane to the target (not less than 7 m),

D is given by the formula: $D = x \cdot \tan n$

The illuminated target consists of a light box, approximately 300 mm × 300 mm × 150 mm, whose front is most conveniently constructed of glass masked with opaque black paper or coated with matt black paint.

The box shall be illuminated by a suitable light source. The inside of the box shall be coated with matt white paint. It may be convenient to use other forms of target, such as that shown in figure 14. It is also acceptable to replace the target system by a projection system and to view the resulting images on a screen.

9.3.1.1.2. Procedure

Mount the safety-glass pane at the specified rake angle on a suitable stand in such a way that the observation is carried out in the horizontal plane passing through the centre of the target. The light box shall be viewed in a dark or semi-dark room, through each part of the area being examined, in order to detect the presence of any secondary image associated with the illuminated target. Rotate the safety-glass pane as necessary to ensure that the correct direction of view is maintained. A monocular may be used for viewing.

9.3.1.1.3. Expression of results

Determine whether,

when target (a) (see figure 11(a)) is used, the primary and secondary images of the circle separate, i.e. whether the limit value of n is exceeded, or

when target (b) (see figure 11(b)) is used, the secondary image of the spot shifts beyond the point of tangency with the inside edge of the circle, i.e. whether the limit value of n is exceeded.

Figure 11

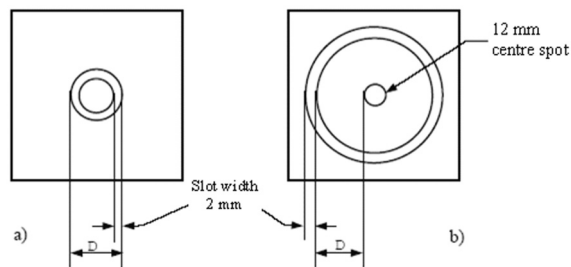
Dimensions of targets

Figure 12

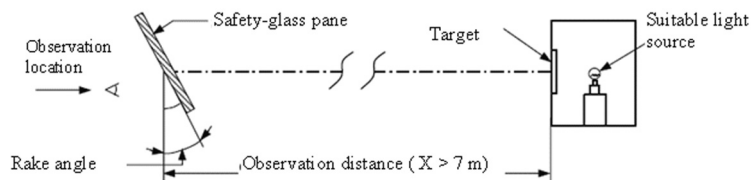
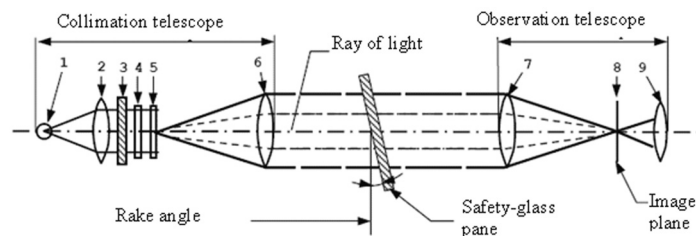
Arrangement of apparatus

Figure 13

Apparatus for collimation-telescope test

- (1) Lamp bulb
- (2) Condenser aperture > 8,6 mm
- (3) Ground-glass screen aperture > condenser aperture
- (4) Colour filter with central hole approximately 0,3 mm in diameter, diameter > 8,6 mm
- (5) Polar co-ordinate plate, diameter > 8,6 mm
- (6) Achromatic lens, f 86 mm, aperture 10 mm
- (7) Achromatic lens, f 86 mm, aperture 10 mm
- (8) Black spot, diameter approximately 0,3 mm
- (9) Achromatic lens, f = 20 mm, aperture < 10 mm

9.3.1.2. Collimation-telescope test

If necessary, the procedure described in this paragraph shall be applied.

9.3.1.2.1. Apparatus

The apparatus comprises a collimator and a telescope and may be set up in accordance with figure 13. However, any equivalent optical system may be used.

9.3.1.2.2. Procedure

The collimation telescope forms at infinity the image of a polar co-ordinate system with a bright point at its centre (see figure 14).

In the focal plane of the observation telescope, a small opaque spot with a diameter slightly larger than of the projected bright point is placed on the optical axis, thus obscuring the bright point.

When a test piece which exhibits a secondary image is placed between the telescope and the collimator, a second, less bright point appears at a certain distance from the centre of the polar co-ordinate system. The secondary-image separation can be read out as the distance between the points seen through the observation telescope (see figure 14). (The distance between the dark spot and the bright point at the centre of the polar coordinate system-represents the optical deviation).

9.3.1.2.3. Expression of results

The safety-glass pane shall first be examined by a simple scanning technique to establish the area giving the strongest secondary image. That area shall then be examined by the collimation-telescope system at the appropriate angle of incidence. The maximum secondary-image separation shall be measured.

9.3.1.3. The direction of observation in the horizontal plane shall be maintained approximately normal to the trace of the windscreen in that plane.

9.3.2. The measurements shall be performed in the zones as defined in paragraph 9.2.2 above according to the vehicle categories.

9.3.2.1. Vehicle type

The test shall be repeated if the windscreen is to be fitted to a vehicle of a type in which the forward field of vision differs from that of the vehicle type for which the windscreen has already been approved.

9.3.3. Indices of difficulty of the secondary characteristics

9.3.3.1. Nature of the material

Polished (plate) glass	Float glass	Sheet glass
1	1	2

9.3.3.2. Other secondary characteristics

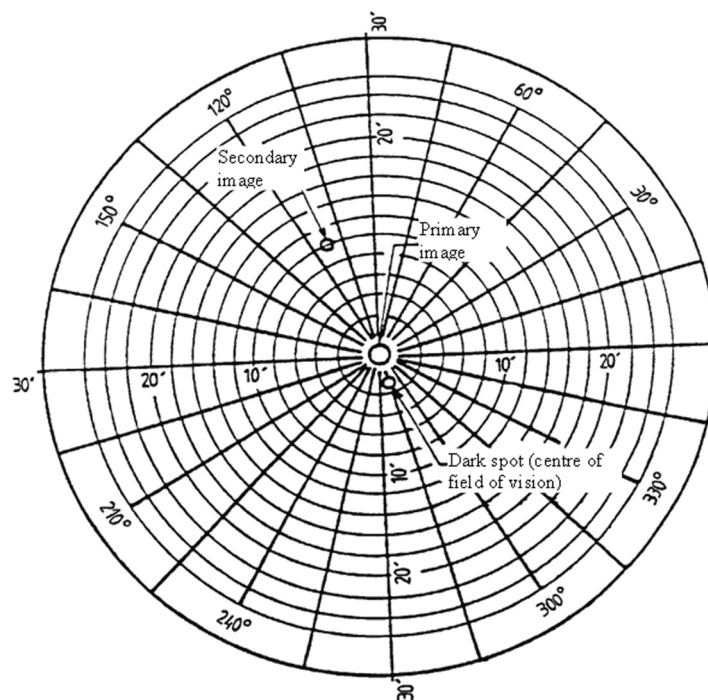
No other secondary characteristics are involved.

9.3.4. Number of samples

Four samples shall be submitted for testing.

Figure 14

Example of observation by the collimation-telescope test method



9.3.5. Interpretation of results

A windscreen type shall be considered satisfactory with respect to secondary-image separation if, in the four samples submitted for testing, separation of the primary and secondary images does not exceed the values given below for each zone.

Vehicle category	Zone	Maximum values of the separation of the primary and secondary images
M1 and N1	A - extended according to para. 9.2.2.1.	15' of arc
	B - reduced according to para. 2.4 of annex 18	25' of arc
M and N categories other than M1	I	15' of arc
Other categories of vehicles	I'	15' of arc

- 9.3.5.1. For vehicles of categories M and N, no measurements shall be made in a peripheral area 25 mm wide.
- 9.3.5.2. For agricultural and forestry tractors and for construction-site vehicles, no measurements shall be made in a peripheral area 100 mm wide.
- 9.3.5.3. In the case of split windscreens, no measurements shall be made in a strip 35 mm from the edge of the glass pane which is to be adjacent to the dividing pillar.
- 9.3.5.4. A maximum value of 25' of arc is permitted for all portions of zone I or zone A which are less than 100 mm from the edge of the windscreen.
- 9.3.5.5. Slight deviations from the requirements may be allowed in the reduced test area B according to paragraph 2.4 of annex 18 provided they are localized and recorded in the report.

9.4. Identification-of-colours test

When a windscreen is tinted in the zones defined in paragraphs 9.2.5.1, 9.2.5.2 or 9.2.5.3, four windscreens shall be tested for identifiability of the following colours:

white, selective yellow, red, green, blue, amber.

10. BURNING BEHAVIOUR (FIRE-RESISTANCE) TEST

10.1. Purpose and scope of application

This method enables the horizontal burning rate of materials used in the passenger compartment of motor vehicles (for example, private passenger cars, lorries (trucks), estate cars, motor coaches) after exposure to a small flame to be determined.

This method permits testing of materials and components of a vehicle's interior equipment individually or in combination up to a thickness of 13 mm. It is used to judge the uniformity of production lots of such materials with respect to their burning behaviour.

Because of the many differences between the real-world situation (application and orientation within a vehicle, conditions of use, ignition source, etc.) and the precise test conditions prescribed herein, this method cannot be considered as suitable for evaluation of all true in-vehicle burning characteristics.

10.2. Definitions

10.2.1. Burning rate: The quotient of the burnt distance measured according to this method and the time taken to burn that distance. It is expressed in millimetres per minute.

10.2.2. Composite material: A material composed of several layers of similar or different materials intimately held together at their surfaces by cementing, bonding, cladding, welding, etc.

When different materials are connected together intermittently (for example, by sewing, high-frequency-welding, riveting), then in order to permit the preparation of individual samples in accordance with paragraph 10.5 below such materials shall not be considered as composite materials.

10.2.3. Exposed side: The side which is facing towards the passenger compartment when the material is mounted in the vehicle.

10.3. Principle

A sample is held horizontally in a U-shaped holder and is exposed to the action of a defined low-energy flame for 15 seconds in a combustion chamber, the flame acting on the free end of the sample. The test determines whether and when the flame is extinguished or the time which the flame requires to proceed over a measured distance.

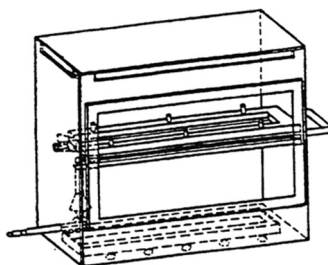
10.4. Apparatus

10.4.1. Combustion chamber (figure 15), preferably of stainless steel, having the dimensions given in figure 16.

The front of the chamber contains a flame-resistant observation window, which may cover the entire front and which can be constructed as an access panel.

The bottom of the chamber has vent holes, and the top has a vent slot all around. The combustion chamber is placed on four feet, 10 mm high. The chamber may have a hole at one end for the introduction of the sample holder containing the sample; in the opposite end, a hole is provided for the gas-supply line. Melted material is caught in a pan (see figure 17) which is placed on the bottom of the chamber between vent holes without covering any vent hole area.

Figure 15

Example of combustion chamber with sample holder and drip pan

- 10.4.2. Sample holder, consisting of two U-shaped metal plates or frames of corrosion-proof material. Dimensions are given in figure 18.

The lower plate is equipped with pins and the upper one with corresponding holes, in order to ensure a consistent holding of the sample. The pins also serve as measuring points at the beginning and end of the burning distance.

A support shall be provided in the form of heat-resistant wires 0,25 mm in diameter spanning the frame at 25-mm intervals over the bottom U-shaped frame (see figure 19).

The plane of the lower side of samples shall be 178 mm above the floor plate. The distance of the front edge of the sample holder from the end of the chamber shall be 22 mm; the distance of the longitudinal sides of the sample holder from the sides of the chamber shall be 50 mm (all inside dimensions). (See figures 15 and 16).

- 10.4.3. Gas burner

The small ignition source is provided by a Bunsen burner having an inside diameter of 9,5 mm. It is so located in the test cabinet that the centre of its nozzle is 19 mm below the centre of the bottom edge of the open end of the sample (see figure 16).

- 10.4.4. Test gas

The gas supplied to the burner shall have a calorific value of about 38 MJ/m³ (for example natural gas).

- 10.4.5. Metal comb, at least 110 mm in length, with seven or eight smooth rounded teeth per 25 mm.

Figure 16

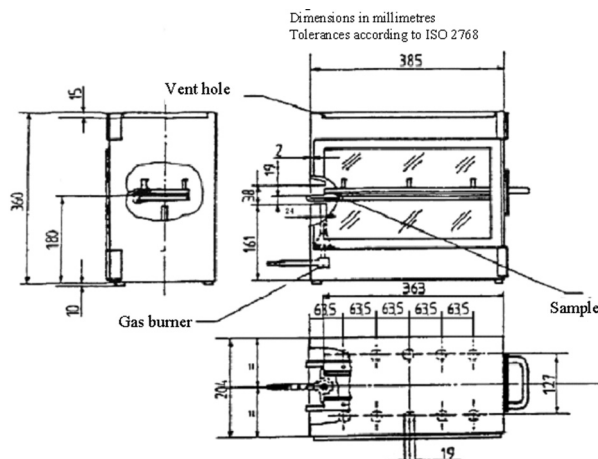
Example of combustion chamber

Figure 17

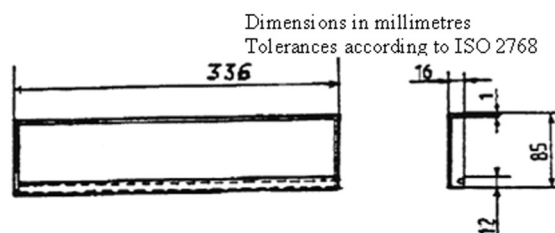
Typical drip pan

Figure 18

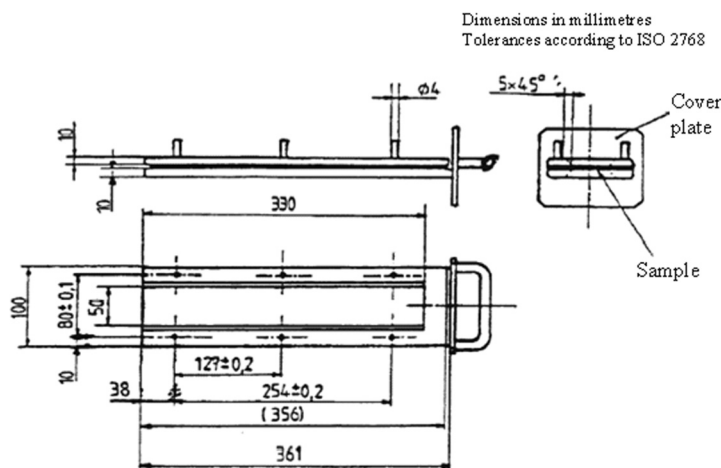
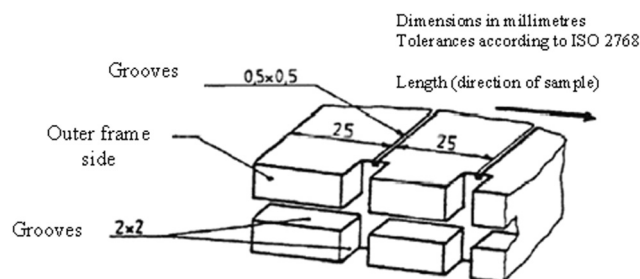
Example of sample holder

Figure 19

Example of section of lower U-frame design for wire support facility

10.4.6. Stop-watch, accurate to 0,5 sec.

10.4.7. Fume cupboard

The combustion chamber may be placed in a fume-cupboard assembly provided that the latter's internal volume is at least 20 times, but not more than 110 times, greater than the volume of the combustion chamber and provided that no single height, width, or length dimension of the fume cupboard is greater than 2,5 times either of the other two dimensions.

Before the test, the vertical velocity of the air through the fume cupboard shall be measured 100 mm forward of and to the rear of the ultimate site of the combustion chamber. It shall be between 0,10 and 0,30 m/s in order to avoid possible discomfort to the operator from combustion products. It is possible to use a fume cupboard with natural ventilation and an appropriate air velocity.

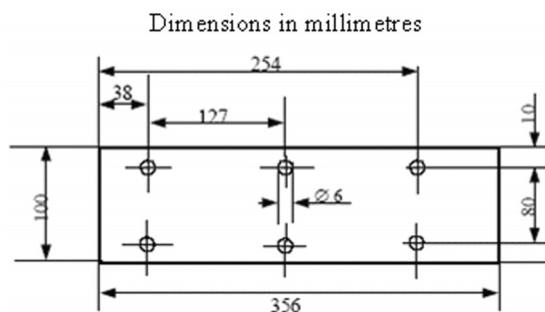
10.5. Samples

10.5.1. Shape and dimensions

The shape and dimensions of samples are given in figure 20. The thickness of the sample corresponds to the thickness of the product to be tested. It shall not be more than 13 mm. When sample-taking so permits, the sample shall have a constant section over its entire length. When the shape and dimensions of a product do not permit taking a sample of the given size, the following minimum dimensions shall be observed:

- (a) for samples having a width of 3 to 60 mm, the length shall be 356 mm. In this case the material is tested over the product's width;
- (b) for samples having a width of 60 to 100 mm, the length shall be at least 138 mm. In this case the potential burning distance corresponds to the length of the sample, the measurement starting at the first measuring point;
- (c) samples less than 60 mm wide and less than 356 mm long, and samples 60 to 100 mm wide and less than 138 mm long, cannot be tested according to the present method, nor can samples less than 3 mm wide.

Figure 20

Sample

10.5.2. Sampling

At least five samples shall be taken from the material under test. In materials having burning rates differing according to the direction of the material (this being established by preliminary tests) the five (or more) samples shall be taken and be placed in the test apparatus in such a way that the highest burning rate will be measured.

When the material is supplied in set widths, a length of at least 500 mm covering the entire width shall be cut. From the piece so cut, the samples shall be taken at not less than 100 mm from the edge of the material and at points equidistant from each other.

Samples shall be taken in the same way from finished products when the shape of the product so permits. If the thickness of the product is over 13 mm it shall be reduced to 13 mm by a mechanical process applied to the side which does not face the passenger compartment.

Composite materials (see paragraph 10.2.2) shall be tested as if they were homogeneous.

In the case of materials comprising superimposed layers of different composition which are not composite materials, all the layers of material included within a depth of 13 mm from the surface facing towards the passenger compartment shall be tested individually.

10.5.3. Conditioning

The samples shall be conditioned for at least 24 hours, but not more than 7 days, at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 5 per cent, and shall be maintained under these conditions until immediately prior to testing.

- 10.6. Procedure
- 10.6.1. Place samples with napped or tufted surfaces on a flat surface, and comb twice against the nap using the comb (paragraph 10.4.5).
- 10.6.2. So place the sample in the sample holder (paragraph 10.4.2) that the exposed side faces downwards, towards the flame.
- 10.6.3. Adjust the gas flame to a height of 38 mm using the mark in the chamber, the air intake of the burner being closed. The flame shall burn for at least one minute, for stabilization, before the first test is started.
- 10.6.4. Push the sample holder into the combustion chamber so that the end of the sample is exposed to the flame, and after 15 seconds cut off the gas flow.
- 10.6.5. Measurement of burning time starts at the moment when the foot of the flame passes the first measuring point. Observe the flame propagation on the side (upper or lower) which burns faster.
- 10.6.6. Measurement of burning time is completed when the flame has come to the last measuring point or when the flame is extinguished before reaching that point. If the flame does not reach the last measuring point, measure the burnt distance up to the point where the flame was extinguished. Burnt distance is the part of the sample destroyed, on the surface or inside, by burning.
- 10.6.7. If the sample does not ignite or does not continue burning after the burner has been extinguished, or the flame goes out before reaching the first measuring point, so that no burning time is measured, note in the test report that the burning rate is 0 mm/min.
- 10.6.8. When running a series of tests or performing repeat tests, make sure before starting a test that the temperature of the combustion chamber and sample holder does not exceed 30 °C.
- 10.7. Calculation
- The burning rate B, in millimetres per minute, is given by the formula:
- $$B = s/t \times 60;$$
- where:
- s is the burnt distance, in millimetres,
- t is the time, in seconds, taken to burn the distance s.
- 10.8. Indices of difficulty of the secondary characteristics
- No secondary characteristics are involved.
- 10.9. Interpretation of results
- 10.9.1. Safety-glass panes faced with plastics material (paragraph 2.3 of this Regulation) and glass-plastics safety panes (paragraph 2.4 of this Regulation) shall be considered satisfactory from the point of view of the fire-resistance test if the burn rate does not exceed 250 mm/min.
- 10.9.2. Rigid plastic glazing (paragraph 2.5.1 of this Regulation), flexible plastic glazing (paragraph 2.5.2 of this Regulation) and rigid plastic double glazed units shall be considered satisfactory from the point of view of the fire-resistance test if the burn rate does not exceed 110 mm/min.
11. TEST OF RESISTANCE TO CHEMICALS
- 11.1. Chemicals used for the test
- 11.1.1. Non-abrasive soap solution: 1 per cent by weight of potassium oleate in deionised water;

11.1.2. Window-cleaning-solution: an aqueous solution of isopropanol and dipropylene glycol monomethyl ether in concentration between 5 and 10 per cent by weight each and ammonium hydroxide in concentration between 1 and 5 per cent by weight;

11.1.3. Undiluted denatured alcohol: 1 part by volume methyl alcohol in 10 parts by volume ethyl alcohol;

11.1.4. Petrol or equivalent reference petrol: a mixture of 50 % by volume toluene, 30 % by volume 2,2,4-trimethyl-pentane, 15 % by volume 2,4,4-trimethyl-1-pentene and 5 % by volume ethyl alcohol;

N.B. The composition of the petrol used shall be recorded in the test report;

11.1.5. Reference kerosene: a mixture of 50 per cent by volume n-octane and 50 per cent by volume n-decane.

11.2. Test method

11.2.1. Immersion test

Two test pieces 180×25 mm shall be tested with each of the chemicals specified in paragraph 11.1 above, using a new test piece for each test and each cleaning product.

Before each test, test pieces shall be cleaned according to the manufacturer's instructions, then conditioned for 48 hours at a temperature of $23^\circ\text{C} \pm 2^\circ\text{C}$ and a relative humidity of 50 per cent ± 5 per cent. These conditions shall be maintained throughout the tests.

The test pieces shall be completely immersed in the test fluid and held for one minute, then removed and immediately wiped dry with a clean absorbent cotton cloth.

11.2.2. Indices of difficulty of the secondary characteristics

	Colourless	Tinted
Colouring of the interlayer or of the plastics coating	1	2

The other secondary characteristics are not concerned.

11.2.3. Interpretation of results

11.2.3.1. The test for resistance to chemical agents shall be considered to have given a satisfactory result if the test piece does not exhibit any softening, tackiness, crazing or apparent loss of transparency.

11.2.3.2. A set of test pieces shall be considered satisfactory with regard to the test for resistance to chemical agents if one of the following conditions is met:

11.2.3.2.1. All the tests have given a satisfactory result;

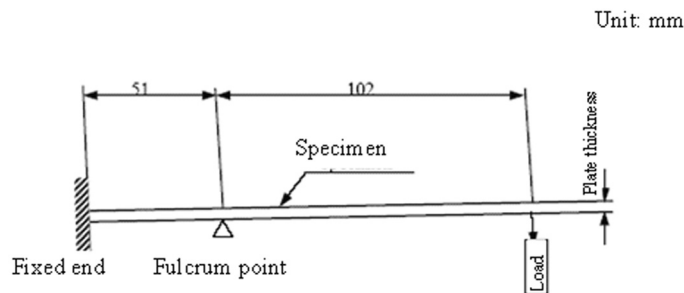
11.2.3.2.2. One test having given an unsatisfactory result, a new series of tests carried out on a new set of test pieces has given a satisfactory result.

11.2.4. Test procedure under load

11.2.4.1. The test specimen shall be simply supported as a horizontal level arm between a fixed supporting edge at one end in such a way that the entire width will rest on a cutting edge (fulcrum) which is 51 mm from the fixed end support. A load shall be suspended from the free end of the test specimen at a distance of 102 mm from the fulcrum as shown in figure 21 below:

Figure 21

Method of setting up the test specimen



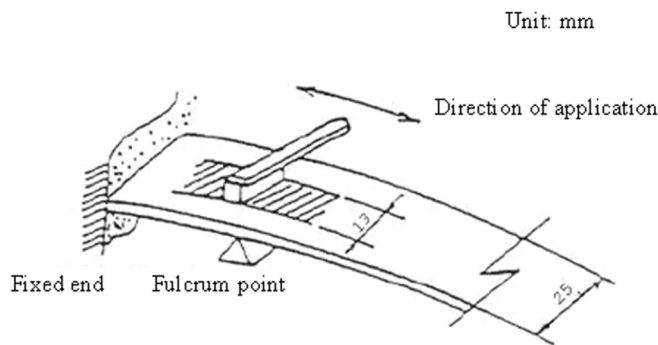
11.2.4.2. The load mass shall be $28,7 t^2$ g where t is the thickness in mm of the test specimen. The resulting stress on the outer fibre of the test specimen is approximately 6,9 MPa.

Example: For a 3 mm thick test specimen placed horizontally between a downward fixed edge and an upward fulcrum edge separated by 51 mm the applied downward load at 102 mm from the fulcrum is to be 258 g.

11.2.4.3. While the test specimen is stressed, one of the prescribed chemicals shall be applied to the top surface of the test specimen above the fulcrum point. The chemical shall be applied with a soft, 13 mm wide brush, wetted before each stroke. Ten individual strokes at 1 s intervals across the width of the test specimen, avoiding the end and edges, shall be required (see figure 22).

Figure 22

Method of applying chemicals to the test specimen



11.2.5. Indices of difficulty of the secondary characteristics

	Colourless	Tinted
Colouring of the plastics coating or plastic glazing	1	2

The other secondary characteristics are not concerned.

11.2.6. Interpretation of results

11.2.6.1. The test for resistance to chemical agents shall be considered to have given a satisfactory result if the test piece does not exhibit any softening, tackiness, crazing or apparent loss of transparency.

11.2.6.2. A set of test pieces shall be considered satisfactory with regard to the test for resistance to chemical agents if one of the following conditions is met:

11.2.6.2.1. All the tests have given a satisfactory result;

11.2.6.2.2. One test having given an unsatisfactory result, a new series of tests carried out on a new set of test pieces has given a satisfactory result.

12. FLEXIBILITY TEST AND FOLD TEST

12.1. Scope

With this test has to be found out whether a plastic is to be classed into the categories of rigid or flexible plastics.

12.2. Test method

From the material of the nominal thickness a rectangular flat sample 300 mm long and 25 mm wide is cut out and horizontally clamped into a clamping device in such a way that 275 mm of the length of the sample freely extend over the holding device. This free end shall be supported horizontally by an appropriate device until the test begins. Sixty seconds after removal of this support the vertical deviation of the free end is indicated in mm. If this deviation exceeds 50 mm a 180° fold test is performed subsequently. The sample is folded concisely, after that it is folded round 0.5 mm thick piece of sheet metal in such a way that it tightly contacts it on both sides.

12.3. Test conditions

- Temperature: $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$
- Relative Humidity: $60\% \pm 5\%$

12.4. Requirements

The vertical deviation must be more than 50 mm for flexible plastics, and 10 seconds after a 180° - folding the material must not show any fracture-like damages at the point of buckling (see figure 23).

13. CROSS-CUT TEST

13.1. Scope

This test gives a simple method to determine the adhesion of coatings to the subsurface. The brittleness and other strength characteristics can be evaluated.

13.2. Apparatus

Cutting tool with 6 blades set at 1 mm apart. A magnifying glass with an enlargement of 2 x to examine the crosscut specimen (see figure 24).

Figure 23

Arrangement of flexibility test

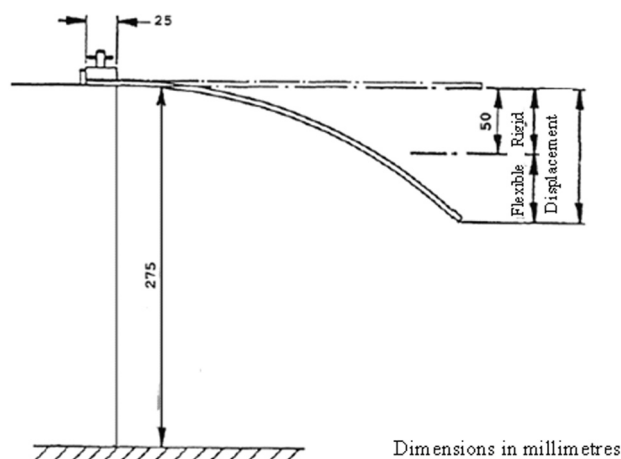
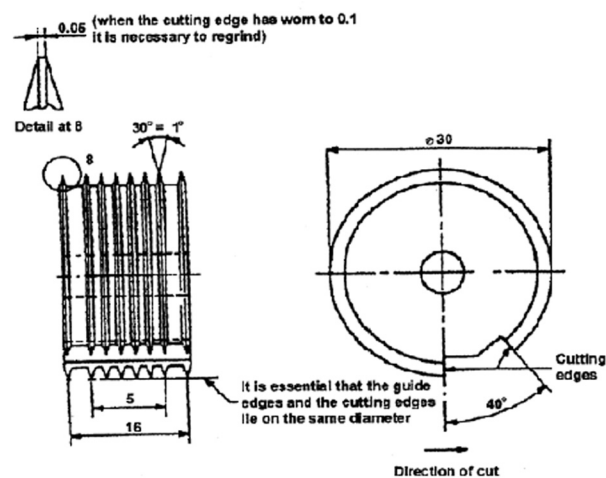


Figure 24
Tool with six blades



13.3. Test Method

Cut through the coating on to the subsurface a pattern with 6 cuts and perpendicular to this another one so that a grid with 25 squares arises (grid-cut).

The cutting tool should be drawn steadily with a speed of 2 to 5 cm/s so that the cuts reach the subsurface but do not penetrate too deeply.

The cutting is conducted in such a way that the two leading heads at the edge of the apparatus touch the surface uniformly. After the test the cuts are examined with a magnifying glass to check that they reach the subsurface. The test is carried out at least at two different positions of the specimen. After the cuts have been produced they are brushed 5 times with slight pressure in both diagonal directions with a hand brush with polyamide bristles.

13.4. Interpretation of results

The grid cuts are examined with a magnifying glass. If the cut edges are perfectly smooth and if no part of the coating is detached then it will be given a cross cut value of Gt0. If there are small fragments detached at the intersection of the cuts and if the exposed area amounts to about 5 % of the grid area the cut value is Gt1.

Larger areas of detachment will be graded in the range Gt2 to Gt5.

CUT VALUE GRADE	EXPOSED AREA OF THE GRID AREA
Gt2	between 5 and 15 %
Gt3	between 15 and 35 %
Gt4	between 35 and 65 %
Gt5	higher than 65 %

ANNEX 4

TOUGHENED-GLASS WINDSCREENS**1. DEFINITION OF TYPE**

Toughened-glass windscreens shall be deemed to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks;****1.1.2. The shape and dimensions.**

Toughened-glass windscreens shall be considered as belonging to one or other of two groups for the purposes of fragmentation and mechanical-properties test, i.e.;

1.1.2.1. flat windscreens, and**1.1.2.2. curved windscreens.****1.1.3. The thickness category in which the nominal thickness 'e' lies (a manufacturing tolerance of $\pm 0,2$ mm being allowed):**

Category I $e \leq 4,5$ mm

Category II $4,5 \text{ mm} < e \leq 5,5 \text{ mm}$

Category III $5,5 \text{ mm} < e \leq 6,5 \text{ mm}$

Category IV $6,5 \text{ mm} < e$

1.2. The secondary characteristics are as follows:**1.2.1. Nature of the material (polished (plate) glass, float glass, sheet glass);****1.2.2. Colouring (colourless or tinted);****1.2.3. The incorporation or otherwise of conductors;****1.2.4. The incorporation or otherwise of opaque obscuration.****2. FRAGMENTATION TEST****2.1. Indices of difficulty of the secondary characteristics****2.1.1. Only the nature of the material is involved.****2.1.2. Float glass and sheet glass are considered to have the same index of difficulty.****2.1.3. The fragmentation tests must be repeated on transition from polished (plate) glass to float glass or sheet glass, and vice versa.****2.2. Number of samples**

Six samples from the smallest-developed-area series and six samples from the largest-developed-area series, selected as prescribed in annex 13, shall be tested.

2.3. Different zones of glass

A toughened-glass windscreen shall comprise two main zones, FI and FII. It may also comprise an intermediate zone, FIII. These zones are as defined below.

2.3.1. Zone FI: Peripheral zone of fine fragmentation, at least 7 cm wide, all round the edge of the windscreen and including an outer strip 2 cm wide not subjected to assessment;

2.3.2. Zone FII: Visibility zone of varying fragmentation, always including a rectangular part at least 20 cm high and 50 cm long;

2.3.2.1. For vehicles of category M1, the centre of the rectangle shall be inside a circle having a radius of 10 cm centred on the projection of the middle of segment V_1-V_2 .

2.3.2.2. For vehicles of categories M and N other than M1, the centre of the rectangle shall be inside a circle having a radius of 10 cm centred on the projection of point 0;

2.3.2.3. For agricultural and forestry tractors and for construction-site vehicles, the position of the visibility zone shall be indicated in the test report.

2.3.2.4. The height of the above rectangle may be reduced to 15 cm for windscreens which are less than 44 cm high.

2.3.3. Zone FIII: Intermediate zone, not more than 5 cm wide, between zones FI and FII.

2.4. Test method

The method used shall be that described in annex 3, paragraph 1.

2.5. Points of impact (see annex 17, figure 2)

2.5.1. The points of impact shall be selected as follows:

Point 1: in the central part of zone FII in an area of high or low stress,

Point 2: in zone FIII, as near as possible to the vertical plane of symmetry of zone FII,

Points 3 and 3': 3 cm from the edges of one median of the sample; when there is a tong mark, one of the breakage points shall be near the edge bearing the tong mark and the other near the opposite edge,

Point 4: at the place where the radius of curvature is smallest on the longest median,

Point 5: 3 cm from the edge of the sample at the place where the radius of curvature of the edge is smallest, either to the left or to the right.

2.5.2. A fragmentation test shall be performed at each of the points 1, 2, 3, 3', 4 and 5.

2.6. Interpretation of results

2.6.1. A test shall be deemed to have given a satisfactory result if fragmentation satisfies all the conditions given in paragraphs 2.6.1.1, 2.6.1.2 and 2.6.1.3 below.

2.6.1.1. Zone FI:

2.6.1.1.1. The number of fragments in any 5 cm × 5 cm square is not less than 40 nor more than 350; however in the case of a count of less than 40, if the number of fragments in any 10 cm × 10 cm square containing the 5 × 5 cm square is not less than 160, this shall be acceptable.

- 2.6.1.1.2. For the purposes of the above rule, a fragment extending across a side of a square shall count as half a fragment.
- 2.6.1.1.3. Fragmentation shall not be checked in a strip 2 cm wide round the edge of the samples, this strip representing the frame of the glass, nor within a radius of 7,5 cm from the point of impact.
- 2.6.1.1.4. A maximum of 3 fragments of an area exceeding 3 cm² shall be allowed. No two of these fragments shall be contained within the same 10 cm diameter circle.
- 2.6.1.1.5. Elongated fragments may be permitted provided that their ends are not knife-edged and that their length does not exceed 7,5 cm, except in the case provided for in paragraph 2.6.2.2 below. If these elongated fragments extend to the edge of the glass, they must not form an angle of more than 45° with it.

2.6.1.2 Zone FII:

- 2.6.1.2.1. The residual visibility after shattering shall be checked in the rectangular area defined in paragraph 2.3.2 above. In that rectangle the aggregate surface area of the fragments of more than 2 cm² shall represent not less than 15 per cent of the area of the rectangle; however, in the case of windscreens less than 44 cm high, or whose angle of installation is less than 15° from the vertical, the visibility percentage shall at least be equal to 10 per cent of the surface of the corresponding rectangle.
- 2.6.1.2.2. No fragment shall have an area of more than 16 cm² except in the case provided for in paragraph 2.6.2.2 below.
- 2.6.1.2.3. Within a radius of 10 cm from the point of impact, but only in that part of the circle which is included in Zone FII, three fragments having an area of more than 16 cm² but less than 25 cm² shall be allowed.
- 2.6.1.2.4. Fragments shall be substantially regular in shape and free from points of the type described in paragraph 2.6.1.2.4.1 below. However, not more than 10 irregular fragments shall be allowed in any 50 × 20 cm rectangle and not more than 25 over the whole surface of the windscreen.

No such fragment shall present a point more than 35 mm long measured in accordance with paragraph 2.6.1.2.4.1 below.

- 2.6.1.2.4.1. A fragment shall be considered as an irregular fragment if it cannot be inscribed in a circle of 40 mm in diameter, if it has at least one point more than 15 mm long when measured from the top of the point to the section whose width is equal to the glazing thickness, and if it has one or more points having a top angle smaller than 40°.
- 2.6.1.2.5. Fragments of elongated shape shall be allowed in Zone FII as a whole, provided they do not exceed 10 cm in length, except in the case provided for in paragraph 2.6.2.2 below.

2.6.1.3. Zone FIII

Fragmentation in this zone must have characteristics intermediate between those of the fragmentation respectively allowed for the two neighbouring zones (FI and FII).

- 2.6.2. A windscreen submitted for approval shall be considered satisfactory from the point of view of fragmentation if at least one of the following conditions is fulfilled:
 - 2.6.2.1. When all the tests carried out using the points of impact defined in paragraph 2.5.1 above have given a satisfactory result;
 - 2.6.2.2. When one test among all those carried out using the points of impact prescribed in paragraph 2.5.1 has given an unsatisfactory result, taking account of deviations which do not exceed the following limits:

Zone FI: not more than five fragments between 7,5 and 15 cm long,

Zone FII: not more than three fragments of between 16 and 20 cm² in area located outside the circle having a radius of 10 cm centred on the point of impact,

Zone FIII: not more than four fragments between 10 and 17,5 cm long

and is repeated on a new sample, which either conforms to the requirements of paragraph 2.6.1 or presents deviations within the above specified limits.

2.6.2.3. When two tests among all the tests carried out using the points of impact prescribed in paragraph 2.5.1 have given an unsatisfactory result for deviations not exceeding the limits specified in paragraph 2.6.2.2, and a further series of tests carried out on a new set of samples conforms to the requirements of paragraph 2.6.1, or not more than two samples of the new set present deviations within the above specified limits of paragraph 2.6.2.2.

2.6.3. If the above-mentioned deviations are found, they shall be noted in the test report and permanent recording(s) of the fragmentation pattern of the relevant parts of the windscreen shall be attached to the report.

3. HEADFORM TEST

3.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

3.2. Number of samples

3.2.1. For each group of toughened-glass windscreens, four samples having approximately the smallest developed area and four samples having approximately the largest developed area, all eight samples being of the same types as those selected for the fragmentation tests (see paragraph 2.2 above), shall be subjected to testing.

3.2.2. Alternatively, at the discretion of the laboratory conducting the tests, for each category of windscreen thickness, six test pieces of the dimension (1 100 mm × 500 mm) $\pm \frac{5}{2}$ mm shall be subjected to testing.

3.3. Test method

3.3.1. The method used shall be that described in annex 3, paragraph 3.1.

3.3.2. The height of drop shall be 1,5 m $\pm \frac{0}{5}$ mm.

3.4. Interpretation of results

3.4.1. The test shall be deemed to have given a satisfactory result if the windscreen or the test piece is fractured.

3.4.2. A set of samples submitted for approval shall be considered satisfactory from the point of view of the headform test if either of the two following conditions is fulfilled, that is to say if:

3.4.2.1. all the tests have given a satisfactory result;

3.4.2.2. one test having given an unsatisfactory result, a further series of tests carried out on a new set of samples has given satisfactory results.

4. OPTICAL QUALITIES

The requirements concerning optical qualities set out in annex 3, paragraph 9, shall apply to every type of windscreen.

ANNEX 5

UNIFORMLY-TOUGHENED GLASS PANES ⁽¹⁾**1. DEFINITION OF TYPE**

Uniformly-toughened glass panes shall be deemed to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks;****1.1.2. The nature of the toughening process (thermal or chemical);****1.1.3. The shape category; two categories are distinguished:****1.1.3.1. Flat glass panes,****1.1.3.2. Flat and curved glass panes.****1.1.4. The thickness category in which the nominal thickness 'e' lies (a manufacturing tolerance of ± 0.2 mm being allowed):**

Category I $e \leq 3,5$ mm

Category II $3,5 \text{ mm} < e \leq 4,5$ mm

Category III $4,5 \text{ mm} < e \leq 6,5$ mm

Category IV $6,5 \text{ mm} < e$

1.2. The secondary characteristics are as follows:**1.2.1. Nature of the material (polished (plate) glass, float glass, sheet glass);****1.2.2. Colouring (colourless or tinted);****1.2.3. The incorporation or otherwise of conductors.****1.2.4. The incorporation or otherwise of opaque obscuration.****2. FRAGMENTATION TEST****2.1. Indices of difficulty of the secondary characteristics**

Material	Index of difficulty
Plate glass	2
Float glass	1
Sheet glass	1

No other secondary characteristics are involved.

2.2. Selection of samples**2.2.1. Samples of each shape category and of each thickness category difficult to produce shall be selected according to the following criteria for testing.**

⁽¹⁾ This type of uniformly-toughened glass pane can also be used for windscreens for slow-moving vehicles which, by construction, cannot exceed 40 km/h.

2.2.1.1. In the case of flat glass panes, two sets of samples shall be provided, corresponding to:

2.2.1.1.1. the largest developed area,

2.2.1.1.2. the smallest angle between two adjacent sides.

2.2.1.2. In the case of flat and curved glass panes, three sets of samples shall be provided, corresponding to:

2.2.1.2.1. the largest developed area,

2.2.1.2.2. the smallest angle between two adjacent sides,

2.2.1.2.3. the largest height of segment.

2.2.2. Tests carried out on samples corresponding to the largest area 'S' shall be considered to be applicable to any other area smaller than $S + 5$ per cent.

2.2.3. If the samples submitted present an angle γ smaller than 30° , the tests shall be considered as applicable to all glass panes produced having an angle greater than $\gamma - 5^\circ$.

If the samples submitted present an angle γ greater than or equal to 30° , the tests shall be considered as applicable to all glass panes produced having an angle equal to or greater than 30° .

2.2.4. If the height of segment h of the samples submitted is greater than 100 mm, the tests shall be considered as applicable to all glass panes produced having a height of segment smaller than $h + 30$ mm.

If the height of segment of the samples submitted is less than or equal to 100 mm, the tests shall be considered as applicable to all glass panes having a height of segment less than or equal to 100 mm.

2.3. Number of samples per set

The number of samples in each group shall be as follows, according to the shape category defined in paragraph 1.1.3 above:

Kind of glass pane	Number of samples
Flat (2 sets)	4
Flat and curved (3 sets)	5

2.4. Test method

2.4.1. The method used shall be that described in annex 3, paragraph 1.

2.5. Points of impact (see annex 17, figure 3)

2.5.1. For flat glass panes and curved glass panes the points of impact represented respectively in annex 17, figures 3(a) and 3(b) on the one hand, and in annex 17, figure 3(c) on the other hand, shall be as follows:

Point 1: 3 cm from the edges of the glass pane in the part where the radius of curvature of the edge is smallest;

Point 2: 3 cm from the edge of one of the medians, the side (if any) of the glass pane bearing tong marks being selected;

Point 3: in the geometric centre of the glass

Point 4: for curved glass panes only; this point shall be selected on the largest median in that part of the pane where the radius of curvature is smallest.

- 2.5.2. Only one test shall be carried out at each prescribed point of impact.
- 2.6. Interpretation of results
- 2.6.1. A test shall be deemed to have given a satisfactory result if fragmentation satisfies the following conditions:
- 2.6.1.1. The number of fragments in any 5 cm × 5 cm square is not less than 40 or more than 400, or in the case of glazing not more than 3,5 mm thick, 450.
- 2.6.1.2. For the purposes of the above rule, a fragment extending across a side of a square shall count as half a fragment.
- 2.6.1.3. Fragmentation shall not be checked in a strip 2 cm wide round the edge of the samples, this strip representing the frame of the glass; nor within a radius of 7,5 cm from the point of impact.
- 2.6.1.4. Fragments of an area exceeding 3 cm² shall not be allowed except in the parts defined in paragraph 2.6.1.3 above.
- 2.6.1.5. A few fragments of elongated shape shall be allowed, provided that:
- their ends are not knife-edged,
- if they extend to the edge of the glass pane they do not form an angle of more than 45° with it,
- and if, except in the case provided for in paragraph 2.6.2.2 below,
- their length does not exceed 7,5 cm.
- 2.6.2. A set of samples submitted for approval shall be considered satisfactory from the point of view of fragmentation if at least one of the following conditions is fulfilled:
- 2.6.2.1. When all tests carried out using the points of impact prescribed in paragraph 2.5.1 above have given a satisfactory result;
- 2.6.2.2. When one test among all those carried out using the points of impact prescribed in paragraph 2.5.1 has given an unsatisfactory result, taking account of deviations which do not exceed the following limits:
- not more than 5 fragments between 6 and 7,5 cm long,
- not more than 4 fragments between 7,5 and 10 cm long,
- and is repeated on a new sample which either conforms to the requirements of paragraph 2.6.1 or presents deviations within the above specified limits.
- 2.6.2.3. When two tests among all the tests carried out using the points of impact prescribed in paragraph 2.5.1 have given an unsatisfactory result, taking account of deviations not exceeding the limits specified in paragraph 2.6.2.2, and a further series of tests carried out on a new set of samples conform to the prescriptions of paragraph 2.6.1 or not more than two samples of the new set present deviations within the above specified limits of paragraph 2.6.2.2.
- 2.6.3. If the above-mentioned deviations are found, they shall be noted in the test report and permanent recording(s) of the fragmentation pattern of the relevant parts of the glass pane shall be attached to the report.
3. MECHANICAL STRENGTH TEST
- 3.1. 227 g ball test

3.1.1. Indices of difficulty of the secondary characteristics.

Material	Index of difficulty	Colouring	Index of difficulty
Polished glass	2	colourless tinted	1
Float glass	1		2
Sheet glass	1		

The other secondary characteristic (namely, incorporation or otherwise of conductors) is not involved.

3.1.2. Number of test pieces

Six test pieces shall be subjected to testing for each thickness category defined in paragraph 1.1.4 above.

3.1.3. Test method

3.1.3.1. The test method used shall be that described in annex 3, paragraph 2.1.

3.1.3.2. The height of drop (from the underface of the ball to the upper surface of the test piece) shall be as indicated in the following table, according to thickness of the glass pane:

Nominal thickness of glass pane (e)	Height of drop
$e \leq 3,5 \text{ mm}$	$2,0 \text{ m} + 5 - 0 \text{ mm}$
$3,5 \text{ mm} < e$	$2,5 \text{ m} + 5 - 0 \text{ mm}$

3.1.4. Interpretation of results

3.1.4.1. The test shall be deemed to have given a satisfactory result if the test piece does not break.

3.1.4.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of mechanical strength if at least one of the following conditions is fulfilled:

3.1.4.2.1 When not more than one test has given an unsatisfactory result,

3.1.4.2.2 When two tests having given unsatisfactory results, a further series of tests carried out on a new set of six test pieces give satisfactory results.

4. OPTICAL QUALITIES

4.1. The provisions concerning regular light transmittance set out in annex 3, paragraph 9.1, shall apply to uniformly-toughened glass panes or parts of glass panes other than windscreens located at places which are essential to the driver's vision.

4.2. The provisions of paragraph 9 of annex 3 shall apply to uniformly-toughened glass panes used as windscreens of slow-moving vehicles which, by construction, cannot exceed 40 km/h. This shall not apply to flat windscreens which fall within an already approved group.

ANNEX 6

ORDINARY LAMINATED-GLASS WINDSCREENS**1. DEFINITION OF TYPE**

Ordinary laminated-glass windscreens shall be deemed to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks.****1.1.2. The shape and dimensions,**

Ordinary laminated-glass windscreens shall be deemed to belong to one group for the purposes of tests of mechanical properties and of resistance to the environment.

1.1.3. The number of layers of glass,**1.1.4. The nominal thickness 'e' of the windscreen, a manufacturing tolerance of 0,2 n mm ('n' being the number of layers of glass in the windscreen) above or below the nominal value being allowed,****1.1.5. The nominal thickness of the interlayer or interlayers,****1.1.6. The nature and type of the interlayer or interlayers (e.g. PVB or other plastics-material interlayer or interlayers).****1.2. The secondary characteristics are as follows:****1.2.1. The nature of the material (polished (plate) glass, float glass, sheet glass),****1.2.2. The colouring (total or partial) of the interlayer or interlayers (colourless or tinted),****1.2.3. The colouring of the glass (colourless or tinted),****1.2.4. The incorporation or otherwise of conductors,****1.2.5. The incorporation or otherwise of opaque obscuration.****2. GENERAL****2.1. In the case of ordinary laminated-glass windscreens, tests other than headform tests (paragraph 3.2 below) and tests of optical qualities shall be conducted on flat test pieces which are either cut from actual windscreens or are specially made for the purpose. In either case the test pieces shall be in all respects rigorously representative of the serially-produced windscreens for which approval is sought.****2.2. Before each test the test pieces shall be stored for not less than four hours at a temperature of 23 °C ± 2 °C. The tests shall take place as soon as possible after the test pieces have been taken out of the receptacle in which they were stored.****3. HEADFORM TEST****3.1. Indices of difficulty of the secondary characteristics**

No secondary characteristic is involved.

3.2. Headform test on a complete windscreen

- 3.2.1. Number of samples
Four samples from the smallest-developed-area series and four samples from the largest-developed-area series selected in accordance with the provisions of annex 13, shall be tested.
- 3.2.2. Test method
- 3.2.2.1. The method used shall be that described in annex 3, paragraph 3.1.
- 3.2.2.2. The drop height shall be $1,5 \text{ m} \begin{smallmatrix} +0 \\ -5 \end{smallmatrix} \text{ mm}$.
- 3.2.3. Interpretation of results
- 3.2.3.1. This test shall be deemed to have given a satisfactory result if the following conditions are fulfilled:
- 3.2.3.1.1. The sample breaks displaying numerous circular cracks centred approximately on the point of impact, the cracks nearest to the point of impact being not more than 80 mm from it;
- 3.2.3.1.2. The layers of glass shall remain adhering to the plastics-material interlayer. One or more partial separation from the interlayer with a distance of less than 4 mm in breadth, on either side of the crack, is permitted outside a circle of 60 mm in diameter centred on the point of impact.
- 3.2.3.1.3. On the impact side:
- 3.2.3.1.3.1. The interlayer must not be laid bare over an area of more than 20 cm^2 ,
- 3.2.3.1.3.2. A tear in the interlayer up to a length of 35 mm is allowed.
- 3.2.3.2. A set of samples submitted for approval shall be considered satisfactory from the point of view of the headform test if one of the following two conditions is met:
- 3.2.3.2.1. All the tests give satisfactory results, or
- 3.2.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of samples gives satisfactory results.
- 3.3. Headform test on flat test pieces
- 3.3.1. Number of test pieces
Six flat test pieces measuring $(1\,100 \text{ mm} \times 500 \text{ mm}) \begin{smallmatrix} +5 \\ -2 \end{smallmatrix}$ shall be subjected to testing.
- 3.3.2. Test method
- 3.3.2.1. The method used shall be that described in annex 3, paragraph 3.1.
- 3.3.2.2. The height of drop shall be $4 \text{ m} \begin{smallmatrix} +25 \\ -0 \end{smallmatrix} \text{ mm}$.
- 3.3.3. Interpretation of results
- 3.3.3.1. This test shall be deemed to have given a satisfactory result if the following conditions are fulfilled:
- 3.3.3.1.1. the test piece yields and breaks, displaying numerous circular cracks centred approximately on the point of impact;
- 3.3.3.1.2. tears in the interlayer are allowed provided that the manikins head does not pass through the test piece.
- 3.3.3.1.3. no large fragments of glass shall become detached from the interlayer.
- 3.3.3.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the headform test if one of the following two conditions is met:
- 3.3.3.2.1. all the tests give satisfactory results, or

- 3.3.3.2.2. one test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

4. MECHANICAL STRENGTH TEST

4.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

4.2. 2 260 g ball test

4.2.1. Number of test pieces

Six square test pieces of 300 mm $\pm_{-0}^{+10}$ mm side shall be subjected to testing.

4.2.2. Test method

4.2.2.1. The method used shall be that described in annex 3, paragraph 2.2.

4.2.2.2. The height of drop (from the underface of the ball to the upper face of the test piece) shall be 4 m $\pm_{-0}^{+25}$ mm.

4.2.3. Interpretation of results

4.2.3.1. The test shall be deemed to have given a satisfactory result if the ball does not pass through the glazing within five seconds after the moment of impact.

4.2.3.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the 2 260 g ball test if one of the following two conditions is met:

4.2.3.2.1. All the tests give satisfactory results, or

4.2.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

4.3. 227 g ball test

4.3.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

4.3.2. Number of test pieces

Twenty square test pieces of 300 mm $\pm_{-0}^{+10}$ mm side shall be subjected to testing.

4.3.3. Test method

4.3.3.1. The method used shall be that described in annex 3, paragraph 2.1.

Ten specimens shall be tested at a temperature of + 40 °C $\pm$ 2 °C and ten at a temperature of – 20 °C $\pm$ 2 °C.

4.3.3.2. The height of drop for the various thickness categories and the mass of the detached fragments are given in the table below:

Thickness of test pieces mm	+ 40 °C		– 20 °C	
	Height of fall m (*)	Maximum permitted mass of the fragments g	Height of fall m (*)	Maximum permitted mass of the fragments g
e ≤ 4,5	9	12	8,5	12
4,5 < e ≤ 5,5	10	15	9	15
5,5 < e ≤ 6,5	11	20	9,5	20
e > 6,5	12	25	10	25

(*) A tolerance of $\pm_{-0}^{+25}$ mm is allowed in height of fall.

4.3.4. Interpretation of results

4.3.4.1. The test shall be considered to have given a satisfactory result if the following conditions are met:

- The ball does not pass through the test piece,
- The test piece does not break into several pieces,
- If the interlayer is not torn, the weight of fragments detached from the side of the glass opposite to the point of impact must not exceed the appropriate values specified in paragraph 4.3.3.2 above.

4.3.4.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the 227 g ball test if one of the following conditions is met:

4.3.4.2.1. Not less than eight tests at each test temperature give a satisfactory result, or

4.3.4.2.2. More than two tests at each test temperature having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

5. TEST OF RESISTANCE TO THE ENVIRONMENT

5.1. Test of resistance to abrasion

5.1.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 4, shall apply, the test being continued for 1 000 cycles.

5.1.2. Interpretation of results

The safety-glass pane shall be considered satisfactory with respect to abrasion resistance if the light scatter as a result of abrasion of the test piece does not exceed 2 per cent.

5.2. Test of resistance to high temperature

The requirements of annex 3, paragraph 5, shall apply.

5.3. Resistance-to-radiation test

5.3.1. General requirement

This test shall be performed only if the laboratory deems it useful in the light of the information in its possession concerning the interlayer.

5.3.2. The requirements of annex 3, paragraph 6.3 shall apply.

5.4. Resistance-to-humidity test

The requirements of annex 3, paragraph 7, shall apply.

6. OPTICAL QUALITIES

The requirements concerning optical qualities set out in annex 3, paragraph 9, shall apply to every type of windscreen. This shall not apply to flat windscreens which fall within an already approved group if the rake angle is less than 40° to the vertical.

ANNEX 7

LAMINATED-GLASS PANES OTHER THAN WINDSCREENS**1. DEFINITION OF TYPE**

Laminated-glass panes other than windscreens shall be deemed to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks.****1.1.2. The thickness category of the pane in which the nominal thickness 'e' lies, a manufacturing tolerance of $\pm 0,2$ n mm ('n' being the number of layers of glass in the pane) being allowed:**

Category I $e \leq 5,5$ mm

Category II $5,5 \text{ mm} < e \leq 6,5 \text{ mm}$

Category III $6,5 \text{ mm} < e$

1.1.3. The nominal thickness of the interlayer or interlayers,**1.1.4. The nature and type of the interlayer or interlayers, e.g. PVB or other plastics-material interlayer or interlayers,****1.1.5. Any special treatment which one or more layers of glass may have undergone.****1.2. The secondary characteristics are as follows:****1.2.1. The nature of the material (polished (plate) glass, float glass, sheet glass),****1.2.2. The colouring (total or partial) of the interlayer or interlayers (colourless or tinted),****1.2.3. The colouring of the glass (colourless or tinted).****1.2.4. The incorporation or otherwise of opaque obscuration.****2. GENERAL****2.1. In the case of laminated-glass panes other than windscreens, the tests shall be conducted on flat test pieces which are either cut from actual glass panes or are specially made. In either case the test pieces shall be in all respects rigorously representative of the glass panes for the production of which approval is sought.****2.2. Before each test the test pieces of laminated glass shall be stored for not less than four hours at a temperature of $23 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$. The tests shall be performed on the test pieces as soon as the test pieces have been taken out of the receptacle in which they were stored.****2.3. The provisions of this annex shall be considered to be met if the glazing submitted for approval is of the same composition as a windscreen already approved under the provisions of annex 6 or annex 8 or annex 9.****3. HEADFORM TEST****3.1. Indices of difficulty of the secondary characteristics**

No secondary characteristic is involved.

3.2. Number of test pieces

Six flat test pieces measuring $(1\,100 \text{ mm} \times 500 \text{ mm}) \begin{smallmatrix} +25 \\ -0 \end{smallmatrix} \text{ mm}$ shall be subjected to testing.

3.3. Test method

3.3.1. The method used shall be that described in annex 3, paragraph 3.1.

3.3.2. The height of drop shall be $1,50 \text{ m} \pm_5^0 \text{ mm}$.

3.4. Interpretation of results

3.4.1. This test shall be deemed to have given a satisfactory result if the following conditions are met:

3.4.1.1. The test piece yields and breaks, displaying numerous circular cracks centred approximately on the point of impact,

3.4.1.2. Tears in the interlayer are allowed, but the manikin's head must not pass through,

3.4.1.3. No large fragments of glass shall become detached from the interlayer.

3.4.2. A set of test pieces subjected to approval testing shall be considered satisfactory from the point of view of the headform test if one of the following two conditions is met:

3.4.2.1. All the tests give satisfactory results, or

3.4.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

4. MECHANICAL STRENGTH TEST - 227 g BALL TEST

4.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

4.2. Number of test pieces

Four flat square test pieces of $(300 \text{ mm} \times 300 \text{ mm}) \pm_{10}^0 \text{ mm}$ side shall be subjected to testing.

4.3. Test method

4.3.1. The method used shall be that described in annex 3, paragraph 2.1.

4.3.2. The height of drop (from the underface of the ball to the upper face of the test piece) shall be as indicated in the following table as a function of nominal thickness:

Nominal thickness	Height of drop
$e \leq 5,5 \text{ mm}$	5 m
$5,5 \text{ mm} < e \leq 6,5 \text{ mm}$	6 m
$6,5 \text{ mm} < e$	7 m

 $\left. \begin{array}{l} 5 \text{ m} \\ 6 \text{ m} \\ 7 \text{ m} \end{array} \right\} \pm_{0}^{25} \text{ mm}$

4.4. Interpretation of results

4.4.1. The test shall be considered to have given a satisfactory result if the following conditions are met:

— the ball does not pass through the test piece,

— the test piece does not break into several fragments,

— the total weight of the few fragments which may be produced on the side opposite to the point of impact does not exceed 15 g.

4.4.2. A set of test pieces subjected to approval testing shall be considered satisfactory from the point of view of mechanical strength if one of the following conditions is met:

4.4.2.1. All the tests have given a satisfactory result, or

4.4.2.2. Not more than two tests having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

5. TEST OF RESISTANCE TO THE ENVIRONMENT

5.1. Test of resistance to abrasion

5.1.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 4, shall apply, the test being continued for 1 000 cycles.

5.1.2. Interpretation of results

The safety-glass pane shall be considered satisfactory from the point of view of abrasion resistance if the light scatter as a result of abrasion of the test piece does not exceed 2 per cent.

5.2. Test of resistance to high temperature

The requirements of annex 3, paragraph 5, shall apply.

5.3. Resistance-to-radiation test

5.3.1. General requirement

This test shall be performed only if the laboratory deems it useful in the light of the information in its possession concerning the interlayer.

5.3.2. Number of samples or test pieces

The requirements of annex 3, paragraph 6.3, shall apply.

5.4. Resistance-to-humidity test

The requirements of annex 3, paragraph 7, shall apply.

6. OPTICAL QUALITIES

The provisions concerning the regular light transmittance set out in annex 3, paragraph 9.1, shall apply to glass panes other than windscreens, or parts of glass panes other than windscreens located at places which are essential to the driver's vision.

ANNEX 8

TREATED LAMINATED-GLASS WINDSCREENS**1. DEFINITION OF TYPE**

Treated laminated-glass windscreens shall be deemed to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks.****1.1.2. The shape and dimensions**

Treated laminated glass windscreens shall be deemed to belong to one group for the purposes of tests of fragmentation, of mechanical properties and of resistance to the environment.

1.1.3. The number of layers of glass,**1.1.4. The nominal thickness 'e' of the windscreen, a manufacturing tolerance of 0,2 n mm ('n' being the number of layers of glass in the windscreen) above and below the nominal value being allowed,****1.1.5. Any special treatment which one or more layers of glass may have undergone,****1.1.6. The nominal thickness of the interlayer or interlayers,****1.1.7. The nature and type of the interlayer or interlayers (e.g. PVB or other plastics-material interlayer or interlayers).****1.2. The secondary characteristics are as follows:****1.2.1. The nature of the material (polished (plate) glass, float glass, sheet glass),****1.2.2. The colouring (total or partial) of the interlayer or interlayers (colourless or tinted),****1.2.3. The colouring of the glass (colourless or tinted),****1.2.4. The incorporation or otherwise of conductors,****1.2.5. The incorporation or otherwise of opaque obscuration.****2. GENERAL****2.1. In the case of treated laminated-glass windscreens, tests other than the headform test on a complete wind-screen and tests of optical qualities shall be conducted on samples and/or flat test pieces which are specially made for the purpose. However, the test pieces shall be in all respects rigorously representative of the serially-produced windscreens for which approval is sought.****2.2. Before each test, the test pieces or samples shall be stored for not less than four hours at a temperature of 23 °C ± 2 °C. The tests shall take place as soon as possible after the test pieces or samples have been taken out of the receptacle in which they were stored.****3. TESTS PRESCRIBED**

Treated laminated glass windscreens shall be subjected to:

3.1. The tests prescribed in annex 6 for ordinary laminated-glass windscreens,

3.2. The fragmentation test described in paragraph 4 below.

4. FRAGMENTATION TEST

4.1. Indices of difficulty of the secondary characteristics

Material	Index of difficulty
Plate glass	2
Float glass	1
Sheet glass	1

4.2. Number of test pieces or samples

One test piece measuring (1 100 × 500 mm) ± 5 mm or one sample for each point of impact shall be subjected to testing.

4.3. Test method

The method used shall be that described in annex 3, paragraph 1.

4.4. Impact point or points

The glass pane shall be struck on each of the outer treated sheets in the centre of the test piece or sample.

4.5. Interpretation of results

4.5.1. For each point of impact the fragmentation test shall be considered to have given a satisfactory result if the total surface area of fragments having a surface area of more than 2 cm² comprised in a rectangle as defined in annex 4, paragraph 2.3.2, represents not less than 15 per cent of the surface of that rectangle.

4.5.1.1. In the case of a sample:

4.5.1.1.1. For vehicles of category M1, the centre of the rectangle shall be situated within a circle having a radius of 10 cm centred on the projection of the middle of segment V₁ V₂.

4.5.1.1.2. For vehicles of categories M and N other than M1, the centre of the rectangle shall be situated within a circle having a radius of 10 cm centred on the projection of point 0.

4.5.1.1.3. For agricultural and forestry tractors and for construction-site vehicles, the position of the visibility zone shall be indicated in the test report.

4.5.1.1.4. The height of the above rectangle may be reduced to 15 cm for windscreens which are less than 44 cm high or whose angle of installation is less than 15° from the vertical; the percentage of visibility shall at least be equal to 10 per cent of the area of the corresponding rectangle.

4.5.1.2. In the case of a test piece, the centre of the rectangle shall be situated on the greater axis of the test piece at 450 mm from one of its edges.

4.5.2. The test piece(s) or sample(s) submitted for approval shall be considered satisfactory from the point of view of fragmentation if either of the following conditions is met:

4.5.2.1. The test gives a satisfactory result for each point of impact, or

4.5.2.2. The test having been repeated on a new set of four test pieces for each point of impact for which it had originally given an unsatisfactory result, the four new tests, performed at the same impact points all give a satisfactory result.

ANNEX 9

SAFETY-GLASS PANES FACED WITH PLASTICS MATERIAL

(on the inside)

1. DEFINITION OF TYPE

Safety glazing materials, as defined in annex 4 to 8, if coated on the inner face, with a layer of plastics material, shall conform not only to the requirements of the appropriate annexes but also to the following requirements.

2. TEST OF RESISTANCE TO ABRASION

2.1. Indices of difficulty and test method

The plastics coating shall be subjected to a test for 100 cycles in accordance with the requirements specified in annex 3, paragraph 4.

2.2. Interpretation of results

The plastics coating shall be considered satisfactory with respect to abrasion resistance if the light scatter as a result of abrasion of the test piece does not exceed 4 per cent.

3. RESISTANCE-TO-HUMIDITY TEST

3.1. In the case of plastics-coated toughened safety glazing material a resistance-to-humidity test shall be performed.

3.2. The requirements of annex 3, paragraph 7, shall apply.

4. TEST OF RESISTANCE TO TEMPERATURE CHANGES

The requirements of annex 3, paragraph 8, shall apply.

5. FIRE-RESISTANCE TEST

The requirements of annex 3, paragraph 10, shall apply.

6. TEST OF RESISTANCE TO CHEMICALS

The requirements of annex 3, paragraph 11.2.1, shall apply.

ANNEX 10

GLASS-PLASTICS WINDSCREENS**1. DEFINITION OF TYPE**

Glass-plastics windscreens shall be considered to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:

1.1.1. The trade names or marks,

1.1.2. The shape and dimensions.

Glass-plastics windscreens shall be deemed to belong to a group for the purposes of tests of mechanical strength, resistance to the environment, resistance to temperature changes and resistance to chemical agents,

1.1.3. The number of plastics layers,

1.1.4. The nominal thickness 'e' of the windscreen, a manufacturing tolerance of $\pm 0,2$ mm being allowed,

1.1.5. The nominal thickness of the layer of glass,

1.1.6. The nominal thickness of the layer(s) of plastics acting as interlayer(s),

1.1.7. The nature and type of the layer(s) of plastics acting as interlayer(s) (e.g. PVB or other material) and of the plastics layer situated on the inner face,

1.1.8. Any special treatment the glass pane may have undergone.

1.2. The secondary characteristics are as follows:

1.2.1 The nature of the material (plate glass, float glass, sheet glass),

1.2.2 The colouring (total or partial) of any layer(s) of plastics (colourless or tinted),

1.2.3. The colouring of the glass (colourless or tinted),

1.2.4. The incorporation or otherwise of conductors,

1.2.5. The incorporation or otherwise of opaque obscuration.

2. GENERAL

2.1. In the case of glass-plastics windscreens, tests other than headform tests (paragraph 3.2) and tests of optical qualities shall be conducted on flat test pieces which are either cut from actual windscreens or are specially made for the purpose. In either case the test pieces shall in all respects be, rigorously representative of the serially-produced windscreens for which approval is sought.

2.2. Before each test, the test pieces shall be stored for not less than four hours at a temperature of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The tests shall take place as soon as possible after the test pieces have been taken out of the receptacle in which they were stored.

3. HEADFORM TEST

3.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

3.2. Headform test on a complete windscreen

3.2.1. Number of samples

Four samples from the series having the smallest developed area and four samples from the series having the largest developed area, selected in accordance with the provisions of annex 13, shall be tested.

3.2.2. Test method

3.2.2.1. The method used shall be that described in annex 3, paragraph 3.1.

3.2.2.2. The height of drop shall be $1,50 \text{ m} \pm \frac{0}{5} \text{ mm}$.

3.2.3. Interpretation of results

3.2.3.1. This test shall be considered to have given a satisfactory result if the following conditions are met.

3.2.3.1.1. The layer of glass breaks, displaying numerous circular cracks centred approximately on the point of impact, the cracks nearest to the point of impact being not more than 80 mm from it;

3.2.3.1.2. The layer of glass remains adhering to the plastics material interlayer. One or more partial separations from the interlayer not more than 4 mm in breadth may be allowed on either side of the crack outside a circle 60 mm in diameter centred on the point of impact;

3.2.3.1.3. A tear in the interlayer of a length up to 35 mm is allowed on the impact side.

3.2.3.2. A set of test pieces submitted for approval shall be considered satisfactory with respect to the headform test if one of the following two conditions is met:

3.2.3.2.1. All the tests give satisfactory results, or

3.2.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

3.3. Headform test on flat test pieces

3.3.1. Number of test pieces

Six flat test pieces measuring $(1\,100 \text{ mm} \times 500 \text{ mm}) \pm \frac{5}{2} \text{ mm}$ shall be subjected to testing.

3.3.2. Test method

3.3.2.1. The method used shall be that described in annex 3, paragraph 3.1.

3.3.2.2. The height of drop shall be $4 \text{ m} \pm \frac{25}{0} \text{ mm}$

3.3.3. Interpretation of results

3.3.3.1. This test shall be considered to have given a satisfactory result if the following conditions are met:

3.3.3.1.1. The layer of glass yields and breaks, displaying numerous circular, cracks centred approximately on the point of impact;

3.3.3.1.2. Tears in the interlayer are allowed, but the manikin's head must not pass through;

- 3.3.3.1.3. No large fragment of glass shall become detached from the interlayer.
- 3.3.3.2. A set of test pieces submitted for approval shall be considered satisfactory with respect to the headform test if one of the following conditions is met:
- 3.3.3.2.1. All the tests give satisfactory results, or
- 3.3.3.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.
4. MECHANICAL STRENGTH TEST
- 4.1. Indices of difficulty, test method and interpretation of results
The requirements of annex 6, paragraph 4, shall apply.
- 4.2. However the third requirement set out in paragraph 4.3.4.1 of annex 6 is not relevant.
5. TEST OF RESISTANCE TO THE ENVIRONMENT
- 5.1. Test of resistance to abrasion
- 5.1.1. Test of resistance to abrasion on the outer face
- 5.1.1.1. The requirements of annex 6, paragraph 5.1, shall apply.
- 5.1.2. Test of resistance to abrasion on the inner face
- 5.1.2.1. The requirements of annex 9, paragraph 2, shall apply.
- 5.2. Test of resistance to high temperature
The requirements of annex 3, paragraph 5, shall apply.
- 5.3. Resistance-to-radiation test
The requirements of annex 3, paragraph 6.3, shall apply.
- 5.4. Resistance-to-humidity test
The requirements of annex 3, paragraph 7, shall apply.
- 5.5. Test of resistance to temperature changes
The requirements of annex 3, paragraph 8, shall apply.
6. OPTICAL QUALITIES
The requirements concerning optical qualities set out in annex 3, paragraph 9, shall apply to each type of windscreen.
7. FIRE-RESISTANCE TEST
The requirements of annex 3, paragraph 10, shall apply.
8. TEST OF RESISTANCE TO CHEMICALS
The requirements of annex 3, paragraph 11.2.1, shall apply.
-

ANNEX 11

GLASS-PLASTICS PANES OTHER THAN WINDSCREENS**1. DEFINITION OF TYPE**

Glass-plastics panes other than windscreens shall be considered to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks,****1.1.2. The thickness category applicable to the nominal thickness 'e' a manufacturing tolerance of $\pm 0,2$ mm being allowed:**

Category I $e \leq 3,5$ mm

Category II $3,5 \text{ mm} < e \leq 4,5 \text{ mm}$

Category III $4,5 \text{ mm} < e$

1.1.3. The nominal thickness of the layer(s) of plastics material acting as interlayer(s),**1.1.4. The nominal thickness of the glass pane,****1.1.5. The type of the layer(s) of plastics material acting as interlayer(s) (e.g. PVB or other material) and of the plastics layer on the inner face,****1.1.6. Any special treatment which the layer of glass may have undergone.****1.2. The secondary characteristics are as follows:****1.2.1. The nature of the material (plate glass, float glass, sheet glass),****1.2.2. The colouring (total or partial) of any layer(s) of plastics (colourless or tinted),****1.2.3. The colouring of the glass (colourless or tinted).****1.2.4. The incorporation or otherwise of opaque obscuration.****2. GENERAL****2.1. In the case of glass-plastics panes other than windscreens the tests shall be conducted on flat test pieces which are either cut from normal glass panes or are specially made. In either case the test pieces shall be in all respects rigorously representative of the glass panes for the production of which approval is sought.****2.2. Before each test, the test pieces of glass-plastics panes shall be stored for not less than four hours at a temperature of $23^\circ\text{C} \pm 2^\circ\text{C}$. The tests shall take place as soon as possible after the test pieces have been taken out of the receptacle in which they were stored.****2.3. The provisions of this annex shall be considered to be met if the glass pane submitted for approval has the same composition as that of a windscreen already approved under the provisions of annex 10.****3. HEADFORM TEST****3.1. Indices of difficulty of the secondary characteristics**

No secondary characteristic is involved.

3.2. Number of test pieces

Six flat test pieces measuring (1 100 mm × 500 mm) $\pm \frac{5}{2}$ mm shall be subjected to testing.

3.3. Test method

3.3.1. The method used shall be that described in annex 3, paragraph 3.1.

3.3.2. The height of drop shall be 1,50 m $\pm \frac{0}{5}$ mm.

3.4. Interpretation of results

3.4.1. This test shall be considered to have given a satisfactory result if the following conditions are met:

3.4.1.1. The layer of glass breaks, displaying numerous cracks;

3.4.1.2. Tears in the interlayer are allowed, provided that the manikin's head does not pass through the test piece;

3.4.1.3. No large fragment of glass shall become detached from the interlayer.

3.4.2. A set of test pieces submitted for approval shall be considered satisfactory with respect to the headform test if one of the following conditions is met:

3.4.2.1. All the tests give satisfactory results, or

3.4.2.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

4. MECHANICAL STRENGTH TEST - 227 g BALL TEST

4.1. The provisions of annex 7, paragraph 4, shall apply, with the exception of the table in paragraph 4.3.2, to be replaced by:

Nominal thickness	Height of drop
$e \leq 3,5$ mm	5 m
$3,5$ mm $< e \leq 4,5$ mm	6 m
$e > 4,5$ mm	7 m

$\left. \begin{array}{l} 5 \text{ m} \\ 6 \text{ m} \\ 7 \text{ m} \end{array} \right\} \begin{array}{l} + \\ - \\ 0 \end{array} \frac{25}{0} \text{ mm}$

4.2. However the provision in annex 7, paragraph 4.4.1.2, is not relevant.

5. TEST OF RESISTANCE TO THE ENVIRONMENT

5.1. Test of resistance to abrasion

5.1.1. Test of resistance to abrasion on the outer face

The requirements of annex 7, paragraph 5.1, shall apply.

5.1.2. Test of resistance to abrasion on the inner face

The requirements of annex 9, paragraph 2.1, shall apply.

5.2. Test of resistance to high temperature

The requirements of annex 3, paragraph 5, shall apply.

5.3. Resistance-to-radiation test

The requirements of annex 3, paragraph 6.3, shall apply.

5.4. Resistance-to-humidity test

The requirements of annex 3, paragraph 7, shall apply.

5.5. Test of resistance to temperature changes

The requirements of annex 3, paragraph 8, shall apply.

6. OPTICAL QUALITIES

The provisions concerning the regular light transmittance set out in annex 3, paragraph 9.1, shall apply to glass panes or parts of glass panes other than windscreens located at places which are essential to the driver's vision.

7. FIRE-RESISTANCE TEST

The requirements of annex 3, paragraph 10, shall apply.

8. TEST OF RESISTANCE TO CHEMICALS

The requirements of annex 3, paragraph 11, shall apply.

ANNEX 12

DOUBLE-GLAZED UNITS**1. DEFINITION OF TYPE**

Double-glazed units shall be considered to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:**1.1.1. The trade names or marks,****1.1.2. The composition of the double-glazed unit (symmetrical, asymmetrical),****1.1.3. The type of each component glass pane as defined in paragraph 1 of annexes 5, 7 or 11 to this Regulation,****1.1.4. The nominal width of the gap between the two glass panes,****1.1.5. The type of sealing.****1.2. The secondary characteristics are:****1.2.1. The secondary characteristics of each component glass pane, as defined in paragraph 1.2 of annexes 5, 7 or 11 to this Regulation.****2. GENERAL****2.1. Each component glass pane forming the double-glazed unit shall either be type-approved or subjected to the requirements set out in the relevant annex to this Regulation (annexes 5, 7 or 11).****2.2. Tests carried out on double-glazed units having a nominal width of gap 'e' shall be considered to be applicable to all double-glazed units having the same characteristics and a nominal width of gap $e \pm 3$ mm. However, the applicant for approval may submit for approval tests the sample having the smallest gap and the sample having the largest gap.****2.3. In the case of double-glazed units having at least one laminated glass pane or one glass-plastics pane, the test pieces shall be stored for at least four hours prior to the test at a temperature of $23\text{ °C} \pm 2\text{ °C}$. The tests shall take place immediately after the test pieces are taken out of the receptacle in which they were stored.****3. HEADFORM TEST****3.1. Index of difficulty of the secondary characteristics**

No secondary characteristic is involved.

3.2. Number of test pieces

Six test pieces ($1\,100\text{ mm} \times 500\text{ mm}$) $\pm \frac{5}{2}$ mm shall be subjected to testing for each category of thickness of the component glass panes and each width of gap as defined in paragraph 1.1.4 above.

3.3. Test method**3.3.1. The method used shall be that described in annex 3, paragraph 3.1.****3.3.2. The height of drop shall be $1,50\text{ m} \pm \frac{0}{5}$ mm.**

- 3.3.3. In the case of an asymmetrical double-glazed unit, three tests shall be carried out on one side and three tests on the other side.

3.4. Interpretation of results

- 3.4.1. Double glazing consisting of two uniformly-toughened glass panes:

The test shall be considered to have given a satisfactory result if both components break;

- 3.4.2. Double glazing consisting of laminated glass panes and/or glass-plastics panes other than windscreens:

The test shall be considered to have given a satisfactory result if the following conditions are met:

- 3.4.2.1. The two components of the test piece yield and break, displaying numerous circular cracks centred approximately on the point of impact;

- 3.4.2.2. Tears in the interlayer(s) are allowed provided that the manikin's head does not pass through the test piece.

- 3.4.2.3. No large fragment of glass becomes detached from the interlayer.

- 3.4.3. Double glazing consisting of a uniformly-toughened glass pane and of a laminated glass pane or glass-plastics pane other than windscreens:

- 3.4.3.1. The toughened-glass pane breaks;

- 3.4.3.2. The laminated glass pane or glass-plastics pane yields and breaks, displaying numerous circular cracks centred approximately on the point of impact;

- 3.4.3.3. Tears in the interlayer(s) are allowed provided that the manikin's head does not pass through the test piece;

- 3.4.3.4. No large fragment of glass becomes detached from the interlayer.

- 3.4.4. A set of test pieces submitted for approval shall be considered satisfactory with respect to behaviour under head impact if one of the following two conditions is met:

- 3.4.4.1. All the tests give satisfactory results,

- 3.4.4.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

4. OPTICAL QUALITIES

The provisions concerning the regular light transmittance set out in annex 3, paragraph 9.1, shall apply to double glazed units or parts of double-glazed units located at places which are essential to the driver's vision.

ANNEX 13

GROUPING OF WINDSCREENS FOR APPROVAL TESTING

1. THE WINDSCREEN'S FEATURES TAKEN INTO ACCOUNT ARE:
 - 1.1. The developed area,
 - 1.2. The height of segment,
 - 1.3. The curvature.
2. A GROUP IS MADE UP OF A THICKNESS CLASS
3. CLASSIFICATION IS PERFORMED IN ASCENDING ORDER OF DEVELOPED AREA
The five largest and the five smallest developed areas shall be selected, and shall be numbered as follows:

1 for the largest	1 for the smallest
2 for the next largest after 1	2 for the next smallest after 1
3 for the next largest after 2	3 for the next smallest after 2
4 for the next largest after 3	4 for the next smallest after 3
5 for the next largest after 4	5 for the next smallest after 4
4. WITHIN EACH OF THE TWO SERIES DEFINED UNDER PARAGRAPH 3 ABOVE, THE HEIGHTS OF SEGMENT SHALL BE INDICATED AS FOLLOWS:
 - 1 for the greatest height of segment,
 - 2 for the next greatest,
 - 3 for the next greatest,
 - etc.
5. WITHIN EACH OF THE TWO SERIES DEFINED UNDER PARAGRAPH 3 ABOVE, THE CURVATURES SHALL BE INDICATED AS FOLLOWS:
 - 1 for the smallest curvature,
 - 2 for the next smallest,
 - 3 for the next smallest,
 - etc.
6. THE NUMBERS ASSIGNED TO EACH WINDSCREEN IN THE TWO SERIES DEFINED UNDER PARAGRAPH 3 ABOVE SHALL BE ADDED TOGETHER
 - 6.1. The windscreen among those having the five largest areas which has the smallest total, and the windscreen among those having the five smallest areas which has the smallest total, shall be subjected to complete tests as defined in one of annexes 4, 6, 8, 9 and 10.
 - 6.2. The other windscreens of the same series shall be subjected to the tests of optical qualities described in annex 3, paragraph 9.
7. A few windscreens having significantly different parameters of shape and/or curvature from the extremes of the selected groups may also be tested if the technical service conducting the tests considers that the parameters in question are likely to have appreciably adverse effects.

8. The limits of the group are determined by developed area of windscreen. Where a windscreen submitted for type-approval has a developed area outside the approved limits and/or has a significantly greater height of segment or a significantly smaller curvature, it shall be considered to be of a new type and shall be subjected to additional tests if the technical service deems such tests technically necessary, having regard to the information already in its possession concerning the product and the material used.
9. Should any other windscreen model subsequently be manufactured by the holder of an approval in a thickness class already approved:
 - 9.1. It shall be ascertained whether that model can be included among the five largest or the five smallest selected for approval of the group in question;
 - 9.2. Numbering by the procedures defined in paragraphs 3, 4 and 5 above shall be performed again.
 - 9.3. If the sum of the numbers assigned to the windscreen newly incorporated among the five largest or the five smallest windscreens
 - 9.3.1. Is found to be the smallest, the following tests shall be carried out:
 - 9.3.1.1. For toughened-glass windscreens:
 - 9.3.1.1.1. Fragmentation,
 - 9.3.1.1.2. Headform test,
 - 9.3.1.1.3. Optical distortion,
 - 9.3.1.1.4. Separation of secondary image,
 - 9.3.1.1.5. Light transmission.
 - 9.3.1.2. For ordinary laminated-glass or glass-plastics windscreens:
 - 9.3.1.2.1. Headform test,
 - 9.3.1.2.2. Optical distortion,
 - 9.3.1.2.3. Separation of secondary image,
 - 9.3.1.2.4. Light transmission.
 - 9.3.1.3. For treated laminated-glass windscreens, the tests prescribed in paragraphs 9.3.1.1.1, 9.3.1.1.2 and 9.3.1.2.
 - 9.3.1.4. For windscreens faced with plastics material, the tests prescribed in paragraph 9.3.1.1 or 9.3.1.2, as the case may be.
 - 9.3.2. If not, only the tests prescribed for checking optical qualities as described in annex 3, paragraph 9, shall be carried out.

ANNEX 14

RIGID PLASTIC GLAZINGS OTHER THAN WINDSCREENS**1. DEFINITION OF TYPE**

Rigid plastic glazings shall be considered to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principle characteristics are as follows:**1.1.1. Trade names or marks;****1.1.2. The chemical designation of the material.****1.1.3. The classification of the material by the manufacturer.****1.1.4. The process of manufacture.****1.1.5. The shape and dimensions.****1.1.6. The nominal thickness. The thickness tolerance limit for extruded plastic products is $\pm 10\%$ of the nominal thickness. For plastic products produced by other techniques (e.g. cast acrylic sheet), the acceptable thickness tolerance is given by the equation (thickness tolerance limits (mm)) = $\pm (0,4 + 0,1 e)$ where e is the sheet thickness in millimetres. Reference standard is ISO 7823/1.****1.1.7. The colouring of the plastic product.****1.1.8. The nature of the surface coating.****1.2. The secondary characteristics are as follows:****1.2.1. The presence or absence of conductors or heating elements.****2. GENERAL****2.1. In the case of rigid plastic panes the tests shall be conducted either on flat test pieces rigorously representative of the finished product or on finished parts. All optical measurements shall be carried out on real parts.****2.2. The test pieces must be freed from protecting maskings and have to be cleaned carefully before the test.****2.2.1. They must be stored for 48 hours at a temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and a relative humidity of $50\% \pm 5\%$.****2.3. To describe the breaking behaviour under dynamical stress, classes will be created depending on the application of the plastics. These classes are related to contact probabilities of the human head with the plastic glazing and they contain different requirements concerning the headform test.****3. FLEXIBILITY TEST****3.1. Indices of difficulty of the secondary characteristics**

No secondary characteristic is involved.

3.2. Number of test pieces

One flat test piece measuring $300\text{ mm} \times 25\text{ mm}$ shall be subjected to testing.

3.3. Test method**3.3.1. The method used shall be that described in annex 3, paragraph 12.**

3.4. Interpretation of results

For a test piece or sample to be considered rigid the vertical deflection of the test piece shall be less than or equal to 50 mm after 60 seconds.

4. HEADFORM TEST

4.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

4.2. Number of test pieces

Six flat test pieces ($1\,170 \times 570 \pm 2$ mm) or six complete parts shall be subjected to testing.

4.3. Test method

4.3.1. The method used shall be that described in annex 3, paragraph 3.2.

4.3.2. For panes like partitions and separating windows which have impact probability (classification VIII/A) the drop height shall be 3 m. The HIC value is also to be measured.

4.3.3. For panes like side windows, back windows and sunroofs which have reduced impact possibilities (classification VIII/B) the drop height shall be 1,5 m. The HIC value is also to be measured.

4.3.4. For panes which do not have contact possibilities as well as for small windows in vehicles and for all windows in trailers (classification VIII/C) there will be no headform testing. A small window is a window into which a 150 mm diameter circle cannot be scribed.

4.4. Interpretation of results

The test shall be deemed to have given a satisfactory result if the following conditions are fulfilled:

4.4.1. The test piece or sample is not penetrated nor shall it break into fully separate large pieces.

4.4.2. The HIC value is less than 1 000.

4.4.3. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the headform test if one of the following conditions is met:

4.4.3.1. All the tests give satisfactory results, or

4.4.3.2. One test having an unsatisfactory result, a further series of tests carried out on a new set of test pieces give satisfactory results.

5. MECHANICAL STRENGTH TEST 227 g BALL TEST

5.1. Indices of difficulty of the secondary characteristics:

1. without conductors or heating elements
2. with conductors or heating elements

5.2. Number of test pieces

Ten flat square pieces 300 ± 10 mm or ten substantially flat finished parts shall be subjected to testing.

5.3. Test method

5.3.1. The method used shall be that prescribed in annex 3, paragraph 2.1.

- 5.3.2. The height of drop for the various thickness values is given in the table below:

Sheet thickness (mm)	Height of drop (m)
< 3	2
4	3
5	4
> 6	5

For intermediate values of test piece thickness in the interval between 3 mm and 6 mm the height of drop must be interpolated.

- 5.4. Interpretation of results

- 5.4.1. The ball test shall be considered to have given a satisfactory result if the following conditions are met:

- the ball does not penetrate the test piece
- the test piece does not break into separate pieces

As a result of the impact, cracks and fissures in the sheet are however permissible.

- 5.4.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the 227 g ball test if one of the following conditions is met:

- 5.4.2.1. Eight or more separate tests give a satisfactory result at the drop height.
- 5.4.2.2. Three or more tests having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

- 5.5. 227 g ball test at $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$

- 5.5.1. To minimize the temperature change of the test piece, the test shall be performed within 30 seconds of the removal of the test piece from the conditioning appliance.

- 5.5.2. The test method shall be that described in paragraph 5.3 of this annex, except that the test temperature is $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

- 5.5.3. Interpretation of results as in paragraph 5.4 of this annex.

6. TEST RESISTANCE TO THE ENVIRONMENT

- 6.1. Test of resistance to abrasion

- 6.1.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 4, shall apply; the test is performed for either 1 000, 500 or 100 cycles to measure abrasion of the surface of the product.

- 6.1.2. Three flat square test pieces of 100 mm side for each type of surface shall be subjected to testing.

- 6.1.3. Interpretation of results

- 6.1.3.1. In the case of glazing of class L, the abrasion test shall be considered to have given a satisfactory result if the total light scatter after abrasion does not exceed 2 per cent after 1 000 cycles on the outer surface of the test sample and 4 per cent after 100 cycles on the inner surface of the test sample.

- 6.1.3.2. In the case of glazing of class M, the abrasion test shall be considered to have given a satisfactory result if the total light scatter after abrasion does not exceed 10 per cent after 500 cycles on the outer surface of the test sample and 4 per cent after 100 cycles on the inner surface of the test sample.

- 6.1.3.3. For sun roofs, no abrasion test is required.

- 6.1.4. A set of samples for approval shall be considered satisfactory if one of the following conditions is met:
- all samples meet the requirements or
 - one sample having failed, a repeat of the tests on a new set of samples gives a satisfactory result.
- 6.2. Test of resistance to simulated weathering
- 6.2.1. Indices of difficulty and test method
- The requirements of annex 3, paragraph 6.4, shall apply. The total ultraviolet radiant exposure with the long arc xenon lamp shall be 500 MJ/m². During irradiation the test pieces shall be exposed to water spray in continuous cycles. During a cycle of 120 minutes the test pieces are exposed to light without water spray for 102 minutes, and to light with water spray for 18 minutes.
- 6.2.1.1. Other methods giving equivalent results shall be allowed.
- 6.2.2. Number of test pieces
- Three flat test pieces 130 × 40 mm cut from a flat sheet sample shall be subjected to testing.
- 6.2.3. Interpretation of results
- 6.2.3.1. The resistance to the simulated weathering shall be considered to have given a satisfactory result if:
- 6.2.3.1.1. The light transmittance measured in accordance with annex 3, paragraph 9.1 does not fall below 95 % of the pre-weathering value. Additionally, for windows which are required for driver visibility the value shall not fall below 70 %.
- 6.2.3.1.2. No bubbles or other visible decompositions, discolourations, milkiness or crazing shall occur during weathering.
- 6.2.4. A set of test pieces or samples submitted for approval shall be considered satisfactory from the point of view of the resistance to simulated weathering if one of the following conditions is met:
- 6.2.4.1. All test pieces have given a satisfactory result.
- 6.2.4.2. One test piece having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces or samples gives satisfactory results.
- 6.3. Cross-cut test
- 6.3.1. Indices of difficulty and test method
- The requirements of annex 3, paragraph 13, shall apply only to coated rigid products.
- 6.3.2. The cross-cut test shall be carried out on one of the test pieces from paragraph 6.2.
- 6.3.3. Interpretation of results
- 6.3.3.1. The cross-cut test shall be considered to have given a satisfactory result if:
- 6.3.3.1.1. The cross-cut value Gt1 is met.
- 6.3.3.2. The test piece shall be considered satisfactory from the point of view of approval if one of the following conditions is met:
- 6.3.3.2.1. The test has given satisfactory results.
- 6.3.3.2.2. The test having given an unsatisfactory result, a further test carried out on another remaining test piece from test 6.2 gives satisfactory results.

- 6.4. Resistance-to-humidity test
 - 6.4.1. Indices of difficulty and test method
The requirements of annex 3, paragraph 7, shall apply.
 - 6.4.2. Ten flat square test pieces of 300 mm side shall be subjected to testing.
 - 6.4.3. Interpretation of results
 - 6.4.3.1. The humidity test shall be considered to have given a satisfactory result if:
 - 6.4.3.1.1. No visible decompositions like bubbles or milkiness occur on any sample,
 - 6.4.3.1.2. and if the light transmittance measured according to annex 3, paragraph 9.1 does not fall to less than 95 % of the pre-test value and additionally to no less than 70 % for any window required for driver visibility.
 - 6.4.4. After testing the test pieces shall be stored for at least 48 hours at a temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and a relative humidity of $50\text{ } \% \pm 5\text{ } \%$, and then subjected to the 227 g ball drop test described under item 5 of this annex.
 - 7. OPTICAL QUALITIES
The requirements of annex 3, paragraph 9.1 shall apply for products which are requisite for driver visibility.
 - 7.1. Interpretation of results
A set of samples shall be considered as satisfactory if one of the following conditions is met:
 - 7.1.1. All samples give a satisfactory results.
 - 7.1.2. One sample having given an unsatisfactory result, a further set of test pieces gives satisfactory results.
 - 8. FIRE RESISTANCE TEST
 - 8.1. Indices of difficulty and test method
The requirements of annex 3, paragraph 10, shall apply.
 - 8.2. Interpretation of results
The fire-resistance test shall be considered to have given a satisfactory result if the burning rate is less than 110 mm/min.
 - 8.2.1. For the purpose of approval a set of samples will be considered satisfactory if one of the following conditions is met:
 - 8.2.1.1. All samples give a satisfactory result.
 - 8.2.1.2. One sample having given an unsatisfactory result a second set of samples gives satisfactory results.
 - 9. RESISTANCE TO CHEMICALS
 - 9.1. Indices of difficulty and test method
The requirements of annex 3, paragraph 11, shall apply.
 - 9.2. Interpretation of results
A set of samples shall be considered acceptable if one of the following conditions is met:
 - 9.2.1. All samples give satisfactory results.
 - 9.2.2. One sample having given an unsatisfactory result, a second set of samples gives satisfactory results.
-

ANNEX 15

FLEXIBLE PLASTIC GLAZINGS OTHER THAN WINDSCREENS**1. DEFINITION OF TYPE**

Flexible plastic glazings shall be considered to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:

1.1.1. Trade names or marks,

1.1.2. The chemical designation of the material.

1.1.3. The classification of the material by the manufacturer.

1.1.4. The process of manufacture.

1.1.5. The nominal thickness (e), a manufacturing tolerance being allowed: $\pm (0,1 \text{ mm} + 0,1 e)$; $d > 0,1 \text{ mm}$.

1.1.6. The colouring of the plastic product.

1.1.7. The nature of the surface coating(s).

1.2. The secondary characteristics are as follows:

1.2.1. No secondary characteristic is involved.

2. GENERAL

2.1. In the case of flexible plastic glazings the tests shall be conducted on flat test pieces which either are cut from finished products or are specially produced for that purpose. In both cases the test piece must in every respect be rigorously representative for the panes which are produced in the run and for which approval is being sought.

2.2. The test pieces must be freed from protecting masks and have to be cleaned carefully before the test.

2.2.1. They must be stored for 48 hours at a temperature of $23 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ and a relative humidity of $50 \% \pm 5 \%$.

3. FLEXIBILITY TEST AND FOLD TEST**3.1. Indices of difficulty of the secondary characteristics**

No secondary characteristic is involved.

3.2. Number of test pieces

One flat test piece measuring $300 \text{ mm} \times 25 \text{ mm}$ shall be subjected to testing.

3.3. Test method

3.3.1. The method used shall be that described in annex 3, paragraph 12.

3.4. Interpretation of results

For a test piece or sample to be considered flexible its vertical deflection shall be more than 50 mm after 60 seconds.

10 seconds after a 180° folding, the material must not show any fracture or damage at the point of bending.

4. MECHANICAL STRENGTH TESTS

4.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

4.2. 227 g ball test at $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$

4.2.1. Number of test pieces

Ten flat square pieces $300 + 10/- 0$ mm shall be subjected to testing.

4.2.2. Test method

4.2.2.1. The method used shall be that prescribed in annex 3, paragraph 2.1.

4.2.2.2. The height of drop is 2 m for all thicknesses.

4.2.3. Interpretation of results

4.2.3.1. The ball test shall be considered to have given a satisfactory result if the ball does not penetrate the test piece.

4.2.3.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the 227 g ball test if one of the following conditions is met:

4.2.3.2.1. Eight or more tests give a satisfactory result at the height of drop.

4.2.3.2.2. More than two tests having given an unsatisfactory result at the minimum height of drop, a further series of tests carried out on a new set of test pieces gives satisfactory results.

4.3. 227 g ball test at $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$

4.3.1. To minimize the temperature change of the test piece the test shall be performed within 30 seconds of the removal of the test piece from the conditioning appliance.

4.3.2. The test method shall be that described in paragraph 4.2.2 of this annex, except that the test piece temperature is $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

4.3.3. Interpretation of results as in paragraph 4.2.3 of this annex.

5. TEST OF RESISTANCE TO THE ENVIRONMENT

5.1. Test of resistance to simulated weathering

5.1.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 6.4 shall apply. The total ultraviolet radiant exposure with the long arc xenon lamp shall be 500 MJ/m^2 . During irradiation the test pieces shall be exposed to water spray in continuous cycles. During a cycle of 120 minutes the test pieces are exposed to light without water spray for 102 minutes, and to light with water spray for 18 minutes.

5.1.1.1. Other methods giving equivalent results shall be allowed.

5.1.2. Number of test pieces

Three flat test pieces 130×40 mm cut from a flat sheet sample shall be subjected to testing.

5.1.3. Interpretation of results

The resistance to the simulated weathering test shall be considered to have given a satisfactory result if:

5.1.3.1. The light transmittance measured in accordance with annex 3, paragraph 9.1 does not fall below 95 % of the pre-weathering value. Additionally, for windows which are required for driver visibility the value shall not fall below 70 %.

- 5.1.3.2. No bubbles or other visible decompositions, discolourations, milkiness or crazing shall occur during weathering.
- 5.1.4. A set of test pieces or samples submitted for approval shall be considered satisfactory from the point of view of the resistance to simulated weathering if one of the following conditions is met:
- 5.1.4.1. All test pieces have given a satisfactory result.
- 5.1.4.2. One test piece having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces or samples gives satisfactory results.
6. OPTICAL QUALITIES
- The requirements of annex 3, paragraph 9.1 shall apply for products which are requisite for driver visibility.
- 6.1. Interpretation of results
- A set of samples shall be considered as satisfactory if one of the following conditions is met:
- 6.1.1. All samples have given a satisfactory results.
- 6.1.2. One sample having given an unsatisfactory result, a further set of test pieces gives satisfactory results.
7. FIRE RESISTANCE TEST
- 7.1. Indices of difficulty and test method
- The requirements of annex 3, paragraph 10, shall apply.
- 7.2. Interpretation of results
- The fire-resistance test shall be considered to have given a satisfactory result if the burning rate is less than 110 mm/min.
- 7.2.1. For the purpose of approval a set of samples will be considered satisfactory if one of the following conditions is met:
- 7.2.1.1. All samples give a satisfactory result.
- 7.2.1.2. One sample having given an unsatisfactory result a second set of samples gives satisfactory results.
8. RESISTANCE TO CHEMICALS
- 8.1. Indices of difficulty and test method
- The requirements of annex 3, paragraph 11.2.1, shall apply.
- 8.2. Interpretation of results
- A set of samples shall be considered acceptable if one of the following conditions is met:
- 8.2.1. All samples give satisfactory results.
- 8.2.2. One sample having given an unsatisfactory result, a second set of samples gives satisfactory results.
-

ANNEX 16

RIGID PLASTIC DOUBLE GLAZED UNITS**1. DEFINITION OF TYPE**

Double glazed units shall be considered to belong to different types if they differ in at least one of the following principal or secondary characteristics.

1.1. The principal characteristics are as follows:

1.1.1. The trade names or marks,

1.1.2. The chemical designation of the component sheets.

1.1.3. The classification of the sheets by the manufacturer.

1.1.4. The thickness of the component sheets.

1.1.5. The process of window manufacture.

1.1.6. The width of air gap between the component plastic sheets.

1.1.7. The colouring of the plastic sheets.

1.1.8. The nature and type of coating.

1.2. The secondary characteristics are as follows:

1.2.1. No secondary characteristic is involved.

2. GENERAL

2.1. In the case of rigid plastic double glazed units, tests will be performed on either flat test pieces or finished parts depending upon test requirements.

2.2. The test pieces must be freed from protecting maskings and cleaned before testing. They must be stored for 24 hours at a temperature of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and a relative humidity of $50\% \pm 5\%$ prior to testing.

2.3. The nominal thickness tolerance for extruded plastic products is $\pm 10\%$ of the nominal thickness. For plastic products produced by other techniques (e.g. cast acrylic sheet), the acceptable thickness tolerance is given by the equation:

$$\text{thickness tolerance limits (mm)} = \pm (0,4 + 0,1 e)$$

where e is the sheet nominal thickness.

Reference standard is ISO 7823/1

NB: Where the thickness is not constant due to forming techniques, the measurement of the thickness will be at the geometric centre of the unit.

2.4. Test carried out on rigid plastic double glazed units having a nominal width of gap e measured at the geometrical centre shall be considered to be applicable to all rigid plastic double glazed units having the same characteristics and a nominal width of gap $e \pm 5 \text{ mm}$.

The applicant for approval may alternatively submit the sample having the largest and smallest nominal gaps.

3. FLEXIBILITY TEST

3.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

3.2. Number of test pieces

One test piece for each component sheet of the window measuring 300 mm × 25 mm shall be subjected to testing.

3.3. Test method

3.3.1. The method used shall be that described in annex 3, paragraph 12.

3.4. Interpretation of results

The vertical deviation of both component sheets shall be less than 50 mm after 60 seconds.

4. HEADFORM TEST

4.1. Indices of difficulty of the secondary characteristics

No secondary characteristic is involved.

4.2. Number of test pieces

Six representative windows of size 1 170 × 570 mm (+ 0/- 2 mm in both directions) shall be subjected to testing. The samples will have provision for peripheral clamping.

4.3. Test method

4.3.1. The test method used shall be that described in annex 3, paragraph 3.2. Impact will be on the inner side of the window.

4.3.2. For panes like partitions and separating windows which have high impact probability the drop height shall be 3 m.

The HIC value is also to be measured.

4.3.3. For panes like side windows, back windows and sunroofs which have reduced impact possibilities the drop height shall be 1,5 m.

The HIC value is also to be measured.

4.3.4. For panes which do not have contact possibilities such as windows in trailer caravans as well as for small windows there will be no headform testing. A small window is a window into which a 150 mm diameter circle cannot be scribed.

4.4. Interpretation of results

The test shall be deemed to have given a satisfactory result if the following conditions are fulfilled:

4.4.1. The test piece or sample is not penetrated nor shall it break into fully separate large pieces.

4.4.2. The HIC value is less than 1 000.

- 4.4.3. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the headform test if one of the following conditions is met:

4.4.3.1. All the tests give satisfactory results, or

4.4.3.2. One test having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

5. MECHANICAL STRENGTH TEST 227 g BALL TEST

5.1. Indices of difficulty of the secondary characteristics:

No secondary characteristic is involved.

5.2. Number of test pieces

Ten flat test pieces of the outer component sheet or ten finished parts of size $300 \times 300 \text{ mm} + 10/-0 \text{ mm}$ shall be subjected to testing.

5.3. Test method

5.3.1. The method used shall be that prescribed in annex 3, paragraph 2.1.

Impact will be on the outer side of the test window

5.3.2. The height of drop for the various thickness values of the outer component of the window is given in the table below:

Outer sheet thickness (mm)	Height of drop (m)
< 3	2
4	3
5	4
> 6	5

For intermediate values of thickness in the interval between 3 mm and 6 mm the height of drop must be interpolated.

5.4. Interpretation of results

5.4.1. The ball test shall be considered to have given a satisfactory result if the following conditions are met:

- the ball does not penetrate the test piece
- the test piece does not break into separate pieces.

5.4.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of the 227 g ball test if one of the following conditions is met:

5.4.2.1. Eight or more separate tests give a satisfactory result at the drop height.

5.4.2.2. Three or more tests having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces gives satisfactory results.

5.5. 227 g ball test at $-18^\circ\text{C} \pm 2^\circ\text{C}$

5.5.1. To minimize the temperature change of the test piece, the test shall be performed within 30 seconds of the removal of the test piece from the conditioning appliance.

- 5.5.2. The test method shall be that described in paragraph 5.3 of this annex, except that the test temperature is $-18^{\circ}\text{C} \pm 2^{\circ}\text{C}$.
- 5.5.3. Interpretation of results as in paragraph 5.4 of this annex.
6. TEST RESISTANCE TO THE ENVIRONMENT
- 6.1. Test of resistance to abrasion
- 6.1.1. Indices of difficulty and test method
- The requirements of annex 3, paragraph 4, shall apply; the test is performed for either 1 000, 500 or 100 cycles to measure abrasion of the surface of the product.
- 6.1.2. Three flat square test pieces of 100 mm for each type of surface shall be subjected to testing.
- 6.1.3. Interpretation of results
- 6.1.3.1. In the case of glazing of class L, the abrasion test shall be considered to have given a satisfactory result if the total light scatter after abrasion does not exceed 2 per cent after 1 000 cycles on the outer surface of the test sample and 4 per cent after 100 cycles on the inner surface of the test sample.
- 6.1.3.2. In the case of glazing of class M, the abrasion test shall be considered to have given a satisfactory result if the total light scatter after abrasion does not exceed 10 per cent after 500 cycles on the outer surface of the test sample and 4 per cent after 100 cycles on the inner surface of the test sample.
- 6.1.3.3. For sun roofs, no abrasion test is required.
- 6.1.4. A set of samples for approval shall be considered satisfactory if one of the following conditions is met:
- All samples meet the requirements or
 - One sample having failed, a repeat of the tests on a new set of samples gives a satisfactory result.
- 6.2. Test of resistance to simulated weathering
- 6.2.1. Indices of difficulty and test method
- The requirements of annex 3, paragraph 6.4 shall apply. The total ultraviolet radiant exposure with the long arc xenon lamp shall be 500 MJ/m^2 . During irradiation the test pieces shall be exposed to water spray in continuous cycles. During a cycle of 120 minutes the test pieces are exposed to light without water spray for 102 minutes, and to light with water spray for 18 minutes.
- 6.2.1.1. Other methods giving equivalent results shall be allowed.
- 6.2.2. Number of test pieces
- Three flat test pieces $130 \times 40 \text{ mm}$ cut from the outer skin of the window shall be subjected to testing.
- 6.2.3. Interpretation of results
- 6.2.3.1. The resistance to the simulated weathering shall be considered to have given a satisfactory result if:
- 6.2.3.1.1. The light transmittance measured in accordance with annex 3, paragraph 9.1 does not fall below 95 % of the pre-weathering value. Additionally, for windows which are required for driver visibility the value shall not fall below 70 %.
- 6.2.3.1.2. No bubbles or other visible decompositions, discolourations, milkiness or crazing shall occur during weathering.
- 6.2.4. A set of test pieces or samples submitted for approval shall be considered satisfactory from the point of view of the resistance to simulated weathering if one of the following conditions is met:

- 6.2.4.1. All test pieces have given a satisfactory result.
- 6.2.4.2. One test piece having given an unsatisfactory result, a further series of tests carried out on a new set of test pieces or samples gives satisfactory results.
- 6.3. Cross-cut test
 - 6.3.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 13, shall apply only to coated products.
 - 6.3.2. The cross-cut test shall be carried out on one of the test pieces from 6.2.
 - 6.3.3. Interpretation of results
 - 6.3.3.1. The cross-cut test shall be considered to have given a satisfactory result if:

The cross-cut value Gt1 is met.
 - 6.3.3.2. The test piece shall be considered satisfactory from the point of view of approval if one of the following conditions is met:
 - 6.3.3.2.1. The test has given satisfactory results.
 - 6.3.3.2.2. The test having given an unsatisfactory result, a further test carried out on another remaining test piece from test in paragraph 6.2 gives satisfactory results.
- 6.4. Resistance-to-humidity test
 - 6.4.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 7, shall apply.
 - 6.4.2. Ten square pieces or test windows of 300 × 300 mm shall be subjected to testing.
 - 6.4.3. Interpretation of results
 - 6.4.3.1. The humidity test shall be considered to have given a satisfactory result if:
 - 6.4.3.1.1. No visible decompositions like bubbles or milkiess occur on any sample,
 - 6.4.3.1.2. and if the light transmittance measured according to annex 3, paragraph 9.1 does not fall to less than 95 % of the pre-test value and additionally to no less than 70 % for any window required for driver visibility.
 - 6.4.4. After testing the test pieces shall be stored for at least 48 hours at a temperature of 23 °C ± 2 °C and a relative humidity of 50 % ± 5 %, and then subjected to the 227 g ball drop test described under paragraph 5 of this annex.
- 7. OPTICAL QUALITIES

The requirements of annex 3, paragraph 9.1, shall apply for products which are requisite for driver visibility.

 - 7.1. Interpretation of results

A set of samples shall be considered as satisfactory if one of the following conditions is met:

 - 7.1.1. All samples give satisfactory results.
 - 7.1.2. One sample having given an unsatisfactory result, a further set of test pieces gives satisfactory results.

8. FIRE RESISTANCE TEST

8.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 10, shall apply.

8.2. Interpretation of results

The test needs to be performed separately on both surfaces of the double glazed unit.

The fire-resistance test shall be considered to have given a satisfactory result if the burning rate is less than 110 mm/min.

8.2.1. For the purpose of approval a set of samples will be considered satisfactory if one of the following conditions is met:

8.2.1.1. All samples give a satisfactory result.

8.2.1.2. One sample having given an unsatisfactory result a second set of samples gives satisfactory results.

9. RESISTANCE TO CHEMICALS

9.1. Indices of difficulty and test method

The requirements of annex 3, paragraph 11, shall apply.

Testing will only be applied to samples representative of the outer face of the double glazed unit.

9.2. Interpretation of results

A set of samples shall be considered acceptable if one of the following conditions is met:

9.2.1. All samples give satisfactory results.

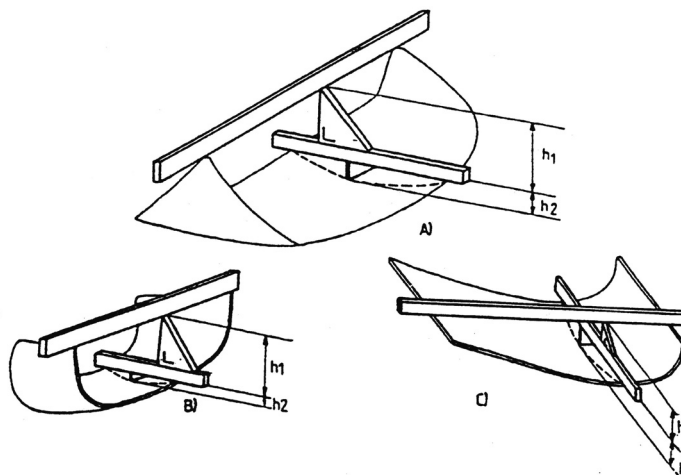
9.2.2. One sample having given an unsatisfactory result, a second set of samples gives satisfactory results.

ANNEX 17

Measurement of the height of segment and position of the points of impact

Figure 1

Determination of the height of segment 'h'

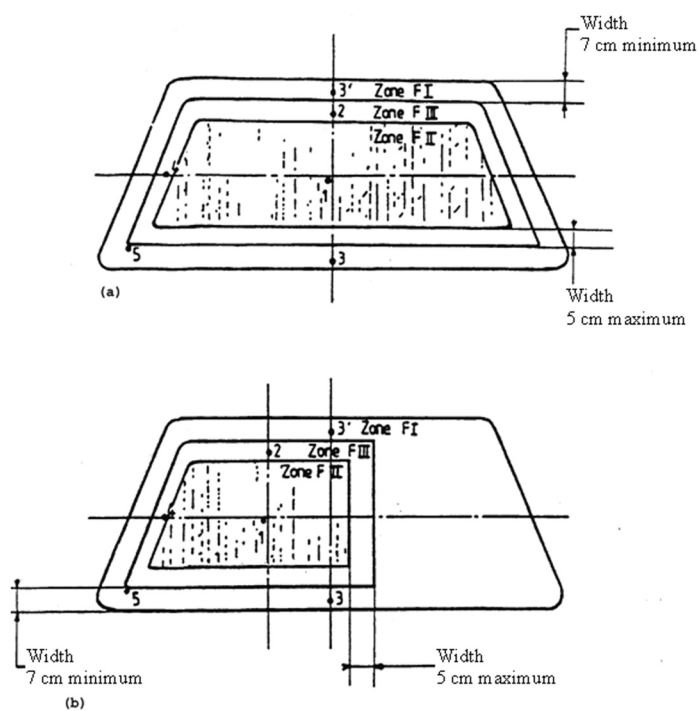


In the case of a safety glazing pane having a simple curvature, the height of segment will be equal to: h_1 maximum.

In the case of a safety glazing pane having a double curvature, the height of segment will be equal to: h_1 maximum + h_2 maximum.

Figure 2

Prescribed points of impact for windscreens



Figures 3(a), 3(b), 3(c)

Prescribed points of impact for uniformly-toughened glass panes

Figure 3(a)

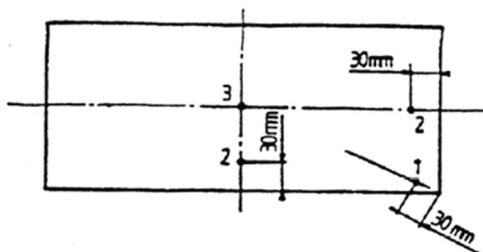
Flat glass panel

Figure 3(b)

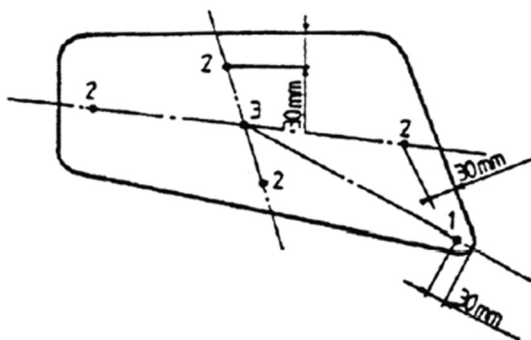
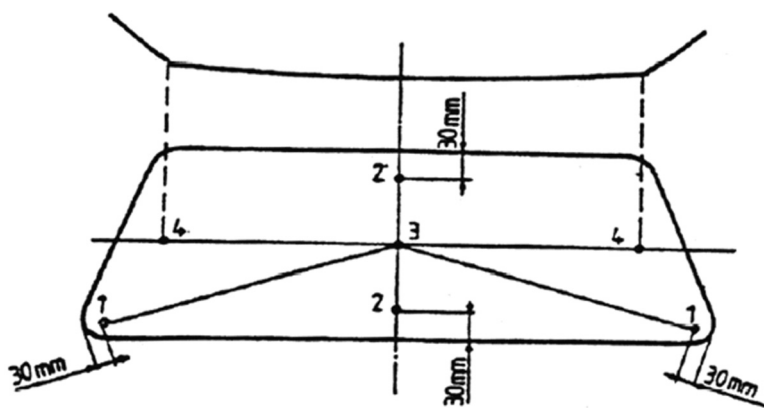
Flat glass panel

Figure 3(c)

Curved glass panel

The points '2' shown in figures 3(a), 3(b), and 3(c) are examples of the sites for point '2' prescribed in annex 5, paragraph 2.5.

ANNEX 18

Procedure for determining test areas on windscreens of vehicles in relation to the 'V' points

1. POSITION OF THE 'V' POINTS
 - 1.1. The position of the 'V' points in relation to the 'R' point (see annex 19 to this Regulation), as indicated by the X, Y and Z co-ordinates in the three-dimensional reference system, are shown in tables 1 and 2.
 - 1.2. Table 1 gives the basic co-ordinates for a design seat-back angle of 25°. The positive direction of the co-ordinates is shown in this annex, figure 3.

Table 1

'V' Point	a	b	c (d)
V ₁	68 mm	-5 mm	665 mm
V ₂	68 mm	-5 mm	589 mm

- 1.3. Correction for design seat-back angles other than 25°
 - 1.3.1. Table 2 shows the further corrections to be made to the X and Z co-ordinates of each 'V' point when the design seat-back angle is not 25°. The positive direction of the co-ordinates is shown in this annex, figure 3.

Table 2

Seat-back angle (in °)	Horizontal co-ordinates X	Vertical co-ordinates Z	Seat-back angle (in °)	Horizontal co-ordinates X	Vertical co-ordinates Z
5	- 186 mm	28 mm	23	- 17 mm	5 mm
6	- 176 mm	27 mm	24	- 9 mm	2 mm
7	- 167 mm	27 mm	25	0 mm	0 mm
8	- 157 mm	26 mm	26	9 mm	- 3 mm
9	- 147 mm	26 mm	27	17 mm	- 5 mm
10	- 137 mm	25 mm	28	26 mm	- 8 mm
11	- 128 mm	24 mm	29	34 mm	- 11 mm
12	- 118 mm	23 mm	30	43 mm	- 14 mm
13	- 109 mm	22 mm	31	51 mm	- 17 mm
14	- 99 mm	21 mm	32	59 mm	- 21 mm
15	- 90 mm	20 mm	33	67 mm	- 24 mm
16	- 81 mm	18 mm	34	76 mm	- 28 mm
17	- 71 mm	17 mm	35	84 mm	- 31 mm
18	- 62 mm	15 mm	36	92 mm	- 35 mm
19	- 53 mm	13 mm	37	100 mm	- 39 mm
20	- 44 mm	11 mm	38	107 mm	- 43 mm
21	- 35 mm	9 mm	39	115 mm	- 47 mm
22	- 26 mm	7 mm	40	123 mm	- 52 mm

2. TEST AREAS
 - 2.1. Two test areas shall be determined from the 'V' points.
 - 2.2. 'Test area A' is the area of the outer surface of the windscreen bounded by the intersection of the following four planes (see figure 1):
 - (a) a plane inclined upwards from the X axis at 3°, passing through V₁, and parallel to the Y axis (plane 1);
 - (b) a plane inclined downwards from the X axis at 1°, passing through V₂, and parallel to the Y axis (plane 2);
 - (c) a vertical plane passing through V₁ and V₂ and inclined at 13° to the left of the X axis in the case of left-hand drive vehicles and to the right of the X axis in the case of right-hand drive vehicles (plane 3);

- (d) a vertical plane passing through V_1 and V_2 and inclined at 20° to the right of the X axis in the case of left-hand drive vehicles and to the left of the X axis in the case of right-hand drive vehicles (plane 4);
- 2.3. 'Test area B' is the area of the outer surface of the windscreen bounded by the intersection of the following four planes:
- (a) a plane inclined upwards from the X axis at 7° , passing through V_1 , and parallel to the Y axis (plane 5);
 - (b) a plane inclined downwards from the X axis at 5° , passing through V_2 , and parallel to the Y axis (plane 6);
 - (c) a vertical plane passing through V_1 and V_2 and inclined at 17° to the left of the X axis in the case of left-hand drive vehicles and to the right of the X axis in the case of right-hand drive vehicles (plane 7);
 - (d) a plane symmetrical with respect to plane 7 in relation to the longitudinal median plane of the vehicle (plane 8).
- 2.4. The 'reduced test area B' is test area B with the exclusion of the following areas ⁽¹⁾ (see figures 2 and 3).
- 2.4.1. the test area A defined under paragraph 2.2, extended according to paragraph 9.2.2.1 of annex 3;
- 2.4.2. at the discretion of the vehicle manufacturer, one of the two following paragraphs may apply:
- 2.4.2.1. any opaque obscuration bounded downwards by plane 1 and laterally by plane 4 and its symmetrical in relation to the longitudinal median plane of the vehicle (plane 4);
- 2.4.2.2. any opaque obscuration bounded downwards by plane 1 provided it is inscribed in an area 300 mm wide centred on the longitudinal median plane of the vehicle and provided the opaque obscuration below the plane 5 trace is inscribed in an area limited laterally by the traces of planes passing by the limits of a 150 mm wide segment ⁽²⁾ and parallel respectively to the traces of planes 4 and 4'.
- 2.4.3. any opaque obscuration bounded by the intersection of the outer surface of the windscreen:
- (a) with a plane inclined downwards from the X axis at 4° , passing through V_2 , and parallel to the Y axis (plane 9);
 - (b) with plane 6;
 - (c) with planes 7 and 8 or the edge of the outer surface of the windscreen if the intersection of plane 6 with plane 7 (plane 6 with plane 8) doesn't cross the outer surface of the windscreen;
- 2.4.4. any opaque obscuration bounded by the intersection of the outer surface of the windscreen:
- (a) with a horizontal plane passing through V_1 (plane 10);
 - (b) with plane 3 ⁽³⁾
 - (c) with plane 7 ⁽⁴⁾ or the edge of the outer surface of the windscreen if the intersection of plane 6 with plane 7 (plane 6 with plane 8) doesn't cross the outer surface of the windscreen;
 - (d) with plane 9;

⁽¹⁾ But taking into account the fact that the datum points as defined under paragraph 2.5 must be located in the transparent area.

⁽²⁾ Measured on the outer surface of the windscreen and on the trace of plane 1.

⁽³⁾ For the other side of the windscreen, with a symmetrical plane with respect to plane 3 in relation to the longitudinal median plane of the vehicle.

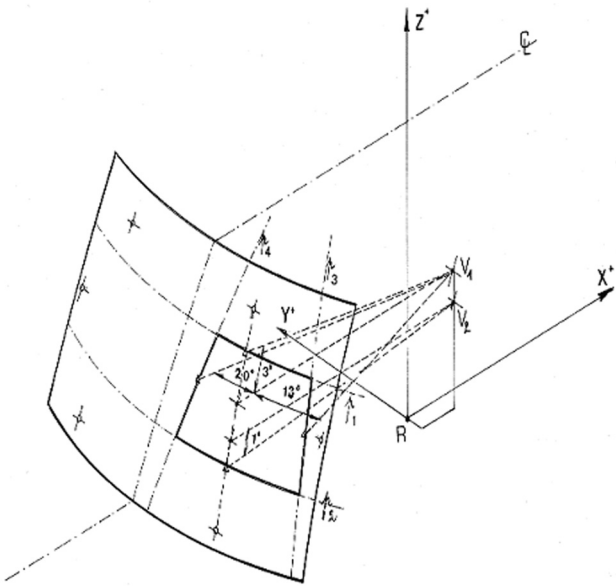
⁽⁴⁾ For the other side of the windscreen, with plane 8.

- 2.4.5. an area within 25 mm from the edge of the outer surface of the windscreen or from any opaque obscuration. This area shall not impinge on the extended test area A.
- 2.5. Definition of the datum points (see figure 3)

The datum points are points situated at the intersection with the outer surface of the windscreen of lines radiating forward from the V points:

 - 2.5.1. upper vertical datum point forward of V_1 and 7° above the horizontal (P_{r1});
 - 2.5.2. lower vertical datum point forward of V_2 and 5° below the horizontal (P_{r2});
 - 2.5.3. horizontal datum point forward of V_1 and 17° to the left (P_{r3});
 - 2.5.4. three additional datum points symmetrical to the points defined under paragraphs 2.5.1 to 2.5.3 in relation to the longitudinal median plane of the vehicle (respectively P'_{r1} , P'_{r2} , P'_{r3}).

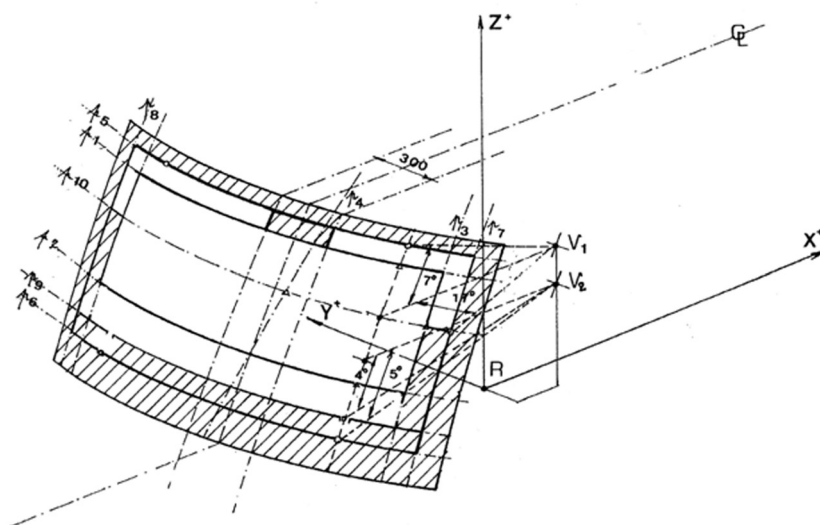
Figure 1
Test area 'A' (example of a left-hand steering control vehicle)



C_L : trace of the longitudinal median plane of the vehicle
 P_i : trace of the relevant plane (see text)

Figure 2a

Reduced test area 'B' (example of a left-hand steering control vehicle) — upper obscuration area as defined in paragraph 2.4.2.2



C_L : trace of the longitudinal median plane of the vehicle

P_i : trace of the relevant plane (see text)

Figure 2b

Reduced test area 'B' (example of a left-hand steering control vehicle) — upper obscuration area as defined in paragraph 2.4.2.1

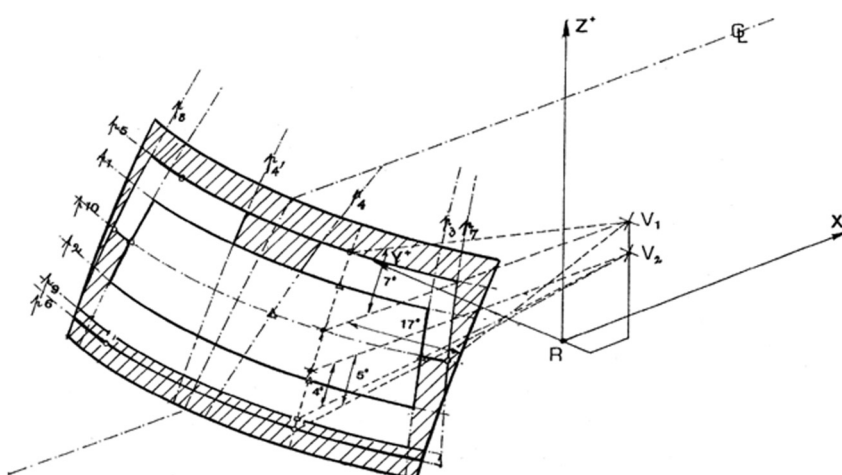
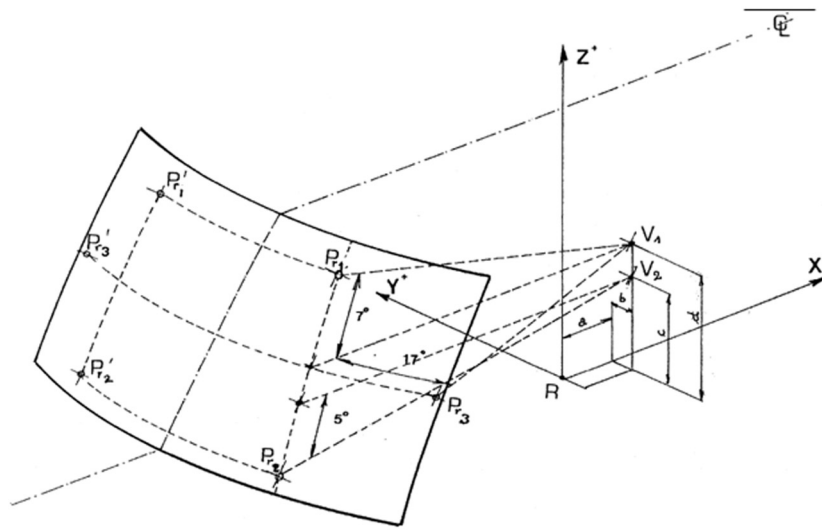


Figure 3

Determination of the datum points (example of a left-hand steering control vehicle)



- | | |
|-------------|--|
| C_L : | trace of the median plane of the vehicle |
| P_{ri} : | datum points |
| a, b, c, d: | co-ordinates of 'V' points (see text) |

ANNEX 19

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 specification 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 DH 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 thigh of the 3 DH machine installed in the vehicle seat in accordance with the procedure described in paragraph 3 below. The H point is located in the centre of the centre line of the device which is between the H point sight buttons on either side of the DH 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 as fixed in relation to the seat-cushion structure and as moving 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 centre line of the probe of the 3 DH 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 DH 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 measured between a vertical line through the R point and the torso line in a position corresponding to the design position of the seat-back specified by the vehicle manufacturer.

2.8. 'Centre plane of occupant' (CPO) means the median plane of the 3 DH 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 centre plane of the seat coincides with the centre plane of the occupant. For other seats, the centre plane 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 machine or other procedures, the R point indicated by the vehicle 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 this 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 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 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 DETERMINING THE H POINT AND THE ACTUAL TORSO ANGLE

- 4.1. The vehicle shall be preconditioned at a temperature of 20 °C ± 10 °C, at the manufacturer's discretion, to ensure that the seat material reaches room temperature. If the seat to be checked has never been used, a 70 to 80 kg person or device shall be placed 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 minutes prior to installation of the 3 DH machine.
- 4.2. The vehicle shall be in the measuring attitude defined in paragraph 2.11 above.
- 4.3. The seat, if 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 be then 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 taken up by the 3 DH 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 the test is performed 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 DH machine so that the centre plane of the occupant (CPO) coincides with the centre plane of the 3 DH machine. At the manufacturer's request, the 3 DH machine may be moved inboard with respect to the CPO if the 3 DH machine is located so far outboard that the seat edge will not permit levelling of the 3 DH 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. The line through the H point sight buttons shall be parallel to the ground and perpendicular to the longitudinal centre plane of the seat.
- 4.7. Adjust the feet and leg positions of the 3 DH machine as follows:
- 4.7.1. Seats for 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 at approximately the same distance to the left of the centre plane of the 3 DH machine as the right foot is to the right. The spirit level verifying the transverse orientation of the 3 DH 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 centre plane 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. Outboard rear seats:
- 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 level, the foot which first come 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 seats:
- 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 DH machine.
- 4.9. Tilt the back pan forward against the forward stop and draw the 3 DH machine away from the seat-back using the T-bar. Reposition the 3 DH machine on the seat by one of the following methods:
- 4.9.1. If the 3 DH machine tends to slide rearward, use the following procedure: allow the 3 DH 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, re-position the lower leg.
- 4.9.2. If the 3 DH machine does not tend to slide rearward, use the following procedure: slide the 3 DH 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 DH 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 through 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 seatback. Care must be exercised throughout the remainder of the procedure to prevent the 3 DH machine from sliding forward.
- 4.11. Install the right and left buttock weights and then, alternatively, the eight torso weights. Maintain the 3 DH machine level.
- 4.12. Tilt the back pan forward to release the tension on the back-seat. Rock the 3 DH machine from side to side through a 10° arc (5° to each side of the vertical centre plane) for three complete cycles to release any accumulated friction between the 3 DH machine and the seat.

During the rocking action, the T-bar of the 3 DH 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 should be exercised in holding the T-bar and rocking the 3 DH machine to ensure that no inadvertent exterior loads are applied in a vertical or fore-and-aft direction.

The feet of the 3 DH machine are not to be restrained or held during this step. If the feet change position, they should then be allowed to remain in that attitude.

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 DH 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; 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 DH machine's seat pan on the seat.

4.13. Holding the T-bar to prevent the 3 DH 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 should be taken to ensure that no exterior downward or lateral loads are applied to the 3 DH machine. If another level adjustment of the 3 DH machine is necessary, rotate the back pan forward, re-level, and repeat the procedure from 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 DH machine with the probe in its fully rearward position.

4.15. If a repetition of the installation of the 3 DH machine is desired, the seat assembly shall remain unloaded for a minimum period of 30 minutes prior to the repetition. The 3 DH machine shall 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 DH 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 DH machine)

1. BACK AND SEAT PANS

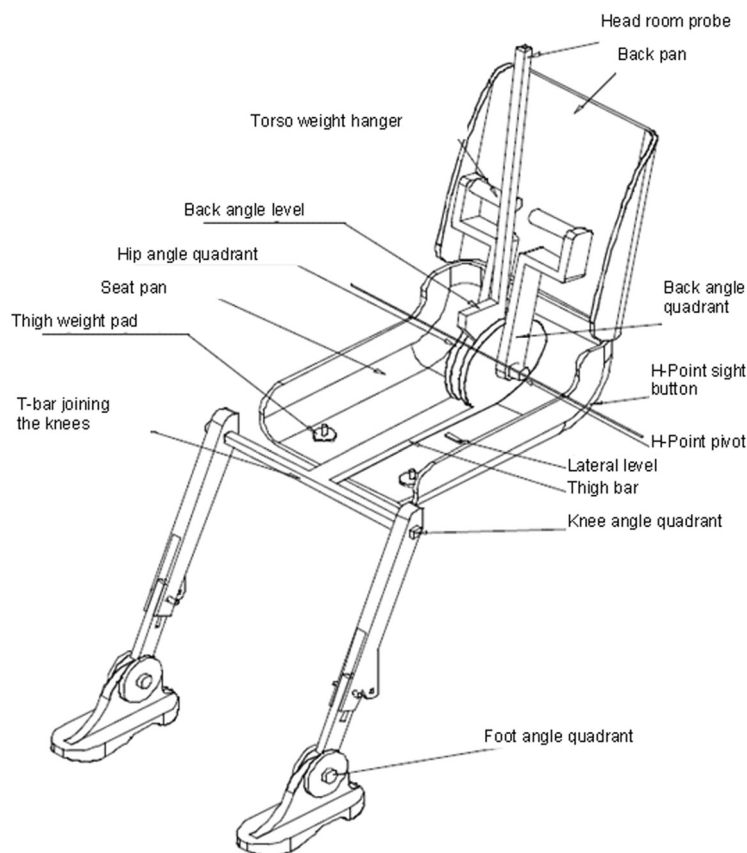
The back and seat pans are constructed of reinforced plastics and metal; they simulate the human torso and thighs and are mechanically hinged at the H point. A quadrant is fastened to the probe hinged at the H point to measure the actual torso angle. An adjustable thigh bar, attached to the seat pan, 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 DH machine should be checked for free movement without encountering any noticeable friction.

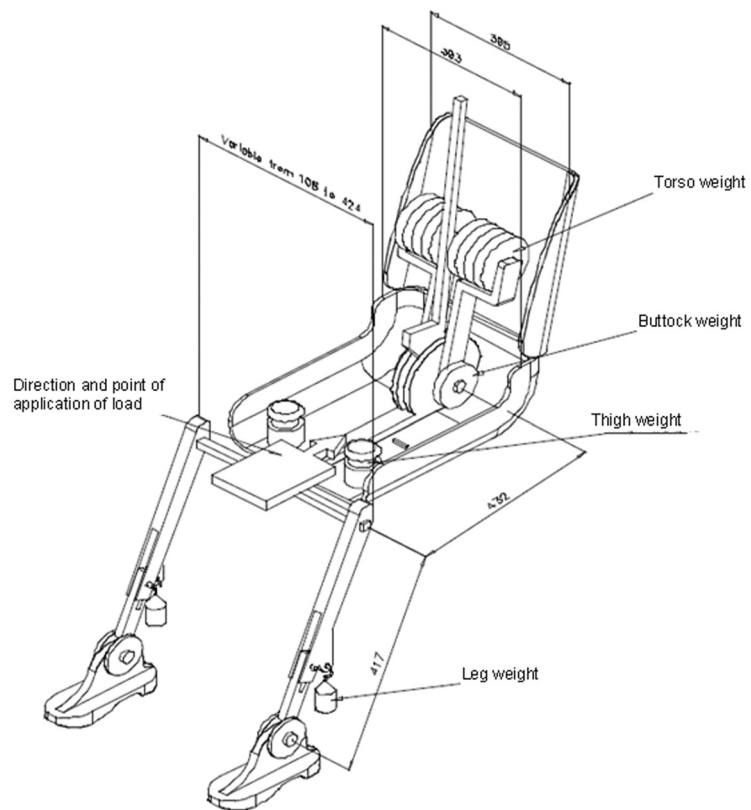
Figure 1

Designation of 3 DH machine components



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

Figure 2

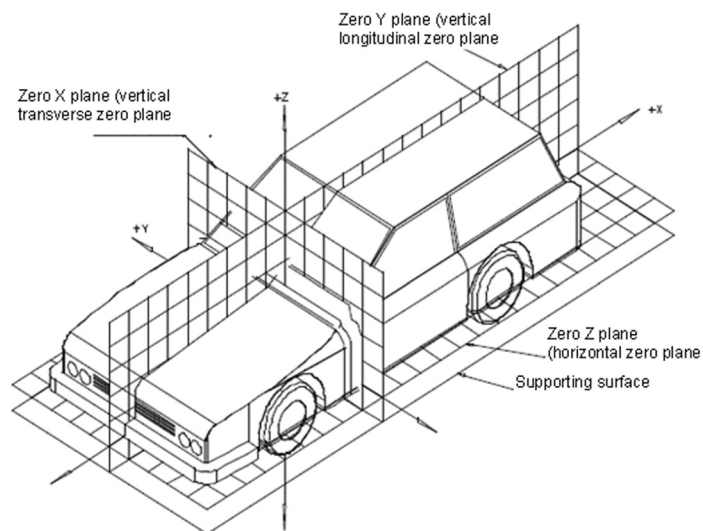
Dimensions of 3 DH machine components and load distribution

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 determined by positioning the vehicle on a 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 determined in relation to the fiducial marks defined by the vehicle manufacturer.

Figure

Three-dimensional reference system

(*) The reference system corresponds to ISO Standard 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-character code. The first character is an Arabic numeral which designates the row of seats, counting from the front to the rear of the vehicle. The second 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 the 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 20

CHECKS ON CONFORMITY OF PRODUCTION

1. DEFINITIONS

For the purpose of this annex:

- 1.1. 'Type of product' means all glass panes having the same principal characteristics;
- 1.2. 'Thickness class' means all glass panes whose component parts have the same thickness within the permitted tolerances;
- 1.3. 'Production unit' means all production facilities of one or several types of glass panes established in the same place; it may include several production lines;
- 1.4. 'Shift' means a period of production carried out by the same production line during daily working hours;
- 1.5. 'Production run' means a continuous period of production of the same type of product in the same production line;
- 1.6. 'Ps' means the number of glass panes of the same type of product produced by the same shift;
- 1.7. 'Pr' means the number of glass panes of the same type of product produced during a production run.

2. TESTS

The glass panes shall be subjected to the following tests:

- 2.1. Toughened-glass windscreens
 - 2.1.1. Fragmentation test in accordance with the requirements of annex 4, paragraph 2.
 - 2.1.2. Light transmission measurement in accordance with the requirements of annex 3, paragraph 9.1.
 - 2.1.3. Optical distortion test in accordance with the requirements of annex 3, paragraph 9.2.
 - 2.1.4. Secondary image separation test in accordance with the requirements of annex 3, paragraph 9.3.
- 2.2. Uniformly-toughened glass panes
 - 2.2.1. Fragmentation test in accordance with the requirements of annex 5, paragraph 2.
 - 2.2.2. Light transmission measurement in accordance with the requirements of annex 3, paragraph 9.1.
 - 2.2.3. In the case of glass panes used as windscreens:
 - 2.2.3.1. Optical distortion test in accordance with the requirements of annex 3, paragraph 9.2.
 - 2.2.3.2. Secondary image separation test in accordance with the requirements of annex 3, paragraph 9.3.
- 2.3. Ordinary laminated-glass windscreens and glass-plastics windscreens
 - 2.3.1. Headform test in accordance with the requirements of annex 6, paragraph 3.
 - 2.3.2. 2 260 g ball test in accordance with the requirements of annex 6, paragraph 4.2 and annex 3, paragraph 2.2.
 - 2.3.3. Test of resistance to high temperature in accordance with the requirements of annex 3, paragraph 5.

- 2.3.4. Light transmission measurement in accordance with the requirements of annex 3, paragraph 9.1.
- 2.3.5. Optical distortion test in accordance with the requirements of annex 3, paragraph 9.2.
- 2.3.6. Secondary image separation test in accordance with the requirements of annex 3, paragraph 9.3.
- 2.3.7. In the case of glass-plastics windscreens only:
 - 2.3.7.1. Test of resistance to abrasion in accordance with the requirements of annex 9, paragraph 2.1.
 - 2.3.7.2. Resistance-to-humidity test in accordance with the requirements of annex 9, paragraph 3.
 - 2.3.7.3. Test of resistance to chemicals in accordance with the requirements of annex 3, paragraph 11.2.1.
- 2.4. Ordinary laminated-glass and glass-plastics panes other than windscreens
 - 2.4.1. 227 g ball test in accordance with the requirements of annex 7, paragraph 4.
 - 2.4.2. Test of resistance to high temperature in accordance with the requirements of annex 3, paragraph 5.
 - 2.4.3. Light transmission measurement in accordance with the requirements of annex 3, paragraph 9.1.
 - 2.4.4. In the case of glass-plastics panes only:
 - 2.4.4.1. Test of resistance to abrasion in accordance with the requirements of annex 9, paragraph 2.1.
 - 2.4.4.2. Resistance-to-humidity test in accordance with the requirements of annex 9, paragraph 3.
 - 2.4.4.3. Test of resistance to chemicals in accordance with the requirements of annex 3, paragraph 11.2.1.
 - 2.4.5. The above provisions shall be considered to be met if the corresponding tests have been carried out on a windscreen of the same composition.
- 2.5. Treated laminated-glass windscreens
 - 2.5.1. In addition to the tests prescribed in paragraph 2.3 of this annex, a fragmentation test shall be carried out in accordance with the requirements of annex 8, paragraph 4.
- 2.6. Glass panes faced with plastics material

In addition to the tests prescribed in the various paragraphs of this the following tests shall be carried out:

 - 2.6.1. Test of resistance to abrasion in accordance with the requirements of annex 9, paragraph 2.1.
 - 2.6.2. Resistance-to-humidity test in accordance with the requirements of annex 9, paragraph 3.
 - 2.6.3. Test of resistance to chemicals in accordance with the requirements of annex 3, paragraph 11.2.1.
- 2.7. Double-glazed units
 - 2.7.1. The tests to be performed are those specified in this annex for each glass pane composing the double-glazed unit, with the same frequency and the same requirements.
 - 2.7.2. In the case of double-glazed units, light transmission measurement shall be performed with the requirements of Annex 3, paragraph 9.1.

- 2.8. Rigid plastic panes other than windscreens
- 2.8.1. 227 g ball drop test in accordance with annex 14, paragraph 5.
- 2.8.2. Light transmission measurement in accordance with annex 3, paragraph 9.1.
- 2.8.3. The abrasion test in accordance with annex 14, paragraph 6.1.
- 2.8.4. Cross-cut test in accordance with annex 14, paragraph 6.3.

NB: The above test of paragraph 2.8.2 only applies if the glazing is to be used in a location requisite for driving visibility.

The above test of paragraph 2.8.4 will be carried out on samples that have not been subjected to test in accordance with paragraph 6.2 of annex 14.

- 2.8.5. Test of resistance to chemicals in accordance with annex 3, paragraph 11.

- 2.9. Flexible plastic panes other than windscreens
- 2.9.1. 227 g ball drop test in accordance with annex 15, paragraph 4.

- 2.9.2. Light transmission measurement in accordance with annex 3, paragraph 9.1.

NB: The above test of paragraph 2.9.2 only applies if the glazing is to be used in a location requisite for driving visibility.

- 2.9.3. Test of resistance to chemicals in accordance with annex 3, paragraph 11.2.1.

- 2.10. Rigid plastic double glazed units
- 2.10.1. 227 g ball drop test in accordance with annex 16, paragraph 5.

- 2.10.2. Light transmission measurement in accordance with annex 3, paragraph 9.1.

NB: The above test of paragraph 2.10.2 only applies if the glazing is to be used in a location requisite for driving visibility.

- 2.10.3. Test of resistance to chemicals in accordance with annex 3, paragraph 11.

3. FREQUENCY OF TESTS AND RESULTS

3.1. Fragmentation test

3.1.1. Tests

- 3.1.1.1. A first series of tests consisting of a break at each impact point specified by this Regulation shall be carried out at the beginning of the production of each new type of glass pane to determine the most severe break point. The result of the tests shall be recorded.

However, for toughened-glass windscreens, the first series of tests shall be carried out only if the annual production of this type of glass pane exceeds 200 units.

- 3.1.1.2. During the production run the check test shall be carried out using the break point as determined in paragraph 3.1.1.1.

- 3.1.1.3. A check shall be carried out at the beginning of each production run or following a change of colour.

3.1.1.4. During the production run the check tests shall be carried out at the following minimum frequency:

Toughened-glass windscreens	Toughened-glass panes other than windscreens	Treated laminated-glass windscreens
$P_s \leq 200$: one break per production run	$P_r \leq 500$: one per shift	0,1 per cent per type
$P_s > 200$: one break every four hours of production	$P_r > 500$: two per shift	

3.1.1.5. A check shall be carried out at the end of the production run on one of the last glass panes manufactured.

3.1.1.6. For $P_r < 20$, only one fragmentation test per production run shall be carried out.

3.1.2. Results

All results shall be recorded, including the results without permanent recording of the fragmentation pattern.

In addition, a test with permanent recording of the fragmentation pattern shall be made once per shift, except for $P_r \leq 500$. In this last case only one test with permanent recording of the fragmentation pattern shall be made per production run.

3.2. Headform test

3.2.1. Tests

The check shall be carried out on samples corresponding to at least 0,5 per cent of the daily production of laminated-glass windscreens of one production line. A maximum of 15 windscreens per day shall be tested.

The choice of samples shall be representative of the production of the various types of windscreen.

As an alternative and with the agreement of the administrative service, these tests may be replaced by the 2 260 g ball test (see paragraph 3.3 below). Behaviour under head impact shall in any event be checked on at least two samples for each thickness class per year.

3.2.2. Results

All results shall be recorded.

3.3. 2 260 g ball-impact test

3.3.1. Tests

The minimum frequency for the check shall be one complete test per month for each thickness class.

3.3.2. Results

All results shall be recorded.

3.4. 227 g ball-impact test

3.4.1. Tests

The test pieces shall be cut from samples. However, for practical reasons, the tests may be carried out on finished products or parts of them.

The check shall be carried out on a sampling corresponding to at least 0,5 per cent of the production of one shift with a maximum of ten samples per day.

3.4.2. Results

All results shall be recorded.

3.5. Test of resistance to high temperature

3.5.1. Tests

The test pieces shall be cut from samples. However, for practical reasons, the tests may be carried out on finished products or parts of them. These shall be selected so that all interlayers are tested proportionately to their use.

The check shall be carried out on at least three samples per colour of interlayer taken from the daily production.

3.5.2. Results

All results shall be recorded.

3.6. Light transmission

3.6.1. Tests

Representative samples of tinted finished products shall be subjected to this test.

The check shall be carried out at least at the beginning of every production run if there is any change in the characteristics of the glazing pane affecting the results of the test.

Windscreens and other glazing panes having a regular light transmittance measured during type approval of not less than 75 per cent, and glass panes whose symbol is V (see paragraph 5.5.2 of this Regulation), shall be exempted from this test.

Alternatively, for toughened-glass panes, a certificate of compliance with the above requirements may be submitted by the glass supplier.

3.6.2. Results

The value of regular light transmission shall be recorded. In addition, for windscreens with opaque obscuration, it shall be verified from the drawings referred to in paragraph 3.2.1.2.2.4 of this Regulation, that such bands are outside the test area B or zone I according to the category of vehicle for which the windscreen is intended. Any opaque obscuration must be in conformity with the provisions contained in annex 18.

3.7. Optical distortion and separation of secondary image

3.7.1. Tests

Every windscreen shall be inspected for visual defects. In addition, using the methods specified in this Regulation or any method giving similar results, measurements shall be made in the various areas of vision at the following minimum frequencies:

either where $P_s \leq 200$, one sample per shift,

or, where $P_s > 200$, two samples per shift,

or 1 per cent of the whole production, the samples chosen being representative of all production.

3.7.2. Results

All results shall be recorded.

3.8. Test of resistance to abrasion

3.8.1. Tests

Plastics-surfaced, glass-plastics and plastic glazing panes only shall be submitted to this test. There shall be at least one check per month and per type of plastic material surfacing or plastic material.

3.8.2. Results

The measurement of the light scatter shall be recorded.

3.9. Resistance-to-humidity test

3.9.1. Tests

Plastics-surfaced and glass-plastics glazing panes only shall be submitted to this test. There shall be at least one check per month and per type of plastic material surfacing or plastic material.

3.9.2. Results

All results shall be recorded.

3.10. Test of resistance to chemicals

3.10.1. Tests

Plastics-surfaced, glass-plastics and plastic glazing panes only shall be submitted to this test. There shall be at least one check per month and per type of plastic material surfacing or plastic material.

3.10.2. Results

All results shall be recorded.

3.11. Cross-cut test

3.11.1. Tests

Only rigid plastic glazing with an abrasion resistant coating shall be submitted to this test. There shall be at least one check per week and per type of plastic material and its coating, on samples that have not been subjected to the test for simulated weathering (annex 14, paragraph 6.2).

A test on weathered samples shall be carried out each 3 months.

3.11.2. Results

All results shall be recorded.

ANNEX 21

Provisions regarding the installation of safety glazing on vehicles**1. SCOPE**

This annex sets out provisions regarding the installation of safety glazing in vehicles of categories M, N and O ⁽¹⁾ in order to ensure a high level of safety for the occupants and, in particular, to provide the driver with a high degree of visibility in all traffic conditions, not only forwards but also rearwards and laterally.

It does not apply to armoured vehicles as defined hereunder in paragraph 2.3.

2. DEFINITIONS

For the purpose of this annex,

- 2.1. 'Vehicle' means any motor vehicle and its trailer, intended for use on the road, having at least four wheels and a maximum design speed exceeding 25 km/h, with the exception of vehicles which run on rails and all mobile machinery;
- 2.2. 'Category of vehicles' means a set of vehicles entering into the relevant category of the classification adopted in annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) ⁽¹⁾;
- 2.3. 'Special purpose vehicle', 'motor caravan', 'armoured vehicle', 'ambulance', 'hearse', 'convertible', are respectively defined in annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) ⁽¹⁾.
- 2.4. 'Double-deck vehicle' is defined in paragraph 2.1.2 of Regulation No 107.

3. GENERAL PROVISIONS APPLICABLE TO VEHICLES OF CATEGORIES M, N AND O

- 3.1. Safety glazing shall be fitted in such a way that, despite the stresses to which the vehicle is submitted under normal operating conditions, it remains in position and continues to afford visibility and safety to the occupants of the vehicle;
- 3.2. Safety glazing shall bear the appropriate component type-approval mark specified in paragraph 5.4 of this Regulation, followed when required, by one of the additional symbols provided for in paragraph 5.5.

4. SPECIFIC PROVISIONS APPLICABLE TO VEHICLES OF CATEGORIES M AND N ⁽¹⁾**4.1. Windscreens**

- 4.1.1. The regular light transmittance shall not be less than 70 per cent.
- 4.1.2. The windscreen must be type approved for the vehicle type for which it is intended to be fitted.
- 4.1.3. The windscreen must be correctly fitted with reference to the vehicle driver's 'R' point.
- 4.1.4. Vehicles having a maximum design speed greater than 40 km/h may not be fitted with a toughened windscreen.

4.2. Safety glazing other than windscreens and partition glazing**4.2.1. Safety glazing requisite for the driver's forwards field of vision**

- 4.2.1.1. The safety glazing through which the driver's forwards field of vision as defined in paragraph 2.18.1 of this Regulation is obtained, must have a regular light transmittance of at least 70 per cent.

⁽¹⁾ As defined in annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (TRANS/WP.29/78/Rev.1/Amend.2).

4.2.1.2. Plastic safety glazing shall bear an additional symbol /B/L, as defined in paragraphs 5.5.5 and 5.5.7 of this Regulation.

4.2.2. Safety glazing requisite for the driver's rearward vision

4.2.2.1. The safety glazing defined in paragraph 2.18.2 of this Regulation must have a light transmittance of at least 70 per cent, but where two exterior rear view mirrors are fitted, the glazing is allowed to have a light transmittance below 70 per cent, provided that it shall bear the additional symbol V specified in paragraph 5.5.2 of this Regulation.

4.2.2.2. Plastic safety glazing shall bear an additional symbol A/L or B/L, as defined in paragraphs 5.5.5 and 5.5.7 of this Regulation.

As an alternative, the rear glazing in the folding roof of a convertible vehicle may bear the additional symbol /B/M.

The rear glazing in the folding roof of a convertible vehicle may be made of a flexible plastic pane.

4.2.3. Other safety glazing

4.2.3.1. The safety glazing not covered by the definitions of paragraphs 2.18.1 and 2.18.2 of this Regulation shall bear the additional symbol V specified in paragraph 5.5.2 of this Regulation, if the light transmittance is below 70 per cent.

4.2.3.2. Plastic safety glazings shall bear one of the additional symbols defined in paragraphs 5.5.5, 5.5.6, and 5.5.7 of this Regulation. However, when the vehicle is intended for conveying passengers, glazings with the additional symbols /C/L or /C/M are not allowed at locations where there is a risk of head impact.

4.2.4. Exemptions

In the case of plastic safety glazings, the provisions related to abrasion resistance as referred in paragraphs 4.2.2.2 and 4.2.3.2 of this annex do not apply for the vehicles and glazing locations listed below:

- (a) ambulances
- (b) hearses
- (c) trailers, including caravans
- (d) sunroofs and glazings located in the roof of a vehicle
- (e) all glazings of the upper deck of a double-deck vehicle

No abrasion test/symbol is required.

4.3. Particular requirements

4.3.1. Any forward-facing glazing other than a windscreen must be constituted either by laminated glass or a plastic pane bearing the additional symbol /A, as defined in paragraphs 5.5.5 and 5.5.7 of this Regulation.

4.3.2. Paragraph 4.3.1 is not applicable to vehicles having a maximum design speed lower than 40 km/h.

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 105 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of vehicles intended for the carriage of dangerous goods with regard to their specific constructional features

Incorporating all valid text up to:

Supplement 1 to the 04 series of amendments — Date of entry into force: 22 July 2009

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ANNEXES

Annex 1 — Communication concerning the approval or extension or refusal or withdrawal of approval or production definitely discontinued of a vehicle type with regard to specific constructional features for the transport of dangerous goods

Annex 2 — Arrangements of approval marks

1. SCOPE

The provisions of this Regulation apply to the construction of base vehicles of motor vehicles of category N and their trailers of category O ⁽¹⁾, intended for the transport of dangerous goods and subject to section 9.1.2 of Annex B to the European Agreement concerning the international Carriage of Dangerous Goods by Road (ADR).

2. DEFINITIONS

For the purpose of this Regulation:

⁽¹⁾ As defined in annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev.1/Amend.2).

- 2.1. 'Base vehicle' (hereinafter referred to as 'vehicle') means a chassis-cab vehicle, a tractor for semi-trailer, a trailer-chassis or a trailer with a self-supporting body intended for the transport of dangerous goods;
- 2.2. 'Vehicle type' means vehicles which do not differ essentially with regard to the constructional features specified in this Regulation.
3. APPLICATION FOR APPROVAL
 - 3.1. The application for approval of a vehicle type with regard to its specific constructional features shall be submitted by the vehicle manufacturer or by his duly accredited representative.
 - 3.2. The application for approval shall be accompanied by the undermentioned documents in triplicate and by the following particulars:
 - 3.2.1. A detailed description of the vehicle type with respect to its relevant structure, engine (compression-ignition, positive ignition), dimensions, configuration and constituent materials;
 - 3.2.2. Vehicle designation, according to paragraph 9.1.1.2 of the ADR (EX/II, EX/III, AT, FL, OX, MEMU);
 - 3.2.3. Drawings of the vehicle;
 - 3.2.4. The maximum technical mass (kg) of the complete vehicle.
 - 3.3. A vehicle representative of the type to be approved shall be submitted to the technical service responsible for conducting the approval tests.
4. APPROVAL
 - 4.1. If the vehicle submitted for approval pursuant to this Regulation meets the provisions of paragraph 5 below, 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 04 for the Regulation in its 04 series of amendments) shall indicate the series of amendment incorporating the most recent major technical amendments made to the provisions at the time of issue of the approval. The same Contracting Party may not assign the same number to another vehicle type within the meaning of paragraph 2.2 above.
 - 4.3. Notice of approval or of extension of approval of a vehicle type pursuant to this Regulation shall be communicated to the Contracting Parties by means of a form conforming to the model reproduced in annex 1 to this 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, followed by the letter 'R', a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1., and
- 4.4.3. An additional symbol separated from the approval number and consisting of the symbol identifying the vehicle designation in accordance with paragraph 9.1.1.2 of the ADR. In the case of MEMU vehicles, the identifying symbol may be 'EX/III'
- 4.5. If the vehicle conforms to a vehicle type approved under one or more other Regulations annexed to this 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 affixed by the manufacturer.
- 4.8. Annex 2 to this Regulation gives an example of the approval mark.
5. TECHNICAL PROVISIONS
- 5.1. Vehicles shall, depending on the vehicle designation, comply with the provisions below as assigned in the table overleaf ⁽²⁾.

For the purpose of this Regulation, MEMU vehicles shall comply with the requirements applicable to EX/III vehicles.

Vehicles approved as being in compliance with the requirements applicable to EX/III under this Regulation, as amended by the 04 series of amendments, shall be deemed to comply with the requirements applicable to MEMU vehicles.

5.1.1. ELECTRICAL EQUIPMENT

5.1.1.1. General provisions

The electrical installation as a whole shall meet the following provisions, in accordance with the table of paragraph 5.1.

⁽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, 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, 53 for Thailand, 54 and 55 (vacant), 56 for Montenegro, 57 (vacant) and 58 for Tunisia. 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.

⁽²⁾ In this Regulation, references to other ECE Regulations shall be deemed to refer also to any other international rules that apply the same technical requirements as the respective ECE Regulation. References to specific sections of the respective ECE Regulations shall be interpreted accordingly.

5.1.1.2. Wiring

5.1.1.2.1. The size of conductors shall be large enough to avoid overheating. Conductors shall be adequately insulated. All circuits shall be protected by fuses or automatic circuit breakers, except for the following:

- from the battery to the cold start and stopping systems of the engine
- from the battery to the alternator
- from the alternator to the fuse or circuit breaker box
- from the battery to the starter motor
- from the battery to the power control housing of the endurance braking system, if this system is electrical or electromagnetic
- from the battery to the electrical lifting mechanism for lifting the bogie axle.

The above unprotected circuits shall be as short as possible.

		VEHICLE DESIGNATION (according to paragraph 9.1 of the ADR)				
TECHNICAL PROVISIONS		EX/II	EX/III	AT	FL	OX
	Electrical equipment					
5.1.1.2.	Wiring		X	X	X	X
5.1.1.3.	Battery master switch		X		X	
5.1.1.3.1.			X		X	
5.1.1.3.2.			X		X	
5.1.1.3.3.					X	
5.1.1.3.4.			X		X	
5.1.1.4.	Batteries	X	X		X	
5.1.1.5.	Permanently energized circuits		X		X	
5.1.1.5.1.					X	
5.1.1.5.2.			X			
5.1.1.6.	Electrical installation behind cab		X		X	
5.1.2.	Prevention of fire risks					
5.1.2.2.	Vehicle cab					X
5.1.2.3.	Fuel tanks	X	X		X	X
5.1.2.4.	Engine	X	X		X	X
5.1.2.5.	Exhaust system	X	X		X	
5.1.2.6.	Endurance braking system		X	X	X	X
5.1.2.7.	Combustion heaters					

		VEHICLE DESIGNATION (according to paragraph 9.1 of the ADR)				
TECHNICAL PROVISIONS		EX/II	EX/III	AT	FL	OX
5.1.2.7.1.		X	X	X	X	X
5.1.3.	Braking equipment					
5.1.3.1.	Braking equipment		X	X	X	X
5.1.3.2.	Braking equipment	X				
5.1.4.	Speed limitation device	X	X	X	X	X
5.1.5.	Coupling devices for trailers	X	X			

5.1.1.2.2. Cables shall be securely fastened and positioned in such a way that the conductors are adequately protected against mechanical and thermal stresses.

5.1.1.3. Battery master switch

5.1.1.3.1. A switch for breaking the electrical circuits shall be placed as close to the battery as practicable. If a single pole switch is used it shall be placed in the supply lead and not in the earth lead.

5.1.1.3.2. A control device to facilitate the disconnecting and the reconnecting functions of the switch shall be installed in the driver's cab. It shall be readily accessible to the driver and distinctively marked. It shall be protected against inadvertent operation by either adding a protective cover, by using a dual movement control device, or by other suitable means. Additional control devices may be installed provided they are distinctively marked and protected against inadvertent operation. If the control device(s) are electrically operated, the circuits of the control device(s) are subject to the requirements of paragraph 5.1.1.5.

5.1.1.3.3. The switch shall have a casing with protection degree IP65 in accordance with IEC Standard 529.

5.1.1.3.4. The cable connections on the switch shall have protection degree IP54. However, this does not apply if these connections are contained in a housing which may be the battery box. In this case it is sufficient to insulate the connections against short circuits, for example with a rubber cap.

5.1.1.4. Batteries

The battery terminals shall be electrically insulated or covered by the insulating battery box cover. If the batteries are not located under the engine bonnet, they shall be fitted in a vented box.

5.1.1.5. Permanently energized circuits

5.1.1.5.1. Those parts of the electrical installation, including the leads which shall remain energized when the battery master-switch is open, shall be suitable for use in hazardous areas. Such equipment shall meet the appropriate requirements of IEC 60079 ⁽¹⁾, parts 0 and 14 and the additional requirements applicable of IEC parts 1, 2, 5, 6, 7, 11, 15 or 18 ⁽²⁾.

For the application of IEC 60079 part 14, the following classification shall be used:

Permanently energized electrical equipment including the leads that are not subject to paragraphs 5.1.1.3 and 5.1.1.4 shall meet the requirements for zone 1 for electrical equipment in general or meet the requirements for zone 2 for electrical equipment situated in the driver's cab. The requirements for explosion group IIC, temperature class T6, shall be met.

⁽¹⁾ The requirements of IEC 60079 part 14 do not take precedence over the requirements of this Regulation.

⁽²⁾ As an alternative, the general requirements of EN 50014 and the additional requirements of EN 50015, 50016, 50017, 50018, 50019, 50020, or 50028 may be used.

The supply leads for permanently energized equipment shall either comply with the provisions of IEC 60079, part 7 ('Increased safety') and be protected by a fuse or automatic circuit breaker placed as close to the source of power as practicable or, in the case of 'intrinsically safe equipment', they shall be protected by a safety barrier placed as close to the source of power as practicable.

However, for permanently energized electrical equipment installed in an environment where the temperature caused by non-electrical equipment situated in that environment exceeds the T6 temperature limit, the temperature classification of the permanently energized electrical equipment shall be at least that of the T4 temperature class.

5.1.1.5.2. Bypass connections to the battery master switch for electrical equipment which must remain energized when the battery master switch is open shall be protected against overheating by suitable means, such as a fuse, a circuit breaker or a safety barrier (current limiter).

5.1.1.6. Provisions concerning that part of the electrical installation situated to the rear of the driver's cab
The whole installation shall be so designed, constructed and protected such that it cannot provoke any ignition or short-circuit under normal conditions of vehicle use and that these risks can be minimized in the event of an impact or deformation. In particular:

5.1.1.6.1. Wiring

The wiring located to the rear of the driver's cab shall be protected against impact, abrasion and chafing during normal vehicle operation. Examples of appropriate protection are given in the figures 1, 2, 3 and 4 below. However, the sensor cables of antilock braking devices do not need additional protection.

Figure 1

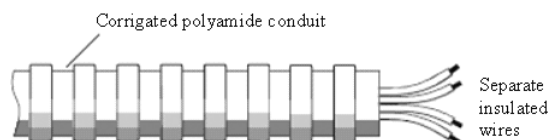


Figure 2

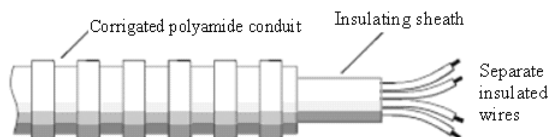


Figure 3

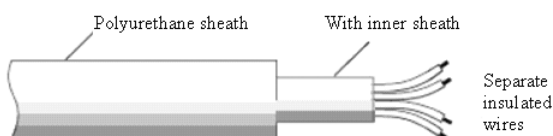
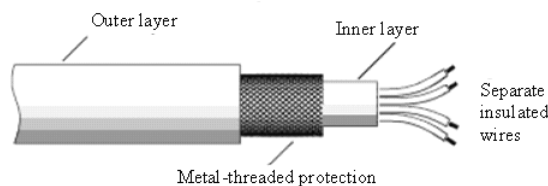


Figure 4



5.1.1.6.2. Lighting

Lamp bulbs with a screw cap shall not be used.

5.1.1.6.3. Electrical lifting mechanism

The electrical equipment of the mechanism for lifting a bogie axle shall be installed outside the chassis frame in a sealed housing.

5.1.2. Prevention of fire risks

5.1.2.1. General provisions

The following technical provisions shall apply in accordance with the table of paragraph 5.1.

5.1.2.2. Vehicle cab

Unless the driver's cab is made of materials which are not readily flammable, a shield made of metal or other suitable material of the same width as the tank shall be fitted at the rear of the cab. Any window in the rear of the cab or in the shield shall be hermetically closed and made of fire resistant safety glass with fire resistant frames. Furthermore, there shall be a clear space of not less than 15 cm between the tank and the cab or the shield.

5.1.2.3. Fuel tanks

The fuel tanks for supplying the engine of the vehicle shall meet the following requirements:

5.1.2.3.1. In the event of any leakage, the fuel shall drain to the ground without coming into contact with hot parts of the vehicle or the load;

5.1.2.3.2. Fuel tanks containing petrol shall be equipped with an effective flame trap at the filler opening or with a closure with which the opening can be kept hermetically sealed.

5.1.2.4. Engine

The engine propelling the vehicle shall be so equipped and situated to avoid any danger to the load through heating or ignition. In the case of EX/II, EX/III and MEMU vehicles the engine shall be of compression-ignition construction.

5.1.2.5. Exhaust system

The exhaust system as well as the exhaust pipes shall be so directed or protected to avoid any danger to the load through heating or ignition. Parts of the exhaust system situated directly below the fuel tank (diesel) shall have a clearance of at least 100 mm or be protected by a thermal shield.

The exhaust system of EX/II, EX/III and MEMU vehicles shall be so constructed and situated that any excess heat shall not constitute a hazard to the load by raising the temperature on the inner surface of the load compartment above 80 °C ⁽¹⁾.

⁽¹⁾ Compliance with these requirements shall be verified on the completed vehicle.

5.1.2.6. Vehicle endurance braking

Vehicles equipped with endurance braking systems emitting high temperatures placed behind the rear wall of the driver's cab shall be equipped with a thermal shield securely fixed and located between this system and the tank or load so as to avoid any heating, even local, of the tank shell or the load.

In addition, the thermal shield shall protect the braking system against any outflow or leakage, even accidental, of the load. For instance, a protection including a twin-shell shield shall be considered satisfactory.

5.1.2.7. Combustion heaters

5.1.2.7.1. Combustion heaters shall comply with the relevant technical requirements of ECE Regulation No 122 (including those of Annex 9) as amended, in accordance with the dates of application specified therein.

5.1.3. Braking equipment

Vehicles subject to the requirements of marginal 10 221 of ADR shall fulfil all the relevant requirements of Regulation No 13 (including those of annex 5) as amended in accordance with the dates of application specified therein.

5.1.3.1. EX/III, AT, FL, OX and MEMU vehicles shall fulfil all relevant requirements of Regulation No 13 including those of annex 5.

5.1.3.2. EX/II vehicles shall fulfil all relevant requirements of Regulation No 13. Nevertheless, the requirements of annex 5 are not applicable.

5.1.4. Speed limitation

Power driven vehicles of categories N2 and N3 shall be equipped with a speed limitation device according to the technical requirements of Regulation No 89, as amended. The device shall be set in such a way that the speed cannot exceed 90 km/h, bearing in mind the technological tolerance of the device.

5.1.5. Coupling devices for trailer

Coupling devices for trailers shall comply with the technical requirements of Regulation No 55 as amended in accordance with the dates of application specified therein.

6. MODIFICATION OF THE VEHICLE TYPE AND EXTENSION OF APPROVAL

6.1. Every modification of the vehicle type 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 alteration, shall be communicated by the procedure specified in paragraph 4.3 to the Contracting Parties.

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 Parties by means of a communication form conforming to the model in annex 1 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. Vehicles approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraph 5 above.
- 7.2. The competent authority which has granted type-approval may at any time verify the conformity control methods applicable to each production facility. The normal frequency of these verifications shall be once per 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 above is not complied with.
- 8.2. If a Contracting Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith 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 under 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. TRANSITIONAL PROVISIONS

- 10.1. As from the official date of entry into force of the 04 series of amendments, no Contracting Party applying this Regulation shall refuse to grant ECE approval under this Regulation as amended by the 04 series of amendments.
- 10.2. As from 1 January 2008 Contracting Parties applying this Regulation shall grant ECE approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 04 series of amendments.
- 10.3. Contracting Parties applying this Regulation shall continue to grant approvals and extensions of such approvals to those types of vehicle which comply with the requirements of this Regulation, as amended by the preceding series of amendments until 31 December 2007.
- 10.4. No Contracting Party applying this Regulation shall refuse national or regional type approval of a vehicle type approved to the 04 series of amendments to this Regulation.
- 10.5. As from 1 January 2008, no Contracting Party applying this Regulation shall grant national or regional type approval of a vehicle type approved to the preceding series of amendments to this Regulation.

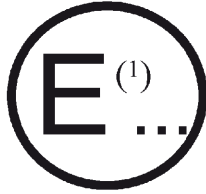
11. NAMES AND ADDRESSES OF TECHNICAL SERVICES CONDUCTING APPROVAL TESTS, AND ADMINISTRATIVE DEPARTMENTS

The Contracting Parties to the Agreement applying this Regulation shall communicate to the secretariat of the United Nations 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 I

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 specific constructional features for the transport of dangerous goods.

Approval No Extension No

1. Trade name or mark of the vehicle
2. Vehicle category: N1, N2, N3, O1, O2, O3, or O4: (chassis-cab, tractor for semi-trailer, trailer-chassis, trailer with a self-supporting body ⁽²⁾.
3. Vehicle type:
4. Vehicle designation (EX/II, EX/III, FL, OX, AT, MEMU):
5. Manufacturer's name and address:
6. If applicable, name and address of manufacturer's representative:
7. Mass of the vehicle:
- 7.1. Technical maximum mass of complete vehicle:
8. Specific equipment of the vehicle:
- 8.1. The vehicle is/is not ⁽²⁾ equipped with specific electrical devices.
 Summary description:

- 8.2. The vehicle is/is not ⁽²⁾ equipped with devices for the prevention of fire risks.
 Summary description

- 8.3. In the case of a motor vehicle:
 - 8.3.1. Type of engine: positive-ignition, compression-ignition ⁽²⁾
9. Vehicle submitted for approval on:
10. Technical service responsible for carrying out approval inspections:
11. Date of report issued by that service:
12. Number of report issued by that service:
13. Approval granted/refused/extended/withdrawn
14. Position of approval mark on the vehicle:
15. Place:
16. Date:
17. Signature:

⁽¹⁾ Distinguishing number of the country which has granted/extended/refused or withdrawn approval.

⁽²⁾ Strike out what does not apply.

ANNEX 2

ARRANGEMENT OF APPROVAL MARKS

MODEL A

(see paragraph 4.4 of this Regulation)

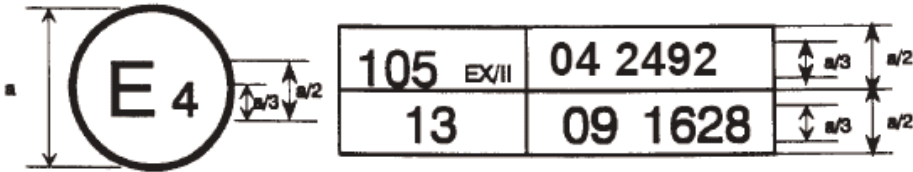


a = 8 mm min.

The above approval mark affixed to a vehicle shows that the vehicle type concerned, intended for the transport of dangerous goods, has been approved in the Netherlands (E4), pursuant to Regulation No 105, under the approval number 0424 92 and designated EX/II (according to paragraph 9.1.1.2 of Annex B to ADR). The first two digits of the approval number indicate that the approval was granted in accordance with the requirements of Regulation No 105, as amended by the 04 series of amendments.

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 105 and 13 ⁽¹⁾. The first two digits of the approval numbers indicate that, at the dates when respective approvals were granted, Regulation No 105 included the 04 series of amendments, while Regulation No 13 already included the 09 series of amendments.

⁽¹⁾ The second Regulation number is given merely as an example.

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/wp29docstts.html>

Regulation No 112 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam or a driving beam or both and equipped with filament lamps and/or LED modules

Incorporating all valid text up to:

Supplement 12 to the original version of the Regulation — Date of entry into force: 19 August 2010

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A. ADMINISTRATIVE PROVISIONS

0. SCOPE ⁽¹⁾

This Regulation applies to headlamps for vehicles of categories L, M, N and T ⁽²⁾.

1. DEFINITIONS

For the purpose of this Regulation,

- 1.1. ‘Lens’ means the outermost component of the headlamp (unit) which transmits light through the illuminating surface;
- 1.2. ‘Coating’ means any product or products applied in one or more layers to the outer face of a lens;
- 1.3. Headlamps of different ‘types’ mean headlamps which differ in such essential respects as:
- 1.3.1. the trade name or mark;
- 1.3.2. the characteristics of the optical system;
- 1.3.3. the inclusion or elimination of components capable of altering the optical effects by reflection, refraction, absorption and/or deformation during operation;
- 1.3.4. suitability for right-hand or left-hand traffic or for both traffic systems;
- 1.3.5. the kind of beam produced (passing beam, driving beam or both);
- 1.3.6. the materials constituting the lenses and coating, if any;
- 1.3.7. the category of filament lamp used and/or the LED module specific identification code(s).
- 1.3.8. However, a device intended for the installation on the left side of the vehicle and the corresponding device intended for the installation on the right side of the vehicle shall be considered to be of the same type.
- 1.4. Headlamps of different ‘Classes’ (A or B) mean headlamps identified by particular photometric provisions.
- 1.5. The definitions given in Regulation No 48 and its series of amendments in force at the time of application for type approval shall apply to this Regulation.

⁽¹⁾ Nothing in this Regulation shall prevent a Party to the Agreement applying this Regulation from prohibiting the combination of a headlamp incorporating a lens of plastic material approved under this Regulation with a mechanical headlamp-cleaning device (with wipers).

⁽²⁾ As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (document TRANS/WP.29/78/Rev.1/Amend.2 as last amended by Amend.4).

- 1.6. References made in this Regulation to standard (étalon) filament lamp(s) and to Regulation No 37 shall refer to Regulation No 37 and its series of amendments in force at the time of application for type approval.
2. APPLICATION FOR APPROVAL OF A HEADLAMP
 - 2.1. The application for approval shall be submitted by the owner of the trade name or mark or by his duly accredited representative. It shall specify:
 - 2.1.1. whether the headlamp is intended to provide both a passing beam and a driving beam or only one of these beams;
 - 2.1.2. whether, if the headlamp is intended to provide a passing beam, it is designed for both left-hand and right-hand traffic or for either left-hand or right-hand traffic only;
 - 2.1.3. if the headlamp is equipped with an adjustable reflector, the mounting position(s) of the headlamp in relation to the ground and the longitudinal median plane of the vehicle;
 - 2.1.4. whether it concerns a Class A or B headlamp;
 - 2.1.5. the category of the filament lamp(s) used, as listed in Regulation No 37 and its series of amendments in force at the time of application for type approval, and/or the light source module specific identification code(s) for LED modules, if available.
 - 2.2. Every application for approval shall be accompanied by:
 - 2.2.1. drawings in triplicate in sufficient detail to permit identification of the type and representing a frontal view of the headlamp, with details of lens ribbing if any, and the cross-section. The drawings shall indicate the space(s) reserved for the approval mark and in case of LED module(s) also the space reserved for the specific identification code(s) of the module(s);
 - 2.2.1.1. if the headlamp is equipped with an adjustable reflector, an indication of the mounting position(s) of the headlamp in relation to the ground and the longitudinal median plane of the vehicle, if the headlamp is for use in that (those) position(s) only;
 - 2.2.2. a brief technical description including, in the case where headlamps are used to produce bend lighting, the extreme positions according to paragraph 6.2.9 below. In the case of LED module(s) this shall include:
 - (a) a brief technical specification of the LED module(s);
 - (b) a drawing with dimensions and the basic electrical and photometric values and the objective luminous flux;
 - (c) in case of electronic light source control gear, information on the electrical interface necessary for approval testing;
 - 2.2.3. two samples of each type of headlamp, one sample intended for the installation on the left side of the vehicle and one sample intended for the installation of the right side of the vehicle.
 - 2.2.4. For the test of plastic material of which the lenses are made:
 - 2.2.4.1. fourteen lenses;

- 2.2.4.1.1. ten of these lenses may be replaced by ten samples of material at least 60 × 80 mm in size, having a flat or convex outer surface and a substantially flat area (radius of curvature not less than 300 mm) in the middle measuring at least 15 × 15 mm;
- 2.2.4.1.2. every such lens or sample of material shall be produced by the method to be used in mass production;
- 2.2.4.2. a reflector to which the lenses can be fitted in accordance with the manufacturer's instructions.
- 2.2.5. For testing the ultraviolet (UV)-resistance of light transmitting components made of plastic material against UV radiation of LED modules inside the headlamp:
 - 2.2.5.1. one sample of each of the relevant material as being used in the headlamp or one headlamp sample containing these. Each material sample shall have the same appearance and surface treatment, if any, as intended for use in the headlamp to be approved;
 - 2.2.5.2. the UV-resistance testing of internal materials to light source radiation is not necessary if no LED modules other than low-UV-types as specified in Annex 10 of this Regulation are being applied or if provisions are taken, to shield the relevant headlamp components from UV radiation, e.g. by glass filters.
- 2.2.6. One electronic light source control gear, if applicable.
- 2.3. The materials making up the lenses and coatings, if any, shall be accompanied by the test report of the characteristics of these materials and coatings if they have already been tested.
- 3. MARKINGS
 - 3.1. Headlamps submitted for approval shall bear the trade name or mark of the applicant.
 - 3.2. They shall comprise, on the lens and on the main body ⁽¹⁾, spaces of sufficient size for the approval mark and the additional symbols referred to in paragraph 4; these spaces shall be indicated on the drawings referred to in paragraph 2.2.1 above.
 - 3.3. Headlamps designed to satisfy the requirements both of right-hand and of left-hand traffic shall bear markings indicating the two settings of the optical unit or LED module on the vehicle or of the filament lamp on the reflector; these markings shall consist of the letters 'R/D' for the position for right-hand traffic and the letters 'L/G' for the position for left-hand traffic.
 - 3.4. In the case of lamps with LED module(s), the lamp shall bear the marking of the rated voltage and rated wattage and the light source module specific identification code.
 - 3.5. LED module(s) submitted along with the approval of the lamp:
 - 3.5.1. shall bear the trade name or mark of the applicant. This marking shall be clearly legible and indelible;
 - 3.5.2. shall bear the specific identification code of the module. This marking shall be clearly legible and indelible.

This specific identification code shall comprise the starting letters 'MD' for 'MODULE' followed by the approval marking without the circle as prescribed in paragraph 4.2.1 below and in the case several non identical light source modules are used, followed by additional symbols or characters. This specific identification code shall be shown in the drawings mentioned in paragraph 2.2.1 above. The approval marking does not have to be the same as the one on the lamp in which the module is used, but both markings shall be from the same applicant.

⁽¹⁾ If the lens cannot be detached from the main body of the headlamp, a unique marking as per paragraph 4.2.5 shall be sufficient.

- 3.6. If an electronic light source control gear which is not part of a LED module is used to operate a LED module(s), it shall be marked with its specific identification code(s), the rated input voltage and wattage.
4. APPROVAL
- 4.1. General
- 4.1.1. If all the samples of a type of headlamp submitted pursuant to paragraph 2 above satisfy the provisions of this Regulation, approval shall be granted.
- 4.1.2. Where grouped, combined or reciprocally incorporated lamps satisfy the requirements of more than one Regulation, a single international approval mark may be affixed provided that each of the grouped, combined or reciprocally incorporated lamps satisfies the provisions applicable to it.
- 4.1.3. 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 may not assign the same number to another type of headlamp covered by this Regulation.
- 4.1.4. Notice of approval or of extension or refusal or withdrawal of approval or production definitely discontinued of a type of headlamp pursuant to this Regulation shall be communicated to the Parties to the 1958 Agreement applying this Regulation, by means of a form conforming to the model in Annex 1 to this Regulation, with the indications according to paragraph 2.2.1.1.
- 4.1.4.1. if the headlamp is equipped with an adjustable reflector and if this headlamp is to be used only in mounting positions according to the indications in paragraph 2.2.1.1 the applicant shall be obliged by the Approval Authority to inform the user in a proper way about the correct mounting position(s).
- 4.1.5. In addition to the mark prescribed in paragraph 3.1, an approval mark as described in paragraphs 4.2 and 4.3 below shall be affixed in the spaces referred to in paragraph 3.2 above to every headlamp conforming to a type approved under this Regulation.
- 4.2. Composition of the approval mark
- The approval mark shall consist of:
- 4.2.1. An international approval mark, comprising:
- 4.2.1.1. a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted approval ⁽¹⁾;
- 4.2.1.2. the approval number prescribed in paragraph 4.1.3 above;
- 4.2.2. the following additional symbol (or symbols):

⁽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, 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, 53 for Thailand, 54 and 55 (vacant) and 56 for Montenegro. 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.

- 4.2.2.1. on headlamps meeting left-hand traffic requirements only, a horizontal arrow pointing to the right of an observer facing the headlamp, i.e. to the side of the road on which the traffic moves;
- 4.2.2.2. on headlamps designed to meet the requirements of both traffic systems by means of an appropriate adjustment of the setting of the optical unit or the filament lamp or LED module(s), a horizontal arrow with a head on each end, the heads pointing respectively to the left and to the right;
- 4.2.2.3. on headlamps meeting the requirements of this Regulation in respect of the passing beam only, the letters 'C' for Class A headlamp or 'HC' for Class B headlamp;
- 4.2.2.4. on headlamps meeting the requirements of this Regulation in respect of the driving beam only, the letters 'R' for Class A headlamp or 'HR' for Class B headlamp;
- 4.2.2.5. on headlamps meeting the requirements of this Regulation in respect of both the passing beam and the driving beam, the letters 'CR' for Class A headlamp or 'HCR' for Class B headlamp;
- 4.2.2.6. on headlamps incorporating a lens of plastic material, the group of letters 'PL' to be affixed near the symbols prescribed in paragraphs 4.2.2.3 to 4.2.2.5 above;
- 4.2.2.7. on headlamps meeting the requirements of this Regulation in respect of the driving beam, an indication of the maximum luminous intensity expressed by a reference mark, as defined in paragraph 6.3.2.1.2 below, placed near the circle surrounding the letter 'E';

In the case of grouped or reciprocally incorporated driving beam headlamps, indication of the maximum luminous intensity of the driving beams as a whole shall be expressed as above.

- 4.2.3. In every case the relevant operating mode used during the test procedure according to paragraph 1.1.1.1 of Annex 4 and the permitted voltage(s) according to paragraph 1.1.1.2 of Annex 4 shall be stipulated on the approval forms and on the communication forms transmitted to the countries which are Contracting Parties to the Agreement and which apply this Regulation.

In the corresponding cases the device shall be marked as follows:

- 4.2.3.1. on headlamps meeting the requirements of this Regulation which are so designed that the filament or LED module(s) producing the principal passing beam shall not be lit simultaneously with that of any other lighting function with which it may be reciprocally incorporated: an oblique stroke (/) shall be placed behind the passing lamp symbol in the approval mark.
- 4.2.3.2. on headlamps equipped with filament lamps and meeting the requirements of Annex 4 to this Regulation only when supplied with a voltage of 6 V or 12 V, a symbol consisting of the number 24 crossed out by an oblique cross (x), shall be placed near the filament lamp holder.
- 4.2.4. The two digits of the approval number (at present 00) which indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval and, if necessary, the required arrow may be marked close to the above additional symbols.
- 4.2.5. The marks and symbols referred to in paragraphs 4.2.1 to 4.2.3 above shall be clearly legible and be indelible. They may be placed on an inner or outer part (transparent or not) of the headlamp, which cannot be separated from the transparent part of the headlamp emitting the light. In any case they shall be visible when the headlamp is fitted on the vehicle or when a movable part such as the hood is opened.

- 4.3. Arrangement of the approval mark

- 4.3.1. Independent lamps

Annex 2, figures 1 to 10, to this Regulation gives examples of arrangements of the approval mark with the abovementioned additional symbols.

- 4.3.2. Grouped, combined or reciprocally incorporated lamps
- 4.3.2.1. Where grouped, combined or reciprocally incorporated lamps have been found to comply with the requirements of several Regulations, a single international approval mark may be affixed, consisting of a circle surrounding the letter 'E' followed by the distinguishing number of the country which has granted the approval, and an approval number. This approval mark may be located anywhere on the grouped, combined or reciprocally incorporated lamps, provided that:
- 4.3.2.1.1. it is visible as per paragraph 4.2.5;
- 4.3.2.1.2. no part of the grouped, combined or reciprocally incorporated lamps that transmits light can be removed without at the same time removing the approval mark.
- 4.3.2.2. The identification symbol for each lamp appropriate to each Regulation under which approval has been granted, together with the corresponding series of amendments incorporating the most recent major technical amendments to the Regulation at the time of issue of the approval, and if necessary, the required arrow shall be marked:
- 4.3.2.2.1. either on the appropriate light-emitting surface,
- 4.3.2.2.2. or in a group, in such a way that each of the grouped, combined or reciprocally incorporated lamps may be clearly identified (see four possible examples in Annex 2).
- 4.3.2.3. The size of the components of a single approval mark shall not be less than the minimum size required for the smallest of the individual marks by the Regulation under which approval has been granted.
- 4.3.2.4. An approval number shall be assigned to each type approved. The same Contracting Party may not assign the same number to another type of grouped, combined or reciprocally incorporated lamps covered by this Regulation.
- 4.3.2.5. Annex 2, figure 11, to this Regulation gives examples of arrangements of approval marks for grouped, combined or reciprocally incorporated lamps with all the abovementioned additional symbols.
- 4.3.3. Lamps, the lens of which are used for different types of headlamps and which may be reciprocally incorporated or grouped with other lamps
- The provisions laid down in paragraph 4.3.2 above are applicable.
- 4.3.3.1. In addition, where the same lens is used, the latter may bear the different approval marks relating to the different types of headlamps or units of lamps, provided that the main body of the headlamp, even if it cannot be separated from the lens, also comprises the space described in paragraph 3.2 above and bears the approval marks of the actual functions.
- If different types of headlamps comprise the same main body, the latter may bear the different approval marks.
- 4.3.3.2. Annex 2, figure 12, to this Regulation gives examples of arrangements of approval marks relating to the above case.
- B. TECHNICAL REQUIREMENTS FOR HEADLAMPS ⁽¹⁾
5. GENERAL SPECIFICATIONS
- 5.1. Each sample shall conform to the specifications set forth in paragraphs 6 to 8 below.
- 5.2. Headlamps shall be so made as to retain their prescribed photometric characteristics and to remain in good working order when in normal use, in spite of the vibrations to which they may be subjected.

⁽¹⁾ Technical requirements for filament lamps: see Regulation No 37.

- 5.2.1. Headlamps shall be fitted with a device enabling them to be so adjusted on the vehicles as to comply with the rules applicable to them. Such a device need not be fitted on units in which the reflector and the diffusing lens cannot be separated, provided the use of such units is confined to vehicles on which the headlamp setting can be adjusted by other means.

Where a headlamp providing a principal passing beam and a headlamp providing a driving beam, each equipped with its own filament lamp or LED module(s), are assembled to form a composite unit the adjusting device shall enable each optical system individually to be duly adjusted.

- 5.2.2. However, these provisions shall not apply to headlamp assemblies whose reflectors are indivisible. For this type of assembly the requirements of paragraph 6.3 of this Regulation apply.

- 5.3. The headlamp shall be equipped with:

- 5.3.1. filament lamp(s) approved according to Regulation No 37. Any filament lamp covered by Regulation No 37 may be used, provided that no restriction on the use is made in Regulation No 37 and its series of amendments in force at the time of application for type approval.

- 5.3.1.1. The design of the device shall be such that the filament lamp can be fixed in no other position but the correct one ⁽¹⁾.

- 5.3.1.2. The filament lamp holder shall conform to the characteristics given in IEC Publication 60061. The holder data sheet relevant to the category of filament lamp used, applies.

- 5.3.2. and/or LED module(s):

- 5.3.2.1. electronic light source control gear(s), if applicable, shall be considered to be part of the headlamp; they may be part of the LED module(s);

- 5.3.2.2. the headlamp, if equipped with LED modules, and the LED module(s) themselves shall comply with the relevant requirements specified in Annex 10 of this Regulation. The compliance with the requirements shall be tested.

- 5.3.2.3. The total objective luminous flux of all LED modules producing the principal passing beam and measured as described in paragraph 5 of Annex 10 shall be equal or greater than 1 000 lumens.

- 5.4. Headlamps designed to satisfy the requirements both of right hand and of left hand traffic may be adapted for traffic on a given side of the road either by an appropriate initial setting when fitted on the vehicle or by selective setting by the user. Such initial or selective setting may consist, for example, of fixing either the optical unit at a given angle on the vehicle or the filament lamp or LED module(s) producing the principal passing beam at a given angle/position in relation to the optical unit. In all cases, only two different and clearly distinct settings, one for right hand and one for left-hand traffic, shall be possible, and the design shall preclude inadvertent shifting from one setting to the other or setting in an intermediate position. Where two different setting positions are provided for the filament lamp or LED module(s) producing the principal passing beam, the components for attaching the filament lamp or LED module(s) producing the principal passing beam to the reflector must be so designed and made that, in each of its two settings, this filament lamp or LED module(s) will be held in position with the precision required for headlamps designed for traffic on only one side of the road. Conformity with the requirements of this paragraph shall be verified by visual inspection and, where necessary, by a test fitting.

- 5.5. Complementary tests shall be done according to the requirements of Annex 4 to ensure that in use there is no excessive change in photometric performance.

- 5.6. Light transmitting components made of plastic material shall be tested according to the requirements of Annex 6.

⁽¹⁾ A headlamp is regarded as satisfying the requirements of this paragraph if the filament lamp can be easily fitted into the headlamp and the positioning lugs can be correctly fitted into their slots even in darkness.

- 5.7. On headlamps designed to provide alternately a driving beam and a passing beam, or a passing beam and/or a driving beam designed to become bend lighting, any mechanical, electromechanical or other device incorporated in the headlamp for these purposes shall be so constructed that:
- 5.7.1. the device is robust enough to withstand 50 000 operations under normal conditions of use. In order to verify compliance with this requirement, the technical service responsible for approval tests may:
- (a) require the applicant to supply the equipment necessary to perform the test;
 - (b) forego the test if the headlamp presented by the applicant is accompanied by a test report, issued by a technical service responsible for approval tests for headlamps of the same construction (assembly), confirming compliance with this requirement.
- 5.7.2. in the case of failure, the illumination above the line H-H shall not exceed the values of a passing beam according to paragraph 6.2.5; in addition, on headlamps designed to provide a passing and/or a driving beam to become a bend lighting, a minimum illumination of at least 3 lux shall be fulfilled in test point 25 V (VV line, D 75 cm).
- When performing the tests to verify compliance with these requirements, the technical service responsible for approval tests shall refer to the instructions supplied by the applicant.
- 5.7.3. either the principal passing beam or the driving beam shall always be obtained without any possibility of the mechanism stopping in between two positions;
- 5.7.4. the user cannot, with ordinary tools, change the shape or position of the moving parts.
- 5.8. Illumination configuration for different traffic conditions
- 5.8.1. In the case of headlamps designed to meet the requirements of traffic moving on one side of the road (either right or left) only, appropriate measures shall be taken to prevent discomfort to road-users in a country where traffic moves on the side of the road opposite to that of the country for which the headlamp was designed ⁽¹⁾. Such measures may be:
- (a) occulting a part of the outer headlamp lens area;
 - (b) downward movement of the beam. Horizontal movement is allowed;
 - (c) any other measure to remove or reduce the asymmetrical part of the beam.
- 5.8.2. Following the application of this (these) measure(s) the following requirements regarding illumination shall be met with the adjustment left unchanged compared to that for the original traffic direction:
- 5.8.2.1. Passing beam designed for right-hand traffic and adapted to left-hand traffic:
- | | |
|----------------|-----------------------|
| at 0,86D-1,72L | at least 3 lux |
| at 0,57U-3,43R | not more than 1,0 lux |
- 5.8.2.2. Passing beam designed for left-hand traffic and adapted to right-hand traffic:
- | | |
|----------------|-----------------------|
| at 0,86D-1,72R | at least 3 lux |
| at 0,57U-3,43L | not more than 1,0 lux |

⁽¹⁾ Instructions on the installation of lamps fitted with these measures are given in Regulation No 48.

- 5.9. In case of a passing beam headlamp incorporating a light source or LED module(s) producing the principal passing beam and having a total objective luminous flux which exceeds 2 000 lumen a reference shall be made in item 9 of the communication form in Annex 1. The objective luminous flux of LED modules shall be measured as described in paragraph 5 of Annex 10.

6. ILLUMINATION

6.1. General provisions

- 6.1.1. Headlamps shall be so made that they give adequate illumination without dazzle when emitting the passing beam, and good illumination when emitting the driving beam. Bend lighting may be produced by activating one additional filament light source or one or more LED module(s) being part of the passing beam headlamp.

- 6.1.2. The illumination produced by the headlamp shall be determined by means of a flat vertical screen set up 25 m forward of the headlamp, at right angles to its axes as shown in Annex 3 to this Regulation; the test screen shall be sufficiently wide to allow examination and adjustment of the 'cut-off' of the passing beam over at least 5° on either side of the V-V line.

- 6.1.3. Apart from LED module(s), the headlamps shall be checked by means of an uncoloured standard (étalon) filament lamp designed for a rated voltage of 12 V. During the checking of the headlamp, the voltage at the terminals of the filament lamp shall be regulated so as to obtain the reference luminous flux as indicated for each filament lamp at the relevant data sheet of Regulation No 37. The headlamp shall be considered acceptable if it meets the requirements of paragraph 6 with at least one standard (étalon) filament lamp, which may be submitted with the headlamp.

- 6.1.4. LED module(s) shall be measured at 6,3 V, 13,2 V or 28,0 V respectively, if not otherwise specified within this Regulation. LED module(s) operated by an electronic light source control gear, shall be measured as specified by the applicant.

The values obtained by the LED module(s) shall be multiplied by a factor of 0,7 prior to check for compliance.

- 6.1.5. In the case of headlamps equipped with LED module(s) and filament lamps, the part of the headlamp with filament lamp(s) shall be tested according to paragraph 6.1.3 and the part of the headlamp with LED module(s) shall be evaluated according to the provisions of paragraph 6.1.4 and then added to the previous result obtained from the filament lamp(s) tested.

6.2. Provisions concerning passing beams

- 6.2.1. The luminous intensity distribution of the principal passing beam headlamp shall incorporate a 'cut-off' (see figure 1), which enables the headlamp to be adjusted correctly for the photometric measurements and for the aiming on the vehicle.

The 'cut-off' shall provide:

(a) For right hand traffic beams:

- (i) a straight 'horizontal part' towards the left;
- (ii) a raised 'elbow-shoulder' part towards the right.

(b) For left hand traffic beams:

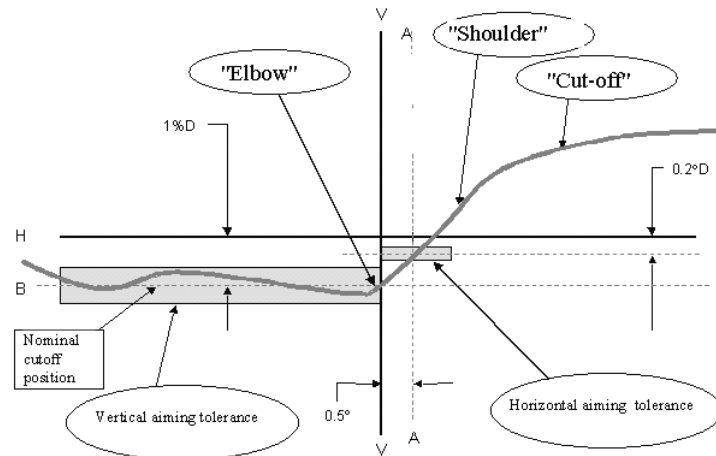
- (i) a straight 'horizontal part' towards the right;
- (ii) a raised 'elbow-shoulder' part towards the left.

In each case the 'elbow-shoulder' part shall have a sharp edge.

6.2.2. The headlamp shall be visually aimed by means of the 'cut-off' (see figure 1) as follows:

6.2.2.1. for vertical adjustment: the horizontal part of the 'cut-off' is moved upward from below line B and adjusted to its nominal position one per cent (25 cm) below the H-H line;

Figure 1



Note: The scales are different for vertical and horizontal lines.

6.2.2.2. for horizontal adjustment: the 'elbow-shoulder' part of the 'cut-off' shall be moved:

for right hand traffic from right to left and shall be horizontally positioned after its movement so that:

- (a) above the line $0,2^\circ D$ its 'shoulder' shall not exceed the line A to the left;
- (b) the the line $0,2^\circ D$ or below its 'shoulder' should cross the line A; and
- (c) the kink of the 'elbow' should be primarily on the V-V line;

or

for left hand traffic from left to right and shall be horizontally positioned after its movement so that:

- (a) above the line $0,2^\circ D$ its 'shoulder' shall not exceed the line A to the right;
- (b) on the line $0,2^\circ$ or below its 'shoulder' cross the line A; and
- (c) the kink of the 'elbow' should be primarily on the V-V line;

6.2.2.3. Where a headlamp so aimed does not meet the requirements set out in paragraphs 6.2.5 to 6.2.7 and 6.3, its alignment may be changed, provided that the axis of the beam is not displaced:

Horizontally from line A by more than:

- (a) $0,5^\circ$ to the left or $0,75^\circ$ to the right, for right hand traffic; or
- (b) $0,5^\circ$ to the right or $0,75^\circ$ to the left, for left hand traffic; and

vertically not more than $0,25^\circ$ up or down from line B.

- 6.2.2.4. If, however, vertical adjustment cannot be performed repeatedly to the required position within the tolerances described in paragraph 6.2.2.3 above, the instrumental method of Annex 9, paragraphs 2 and 3 shall be applied to test compliance with the required minimum quality of the 'cut-off' and to perform the vertical and horizontal adjustment of the beam.
- 6.2.3. When so aimed, the headlamp, if its approval is sought solely for provision of a passing beam ⁽¹⁾, need comply only with the requirements set out in paragraphs 6.2.4 to 6.2.6 below; if it is intended to provide both a passing beam and a driving beam, it shall comply with the requirements set out in paragraphs 6.2.4 to 6.2.6 and 6.3.
- 6.2.4. The illumination produced on the screen by the passing beam shall meet the following requirements:

Point on measuring screen		Required illumination in lux	
Headlamps for right-hand traffic	Headlamps for left-hand traffic	Class A headlamp	Class B headlamp
Point B 50 L	Point B 50 R	$\leq 0,4$	$\leq 0,4$
Point 75 R	Point 75 L	≥ 6	≥ 12
Point 75 L	Point 75 R	< 12	≤ 12
Point 50 L	Point 50 R	< 15	≤ 15
Point 50 R	Point 50 L	≥ 6	≥ 12
Point 50 V	Point 50 V	—	≥ 6
Point 25 L	Point 25 R	$\geq 1,5$	≥ 2
Point 25 R	Point 25 L	$\geq 1,5$	≥ 2
Any point in zone III		$\leq 0,7$	$\leq 0,7$
Any point in zone IV		≥ 2	≥ 3
Any point in zone I		≤ 20	$\leq 2E^{(*)}$

(*) E is the actually measured value in points 50R respectively 50L.

- 6.2.5. There shall be no lateral variations detrimental to good visibility in any of the zones I, II, III and IV.
- 6.2.6. The illumination values in zones 'A' and 'B' as shown in figure C in Annex 3 shall be checked by the measurement of the photometric values of points 1 to 8 on this figure; these values shall lie within the following limits ⁽²⁾:

$$1 + 2 + 3 \geq 0,3 \text{ lux, and}$$

$$4 + 5 + 6 \geq 0,6 \text{ lux, and}$$

$$0,7 \text{ lux} \geq 7 \geq 0,1 \text{ lux and}$$

$$0,7 \text{ lux} \geq 8 \geq 0,2 \text{ lux}$$

⁽¹⁾ Such a special 'passing beam' headlamp may incorporate a driving beam not subject to requirements.

⁽²⁾ Illumination values in any point of zones A and B, which also lies within zone III, shall not exceed 0,7 lux.

- 6.2.7. Headlamps designed to meet the requirements of both right-hand and left-hand traffic must, in each of the two setting positions of the optical unit or LED module(s) producing the principal passing beam or of the filament lamp, meet the requirements set forth above for the corresponding direction of traffic.
- 6.2.8. The requirements in paragraph 6.2.4 above shall also apply to headlamps designed to provide bend lighting and/or that include the additional light source or LED module(s) referred to in paragraph 6.2.9.2. In the case of a headlamp designed to provide bend lighting its alignment may be changed, provided that the axis of the beam is not displaced vertically by more than 0,2°.
- 6.2.8.1. If bend lighting is obtained by:
- 6.2.8.1.1. swivelling the passing beam or moving horizontally the kink of the elbow of the cut-off, the measurements shall be carried out after the complete headlamp assembly has been re-aimed horizontally, e.g. by means of a goniometer;
- 6.2.8.1.2. moving one or more optical parts of the headlamp without moving horizontally the kink of the elbow of the cut-off, measurements shall be carried out with these parts being in their extreme operating position;
- 6.2.8.1.3. means of one additional filament light source or one or more LED module(s) without moving horizontally the kink of the elbow of the cut-off, measurements shall be carried out with this light source or LED module(s) activated.
- 6.2.9. Only one filament light source or one or more LED module(s) are permitted for the principal passing beam. Additional light sources or LED modules are permitted only as follows (see Annex 10):
- 6.2.9.1. one additional light source according to Regulation No 37 or one or more additional LED module(s) may be used inside the passing beam headlamp to contribute to bend lighting;
- 6.2.9.2. one additional light source according to Regulation No 37 and/or one or more LED module(s), inside the passing beam headlamp, may be used for the purposes of generating infrared radiation. It/they shall only be activated at the same time as the principal light source or LED module(s). In the event that the principal light source or (one of) the principal LED module(s) fails, this additional light source and/or LED module(s) shall be automatically switched off;
- 6.2.9.3. in the event of failure of an additional filament light source or one or more additional LED module(s), the headlamp shall continue to fulfil the requirements of the passing beam.
- 6.3. Provisions concerning driving beams
- 6.3.1. In the case of a headlamp designed to provide a driving beam and a passing beam, measurements of the illumination produced on the screen by the driving beam shall be taken with the same headlamp alignment as for measurements under paragraphs 6.2.4 to 6.2.6 above; in the case of a headlamp providing a driving beam only, it shall be so adjusted that the area of maximum illumination is centred on the point of intersection of lines H-H and V-V; such a headlamp need meet only the requirements referred to in paragraph 6.3. Where more than one light source is used to provide the driving beam, the combined functions shall be used to determine the maximum value of the illumination (EM).
- 6.3.2. Irrespective of the type of light source (LED module(s) or filament light source(s)) used to produce the principal passing beam, several light sources:
- (a) either filament light sources listed in Regulation No 37; or
- (b) LED module(s) may be used for each individual driving beam.

6.3.3. The illumination produced on the screen by the driving beam shall meet the following requirements.

6.3.3.1. The point of intersection (HV) of lines hh and vv shall be situated within the isolux 80 per cent of maximum illumination. This maximum value (E_M) shall not be less than 32 lux for Class A headlamps and 48 lux for Class B headlamps. The maximum value shall in no circumstances exceed 240 lux; in addition, in the case of a combined passing and driving headlamp, this maximum value shall not be more than 16 times the illumination measured for the passing beam at point 75 R (or 75 L).

6.3.3.1.1. The maximum intensity (I_M) of the driving beam expressed in thousands of candelas shall be calculated by the formula:

$$I_M = 0,625 E_M$$

6.3.3.1.2. The reference mark (I'_M) of this maximum intensity, referred to in paragraph 4.2.2.7 above, shall be obtained by the ratio:

$$I'_M = \frac{I_M}{3} = 0,208 E_M$$

This value shall be rounded off to the value 7,5 – 10 – 12,5 – 17,5 – 20 – 25 – 27,5 – 30 – 37,5 – 40 – 45 – 50.

6.3.3.2. Starting from point HV, horizontally to the right and left, the illumination shall be not less than 16 lux for Class A headlamp and 24 lux for Class B headlamp up to a distance of 1,125 m and not less than 4 lux for Class A headlamp and 6 lux for Class B headlamp up to a distance of 2,25 m.

6.4. In the case of headlamps with adjustable reflector the requirements of paragraphs 6.2 and 6.3 are applicable for each mounting position indicated according to paragraph 2.1.3. For verification the following procedure shall be used:

6.4.1. Each applied position is realised on the test goniometer with respect to a line joining the centre of the light source and point HV on a aiming screen. The adjustable reflector is then moved into such a position that the light pattern on the screen corresponds to the aiming prescriptions of paragraphs 6.2.1 to 6.2.2.3 and/or 6.3.1;

6.4.2. with the reflector initially fixed according to paragraph 6.4.1, the headlamp must meet the relevant photometric requirements of paragraphs 6.2 and 6.3;

6.4.3. additional tests are made after the reflector has been moved vertically $\pm 2^\circ$ or at least into the maximum position, if less than 2° , from its initial position by means of the headlamps adjusting device. Having re-aimed the headlamp as a whole (by means of the goniometer for example) in the corresponding opposite direction the light output in the following directions shall be controlled and lie within the required limits:

principal passing beam: points HV and 75 R (75 L respectively);

driving beam: E_M and point HV (percentage of E_M).

6.4.4. if the applicant has indicated more than one mounting position, the procedure of paragraphs 6.4.1 to 6.4.3 shall be repeated for all other positions;

6.4.5. if the applicant has not asked for special mounting positions, the headlamp shall be aimed for measurements of paragraphs 6.2 and 6.3 with the headlamps adjusting device in its mean position. The additional test of paragraph 6.4.3 shall be made with the reflector moved into its extreme positions (instead of $\pm 2^\circ$) by means of the headlamps adjusting device.

- 6.5. The screen illumination values mentioned in paragraphs 6.2.4 to 6.2.7 and 6.3 above shall be measured by means of a photo receptor, the effective area of which shall be contained within a square of 65 mm side.
7. COLOUR
- 7.1. The colour of the light emitted shall be white.
8. GAUGING OF DISCOMFORT
- The discomfort caused by the passing beam of headlamps shall be gauged ⁽¹⁾.
- C. FURTHER ADMINISTRATIVE PROVISIONS
9. MODIFICATION OF THE HEADLAMP TYPE AND EXTENSION OF APPROVAL
- 9.1. Every modification of the headlamp type shall be notified to the administrative department which approved the headlamp type. The said department may then either:
- 9.1.1. Consider that the modifications made are unlikely to have appreciable adverse effects and that in any event the headlamp still complies with the requirements; or
- 9.1.2. Require a further test report from the technical service responsible for conducting the tests.
- 9.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 4.1.4 above to the Parties to the Agreement which apply this Regulation.
- 9.3. The competent authority issuing the extension of approval shall assign a series number to each communication form drawn up 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.
10. 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:
- 10.1. Headlamps approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraphs 6 and 7.
- 10.2. the minimum requirements for conformity of production control procedures set forth in Annex 5 to this Regulation shall be complied with.
- 10.3. The minimum requirements for sampling by an inspector set forth in Annex 7 to this Regulation shall be complied with.
- 10.4. 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.
- 10.5. Headlamps with apparent defects are disregarded.
- 10.6. The reference mark is disregarded.
11. PENALTIES FOR NON-CONFORMITY OF PRODUCTION
- 11.1. The approval granted in respect of a type of headlamp pursuant to this Regulation may be withdrawn if the requirements are not complied with or if a headlamp bearing the approval mark does not conform to the type approved.

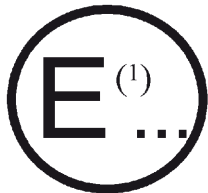
⁽¹⁾ This requirement will be the subject of a recommendation to administrations.

- 11.2. 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.
12. PRODUCTION DEFINITELY DISCONTINUED
- If the holder of the approval completely ceases to manufacture a type of headlamp 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.
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 withdrawal of approval, or production definitely discontinued, issued in other countries, are to be sent.
14. TRANSITIONAL PROVISIONS
- 14.1. As from the official date of entry into force of Supplement 8, no Contracting Party applying this Regulation shall refuse to grant approvals under this Regulation as amended by Supplement 8 to the original version of the Regulation.
- 14.2. As from 24 months from the entry into force of Supplement 8, Contracting Parties applying this Regulation shall grant approvals only if the headlamp type to be approved meets the requirements of this Regulation as amended by Supplement 8 to the original version of the Regulation.
- 14.3. Approvals granted under the preceding supplements to this Regulation shall remain valid.
- 14.4. Contracting Parties applying this Regulation shall continue to grant approvals on the basis of the preceding supplements to this Regulation, provided that the headlamps are intended as replacements for fitting to vehicles in use.
- 14.5. Contracting Parties applying this Regulation shall not refuse to grant extensions of approvals to the preceding supplements to this Regulation.
-

ANNEX I

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 headlamp pursuant to Regulation No 112

Approval No

Extension No

1. Trade name or mark of the device:
2. Manufacturer's name for the type of device:
3. Manufacturer's name and address:
4. If applicable, name and address of manufacturer's representative:

5. Submitted for approval on:
6. Technical service responsible for conducting approval tests:

7. Date of report issued by that service:
8. Number of report issued by that service:
9. Brief description:
 Category as described by the relevant marking ⁽³⁾:

 Number and category(ies) of filament lamp(s):

 Measures according to paragraph 5.8 of this Regulation:
 Number and specific identification code(s) of LED module(s)
 Number and specific identification code(s) of electronic light source control gear(s).....

 Total objective luminous flux as described in paragraph 5.8 exceeds 2 000 lumen: yes/no ⁽²⁾
 The adjustment of the 'cut-off' has been determined at: 10 m/25 m ⁽²⁾
 The determination of the minimum sharpness of the 'cut-off' has been carried out at: 10 m/25 m ⁽²⁾.

10. Approval mark position:
11. Reason(s) for extension of approval:
12. Approval granted/extended/refused//withdrawn ⁽²⁾
13. Place:
14. Date:
15. Signature:
16. 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/refused/withdrawn approval (see the provisions of the Regulation concerning approval).

⁽²⁾ Strike out which does not apply.

⁽³⁾ Indicate the appropriate marking selected from the list below:

C, C, C, R, R PL, CR, CR, CR, C/R, C/R, C/R, C/, C/, C/
 C PL, C PL, C PL, CR PL, CR PL, CR PL, C/R PL, C/R PL, C/R PL,
 C/PL, C/PL, C/PL
 HC, HC, HC, HR, HR PL, HCR, HCR, HCR, HC/R, HC/R, HC/R, HC/, HC/, HC/
 HC PL, HC PL, HC PL, HCR PL, HCR PL, HCR PL, HC/R PL, HC/R PL, HC/R PL,
 HC/PL, HC/PL, HC/PL

ANNEX 2

EXAMPLES OF ARRANGEMENT OF APPROVAL MARKS

Figure 1

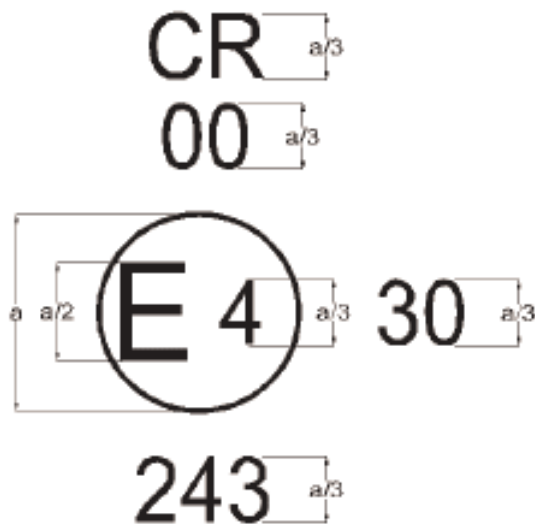
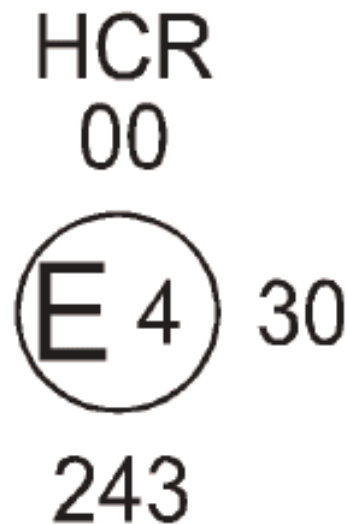


Figure 2



$$a \geq 8\text{mm}$$

The headlamp bearing one of the above approval marks has been approved in the Netherlands (E 4) pursuant to Regulation No 112 under approval number 243, meeting the requirements of this Regulation in its original form (00). The passing beam is designed for right-hand traffic only. The letters CR (Figure 1) indicate that it concerns a Class A passing and driving beam and the letters HCR (Figure 2) indicate that it concerns a Class B passing and driving beam.

The figure 30 indicates that the maximum luminous intensity of the driving beam is between 86 250 and 101 250 candelas.

Note: The approval number and additional symbols shall be placed close to the circle and either above or below the letter 'E', or to the right or left of that letter. The digits of the approval number shall be on the same side of the letter 'E' and face in the same direction.

The use of roman numerals as approval numbers should be avoided so as to prevent any confusion with other symbols.

Figure 3



Figure 4a



Figure 4b



The headlamp bearing the above approval mark meets the requirements of this Regulation in respect of both the passing beam and the driving beam and is designed:

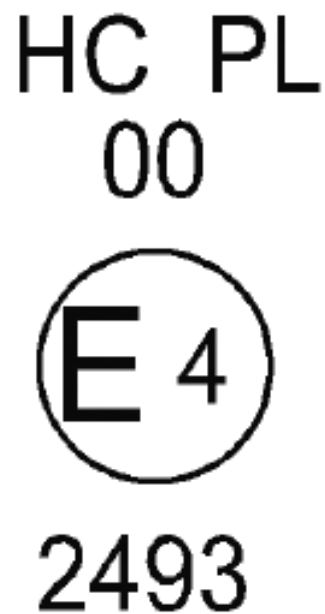
Figure 3: Class A for left hand traffic only.

Figures 4a and 4b: Class B for both traffic systems by means of an appropriate adjustment of the setting of the optical unit or the filament lamp on the vehicle.

Figure 5



Figure 6



The headlamp bearing the above approval mark is a headlamp incorporating a lens of plastic material meeting the requirements of this Regulation in respect of the passing beam only and is designed:

Figure 5: Class A for both traffic systems.

Figure 6: Class B for right-hand traffic only.

Figure 7

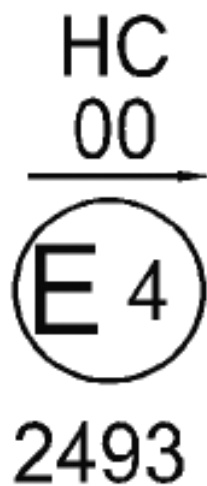
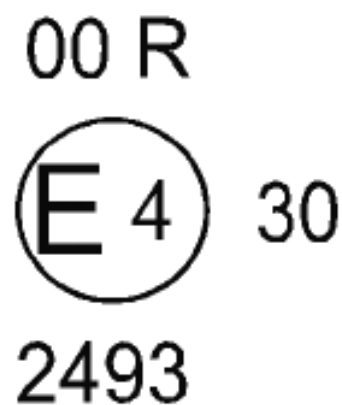


Figure 8



The headlamp bearing the above approval mark is a headlamp meeting the requirements of this Regulation:

Figure 7: Class B in respect of the passing beam only and is designed for left-hand traffic only.

Figure 8: Class A in respect of the driving beam only.

Figure 9

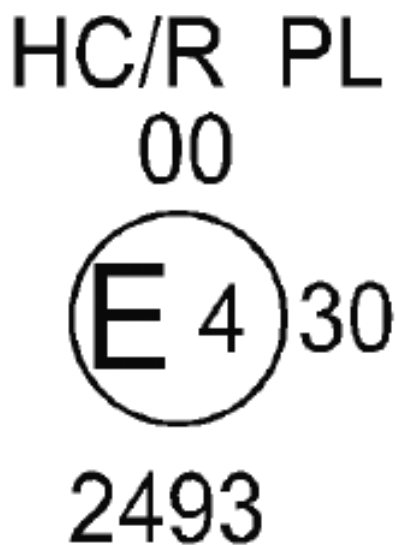
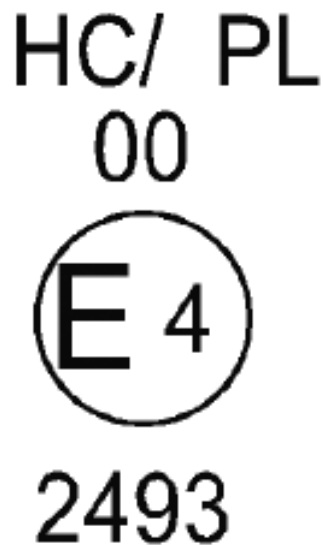


Figure 10



Identification of a headlamp incorporating a lens of plastic material meeting the requirements of this Regulation:

Figure 9: Class B in respect to both the passing beam and driving beam and designed for right-hand traffic only.

Figure 10: Class B in respect to the passing beam only and designed for right-hand traffic only.

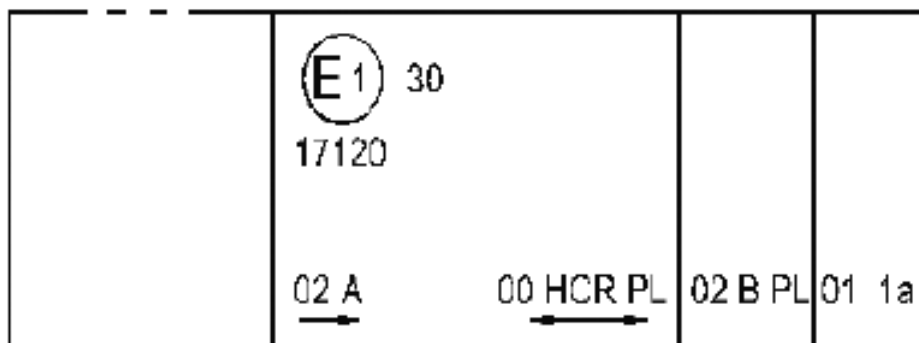
The passing beam shall not be operated simultaneously with the driving beam and/or another reciprocally incorporated headlamp.

Figure 11

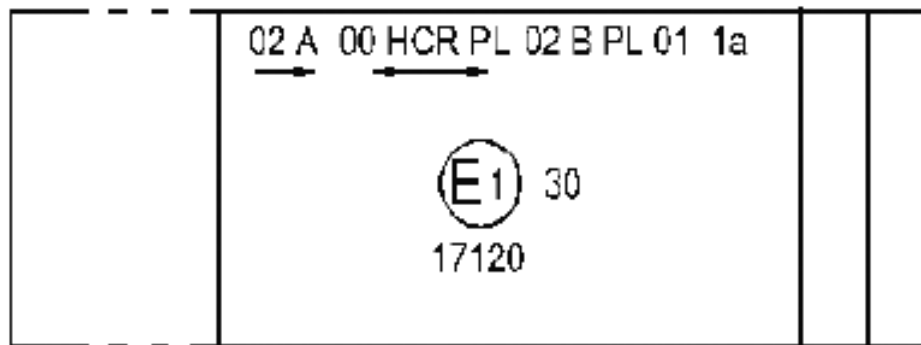
Simplified marking for grouped, combined or reciprocally incorporated lamps

(The vertical and horizontal lines schematise the shape of the light-signalling device. They are not part of the approval mark.)

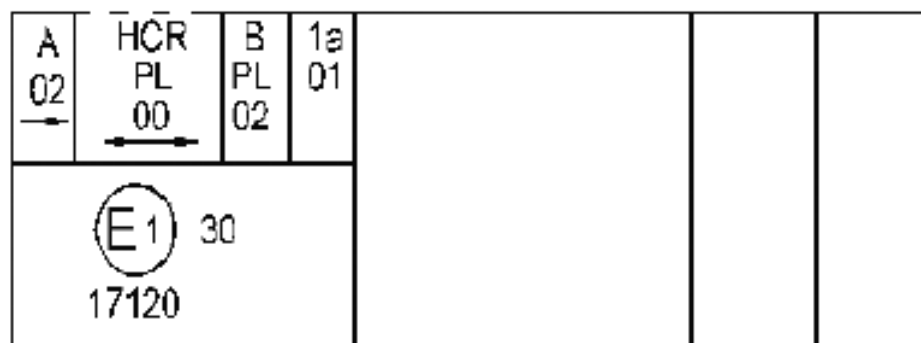
MODEL A



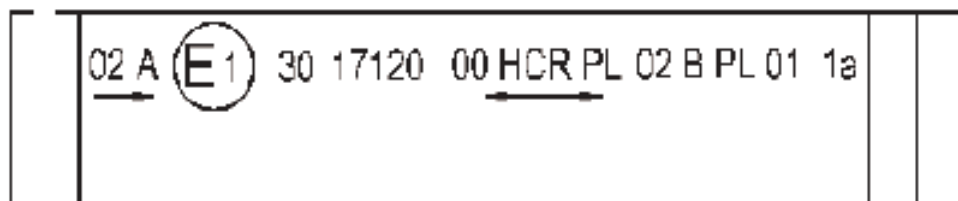
MODEL B



MODEL C



MODEL D



Note: The four examples above correspond to a lighting device bearing an approval mark comprising:

A front position lamp approved in accordance with the 02 series of amendments to Regulation No 7,

A headlamp, Class B, with a passing beam designed for right- and left-hand traffic and a driving beam with a maximum intensity comprised between 86 250 and 101 250 candelas (as indicated by the number 30), approved in accordance with the requirements of this Regulation in its original form (00) and incorporating a lens of plastic material,

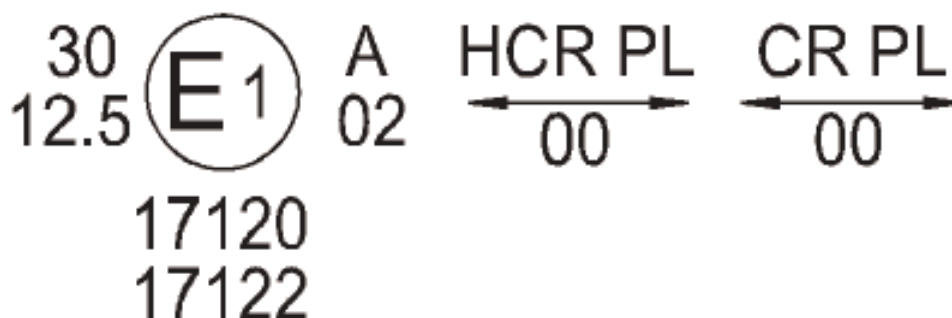
A front fog lamp approved in accordance with the 02 series of amendments to Regulation No 19 and incorporating a lens of plastic material,

A front direction indicator lamp of category 1a approved in accordance with the 01 series of amendments to Regulation No 6.

Figure 12

Lamp reciprocally incorporated with a headlamp

Example 1



The above example corresponds to the marking of a lens of plastic material intended to be used in different types of headlamps, namely:

Either A headlamp, Class B, with a passing beam designed for both traffic systems and a driving beam with a maximum luminous intensity comprised between 86 250 and 101 250 candelas (as indicated by the number 30), approved in Germany (E1) in accordance with the requirements of this Regulation in its original form (00),

which is reciprocally incorporated with

A front position lamp approved in accordance with the 02 series of amendments to Regulation No 7;

Or A headlamp, Class A, with a passing beam designed for both traffic systems and a driving beam with a maximum luminous intensity comprised between 33 750 cd and 45 000 cd (as indicated by the number 12.5), approved in Germany (E1) in accordance with the requirements of this Regulation in its original form (00),

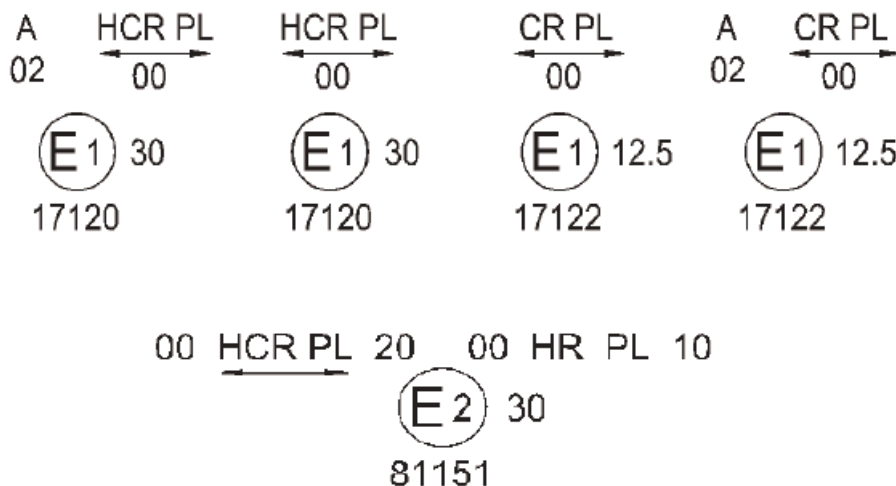
which is reciprocally incorporated with

The same front position lamp as above;

Or even either of the abovementioned headlamps approved as a single lamp.

The main body of the headlamp shall bear the only valid approval number, for instance:

Example 2



The above example corresponds to the marking of a lens of plastic material used in a unit of two headlamps approved in France (E2) under approval number 81151, consisting of:

A headlamp, Class B, emitting a passing beam and a driving beam with a maximum luminous intensity between x and y candelas, meeting the requirements of this Regulation, and

A headlamp, Class B, emitting a driving beam designed for both traffic systems with a maximum luminous intensity between w and z candelas, meeting the requirements of this Regulation, the maximum luminous intensities of the driving beams as a whole being comprised between 86 250 and 101 250 candelas.

Figure 13

LED modules



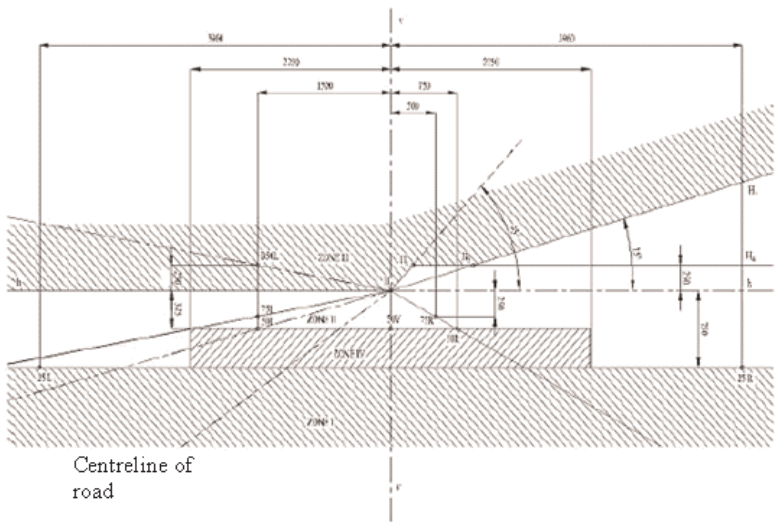
MD E3 17325

The LED module bearing the light source module identification code shown above has been approved together with a headlamp initially approved in Italy (E3) under approval number 17325.

ANNEX 3

MEASURING SCREEN

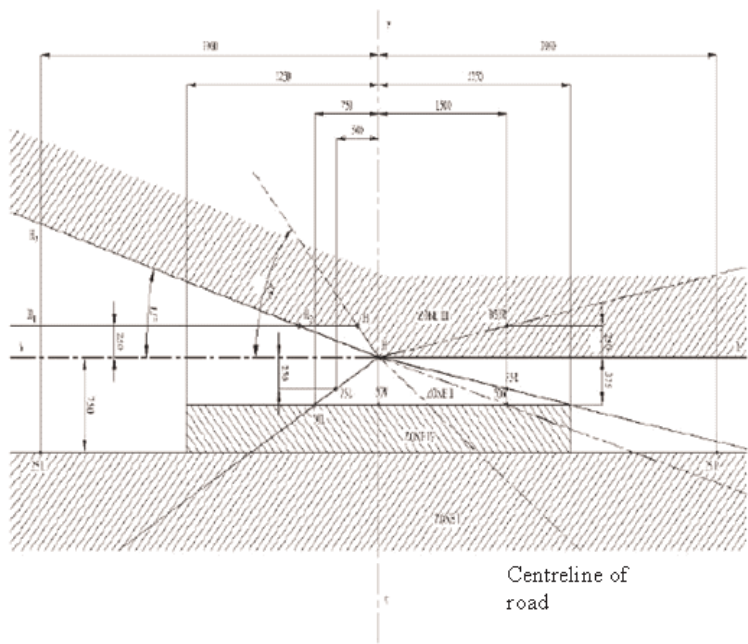
A. Headlamp for right-hand traffic
(dimension in mm with screen at 25 m distance)



h-h: horizontal plane
v-v: vertical plane

} passing through
focus of headlamp

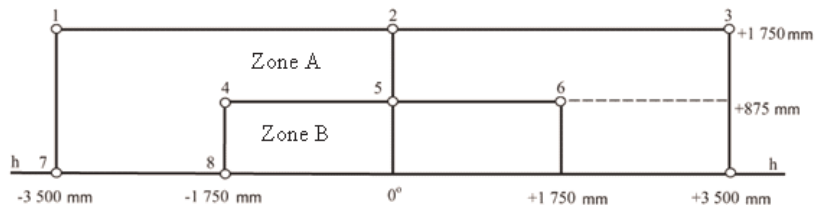
B. Headlamp for left-hand traffic
(dimension in mm with screen at 25 m distance)



h-h: horizontal plane
v-v: vertical plane

} passing through
focus of headlamp

Figure C



Note: Figure C shows the measuring points for right-hand traffic. Points 7 and 8 move to their corresponding location at the right-hand side of the picture for left-hand traffic.

ANNEX 4

Tests for stability of photometric performance of headlamps in operation

TESTS ON COMPLETE HEADLAMPS

Once the photometric values have been measured according to the prescriptions of this Regulation, in the point for $E_{\max}$ for driving beam and in points HV, 50 R, B 50 L for passing beam (or HV, 50 L, B 50 R for headlamps designed for left-hand traffic) a complete headlamp sample shall be tested for stability of photometric performance in operation. 'Complete headlamp' shall be understood to mean the complete lamp itself including those surrounding body parts and lamps which could influence its thermal dissipation.

The tests shall be carried out:

- (a) in a dry and still atmosphere at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$, the test sample being mounted on a base representing the correct installation on the vehicle;
- (b) in case of replaceable light sources: using mass production filament light sources, which have been aged for at least one hour, or mass production gas-discharge light sources, which have been aged for at least 15 hours or mass production LED modules which have been aged for at least 48 hours and cooled down to ambient temperature before starting the tests as specified in this Regulation. The LED modules supplied by the applicant shall be used.

The measuring equipment shall be equivalent to that used during headlamp type approval tests.

The test sample shall be operated without being dismantled from or readjusted in relation to its test fixture. The light source used shall be a light source of the category specified for that headlamp.

1. TEST FOR STABILITY OF PHOTOMETRIC PERFORMANCE

The tests shall be carried out in a dry and still atmosphere at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$, the complete headlamp being mounted on a base representing the correct installation on the vehicle.

1.1. Clean headlamp

The headlamp shall be operated for 12 hours as described in paragraph 1.1.1 and checked as prescribed in paragraph 1.1.2.

1.1.1. Test procedure ⁽¹⁾

The headlamp shall be operated for a period according to the specified time, so that:

- 1.1.1.1. (a) In the case where only one lighting function (driving or passing beam or front fog lamp) is to be approved, the corresponding filament and/or LED module(s) is (are) lit for the prescribed time ⁽²⁾,
- (b) In the case of a headlamp with a passing beam and one or more driving beams or in the case of a headlamp with a passing beam and a front fog lamp:

- (i) the headlamp shall be subjected to the following cycle until the time specified is reached:

15 minutes, principal passing-beam filament or principal passing beam LED module(s) lit;

5 minutes, all filaments and/or LED module(s) lit;

- (ii) if the applicant declares that the headlamp is to be used with only the passing beam lit or only the driving beam(s) lit ⁽³⁾ at a time, the test shall be carried out in accordance with this condition, activating ⁽²⁾ successively the passing beam half of the time and the driving beam(s) (simultaneously) for half the time specified in paragraph 1.1 above.

- (c) In the case of a headlamp with a front fog lamp and one or more driving beams:
- (i) the headlamp shall be subjected to the following cycle until the time specified is reached:
 - 15 minutes, front fog lamp lit;
 - 5 minutes, all filaments and/or all LED modules lit.
 - (ii) if the applicant declares that the headlamp is to be used with only the front fog lamp lit or only the driving beam(s) lit ^(?) at a time, the test shall be carried out in accordance with this condition, activating ^(?) successively the front fog lamp half of the time and the driving beam(s) (simultaneously) for half the time specified in paragraph 1.1 above.
- (d) In the case of headlamp with a passing beam, one or more driving beams and a front fog lamp:
- (i) the headlamp shall be subjected to the following cycle until the time specified is reached:
 - 15 minutes, principal passing-beam filament or principal passing beam LED module(s) lit;
 - 5 minutes, all filaments and/or all LED modules lit;
 - (ii) if the applicant declares that the headlamp is to be used with only the passing beam lit or only the driving beam(s) ^(?) lit at a time, the test shall be carried out in accordance with this condition, activating ^(?) successively the principal passing beam half of the time and the driving beam(s) for half the time specified in paragraph 1.1 above, while the front fog lamp is subjected to a cycle of 15 minutes off and 5 minutes lit for half of the time and during the operation of the driving beam;
 - (iii) if the applicant declares that the headlamp is to be used with only the passing beam lit or only the front fog lamp ^(?) lit at a time, the test shall be carried out in accordance with this condition, activating ^(?) successively the principal passing beam half of the time and the front fog lamp for half of the time specified in paragraph 1.1 above, while the driving beam(s) is(are) subjected to a cycle of 15 minutes off and 5 minutes lit for half of the time and during the operation of the principal passing beam;
 - (iv) if the applicant declares that the headlamp is to be used with only the passing beam lit or only the driving beam(s) ^(?) lit or only the front fog lamp ^(?) lit at a time, the test shall be carried out in accordance with this condition, activating ^(?) successively the principal passing beam one third of the time, the driving beam(s) one third of the time and the front fog lamp for one third of the time specified in paragraph 1.1 above.
- (e) In the case of a passing beam designed to provide bend lighting with the addition of a filament light source and/or one or more LED module(s), this light source and/or LED module(s) shall be switched on for one minute, and switched off for nine minutes during the activation of the passing beam only (see Annex 4 — Appendix 1).

1.1.1.2. Test voltage

The voltage shall be applied to the terminals of the test sample as follows.

- (a) In case of replaceable filament light source(s) operated directly under vehicle voltage system conditions:

The test shall be performed at 6,3 V, 13,2 V or 28,0 V as applicable except if the applicant specifies that the test sample may be used at a different voltage. In this case, the test shall be carried out with the filament light source operated at the highest voltage that can be used.

- (b) In case of replaceable gas discharge light source(s): The test voltage for the electronic light source control-gear is 13,2 ± 0,1 volts for 12 V vehicle voltage system, or otherwise specified in the application for approval.

- (c) In the case of non-replaceable light source operated directly under vehicle voltage system conditions: All measurements on lighting units equipped with non-replaceable light sources (filament light sources and/or others) shall be made at 6,3 V, 13,2 V or 28,0 V or at other voltages according to the vehicle voltage system as specified by the applicant respectively.
- (d) In the case of light sources, replaceable or non-replaceable, being operated independently from vehicle supply voltage and fully controlled by the system, or, in the case of light sources supplied by a supply and operating device, the test voltages as specified above shall be applied to the input terminals of that device. The test laboratory may require from the manufacturer the supply and operating device or a special power supply needed to supply the light source(s).
- (e) LED module(s) shall be measured at 6,75 V, 13,2 V or 28,0 V respectively, if not otherwise specified within this Regulation. LED module(s) operated by an electronic light source control gear, shall be measured as specified by the applicant.
- (f) Where signalling lamps are grouped, combined or reciprocally incorporated into the test sample and operating at voltages other than the nominal rated voltages of 6 V, 12 V or 24 V respectively, the voltage shall be adjusted as declared by the manufacturer for the correct photometric functioning of that lamp.

1.1.2. Test results

1.1.2.1. Visual inspection

Once the headlamp has been stabilised to the ambient temperature, the headlamp lens and the external lens, if any, shall be cleaned with a clean, damp cotton cloth. It shall then be inspected visually; no distortion, deformation, cracking or change in colour of either the headlamp lens or the external lens, if any, shall be noticeable.

1.1.2.2. Photometric test

To comply with the requirements of this Regulation, the photometric values shall be verified in the following points:

Passing beam:

50 R — B 50 L — HV for headlamps designed for right-hand traffic,

50 L — B 50 R — HV for headlamps designed for left-hand traffic.

Driving beam: Point of $E_{\max}$

Another aiming may be carried out to allow for any deformation of the headlamp base due to heat (the change of the position of the cut-off line is covered in paragraph 2 of this Annex).

A 10 per cent discrepancy between the photometric characteristics and the values measured prior to the test is permissible including the tolerances of the photometric procedure.

1.2. Dirty headlamp

After being tested as specified in paragraph 1.1 above, the headlamp shall be operated for one hour as described in paragraph 1.1.1, after being prepared as prescribed in paragraph 1.2.1, and checked as prescribed in paragraph 1.1.2.

1.2.1. Preparations of the headlamp

1.2.1.1. Test mixture

1.2.1.1.1. For headlamp with the outside lens in glass:

The mixture of water and a polluting agent to be applied to the headlamp shall be composed of:

9 parts by weight of silica sand with a particle size of 0-100 μm ,

1 part by weight of vegetal carbon dust (beechwood) with a particle size of 0-100 μm ,

0,2 parts by weight of NaCMC ⁽⁴⁾, and

an appropriate quantity of distilled water, with a conductivity of ≤ 1 mS/m.

The mixture must not be more than 14 days old.

1.2.1.1.2. For headlamp with outside lens in plastic material:

The mixture of water and polluting agent to be applied to the headlamp shall be composed of:

9 parts by weight of silica sand with a particle size of 0-100 μm ,

1 part by weight of vegetal carbon dust (beechwood) with a particle size of 0-100 μm ,

0,2 part by weight of NaCMC ⁽⁴⁾,

13 parts by weight of distilled water with a conductivity of ≤ 1 mS/m, and

2 ± 1 parts by weight of surface-actant ⁽⁵⁾

The mixture must not be more than 14 days old.

1.2.1.2. Application of the test mixture to the headlamp

The test mixture shall be uniformly applied to the entire light-emitting surface of the headlamp and then left to dry. This procedure shall be repeated until the illumination value has dropped to 15-20 per cent of the values measured for each following point under the conditions described in this Annex:

Point of E_{max} in passing beam/driving beam and in driving beam only,

50 R and 50 V ⁽⁶⁾ for a passing lamp only, designed for right-hand traffic,

50 L and 50 V ⁽⁶⁾ for a passing lamp only, designed for left-hand traffic.

2. TEST FOR CHANGE IN VERTICAL POSITION OF THE CUT-OFF LINE UNDER THE INFLUENCE OF HEAT

This test consists of verifying that the vertical drift of the cut-off line under the influence of heat does not exceed a specified value for an operating passing lamp.

The headlamp tested in accordance with paragraph 1, shall be subjected to the test described in paragraph 2.1, without being removed from or readjusted in relation to its test fixture.

2.1. Test

The test shall be carried out in a dry and still atmosphere at an ambient temperature of $23^\circ\text{C} \pm 5^\circ\text{C}$.

Using a mass production filament lamp or the LED module(s) as submitted with the headlamp, which has (have) been aged for at least one hour, the headlamp shall be operated on the principal passing beam without being dismounted from or readjusted in relation to its test fixture. (For the purpose of this test, the voltage shall be adjusted as specified in paragraph 1.1.1.2). The position of the cut-off line in its horizontal part (between vv and the vertical line passing through point B 50 L for right-hand traffic or B 50 R for left-hand traffic) shall be verified 3 minutes (t_3) and 60 minutes (t_{60}) respectively after operation.

The measurement of the variation in the cut-off line position as described above shall be carried out by any method giving acceptable accuracy and reproducible results.

2.2. Test results

2.2.1. The result in milliradians (mrad) shall be considered as acceptable for a passing lamp, only when the absolute value $\Delta r_I = |r_3 - r_{60}|$ recorded on the headlamp is not more than 1,0 mrad ($\Delta r_I \leq 1,0$ mrad).

2.2.2. However, if this value is more than 1,0 mrad but not more than 1,5 mrad ($1,0 \text{ mrad} < \Delta r_I \leq 1,5 \text{ mrad}$) a second headlamp shall be tested as described in paragraph 2.1 after being subjected three consecutive times to the cycle as described below, in order to stabilise the position of mechanical parts of the headlamp on a base representative of the correct installation on the vehicle:

Operation of the passing beam for one hour, (the voltage shall be adjusted as specified in paragraph 1.1.1.2),

Period of rest for one hour.

The headlamp type shall be considered as acceptable if the mean value of the absolute values Δr_I measured on the first sample and Δr_{II} measured on the second sample is not more than 1,0 mrad.

$$\left(\frac{\Delta r_I + \Delta r_{II}}{2} \leq 1 \text{ mrad} \right)$$

⁽¹⁾ For the test schedule see Annex 8 to this Regulation.

⁽²⁾ When the tested headlamp includes signalling lamps, the latter shall be lit for the duration of the test, except for a daytime running lamp. In the case of a direction indicator lamp, it shall be lit in flashing mode with an on/off time of approximately one to one.

⁽³⁾ Should two or more lamp filaments and/or LED module(s) be simultaneously lit when headlamp flashing is used, this shall not be considered as being normal use of the filaments and/or LED module(s).

⁽⁴⁾ NaCMC represents the sodium salt of carboxymethylcellulose, customarily referred to as CMC. The NaCMC used in the dirt mixture shall have a degree of substitution (DS) of 0,6-0,7 and a viscosity of 200-300 cP for a 2 per cent solution at 20 °C.

⁽⁵⁾ The tolerance on quantity is due to the necessity of obtaining a dirt that correctly spreads out on all the plastic lens.

⁽⁶⁾ Point 50 V is situated 375 mm below HV on the vertical line v-v on the screen at 25 m distance.

APPENDIX 1

Overview of operational periods concerning test for stability of photometric performance

Abbreviations: P: passing beam lamp

D: driving beam lamp ($D_1 + D_2$ means two driving beams)

F: front fog lamp



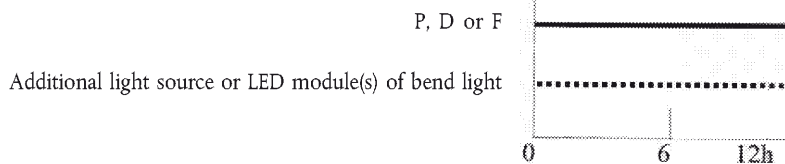
means a cycle of 15 minutes off and 5 minutes lit



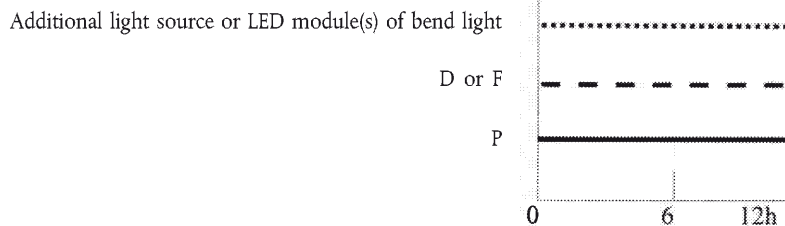
means a cycle of 9 minutes off and 1 minute lit

All following grouped headlamps and front fog lamps together with the added marking symbols are given as examples and are not exhaustive.

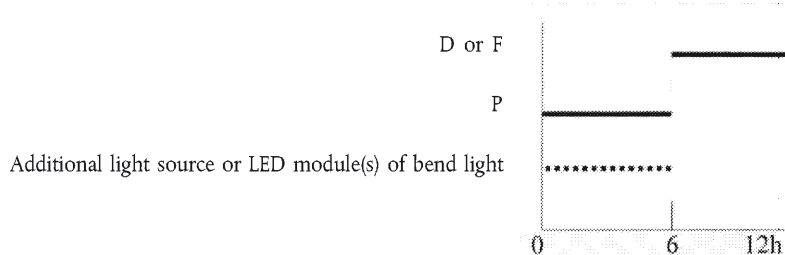
1. P or D or F (HC or HR or B)



2. P + F (HC B) or P + D (HCR)



3. P + F (HC/B) or HC/B or P + D (HC/R)



ANNEX 5

Minimum requirements for conformity of production control procedures

1. GENERAL

1.1. The conformity requirements shall be considered satisfied from a mechanical and a geometrical standpoint, if the differences do not exceed inevitable manufacturing deviations within the requirements of this Regulation. This condition also applies to colour.

1.2. With respect to photometric performances, the conformity of mass produced headlamps shall not be contested if, when testing photometric performances of any headlamp chosen at random and equipped with a standard (étalon) filament lamp and/or LED module(s), as present in the lamp:

1.2.1. no measured value deviates unfavourably by more than 20 per cent from the value prescribed in this Regulation. For values B 50 L (or R) and zone III, the maximum unfavourable deviation may be respectively:

B 50 L (or R): 0,2 lx equivalent 20 per cent

0,3 lx equivalent 30 per cent

Zone III: 0,3 lx equivalent 20 per cent

0,45 lx equivalent 30 per cent

1.2.2. or if

1.2.2.1. for the passing beam, the values prescribed in this Regulation are met at HV (with a tolerance of + 0,2 lx) and related to that aiming at least one point of each area delimited on the measuring screen (at 25 m) by a circle 15 cm in radius around points B 50 L (or R) ⁽¹⁾ (with a tolerance of + 0,1 lx), 75 R (or L), 50 V, 25 R, 25 L, and in the entire area of zone IV which is not more than 22,5 cm above line 25 R and 25 L;

1.2.2.2. and if, for the driving beam, HV being situated within the isolux 0,75 E_{max} , a tolerance of + 20 per cent for maximum values and – 20 per cent for minimum values is observed for the photometric values at any measuring point specified in paragraph 6.3.2 of this Regulation.

1.2.3. If the results of the test described above do not meet the requirements, the alignment of the headlamp may be changed, provided that the axis of the beam is not displaced laterally by more than 1° to the right or left.

1.2.4. If in the case of a lamp equipped with a replaceable filament light source the results of the tests described above do not meet the requirements, tests shall be repeated using another standard (étalon) filament lamp.

1.3. With respect to the verification of the change in vertical position of the cut-off line under the influence of heat, the following procedure shall be applied:

One of the sampled headlamps shall be tested according to the procedure described in paragraph 2.1 of Annex 4 after being subjected three consecutive times to the cycle described in paragraph 2.2.2 of Annex 4.

The headlamp shall be considered as acceptable if Δr does not exceed 1.5 mrad.

If this value exceeds 1,5 mrad but is not more than 2,0 mrad, a second sample shall be subjected to the test after which the mean of the absolute values recorded on both samples shall not exceed 1,5 mrad.

1.4. If, however, vertical adjustment cannot be performed repeatedly to the required position within the tolerances described in paragraph 6.2.2.3 of this Regulation, one sample shall be tested according to the procedure described in paragraphs 2 and 3 of Annex 9.

⁽¹⁾ Letters in brackets refer to headlamps intended for left-hand traffic.

2. MINIMUM REQUIREMENTS FOR VERIFICATION OF CONFORMITY BY THE MANUFACTURER

For each type of headlamp the holder of the approval mark shall carry out at least the following tests, at appropriate intervals. The tests shall be carried out in accordance with the provision of this Regulation.

If any sampling shows non-conformity with regard to the type of test concerned, further samples shall be taken and tested. The manufacturer shall take steps to ensure the conformity of the production concerned.

2.1. Nature of tests

Tests of conformity in this Regulation shall cover the photometric characteristics and the verification of the change in vertical position of the cut-off line under the influence of heat.

2.2. Methods used in tests

2.2.1. Tests shall generally be carried out in accordance with the methods set out in this Regulation.

2.2.2. In any test of conformity carried out by the manufacturer, equivalent methods may be used with the consent of the competent authority responsible for approval tests. The manufacturer is responsible for proving that the applied methods are equivalent to those laid down in this Regulation.

2.2.3. The application of paragraphs 2.2.1 and 2.2.2 requires regular calibration of test apparatus and its correlation with measurement made by a competent authority.

2.2.4. In all cases the reference methods shall be those of this Regulation, particular for the purpose of administrative verification and sampling.

2.3. Nature of sampling

Samples of headlamps shall be selected at random from the production of a uniform batch. A uniform batch means a set of headlamps of the same type, defined according to the production methods of the manufacturer.

The assessment shall, in general, cover series production from individual factories. However, a manufacturer may group together records concerning the same type from several factories provided these operate under the same quality system and quality management.

2.4. Measured and recorded photometric characteristics

The sampled headlamps shall be subjected to photometric measurements at the points provided for in the Regulation, the reading being limited at the points E_{max} , HV ⁽¹⁾, HL, HR ⁽²⁾ in the case of a driving beam, and to points B 50 L (or R), HV, 50 V, 75 R (or L) and 25 L (or R) in the case of the passing beam (see figure in Annex 3).

2.5. Criteria governing acceptability

The manufacturer is responsible for carrying out a statistical study of the test results and for defining, in agreement with the competent authority, criteria governing acceptability of his products in order to meet the specification laid down for verification of conformity of products in paragraph 10.1 of this Regulation.

The criteria governing acceptability shall be such that, with a confidence level of 95 per cent, the minimum probability of passing a spot check in accordance with Annex 7 (first sampling) would be 0,95.

⁽¹⁾ When the driving beam is reciprocally incorporated with the passing beam, HV in the case of the driving beam shall be the same measuring point as in the case of the passing beam.

⁽²⁾ HL and HR: points 'hh' located at 1,125 m to the left and to the right of point HV respectively.

ANNEX 6

Requirements for lamps incorporating lenses of plastic material — testing of lens or material samples and of complete lamps

1. GENERAL SPECIFICATIONS

- 1.1. The samples supplied pursuant to paragraph 2.2.4 of this Regulation shall satisfy the specifications indicated in paragraphs 2.1 to 2.5 below.
- 1.2. The two samples of complete lamps supplied pursuant to paragraph 2.2.3 of this Regulation and incorporating lenses of plastic material shall, with regard to the lens material, satisfy the specifications indicated in paragraph 2.6 below.
- 1.3. The samples of lenses of plastic material or samples of material shall be subjected, with the reflector to which they are intended to be fitted (where applicable), to approval tests in the chronological order indicated in table A reproduced in Appendix 1 to this Annex.
- 1.4. However, if the lamp manufacturer can prove that the product has already passed the tests prescribed in paragraphs 2.1 to 2.5 below, or the equivalent tests pursuant to another regulation, those tests need not be repeated; only the tests prescribed in Appendix 1, table B, shall be mandatory.

2. TESTS

2.1. Resistance to temperature changes

2.1.1. Tests

Three new samples (lenses) shall be subjected to five cycles of temperature and humidity (RH = relative humidity) change in accordance with the following programme:

3 hours at $40\text{ °C} \pm 2\text{ °C}$ and 85-95 per cent RH;

1 hour at $23\text{ °C} \pm 5\text{ °C}$ and 60-75 per cent RH;

15 hours at $-30\text{ °C} \pm 2\text{ °C}$;

1 hour at $23\text{ °C} \pm 5\text{ °C}$ and 60-75 per cent RH;

3 hours at $80\text{ °C} \pm 2\text{ °C}$;

1 hour at $23\text{ °C} \pm 5\text{ °C}$ and 60-75 per cent RH;

Before this test, the samples shall be kept at $23\text{ °C} \pm 5\text{ °C}$ and 60-75 per cent RH for at least four hours.

Note: The periods of one hour at $23\text{ °C} \pm 5\text{ °C}$ shall include the periods of transition from one temperature to another which are needed in order to avoid thermal shock effects.

2.1.2. Photometric measurements

2.1.2.1. Method

Photometric measurements shall be carried out on the samples before and after the test.

These measurements shall be made using a standard (étalon) lamp and/or LED module(s), as present in the headlamp, at the following points:

B 50 L and 50 R for the passing beam of a passing lamp or a passing/driving lamp (B 50 R and 50 L in the case of headlamps intended for left-hand traffic);

E_{max} route for the driving beam of a driving lamp or a passing/driving lamp.

2.1.2.2. Results

The variation between the photometric values measured on each sample before and after the test shall not exceed 10 per cent including the tolerances of the photometric procedure.

2.2. Resistance to atmospheric and chemical agents

2.2.1. Resistance to atmospheric agents

Three new samples (lenses or samples of material) shall be exposed to radiation from a source having a spectral energy distribution similar to that of a black body at a temperature between 5 500 K and 6 000 K. Appropriate filters shall be placed between the source and the samples so as to reduce as far as possible radiations with wave lengths smaller than 295 nm and greater than 2 500 nm. The samples shall be exposed to an energetic illumination of $1\,200\text{ W/m}^2 \pm 200\text{ W/m}^2$ for a period such that the luminous energy that they receive is equal to $4\,500\text{ MJ/m}^2 \pm 200\text{ MJ/m}^2$. Within the enclosure, the temperature measured on the black panel placed on a level with the samples shall be $50\text{ °C} \pm 5\text{ °C}$. In order to ensure a regular exposure, the samples shall revolve around the source of radiation at a speed between 1 and 5 min⁻¹.

The samples shall be sprayed with distilled water of conductivity lower than 1 mS/m at a temperature of $23\text{ °C} \pm 5\text{ °C}$, in accordance with the following cycle:

spraying: 5 minutes; drying: 25 minutes.

2.2.2. Resistance to chemical agents

After the test described in paragraph 2.2.1 above and the measurement described in paragraph 2.2.3.1 below have been carried out, the outer face of the said three samples shall be treated as described in paragraph 2.2.2.2 with the mixture defined in paragraph 2.2.2.1 below.

$$\frac{T_5 - T_4}{T_2}$$

2.2.2.1. Test mixture

The test mixture shall be composed of 61,5 per cent n-heptane, 12,5 per cent toluene, 7,5 per cent ethyl tetrachloride, 12,5 per cent trichloroethylene and 6 per cent xylene (volume per cent).

2.2.2.2. Application of the test mixture

Soak a piece of cotton cloth (as per ISO 105) until saturation with the mixture defined in paragraph 2.2.2.1 above and, within 10 seconds, apply it for 10 minutes to the outer face of the sample at a pressure of 50 N/cm², corresponding to an effort of 100 N applied on a test surface of 14 × 14 mm.

During this 10-minute period, the cloth pad shall be soaked again with the mixture so that the composition of the liquid applied is continuously identical with that of the test mixture prescribed.

During the period of application, it is permissible to compensate the pressure applied to the sample in order to prevent it from causing cracks.

2.2.2.3. Cleaning

At the end of the application of the test mixture, the samples shall be dried in the open air and then washed with the solution described in paragraph 2.3 (Resistance to detergents) at $23\text{ °C} \pm 5\text{ °C}$.

Afterwards the samples shall be carefully rinsed with distilled water containing not more than 0,2 per cent impurities at $23\text{ °C} \pm 5\text{ °C}$ and then wiped off with a soft cloth.

2.2.3. Results

2.2.3.1. After the test of resistance to atmospheric agents, the outer face of the samples shall be free from cracks, scratches, chipping and deformation, and the mean variation in transmission $\Delta t = \frac{T_2 - T_3}{T_2}$, measured on the three samples according to the procedure described in Appendix 2 to this Annex shall not exceed 0,020 ($\Delta t_m \leq 0,020$).

2.2.3.2. After the test of resistance to chemical agents, the samples shall not bear any traces of chemical staining likely to cause a variation of flux diffusion, whose mean variation $\Delta d = \frac{T_3 - T_4}{T_2}$, measured on the three samples according to the procedure described in Appendix 2 to this Annex shall not exceed 0,020 ($\Delta d_m \leq 0,020$).

2.2.4. The following test shall be done:

Flat samples of each light transmitting plastic component of the headlamp are exposed to the light of the LED module(s). The parameters such as angles and distances of these samples shall be the same as in the headlamp. These samples shall have the same colour and surface treatment, if any, as the parts of the headlamp.

After 1 500 hours of continuous operation, the colorimetric specifications of the transmitted light must be met, and the surfaces of the samples shall be free of cracks, scratches, scalings or deformation.

2.3. Resistance to detergents and hydrocarbons

2.3.1. Resistance to detergents

The outer face of three samples (lenses or samples of material) shall be heated to $50\text{ °C} \pm 5\text{ °C}$ and then immersed for five minutes in a mixture maintained at $23\text{ °C} \pm 5\text{ °C}$ and composed of 99 parts distilled water containing not more than 0,02 per cent impurities and one part alkylaryl sulphate.

At the end of the test, the samples shall be dried at $50\text{ °C} \pm 5\text{ °C}$.

The surface of the samples shall be cleaned with a moist cloth.

2.3.2. Resistance to hydrocarbons

The outer face of these three samples shall then be lightly rubbed for one minute with a cotton cloth soaked in a mixture composed of 70 per cent n-heptane and 30 per cent toluene (volume per cent), and shall then be dried in the open air.

2.3.3. Results

After the above two tests have been performed successively, the mean value of the variation in transmission $\Delta t = \frac{T_2 - T_3}{T_2}$, measured on the three samples according to the procedure described in Appendix 2 to this Annex shall not exceed 0,010 ($\Delta t_m \leq 0,010$).

2.4. Resistance to mechanical deterioration

2.4.1. Mechanical deterioration method

The outer face of the three new samples (lenses) shall be subjected to the uniform mechanical deterioration test by the method described in Appendix 3 to this Annex.

2.4.2. Results

After this test, the variations:

$$\text{in transmission: } \Delta t = \frac{T_2 - T_3}{T_2},$$

$$\text{and in diffusion: } \Delta d = \frac{T_3 - T_4}{T_2},$$

shall be measured according to the procedure described in Appendix 2 in the area specified in paragraph 2.2.4.1.1 of this Regulation. The mean value of the three samples shall be such that:

$$\Delta t_m \leq 0,100;$$

$$\Delta d_m \leq 0,050.$$

2.5. Test of adherence of coatings, if any

2.5.1. Preparation of the sample

A surface of 20 mm × 20 mm in area of the coating of a lens shall be cut with a razor blade or a needle into a grid of squares approximately 2 mm × 2 mm. The pressure on the blade or needle shall be sufficient to cut at least the coating.

2.5.2. Description of the test

Use an adhesive tape with a force adhesion of $2 \text{ N}/(\text{cm of width}) \pm 20$ per cent measured under the standardised conditions specified in Appendix 4 to this Annex. This adhesive tape, which shall be at least 25 mm wide, shall be pressed for at least five minutes to the surface prepared as prescribed in paragraph 2.5.1.

Then the end of the adhesive tape shall be loaded in such a way that the force of adhesion to the surface considered is balanced by a force perpendicular to that surface. At this stage, the tape shall be torn off at a constant speed of $1,5 \text{ m/s} \pm 0,2 \text{ m/s}$.

2.5.3. Results

There shall be no appreciable impairment of the gridded area. Impairments at the intersections between squares or at the edges of the cuts shall be permitted, provided that the impaired area does not exceed 15 per cent of the gridded surface.

2.6. Tests of the complete headlamp incorporating a lens of plastic material

2.6.1. Resistance to mechanical deterioration of the lens surface

2.6.1.1. Tests

The lens of lamp sample No 1 shall be subjected to the test described in paragraph 2.4.1 above.

2.6.1.2. Results

After the test, the results of photometric measurements carried out on the headlamp in accordance with this Regulation shall not exceed by more than 30 per cent the maximum values prescribed at points B 50 L and HV and not be more than 10 per cent below the minimum values prescribed at point 75 R (in the case of headlamps intended for left-hand traffic, the points to be considered are B 50 R, HV and 75 L).

2.6.2. Test of adherence of coatings, if any

The lens of lamp sample No 2 shall be subjected to the test described in paragraph 2.5 above.

3. VERIFICATION OF THE CONFORMITY OF PRODUCTION

3.1. With regard to the materials used for the manufacture of lenses, the lamps of a series shall be recognised as complying with this Regulation if:

3.1.1. After the test for resistance to chemical agents and the test for resistance to detergents and hydrocarbons, the outer face of the samples exhibits no cracks, chipping or deformation visible to the naked eye (see paragraphs 2.2.2, 2.3.1 and 2.3.2);

3.1.2. After the test described in paragraph 2.6.1.1, the photometric values at the points of measurement considered in paragraph 2.6.1.2 are within the limits prescribed for conformity of production by this Regulation.

3.2. If the test results fail to satisfy the requirements, the tests shall be repeated on another sample of headlamps selected at random.

APPENDIX 1

CHRONOLOGICAL ORDER OF APPROVAL TESTS

A. Tests on plastic materials (lenses or samples of material supplied pursuant to paragraph 2.2.4 of this Regulation).

Samples	Lenses or samples of material										Lenses			
Tests	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.1. Limited photometry (A.6, paragraph 2.1.2)											X	X	X	
1.1.1. Temperature change (A.6, paragraph 2.1.1)											X	X	X	
1.2. Limited photometry (A.6, paragraph 2.1.2)											X	X	X	
1.2.1. Transmission measurement	X	X	X	X	X	X	X	X	X					
1.2.2. Diffusion measurement	X	X	X				X	X	X					
1.3. Atmospheric agents (A.6, paragraph 2.2.1)	X	X	X											
1.3.1. Transmission measurement	X	X	X											
1.4. Chemical agents (A.6, paragraph 2.2.2)	X	X	X											
1.4.1. Diffusion measurements	X	X	X											
1.5. Detergents (A.6, paragraph 2.3.1)				X	X	X								
1.6. Hydrocarbons (A.6, paragraph 2.3.2)				X	X	X								
1.6.1. Transmission measurement				X	X	X								
1.7. Deterioration (A.6, paragraph 2.4.1)							X	X	X					
1.7.1. Transmission measurement							X	X	X					
1.7.2. Diffusion measurement							X	X	X					
1.8. Adherence (A.6, paragraph 2.5)														X
1.9. Resistance to light source radiations (A.6, paragraph 2.2.4)										X				

B. Tests on complete headlamps (supplied pursuant to paragraph 2.2.3 of this Regulation).

Tests	Complete headlamp	
	Sample No	
	1	2
2.1. Deterioration (paragraph 2.6.1.1)	X	
2.2. Photometry (paragraph 2.6.1.2)	X	
2.3. Adherence (paragraph 2.6.2)		X

APPENDIX 2

Method of measurement of the diffusion and transmission of light

1. EQUIPMENT (see figure)

The beam of a collimator K with a half divergence $\beta/2 = 17,4 \times 10^{-4}$ rd is limited by a diaphragm D_T with an opening of 6 mm against which the sample stand is placed.

A convergent achromatic lens L_2 , corrected for spherical aberrations links the diaphragm D_T with the receiver R; the diameter of the lens L_2 shall be such that it does not diaphragm the light diffused by the sample in a cone with a half top angle of $\beta/2 = 14^\circ$.

An annular diaphragm D_D , with angles $\alpha_0/2 = 1^\circ$ and $\alpha_{\max}/2 = 12^\circ$ is placed in an image focal plane of the lens L_2 .

The non-transparent central part of the diaphragm is necessary in order to eliminate the light arriving directly from the light source. It shall be possible to remove the central part of the diaphragm from the light beam in such a manner that it returns exactly to its original position.

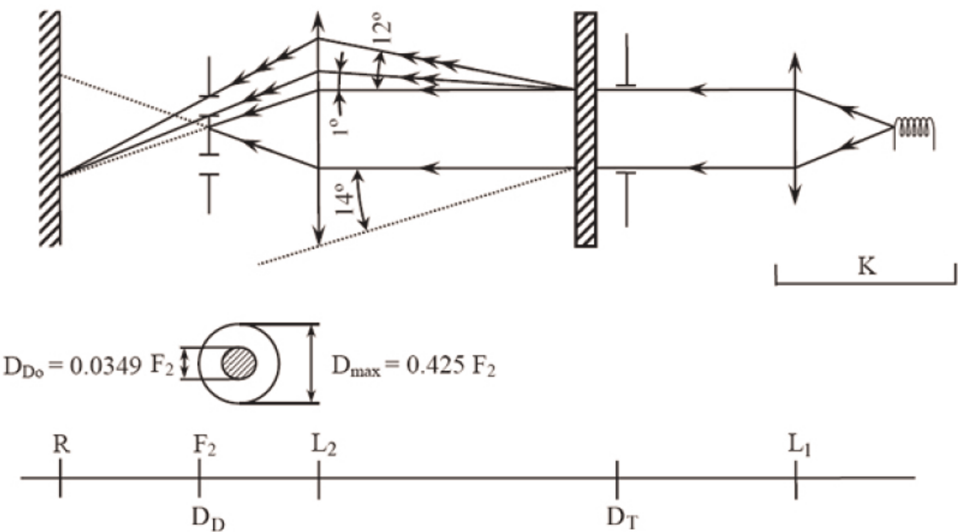
The distance $L_2 D_T$ and the focal length F_2 ⁽¹⁾ of the lens L_2 shall be so chosen that the image of D_T completely covers the receiver R.

When the initial incident flux is referred to 1 000 units, the absolute precision of each reading shall be better than 1 unit.

2. MEASUREMENTS

The following readings shall be taken:

Reading	With sample	With central part of D_D	Quantity represented
T_1	no	no	Incident flux in initial reading
T_2	yes (before test)	no	Flux transmitted by the new material in a field of 24°
T_3	yes (after test)	no	Flux transmitted by the tested material in a field of 24°
T_4	yes (before test)	yes	Flux diffused by the new material
T_5	yes (after test)	yes	Flux diffused by the tested material



⁽¹⁾ For L_2 it is recommended to use a focal distance of about 80 mm.

APPENDIX 3

SPRAY TESTING METHOD

1. TEST EQUIPMENT

1.1. Spray gun

The spray gun used shall be equipped with a nozzle 1,3 mm in diameter allowing a liquid flow rate of $0,24 \pm 0,02$ l/minute at an operating pressure of 6,0 bars $-/+ 0,5$ bar.

Under these operation conditions the fan pattern obtained shall be $170 \text{ mm} \pm 50 \text{ mm}$ in diameter on the surface exposed to deterioration, at a distance of $380 \text{ mm} \pm 10 \text{ mm}$ from the nozzle.

1.2. Test mixture

The test mixture shall be composed of:

Silica sand of hardness 7 on the Mohr scale, with a grain size between 0 and 0,2 mm and an almost normal distribution, with an angular factor of 1,8 to 2;

Water of hardness not exceeding 205 g/m^3 for a mixture comprising 25 g of sand per litre of water.

2. TEST

The outer surface of the lamp lenses shall be subjected once or more than once to the action of the sand jet produced as described above. The jet shall be sprayed almost perpendicular to the surface to be tested.

The deterioration shall be checked by means of one or more samples of glass placed as a reference near the lenses to be tested. The mixture shall be sprayed until the variation in the diffusion of light on the sample or samples measured by the method described in Appendix 2, is such that:

$$\Delta d = \frac{T_1 - T_4}{T_2} = 0,0250 \pm 0,0025$$

Several reference samples may be used to check that the whole surface to be tested has deteriorated homogeneously.

APPENDIX 4

ADHESIVE TAPE ADHERENCE TEST**1. PURPOSE**

This method allows to determine under standard conditions the linear force of adhesion of an adhesive tape to a glass plate.

2. PRINCIPLE

Measurement of the force necessary to unstick an adhesive tape from a glass plate at an angle of 90°.

3. SPECIFIED ATMOSPHERIC CONDITIONS

The ambient conditions shall be at $23\text{ °C} \pm 5\text{ °C}$ and 65 ± 15 per cent RH.

4. TEST PIECES

Before the test, the sample roll of adhesive tape shall be conditioned for 24 hours in the specified atmosphere (see paragraph 3 above).

Five test pieces each 400 mm long shall be tested from each roll. These test pieces shall be taken from the roll after the first three turns were discarded.

5. PROCEDURE

The test shall be under the ambient conditions specified in paragraph 3.

Take the five test pieces while unrolling the tape radially at a speed of approximately 300 mm/s, then apply them within 15 seconds in the following manner:

Apply the tape to the glass plate progressively with a slight length-wise rubbing movement of the finger, without excessive pressure, in such a manner as to leave no air bubble between the tape and the glass plate.

Leave the assembly in the specified atmospheric conditions for 10 minutes.

Unstick about 25 mm of the test piece from the plate in a plane perpendicular to the axis of the test piece.

Fix the plate and fold back the free end of the tape at 90°. Apply force in such a manner that the separation line between the tape and the plate is perpendicular to this force and perpendicular to the plate.

Pull to unstick at a speed of $300\text{ mm/s} \pm 30\text{ mm/s}$ and record the force required.

6. RESULTS

The five values obtained shall be arranged in order and the median value taken as a result of the measurement. This value shall be expressed in Newtons per centimetre of width of the tape.

ANNEX 7

MINIMUM REQUIREMENTS FOR SAMPLING BY AN INSPECTOR

1. GENERAL

1.1. The conformity requirements shall be considered satisfied from a mechanical and a geometrical standpoint in accordance with the requirements of this Regulation, if any, if the differences do not exceed inevitable manufacturing deviations. This condition also applies to colour.

1.2. With respect to photometric performances, the conformity of mass-produced headlamps shall not be contested if, when testing photometric performances of any headlamp chosen at random and equipped with a standard filament lamp and/or LED module(s) present in the headlamp:

1.2.1. no measured value deviates unfavourably by more than 20 per cent from the value prescribed in this Regulation. For values B 50 L (or R) and zone III, the maximum unfavourable deviation may be respectively:

B 50 L (or R):	0,2 lx equivalent 20 per cent
	0,3 lx equivalent 30 per cent
Zone III:	0,3 lx equivalent 20 per cent
	0,45 lx equivalent 30 per cent

1.2.2. or if

1.2.2.1. for the passing beam, the values prescribed in this Regulation are met at HV (with a tolerance of 0,2 lx) and related to that aiming at least one point of each area delimited on the measuring screen (at 25 m) by a circle 15 cm in radius around points B 50 L (or R) (with a tolerance of 0,1 lx), 75 R (or L), 50 V, 25 R, 25 L, and in the entire area of zone IV which is not more than 22,5 cm above line 25 R and 25 L;

1.2.2.2. and if, for the driving beam, HV being situated within the isolux 0,75 $E_{\max}$, a tolerance of + 20 per cent for maximum values and – 20 per cent for minimum values is observed for the photometric values at any measuring point specified in paragraph 6.3.2 of this Regulation. The reference mark is disregarded.

1.2.3. If the results of the test described above do not meet the requirements, the alignment of the headlamp may be changed, provided that the axis of the beam is not displaced laterally by more than 1° to the right or left.

1.2.4. If the results of the tests described above do not meet the requirements, tests shall be repeated using another standard filament lamp and/or LED module(s) present in the headlamp

1.2.5. Headlamps with apparent defects are disregarded.

1.2.6. The reference mark is disregarded.

1.3. If, however, vertical adjustment cannot be performed repeatedly to the required position within the tolerances described in paragraph 6.2.2.3 of this Regulation, one sample shall be tested according to the procedure described in paragraphs 2 and 3 of Annex 9.

2. FIRST SAMPLING

In the first sampling four headlamps are selected at random. The first sample of two is marked A, the second sample of two is marked B.

2.1. The conformity is not contested

2.1.1. Following the sampling procedure shown in Figure 1 of this Annex the conformity of mass-produced headlamps shall not be contested if the deviations of the measured values of the headlamps in the unfavourable directions are:

2.1.1.1. sample A

A1:	one headlamp		0 per cent
	one headlamp	not more than	20 per cent
A2:	both headlamps	more than	0 per cent
	but	not more than	20 per cent
	go to sample B		

2.1.1.2. sample B

B1: both headlamps 0 per cent

2.1.2. or if the conditions of paragraph 1.2.2 for sample A are fulfilled.

2.2. The conformity is contested

2.2.1. Following the sampling procedure shown in Figure 1 of this Annex the conformity of mass-produced headlamps shall be contested and the manufacturer requested to make his production meet the requirements (alignment) if the deviations of the measured values of the headlamps are:

2.2.1.1. sample A

A3:	one headlamp	not more than	20 per cent
	one headlamp	more than	20 per cent
	but	not more than	30 per cent

2.2.1.2. sample B

B2:	in the case of A2		
	one headlamp	more than	0 per cent
	but	not more than	20 per cent
	one headlamp	not more than	20 per cent

B3:	in the case of A2		
	one headlamp		0 per cent
	one headlamp	more than	20 per cent
	but	not more than	30 per cent

2.2.2. or if the conditions of paragraph 1.2.2 for sample A are not fulfilled.

2.3. Approval withdrawn

Conformity shall be contested and paragraph 11 applied if, following the sampling procedure shown in Figure 1 of this Annex, the deviations of the measured values of the headlamps are:

2.3.1. sample A

A4:	one headlamp	not more than	20 per cent
	one headlamp	more than	30 per cent

A5:	Both headlamps	more than	20 per cent
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2.3.2. sample B

B4:	in the case of A2		
	one headlamp	more than	0 per cent
	but	not more than	20 per cent
	one headlamp	more than	20 per cent

B5:	in the case of A2		
	both headlamps	more than	20 per cent

B6:	in the case of A2		
	one headlamp		0 per cent
	one headlamp	more than	30 per cent

2.3.3. or if the conditions of paragraph 1.2.2 for samples A and B are not fulfilled.

3. REPEATED SAMPLING

In the case of A3, B2, B3 a repeated sampling, third sample C of two headlamps, selected from stock manufactured after alignment, is necessary within two months' time after the notification.

3.1. The conformity is not contested

3.1.1. Following the sampling procedure shown in Figure 1 of this Annex the conformity of mass-produced headlamps shall not be contested if the deviations of the measured values of the headlamps are:

3.1.1.1. sample C

C1:	one headlamp		0 per cent
	one headlamp	not more than	20 per cent
C2:	both headlamps	more than	0 per cent
	but	not more than	20 per cent
	go to sample D		

3.1.1.2. sample D

D1:	in the case of C2		
	both headlamps		0 per cent

3.1.2. or if the conditions of paragraph 1.2.2 for sample C are fulfilled.

3.2. The conformity is contested

3.2.1. Following the sampling procedure shown in Figure 1 of this Annex the conformity of mass-produced headlamps shall be contested and the manufacturer requested to make his production meet the requirements (alignment) if the deviations of the measured values of the headlamps are:

3.2.1.1. sample D

D2:	in the case of C2		
	one headlamp	more than	0 per cent
	but	not more than	20 per cent
	one headlamp	not more than	20 per cent

3.2.1.2. or if the conditions of paragraph 1.2.2 for sample C are not fulfilled.

3.3. Approval withdrawn

Conformity shall be contested and paragraph 11 applied if, following the sampling procedure shown in Figure 1 of this Annex, the deviations of the measured values of the headlamps are:

3.3.1. sample C

C3:	one headlamp	not more than	20 per cent
	one headlamp	more than	20 per cent
C4:	both headlamps	more than	20 per cent

3.3.2. sample D

D3:	in the case of C2		
	one headlamp	0 or more than	0 per cent
	one headlamp	more than	20 per cent

3.3.3. or if the conditions of paragraph 1.2.2 for samples C and D are not fulfilled.

4. CHANGE OF THE VERTICAL POSITION OF THE CUT-OFF LINE

With respect to the verification of the change in vertical position of the cut-off line under the influence of heat, the following procedure shall be applied:

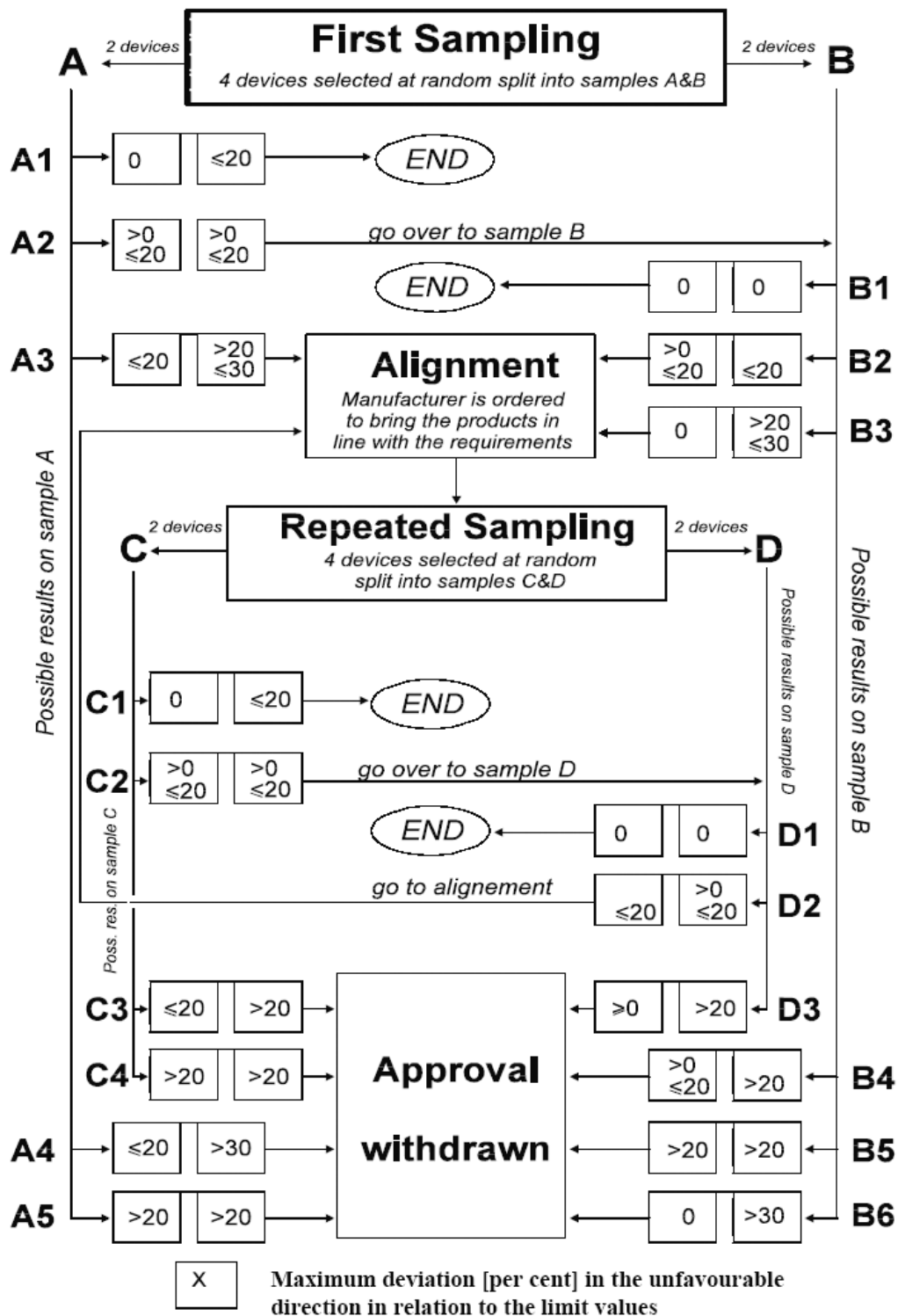
One of the headlamps of sample A after sampling procedure in Figure 1 of this Annex shall be tested according to the procedure described in paragraph 2.1 of Annex 4 after being subjected three consecutive times to the cycle described in paragraph 2.2.2 of Annex 4.

The headlamp shall be considered as acceptable if Δr does not exceed 1,5 mrad.

If this value exceeds 1,5 mrad but is not more than 2,0 mrad, the second headlamp of sample A shall be subjected to the test after which the mean of the absolute values recorded on both samples shall not exceed 1,5 mrad.

However, if this value of 1,5 mrad on sample A is not complied with, the two headlamps of sample B shall be subjected to the same procedure and the value of Δr for each of them shall not exceed 1,5 mrad.

Figure 1



ANNEX 8

Overview of operational periods concerning tests for stability of photometric performance

Abbreviations: P: passing beam lamp

D: driving beam lamp ($D_1 + D_2$ means two driving beams)

F: front fog lamp

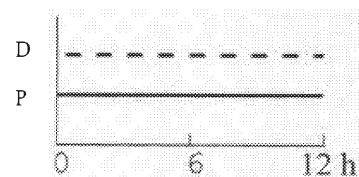
· - - - - -: means a cycle of 15 minutes off and 5 minutes lit.

All following grouped headlamps and front fog lamps together with the added class B marking symbols are given as examples and are not exhaustive.

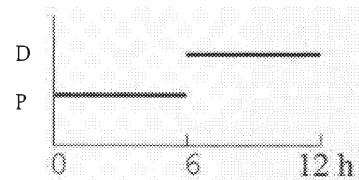
1. P or D or F (HC or HR or B)



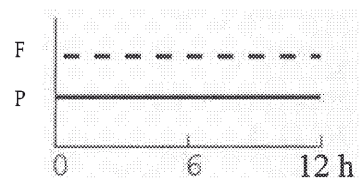
2. P + D (HCR) or P + $D_1 + D_2$ (HCR HR)



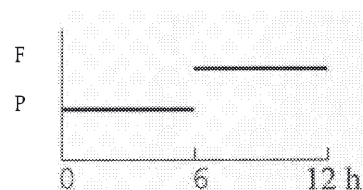
3. P + D (HC/R) or P + $D_1 + D_2$ (HC/R HR)



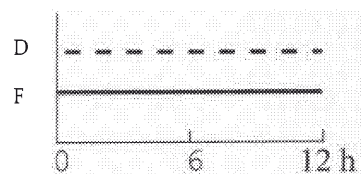
4. P + F (HC B)



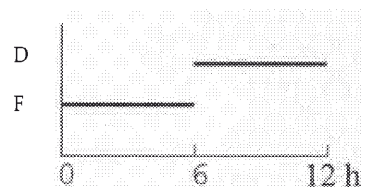
5. P + F (HC B/) or HC/B



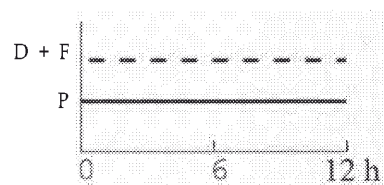
6. $D + F$ (HR B) or $D_1 + D_2 + F$ (HR HR B)



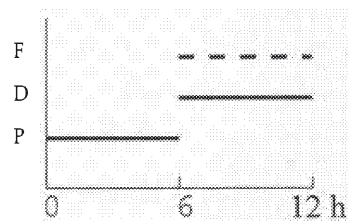
7. $D + F$ (HR B/) or $D_1 + D_2 + F$ (HR HR B/)



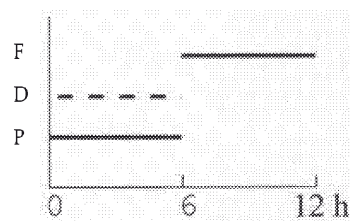
8. $P + D + F$ (HCR B) or $P + D_1 + D_2 + F$ (HCR HR B)



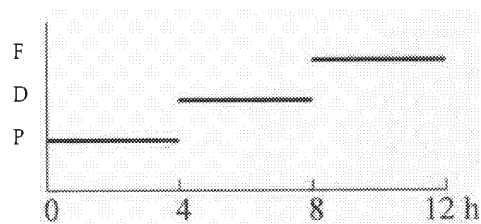
9. $P + D + F$ (HC/R B) or $P + D_1 + D_2 + F$ (HC/R HR B)



10. $P + D + F$ (HCR B/) or $P + D_1 + D_2 + F$ (HCR HR B/)



11. $P + D + F$ (HC/R B/) or $P + D_1 + D_2 + F$ (HC/R HR B/)



ANNEX 9

Instrumental verification of the 'cut-off' for passing beam headlamps

1. GENERAL

In the case where paragraph 6.2.2.4 of this Regulation applies, the quality of the 'cut-off' shall be tested according to the requirements set out in paragraph 2 below and the instrumental vertical and horizontal adjustment of the beam shall be performed according to the requirements set out in paragraph 3 below.

Before carrying out the measurement of the quality of 'cut-off' and the instrumental aiming procedure, a visual pre-aim in accordance with paragraphs 6.2.2.1 and 6.2.2.2 of this Regulation is required.

2. MEASUREMENT OF THE QUALITY OF THE 'CUT-OFF'

To determine the minimum sharpness, measurements shall be performed by vertically scanning through the horizontal part of the 'cut-off' in angular steps of $0,05^\circ$ at either a measurement distance of:

(a) 10 m with a detector having a diameter of approximately 10 mm; or

(b) 25 m with a detector having a diameter of approximately 30 mm.

The measuring distance at which the test was carried out shall be recorded in item 9 of the communication form (see Annex 1 of this Regulation).

To determine the maximum sharpness, measurements shall be performed by vertically scanning through the horizontal part of the 'cut-off' in angular steps of $0,05^\circ$ exclusively at a measurement distance of 25 m and with a detector having a diameter of approximately 30 mm.

The 'cut-off' quality shall be considered acceptable if the requirements of paragraph 2.1 to 2.3 below comply with at least one set of measurements.

2.1. Not more than one 'cut-off' shall be visible ⁽¹⁾

2.2. Sharpness of 'cut-off'

The sharpness factor G is determined by scanning vertically through the horizontal part of the 'cut-off' at $2,5^\circ$ from the V-V where:

$G = (\log E_\beta - \log E_{(\beta + 0,1^\circ)})$ where β = the vertical position in degrees.

The value of G shall not be less than 0,13 (minimum sharpness) and not greater than 0,40 (maximum sharpness).

2.3. Linearity

The part of the horizontal 'cut-off' that serves for vertical adjustment shall be horizontal between $1,5^\circ$ and $3,5^\circ$ from the V-V line (see figure 1).

The inflection points of the 'cut-off' gradient at the vertical lines at $1,5^\circ$, $2,5^\circ$ and $3,5^\circ$ shall be determined by the equation:

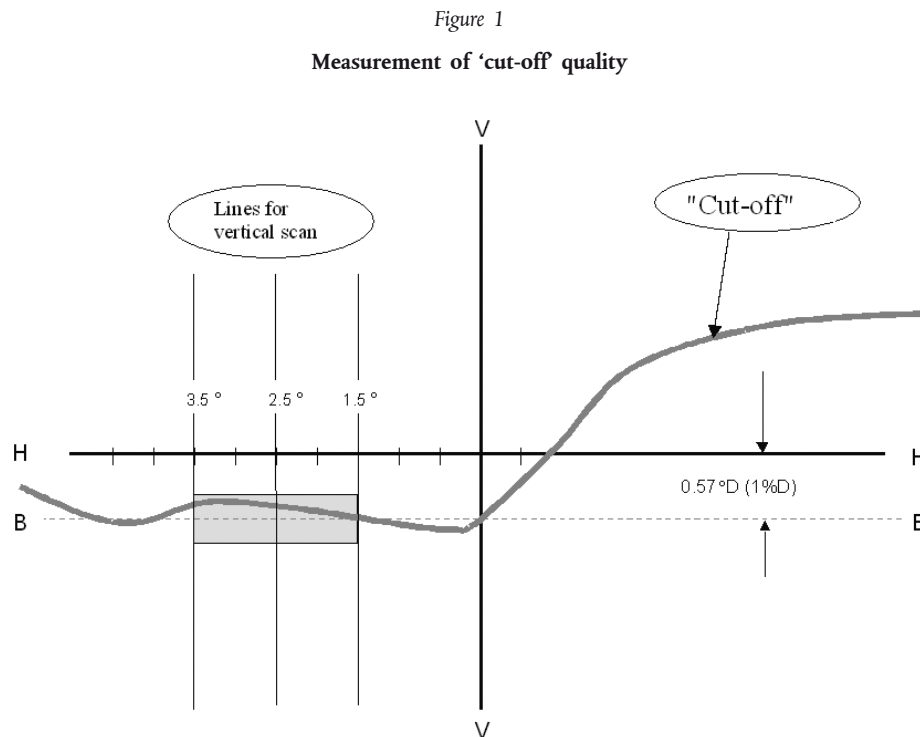
$$(d^2 (\log E)/d\beta^2 = 0)$$

The maximum vertical distance between the inflection points determined shall not exceed $0,2^\circ$.

⁽¹⁾ This paragraph should be amended when an objective test method is available.

3. VERTICAL AND HORIZONTAL ADJUSTMENT

If the 'cut-off' complies with the quality requirements of paragraph 2 of this Annex, the beam adjustment may be performed instrumentally.



Note: The scales are different for vertical and horizontal lines.

3.1. Vertical adjustment

Moving upward from below the line B (see figure 2 below), a vertical scan is carried out through the horizontal part of the 'cut-off' at $2,5^\circ$ from V-V. The inflection point (where $d^2 (\log E)/dv^2 = 0$) is determined and positioned on the line B situated one per cent below H-H.

3.2. Horizontal adjustment

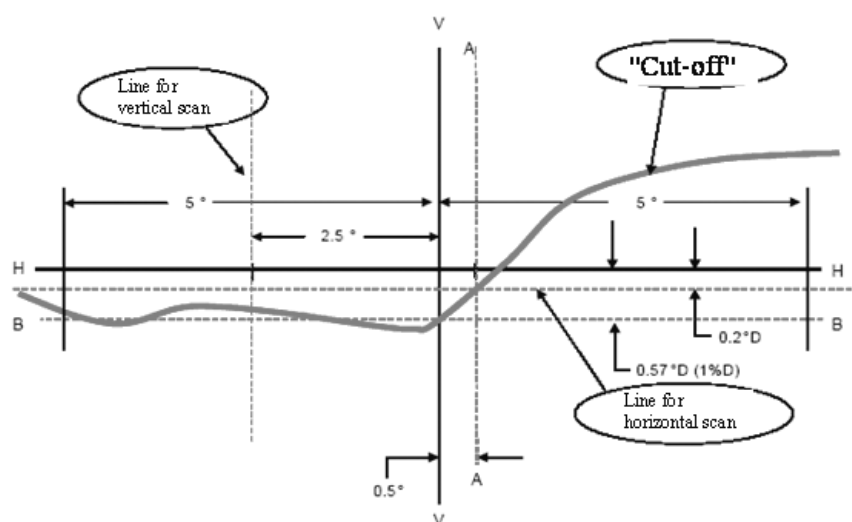
The applicant shall specify one of the following horizontal aim methods:

- (a) The '0,2 D line' method (see figure 2 below).

A single horizontal line at $0,2^\circ$ D shall be scanned from 5° left to 5° right after the lamp has been aimed vertically. The maximum gradient 'G' determined using the formula $G = (\log E_\beta - \log E_{(\beta + 0,1^\circ)})$ where β is the horizontal position in degrees, shall not be less than 0,08.

The inflection point found on the 0,2 D line shall be positioned on the line A.

Figure 2

Instrumental vertical and horizontal adjustment — horizontal line scan method

Note: The scales are different for vertical and horizontal lines.

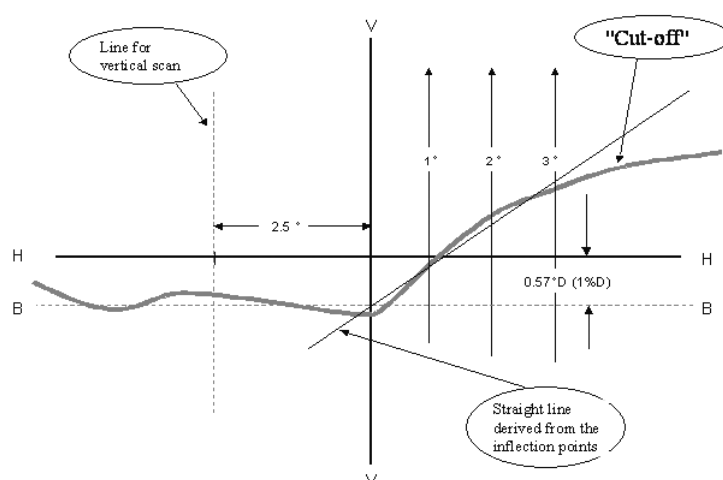
(b) The '3 line' method (see figure 3)

Three vertical lines shall be scanned from 2° D to 2° U at 1°R, 2°R, and 3°R after the lamp has been aimed vertically. The respective maximum gradients 'G' determined using the formula:

$$G = (\log E_{\beta} - \log E_{(\beta + 0.1^{\circ})})$$

where β is the vertical position in degrees, shall not be less than 0,08. The inflection points found on the three lines shall be used to derive a straight line. The intersection of this line and the line B found while performing vertical aim shall be placed on the V line.

Figure 3

Instrumental vertical and horizontal adjustment — three line scan method

Note: The scales are different for vertical and horizontal lines.

ANNEX 10

REQUIREMENTS FOR LED MODULES AND HEADLAMPS INCLUDING LED MODULES**1. GENERAL SPECIFICATIONS**

- 1.1. Each LED module sample submitted shall conform to the relevant specifications of this Regulation when tested with the supplied electronic light source control-gear(s), if any.
- 1.2. LED module(s) shall be so designed as to be and to remain in good working order when in normal use. They shall moreover exhibit no fault in design or manufacture. A LED module shall be considered to have failed if any one of its LEDs has failed.
- 1.3. LED module(s) shall be tamperproof.
- 1.4. The design of removable LED module(s) shall be such that:
 - 1.4.1. when the LED module is removed and replaced by another module provided by the applicant and bearing the same light source module identification code, the photometric specifications of the headlamp shall be met;
 - 1.4.2. LED modules with different light source module identification codes within the same lamp housing, shall not be interchangeable.

2. MANUFACTURE

- 2.1. The LED(s) on the LED module shall be equipped with suitable fixation elements.
- 2.2. The fixation elements shall be strong and firmly secured to the LED(s) and the LED module.

3. TEST CONDITIONS**3.1. Application**

- 3.1.1. All samples shall be tested as specified in paragraph 4 below.
- 3.1.2. The kind of light sources on a LED module shall be light-emitting diodes (LED) as defined in Regulation No 48 paragraph 2.7.1 in particular with regard to the element of visible radiation. Other kinds of light sources are not permitted.

3.2. Operating conditions**3.2.1. LED module operating conditions**

All samples shall be tested under the conditions as specified in paragraphs 6.1.4 and 6.1.5 of this Regulation. If not specified differently in this Annex LED modules shall be tested inside the headlamp as submitted by the manufacturer.

3.2.2. Ambient temperature

For the measurement of electrical and photometric characteristics, the headlamp shall be operated in a dry and still atmosphere at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$.

3.3. Ageing

Upon the request of the applicant the LED module shall be operated for 15 h and cooled down to ambient temperature before starting the tests as specified in this Regulation.

4. SPECIFIC REQUIREMENTS AND TESTS

4.1. Colour rendering

4.1.1. Red content

In addition to measurements as described in paragraph 7 of this Regulation:

The minimum red content of the light of a LED module or headlamp incorporating LED module(s) tested at 50 V shall be such that:

$$k_{\text{red}} = \frac{\int_{\lambda=610 \text{ nm}}^{780 \text{ nm}} E_e(\lambda) V(\lambda) d\lambda}{\int_{\lambda=380 \text{ nm}}^{780 \text{ nm}} E_e(\lambda) V(\lambda) d\lambda} \geq 0,05$$

where:

$E_e(\lambda)$ (unit: W) is the spectral distribution of the irradiance;

$V(\lambda)$ (unit: 1) is the spectral luminous efficiency;

λ (unit: nm) is the wavelength.

This value shall be calculated using intervals of one nanometre.

4.2. UV-radiation

The UV-radiation of a low-UV-type LED module shall be such that:

$$k_{\text{UV}} = \frac{\int_{\lambda=250 \text{ nm}}^{400 \text{ nm}} E_e(\lambda) S(\lambda) d\lambda}{k_m \int_{\lambda=380 \text{ nm}}^{780 \text{ nm}} E_e(\lambda) V(\lambda) d\lambda} \leq 10^{-5} \text{ W/lm}$$

where:

$S(\lambda)$ (unit: 1) is the spectral weighting function;

$k_m = 683 \text{ lm/W}$ is the maximum value of the luminous efficacy of radiation.

(For definitions of the other symbols see paragraph 4.1.1 above).

This value shall be calculated using intervals of one nanometre. The UV-radiation shall be weighted according to the values as indicated in the Table UV below:

λ	$S(\lambda)$	λ	$S(\lambda)$	λ	$S(\lambda)$
250	0,430	305	0,060	355	0,00016
255	0,520	310	0,015	360	0,00013
260	0,650	315	0,003	365	0,00011
265	0,810	320	0,001	370	0,00009
270	1,000	325	0,00050	375	0,000077
275	0,960	330	0,00041	380	0,000064
280	0,880	335	0,00034	385	0,000530
285	0,770	340	0,00028	390	0,000044
290	0,640	345	0,00024	395	0,000036
295	0,540	350	0,00020	400	0,000030
300	0,300				

Table UV: Values according to 'IRPA/INIRC Guidelines on limits of exposure to ultraviolet radiation'. Wavelengths (in nanometres) chosen are representative; other values should be interpolated.

4.3. Temperature stability

4.3.1. Illuminance

- 4.3.1.1. A photometric measurement of the headlamp shall be made after 1 minute of operation for the specific function at the test point specified below. For these measurements, the aim can be approximate but must be maintained for before and after ratio measurements.

Test points to be measured:

Passing beam 50 V

Driving beam H – V

- 4.3.1.2. The lamp shall continue operation until photometric stability has occurred. The moment at which the photometry is stable is defined as the point in time at which the variation of the photometric value is less than 3 per cent within any 15 minute period. After stability has occurred, aim for complete photometry shall be performed in accordance with the requirements of the specific device. Photometer the lamp at all test points required for the specific device.

- 4.3.1.3. Calculate the ratio between the photometric test point value determined in paragraph 4.3.1.1 and the point value determined in paragraph 4.3.1.2.

- 4.3.1.4. Once stability of photometry has been achieved, apply the ratio calculated above to each of the remainder of the test points to create a new photometric table that describes the complete photometry based on one minute of operation.

- 4.3.1.5. The illuminance values, measured after one minute and after photometric stability has occurred, shall comply with the minimum and maximum requirements.

4.3.2. Colour

The colour of the light emitted measured after one minute and measured after photometric stability has been obtained, as described in paragraph 4.3.1.2 of this Annex, shall both be within the required colour boundaries.

5. The measurement of the objective luminous flux of LED module(s) producing the principal passing beam shall be carried out as follows:

- 5.1. The LED module(s) shall be in the configuration as described in the technical specification as defined in paragraph 2.2.2 of this Regulation. Optical elements (secondary optics) shall be removed by the technical service at the request of the applicant by the use of tools. This procedure and the conditions during the measurements as described below shall be described in the test report.

- 5.2. Three LED modules of each type shall be submitted by the applicant with the light source control gear, if applicable, and sufficient instructions.

Suitable thermal management (e.g. heat sink) may be provided, to simulate similar thermal conditions as in the corresponding headlamp application.

Before the test each LED module shall be aged at least for seventy-two hours under the same conditions as in the corresponding headlamp application.

In the case of use of an integrating sphere, the sphere shall have a minimum diameter of one meter, and at least ten times the maximum dimension of the LED module, whichever is the largest. The flux measurements can also be performed by integration using a goniophotometer. The prescriptions in CIE — Publication 84 — 1989, regarding the room temperature, positioning, etc., shall be taken into consideration.

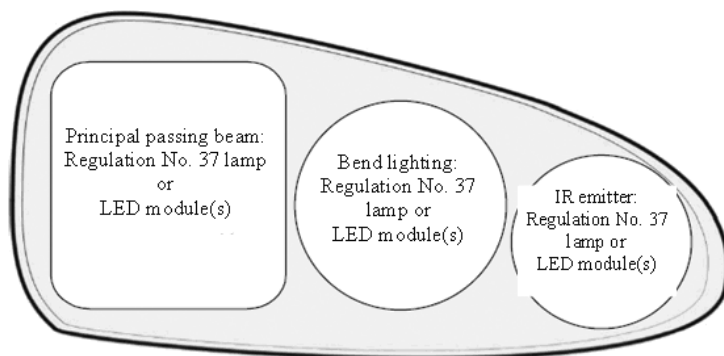
The LED module shall be burned in for approximately one hour in the closed sphere or goniophotometer.

The flux shall be measured after stability has occurred, as explained in paragraph 4.3.1.2 of Annex 10 to this Regulation.

The average of the measurements of the three samples of each type of LED module shall be deemed to be its objective luminous flux.

ANNEX 11

A general illustration for principal passing beam and beam contributors and correlated light source options



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