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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/wp29fdocstts.html>

UN Regulation No 48 – Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices [2021/1718]**Incorporating all valid text up to:**

Supplement 1 to the 07 series of amendments - Date of entry into force: 30 September 2021

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1. SCOPE

This Regulation applies to vehicles of categories M, N, and to their trailers (category O) ⁽¹⁾ with regard to the installation of lighting and light-signalling devices.

2. DEFINITIONS

2.1. General

2.1.1. The definitions given in this Regulation and its series of amendments in force at the time of application for type approval shall apply to the Light-Signalling Devices (LSD), Road Illumination Devices (RID) and Retro-Reflective Devices (RRD) Regulations.

2.1.2. References to standard (étalon) light source(s) shall refer to Regulations Nos. 37, 99 and 128 respectively, and to their series of amendments in force at the time of application for type approval.

2.1.3. "Approval of a vehicle" means the approval of a vehicle type with regard to the number and mode of installation of the lighting and light-signalling devices.

2.1.4. "Device" means an element or an assembly of elements used to perform one or more functions.

2.1.4.1. "Lighting function" means the light emitted by a device to illuminate the road and objects in the direction of vehicle movement.

2.1.4.2. "Light-signalling function" means the light emitted or reflected by a device to give to other road users visual information on the presence, identification and/or the change of movement of the vehicle.

2.1.5. "Lamp" means a device designed to illuminate the road or to emit a light signal to other road users. Rear registration plate lamps and retro-reflectors are likewise to be regarded as lamps. For the purpose of this Regulation, light-emitting rear registration plates, the service-door-lighting system according to the provisions of UN Regulation No. 107 on vehicles of categories M₂ and M₃ and external status indicator as defined in this Regulation are not considered as lamps.

2.1.6. "Change index" means a sequential number, starting from 0, specific to each lamp (function) covered by UN Regulations No. 148, No. 149 and No. 150. It indicates the number of times that the new series of amendments to the pertinent UN Regulation (No. 148, No. 149 and No. 150) have introduced higher stringency requirements for this lamp (function)."

2.2. Type definitions

2.2.1. "Vehicle type with regard to the installation of lighting and light-signalling devices" means vehicles which do not differ in the essential respects mentioned in paragraphs 2.2.1.1. to 2.2.1.4.

The following are likewise considered not to be "vehicles of a different type": vehicles which differ within the meaning of paragraphs 2.2.1.1. to 2.2.1.4., but not in such a way as to entail a change in the kind, number, positioning and geometric visibility of the lamps and the inclination of the dipped-beam prescribed for the vehicle type in question, and vehicles on which optional lamps are fitted or are absent:

2.2.1.1. The dimension and the external shape of the vehicle;

2.2.1.2. The number and positioning of the devices;

2.2.1.3. The headlamp-levelling system;

⁽¹⁾ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6, para. 2 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

- 2.2.1.4. The suspension system.
- 2.3. Vehicle
- 2.3.1. "*Unladen vehicle*" means a vehicle without driver, crew, passengers and load, but with a full supply of fuel, spare wheel and the tools normally carried.
- 2.3.2. "*Laden vehicle*" means a vehicle loaded to its technically permissible maximum mass, as stated by the manufacturer, who shall also fix the distribution of this mass between the axles in accordance with the method described in Annex 5.
- 2.3.3. "*Extreme outer edge*" on either side of the vehicle, means the plane parallel to the median longitudinal plane of the vehicle and touching its lateral outer edge, disregarding the projection:
- 2.3.3.1. Of tyres near their point of contact with the ground, and of connections for tyre-pressure gauges;
- 2.3.3.2. Of any anti-skid devices mounted on the wheels;
- 2.3.3.3. Of devices for indirect vision;
- 2.3.3.4. Of side direction-indicator lamps, end-outline marker lamps, front and rear position lamps, parking lamps, retro-reflectors and side-marker lamps.
- 2.3.3.5. Of customs seals affixed to the vehicle, and of devices for securing and protecting such seals.
- 2.3.3.6. Of service-door lighting systems on vehicles of categories M₂ and M₃ as specified in paragraph 2.1.5.
- 2.3.4. "*Overall dimensions*" means the distance between the two vertical planes defined in paragraph 2.3.3. above.
- 2.3.4.1. "*Overall width*" means the distance between the two vertical planes defined in paragraph 2.3.3. above.
- 2.3.4.2. "*Overall length*" means the distance between the two vertical planes perpendicular to the median longitudinal plane of the vehicle and touching its front and rear outer edge, disregarding the projection:
- (a) Of devices for indirect vision;
- (b) Of end-outline marker lamps;
- (c) Of coupling devices, in the case of motor vehicles.
- For trailers in the "*overall length*" and in any measurement in length the drawbar shall be included, except when specifically excluded.
- 2.3.5. "*Operating tell-tale*" means a visual or auditory signal (or any equivalent signal) indicating that a device has been switched ON and is operating correctly or not.
- 2.3.6. "*Closed-circuit tell-tale*" means a visual (or any equivalent signal) indicating that a device has been switched ON, but not indicating whether it is operating correctly or not.
- 2.3.7. "*Ground*" means the surface on which the vehicle stands which should be substantially horizontal.
- 2.3.8. "*Movable components*" of the vehicle mean those body panels or other vehicle parts the position(s) of which can be changed by tilting, rotating or sliding without the use of tools. They do not include tiltable driver cabs of trucks.

- 2.3.9. "Normal position of use of a movable component" means the position(s) of a movable component specified by the vehicle manufacturer for the normal condition of use and the park condition of the vehicle.
- 2.3.10. "Normal condition of use of a vehicle" means:
- 2.3.10.1. For a motor vehicle, when the vehicle is ready to move with its propulsion system running and its movable components are in the normal position(s) as defined in paragraph 2.3.9.;
- 2.3.10.2. And for a trailer, when the trailer is connected to a drawing motor vehicle in the conditions as prescribed in paragraph 2.3.10.1. and its movable components are in the normal position(s) as defined in paragraph 2.3.9.
- 2.3.11. "Park condition of a vehicle" means:
- 2.3.11.1. For a motor vehicle, when the vehicle is at standstill and its propulsion system is not running and its movable components are in the normal position(s) as defined in paragraph 2.3.9.;
- 2.3.11.2. And for a trailer, when the trailer is connected to a drawing motor vehicle in the condition as described in paragraph 2.3.11.1. and its movable components are in the normal position(s) as defined in paragraph 2.3.9.
- 2.4. Lamps generalities
- 2.4.1. "Equivalent lamps" means lamps having the same function and authorized in the country in which the vehicle is registered; such lamps may have different characteristics from those installed on the vehicle when it is approved on condition that they satisfy the requirements of this Regulation.
- 2.4.2. "Independent lamps" means devices having separate apparent surfaces in the direction of the reference axis, ⁽²⁾ separate light sources and separate lamp bodies.
- 2.4.3. "Grouped lamps" means devices having separate apparent surfaces in the direction of the reference axis² and separate light sources, but a common lamp body.
- 2.4.4. "Combined lamps" means devices having separate apparent surfaces in the direction of the reference axis², but a common light source and a common lamp body.
- 2.4.5. "Reciprocally incorporated lamps" means devices having separate light sources or a single light source operating under different conditions (for example, optical, mechanical, electrical differences), totally or partially common apparent surfaces in the direction of the reference axis² and a common lamp body. ⁽³⁾
- 2.4.6. "Single-function lamp" means a part of a device which performs a single lighting or light-signalling function.
- 2.4.7. "Concealable lamp" means a lamp capable of being partly or completely hidden when not in use. This result may be achieved by means of a movable cover, by displacement of the lamp or by any other suitable means. The term "retractable" is used more particularly to describe a concealable lamp the displacement of which enables it to be inserted within the bodywork.

⁽²⁾ In the case of lighting devices for the rear registration plate and direction-indicators of categories 5 and 6, the "light-emitting surface" shall be used.

⁽³⁾ Examples to enable a decision regarding reciprocal incorporation of lamps can be found in Annex 3, Part 7.

- 2.4.8. "*Distance between two lamps*" which face in the same direction means the shortest distance between the two apparent surfaces in the direction of the reference axis. Where the distance between the lamps clearly meets the requirements of the Regulation, the exact edges of apparent surfaces need not be determined.
- 2.4.9. "*Optional lamp*" means a lamp, the installation of which is left to the discretion of the manufacturer.
- 2.4.10. "*Pair*" means the set of lamps of the same function on the left- and right-hand side of the vehicle.
- 2.4.10.1. "*Matched pair*" means the set of lamps of the same function on the left- and right-hand side of the vehicle, which, as a pair, complies with the photometric requirements.
- 2.4.11. "*Single and multiple lamps*"
- 2.4.11.1. "*A single lamp*" means:
- (a) A device or part of a device having one lighting or light-signalling function, one or more light source(s) and one apparent surface in the direction of the reference axis, which may be a continuous surface or composed of two or more distinct parts; or
 - (b) Any assembly of two lamps marked "D", whether identical or not, having the same function; or
 - (c) Any assembly of two independent retro-reflectors, whether identical or not, that have been approved separately; or
 - (d) Any interdependent lamp system composed of two or three interdependent lamps marked "Y" approved together and providing the same function.
- 2.4.11.2. "*Two lamps*" or "*an even number of lamps*" in the shape of a band or strip, means two lamps with a single light emitting surface, providing such a band or strip is placed symmetrically in relation to the median longitudinal plane of the vehicle.
- 2.4.12. "*Interdependent lamp system*" means an assembly of two or three interdependent lamps providing the same function.
- 2.4.12.1. "*Interdependent lamp marked "Y"*" means a device operating as part of an interdependent lamp system. Interdependent lamps operate together when activated, have separate apparent surfaces in the direction of the reference axis and separate lamp bodies, and may have separate light source(s).
- 2.4.13. "*Lamps marked "D"*" means independent lamps, approved as separate devices in such a way that they are allowed to be used either independently or in an assembly of two lamps to be considered as a "single lamp".
- 2.4.14. Headlamps of different "Classes" mean headlamps identified by particular photometric provisions.
- 2.4.15. Definitions with regard to Headlamps emitting a driving-beam and/or a symmetrical passing-beam for vehicles of categories L and T:
- 2.4.15.1. "*Additional lighting unit*" means the part of a headlamp system that provides the bend lighting. It is independent from the device that provides the principal passing beam, may consist of optical, mechanical and electrical components, and it may be grouped and/or reciprocally incorporated with other lighting or light-signalling devices.

2.4.16. Definitions with regard to retro-reflectors:

2.4.16.1. "*Retro-reflection*" means the reflection in which radiation is returned in directions close to the direction from which it came, this property being maintained even over wide variations of the direction of the incident radiation:

2.4.16.2. "*Retro-reflective device*" means an assembly ready for use and comprising one or more retro-reflective optical units; Retro-reflective devices are divided into classes according to their photometric characteristics: Class IA or IB, Class IIIA or IIIB, and Class IVA. Retro-reflective devices of Classes IB and IIIB are devices combined with other signal lamps which are not watertight and which are integrated into the body of a vehicle.

2.4.17. Definition with regard to Retro-reflective marking:

2.4.17.1. "*Retro-reflective marking material*" means a surface or a device from which, when directionally illuminated, a relatively large portion of the incident radiation is retro-reflected.

2.4.17.2. "*Rear marking plate*" means a plate faced with retro-reflective and fluorescent material or devices intended to increase the visibility and permit easy identification of heavy and long vehicles.

2.4.17.3. "*Slow moving vehicle (SMV) rear marking plate*" means a triangular plate with truncated corners with a characteristic pattern faced with retro-reflectors or retro-reflective materials or fluorescent material.

2.4.17.4. "*Sample unit*" means a complete retro-reflective device ready to be mounted on a vehicle and representative of current production.

2.4.17.5. "*Fluorescence*" means when certain substances are brought near to a source of ultraviolet or blue radiations, they emit radiations which are nearly always of longer wave-length than those producing the effect. This phenomenon is called fluorescence. By day and in twilight, fluorescent colours are brighter than normal colours because they reflect part of the light falling upon them, and in addition they emit light. At night they are not brighter than ordinary colours.

2.5. Lamps

2.5.1. "*Driving-beam (main-beam) headlamp*" means the lamp used to illuminate the road over a long distance ahead of the vehicle.

2.5.2. "*Passing-beam (dipped-beam) headlamp*" means the lamp used to illuminate the road ahead of the vehicle without causing undue dazzle or discomfort to oncoming drivers and other road-users.

2.5.2.1. "*Principal passing-beam (principal dipped-beam)*" means the dipped-beam produced without the contribution of infrared (IR) emitter and/or additional light sources for bend lighting.

2.5.3. "*Direction-indicator lamp*" means the lamp used to indicate to other road-users that the driver intends to change direction to the right or to the left. A direction-indicator lamp or lamps may also be used according to the provisions of UN Regulation No. 97 or No. 116.

2.5.4. "*Stop lamp*" means a lamp used to indicate to other road users to the rear of the vehicle that the longitudinal movement of the vehicle is intentionally retarded.

2.5.5. "*Rear-registration plate illuminating device*" means the device used to illuminate the space reserved for the rear registration plate; such a device may consist of several optical components.

- 2.5.6. "*Front position lamp*" means the lamp used to indicate the presence and the width of the vehicle when viewed from the front.
- 2.5.7. "*Rear position lamp*" means the lamp used to indicate the presence and width of the vehicle when viewed from the rear.
- 2.5.8. "*Retro-reflector*" means a device used to indicate the presence of a vehicle by the reflection of light emanating from a light source not connected to the vehicle, the observer being situated near the source.
- For the purposes of this Regulation the following are not considered as retro-reflectors:
- 2.5.8.1. Retro-reflecting number plates;
- 2.5.8.2. The retro-reflecting signals mentioned in the ADR (European Agreement concerning the international carriage of dangerous goods by road);
- 2.5.8.3. Other retro-reflective plates and signals which shall be used to comply with national requirements for use as regards certain categories of vehicles or certain methods of operation;
- 2.5.8.4. Retro-reflecting materials approved as Class D or E or F according to UN Regulations Nos. 104 or No. 150 and used for other purposes in compliance with national requirements."
- 2.5.9. "*Conspicuity marking*" means a device intended to increase the conspicuity of a vehicle, when viewed from the side or rear (or in the case of trailers, additionally from the front), by the reflection of light emanating from a light source not connected to the vehicle, the observer being situated near the source.
- 2.5.9.1. "*Contour marking*" means a conspicuity marking intended to indicate the horizontal and vertical dimensions (length, width and height) of a vehicle.
- 2.5.9.1.1. "*Full contour marking*" means a contour marking that indicates the outline of the vehicle by a continuous line.
- 2.5.9.1.2. "*Partial contour marking*" means a contour marking that indicates the horizontal dimension of the vehicle by a continuous line, and the vertical dimension by marking the upper corners.
- 2.5.9.2. "*Line marking*" means a conspicuity marking intended to indicate the horizontal dimensions (length and width) of a vehicle by a continuous line.
- 2.5.10. "*Front fog lamp*" means a lamp used to improve the illumination of the road ahead of the vehicle in case of fog or any similar condition of reduced visibility.
- 2.5.11. "*Rear fog lamp*" means a lamp used to make the vehicle more easily visible from the rear in dense fog.
- 2.5.12. "*Reversing lamp*" means the lamp used to illuminate the road to the rear of the vehicle and to warn other road-users that the vehicle is reversing or about to reverse.
- 2.5.13. "*Parking lamp*" means a lamp which is used to draw attention to the presence of a stationary vehicle in a built-up area. In such circumstances it replaces the front and rear position lamps.

- 2.5.14. "*End-outline marker lamp*" means the lamp fitted near to the extreme outer edge and as close as possible to the top of the vehicle and intended to indicate clearly the vehicle's overall width. This lamp is intended, for certain vehicles and trailers, to complement the vehicle's front and rear position lamps by drawing particular attention to its bulk.
- 2.5.15. "*Side marker lamp*" means a lamp used to indicate the presence of the vehicle when viewed from the side.
- 2.5.16. "*Daytime running lamp*" means a lamp facing in a forward direction used to make the vehicle more easily visible when driving during daytime.
- 2.5.17. "*Cornering lamp*" means a lamp used to provide supplementary illumination of that part of the road which is located near the forward corner of the vehicle at the side towards which the vehicle is going to turn.
- 2.5.18. "*Exterior courtesy lamp*" means a lamp used to provide supplementary illumination to assist the entry and exit of the vehicle driver and passenger or in loading operations;
- 2.5.19. "*Manoeuvring lamp*" means a lamp used to provide supplementary illumination to the side of the vehicle to assist during slow manoeuvres.
- 2.5.20. "*External status indicator*" means an optical signal mounted on the outside of the vehicle to indicate the status or the change of the status for Vehicle Alarm System (VAS), Alarm System (AS) and immobilizer of UN Regulations No. 97 and No. 116, when the vehicle is parked.
- 2.6. Signal
- 2.6.1. "*Hazard warning signal*" means the simultaneous operation of all of a vehicle's direction-indicator lamps to show that the vehicle temporarily constitutes a special danger to other road users.
- 2.6.2. "*Emergency stop signal*" means a signal to indicate to other road users to the rear of the vehicle that a high retardation force has been applied to the vehicle relative to the prevailing road conditions.
- 2.6.3. "*Rear-end collision alert signal (RECAS)*" means an automatic signal given by the leading vehicle to the following vehicle. It warns that the following vehicle needs to take emergency action to avoid a collision.
- 2.7. System
- 2.7.1. "*Aiming*" means the positioning of the beam or part thereof on an aiming screen according to the relevant criteria;
- 2.7.2. "*Adjustment*" means the use of the means provided by the system for vertical and/or horizontal aiming of the beam;
- 2.7.3. "*Bend lighting*" means a lighting function to provide enhanced illumination in bends.
- 2.7.4. "*Adaptive front lighting system*" (or "*AFS*") means a lighting device type-approved according to UN Regulations Nos. 123 or No. 149, providing beams with differing characteristics for automatic adaptation to varying conditions of use of the dipped-beam (passing-beam) and, if it applies, the main-beam (driving-beam).
- 2.7.4.1. "*Lighting unit*" means a light-emitting component designed to provide or contribute to one or more front lighting function(s) provided by the AFS.

- 2.7.4.2. "*Installation unit*" means an indivisible housing (lamp body) which contains one or more lighting unit(s).
- 2.7.4.3. "*Lighting mode*" or "*Mode*" of a front-lighting function provided by an AFS means a beam within the provisions either for one of the passing beam classes or for the main beam, designed and specified by the manufacturer for adaptation to dedicated vehicle and ambient conditions;
- 2.7.4.4. "*System control*" means that part(s) of the AFS receiving the AFS control signals from the vehicle and controlling the operation of the lighting units automatically.
- 2.7.4.5. "*AFS control signal*" (V, E, W, T) means the input to the AFS in accordance with the paragraph 6.22.7.4. of this Regulation.
- 2.7.4.6. "*Neutral state*" means the state of the AFS when a defined mode of the class C passing-beam ("basic passing-beam") or of the main beam in the maximum condition of activation, if any, is produced, and no AFS control signal applies.
- 2.7.4.7. "*Adaptive main-beam*" means a main-beam of the AFS that adapts its beam pattern to the presence of oncoming and preceding vehicles in order to improve the long-range visibility for the driver without causing discomfort, distraction or glare to other road users.
- 2.7.5. Definitions with regard to AFS:
- 2.7.5.1. "*Class*" of a passing beam (C, V, E or W) means the designation of a passing beam, identified by particular provisions according to UN Regulation No. 48 (For explanation only. The provisions of the passing-beam classes are dedicated to conditions as follows: C for the basic passing-beam, V for use in lit areas such as towns, E for use on roads such as motorways, W for use in adverse conditions such as wet road);
- 2.7.5.2. "*Bending mode*" means the designation of a mode of a front-lighting function with its illumination being laterally moved or modified (to obtain an equivalent effect), designed for bends, curves or intersections of the road, and, identified by particular photometric provisions;
- (a) "*Category 1 bending mode*" means a bending mode with horizontal movement of the kink of the cut-off;
- (b) "*Category 2 bending mode*" means a bending mode without horizontal movement of the kink of the cut-off;
- 2.7.5.3. "*Right side*" respectively "*left side*" means the combined total of the lighting units intended to be installed to that side of the longitudinal median plane of the vehicle, relative to its forward motion;
- 2.7.5.4. "*Signal*" means any AFS control signal or any additional control input to the system or a control output from the system to the vehicle;
- 2.7.5.5. "*Signal generator*" means a device, reproducing one or more of the signals for system tests;
- 2.7.5.6. "*Supply and operating device*" means one or more components of a system providing power to one or more parts of the system, including such as power and/or voltage control(s) for one or more light sources as e.g. electronic light source control gears;
- 2.7.5.7. "*System reference axis*" for an AFS means the intersection line of the vehicle's longitudinal median plane with the horizontal plane through the centre of reference of one lighting unit specified in the drawings accompanying the application for approval of the device;

- 2.7.5.8. "*Traffic-change function*" means any front-lighting function or a mode thereof, or part(s) thereof only, or any combination of these, intended to avoid glare and provide sufficient illumination in case where a vehicle being equipped with a system designed for one traffic direction only is temporarily used in a country with the opposite direction of traffic.
- 2.7.5.9. "*Substitute function*" means any specified front-lighting and/or front light-signalling, be it a front-lighting and/or a front light-signalling function, or a mode thereof, or part(s) thereof only, or any combination of it, intended to replace a front-lighting function/ mode in case of failure.
- 2.7.5.10. "*Functional unit*" means a part of a lighting unit providing a specific light distribution which may be used for different modes or classes. If used for the bending mode its light distribution may vary as a function of the T-signal (turn-radius); however, the light distribution shall be identical for a given T-signal (turn-radius) in all modes or classes.
- 2.7.6. Definitions with regard to switching and activation:
- 2.7.6.1. "*Switch ON*" means to manually or automatically operate an illuminating or signalling function to effectively emit light, irrespective of whether the function is operating correctly or not.
- 2.7.6.2. "*Switch OFF*" means to manually or automatically operate an illuminating or signalling function to stop emitting light, irrespective of whether the function is operating correctly or not.
- 2.7.6.3. "*Activate*" means to manually or automatically enable an illuminating or signalling function, irrespective of whether light is emitted or not (e.g. enable stand-by mode).
- 2.7.6.4. "*Deactivate*" means to manually or automatically disable an illuminating or signalling function, irrespective of whether light is emitted or not (e.g. disable stand-by mode).
- 2.7.6.5. "*Sequential activation*" means an electrical connection where the individual light sources of a lamp are wired such that they are switched ON in a predetermined sequence according to the relevant UN Regulations
- 2.7.7. "*Retro-reflecting optical unit*" means a combination of optical components producing retro-reflection.
- 2.8. Lens
- 2.8.1. "*Lens*" means the outermost component of the lamp (unit) which transmits light through the illuminating surface;
- 2.8.2. "*Coating*" means any product or products applied in one or more layers to the outer face of a lens;
- 2.8.3. "*Textured outer lens*" or "*Textured outer lens area*" means all or part of an outer lens, designed to modify or influence the propagation of light from the light source(s), such that the light rays are significantly diverted from their original direction.
- 2.9. Light sources
- 2.9.1. "*Light source*" means one or more elements for visible radiation, with a base for mechanical and electrical connection, possibly assembled with one or more components to control the elements for visible radiation.

- 2.9.1.1. "*Replaceable light source*" means a light source which is designed to be inserted in and removed from the holder of its device without tool.
- 2.9.1.2. "*Non-replaceable light source*" means a light source which can only be replaced by replacement of the device to which this light source is fixed.
- (a) In case of a light source module: a light source which can only be replaced by replacement of the light source module to which this light source is fixed;
- (b) In case of AFS: a light source which can only be replaced by replacement of the lighting unit to which this light source is fixed.
- 2.9.1.3. "*Light source module*" means an optical part of a device which is specific to that device. It contains one or more non-replaceable light sources and it may optionally contain one or more holders for approved replaceable light sources.
- 2.9.1.4. "*Filament light source*" (filament lamp) means a light source where the only element for visible radiation is one or more filaments producing thermal radiation.
- 2.9.1.5. "*Gas-discharge light source*" means a light source where the only element for visible radiation is a discharge arc producing electroluminescence.
- 2.9.1.6. "*Light-emitting diode (LED) light source*" means a light source where the only element for visible radiation is one or more solid state junctions producing electroluminescence possibly completed with one or more elements for fluorescence-based conversion.
- 2.9.1.6.1. "*LED substitute light source*" means a LED light source of a category which has a counterpart light source category producing light by another light generating technology.
- 2.9.1.7. "*LED module*" means a light source module containing as light sources only LEDs. However it may optionally contain one or more holders for approved replaceable light sources.
- 2.9.2. "*Electronic light source control gear*" means one or more components between supply and light source to control voltage and/ or electrical current of the light source.
- 2.9.2.1. "*Ballast*" means one or more components, either between supply and light source or integrated with the light source, to control the electrical current of a gas-discharge light source.
- 2.9.3. "*Variable intensity control*" means the device which automatically controls rear light signalling devices producing variable luminous intensities to assure the unvarying perception of their signals. The variable intensity control is part of the lamp, or part of the vehicle, or split between the said lamp and the vehicle.
- 2.10. Photometry
- 2.10.1. "*Objective luminous flux*" means:
- (a) In the case of a light source:
- The value of the objective luminous flux, not including any tolerances, as indicated in the relevant data sheet of the applicable light source Regulation according to which the light source is approved;
- (b) In the case of an LED module:
- The value of the objective luminous flux as indicated in the technical specification submitted with the LED module for approval of the lamp of which the LED module is a part;

- 2.10.2. "Light emitting surface" of a "lighting device", "light-signalling device" or a retro-reflector means the surface as declared in the request for approval by the manufacturer of the device on the drawing, see Annex 3 (see e.g. Parts 1, and 4).

This shall be declared according to one of the following conditions:

- (a) In the case where the outer lens is textured, the declared light emitting surface shall be all or part of the exterior surface of the outer lens;
- (b) In the case where the outer lens is non-textured the outer lens may be disregarded and the light emitting surface shall be as declared on the drawing, see Annex 3 (see e.g. Part 5).

- 2.10.3. "Illuminating surface" (see Annex 3).

- 2.10.3.1. "Illuminating surface of a lighting device" (paragraphs 2.5.1., 2.5.2., 2.5.10., 2.5.12. and 2.5.17.) means the orthogonal projection of the full aperture of the reflector, or in the case of headlamps with an ellipsoidal reflector of the "projection lens", on a transverse plane. If the lighting device has no reflector, the definition of paragraph 2.10.3.2. shall be applied. If the light emitting surface of the lamp extends over part only of the full aperture of the reflector, then the projection of that part only is taken into account.

In the case of a dipped-beam headlamp, the illuminating surface is limited by the apparent trace of the cut-off on to the lens. If the reflector and lens are adjustable relative to one another, the mean adjustment should be used.

In the case of AFS being installed: where a lighting function is produced by two or more simultaneously operated lighting units on a given side of the vehicle, the individual illuminating surfaces, taken together, constitute the illuminating surface to be considered (for example, in the figure of paragraph 6.22.4. below, the individual illuminating surfaces of the lighting units 8, 9 and 11, regarded together and taking into account their respective location, constitute the illuminating surface to be considered for the right hand side of the vehicle).

- 2.10.3.2. "Illuminating surface of a light-signalling device other than a retro-reflector" (paragraphs 2.5.3. to 2.5.7., 2.6.1., 2.5.11. and 2.5.13. to 2.5.16.) means the orthogonal projection of the lamp in a plane perpendicular to its axis of reference and in contact with the exterior light-emitting surface of the lamp, this projection being bounded by the edges of screens situated in this plane, each allowing only 98 per cent of the total luminous intensity of the light to persist in the direction of the axis of reference.

To determine the lower, upper and lateral limits of the illuminating surface only screens with horizontal or vertical edges shall be used to verify the distance to the extreme edges of the vehicle and the height above the ground.

For other applications of the illuminating surface, e.g. distance between two lamps or functions, the shape of the periphery of this illuminating surface shall be used. The screens shall remain parallel, but other orientations are allowed to be used.

In the case of a light-signalling device whose illuminating surface encloses either totally or partially the illuminating surface of another function or encloses a non-lighted surface, the illuminating surface may be considered to be the light emitting surface itself (see e.g. Annex 3, Parts 2, 3, 5 and 6).

- 2.10.3.3. "Illuminating surface of a retro-reflector" (paragraph 2.5.8.) means, as declared by the applicant during the component approval procedure for the retro-reflectors, the orthogonal projection of a retro-reflector in a plane perpendicular to its axis of reference and delimited by planes contiguous to the declared outermost parts of the retro-reflectors' optical system and parallel to that axis. For the purposes of determining the lower, upper and lateral edges of the device, only horizontal and vertical planes shall be considered.

- 2.10.4. The "*apparent surface*" for a defined direction of observation means, at the request of the manufacturer or his duly accredited representative, the orthogonal projection of:

Either the boundary of the illuminating surface projected on the exterior surface of the lens;

Or the light-emitting surface;

Only in the case of a light-signalling device producing variable luminous intensities, its apparent surface that may be variable as specified in paragraph 2.9.3. shall be considered under all conditions permitted by the variable intensity control, if applicable.

In a plane perpendicular to the direction of observation and tangential to the most exterior point of the lens.

Different examples of the application of apparent surface can be found in Annex 3 to this Regulation.

- 2.10.5. "*Axis of reference*" (or "*reference axis*") means the characteristic axis of the lamp determined by the manufacturer (of the lamp) for use as the direction of reference ($H = 0^\circ$, $V = 0^\circ$) for angles of field for photometric measurements and for installing the lamp on the vehicle.

- 2.10.6. "*Centre of reference*" means:

(a) The intersection of the axis of reference with the exterior light-emitting surface or

(b) A point on or near a retro-reflective area

which is designated to be the centre of the device for the purpose of specifying its performance; it is specified by the manufacturer of the lamp.

- 2.10.7. "*Angles of geometric visibility*" means the angles which determine the field of the minimum solid angle in which the apparent surface of the lamp is visible. That field of the solid angle is determined by the segments of the sphere of which the centre coincides with the centre of reference of the lamp and the equator is parallel with the ground. These segments are determined in relation to the axis of reference. The horizontal angles β correspond to the longitude and the vertical angles α to the latitude.

- 2.10.8. "*Photometric stability has occurred*" means the variation of the luminous intensity for the specified test point is less than 3 per cent within any 15 minute period.

- 2.10.9. "*Gonio(photo)meter system (if not otherwise specified in a particular Regulation)*" means a system used for the photometric measurements specified by the angular coordinates in degrees on a sphere with a vertical polar axis according to CIE publication No. 70, Vienna 1987, i.e. corresponding to a gonio(photo)meter system with a horizontal ("*elevation*") axis fixed to the ground and a second, moveable ("*rotation*") axis perpendicular to the fixed horizontal axis (see Annex 14 to this Regulation). *Note:* The above mentioned CIE publication specifies a procedure to correct the angular coordinates in the case where an alternative gonio(photo)meter system is used.

- 2.10.10. "*H plane*" means the horizontal plane containing the centre of reference of the lamp.

- 2.10.11. "*V plane*" means a vertical plane parallel to the median longitudinal plane of the vehicle and containing the center of reference of the lamp.

- 2.10.12. "*Transverse plane*" means a vertical plane perpendicular to the median longitudinal plane of the vehicle.

- 2.10.13. "*Angle of divergence*" means the angle between the straight lines connecting the centre of reference to the centre of the receiver and to the centre of the source of illumination.
- 2.10.14. "*Illumination angle*" means the angle between the axis of reference and the straight line connecting the centre of reference to the centre of the source of illumination.
- 2.10.15. "*Angle of rotation*" means the angle through which the retro-reflective device is rotated about its axis of reference starting from one given position.
- 2.10.16. "*Angular diameter of the retro-reflective device*" means the angle subtended by the greatest dimension of the visible area of the illuminating surface, either at the centre of the source of illumination or at the centre of the receiver.
- 2.10.17. "*Illumination of the retro-reflective device*" is the abbreviated expression used conventionally to designate the illumination measured in a plane perpendicular to the incident rays and passing through the centre of reference.
- 2.10.18. "*Coefficient of luminous intensity (CIL)*" means the quotient of the luminous intensity reflected in the direction considered, divided by the illumination of the retro-reflective device for given angles of illumination, divergence and rotation.

2.11. Colour

2.11.1. Colour of the light emitted from a device

- 2.11.1.1. "*White*" means the chromaticity coordinates (x,y) ⁽⁴⁾ of the light emitted that lie inside the chromaticity areas defined by the boundaries:

W ₁₂	green boundary	$y = 0,150 + 0,640 x$
W ₂₃	yellowish green boundary	$y = 0,440$
W ₃₄	yellow boundary	$x = 0,500$
W ₄₅	reddish purple boundary	$y = 0,382$
W ₅₆	purple boundary	$y = 0,050 + 0,750 x$
W ₆₁	blue boundary	$x = 0,310$

With intersection points:

	x	y
W ₁	0,310	0,348
W ₂	0,453	0,440
W ₃	0,500	0,440
W ₄	0,500	0,382
W ₅	0,443	0,382
W ₆	0,310	0,283

- 2.11.1.2. "*Selective-yellow*" means the chromaticity coordinates (x,y) ⁽⁴⁾ of the light emitted that lie inside the chromaticity areas defined by the boundaries:

SY ₁₂	green boundary	$y = 1,290 x - 0,100$
SY ₂₃	the spectral locus	
SY ₃₄	red boundary	$y = 0,138 + 0,580 x$

⁽⁴⁾ CIE Publication 15.2, 1986, Colorimetry, the CIE 1931 standard colorimetric observer.

SY ₄₅	yellowish white boundary	$y = 0,440$
SY ₅₁	white boundary	$y = 0,940 - x$

With intersection points:

	x	y
SY ₁	0,454	0,486
SY ₂	0,480	0,519
SY ₃	0,545	0,454
SY ₄	0,521	0,440
SY ₅	0,500	0,440

- 2.11.1.3. "Amber" means the chromaticity coordinates (x,y)⁴ of the light emitted that lie inside the chromaticity areas defined by the boundaries:

A ₁₂	green boundary	$y = x - 0,120$
A ₂₃	the spectral locus	
A ₃₄	red boundary	$y = 0,390$
A ₄₁	white boundary	$y = 0,790 - 0,670 x$

With intersection points:

	x	y
A ₁	0,545	0,425
A ₂	0,560	0,440
A ₃	0,609	0,390
A ₄	0,597	0,390

- 2.11.1.4. "Red" means the chromaticity coordinates (x,y)⁴ of the light emitted that lie inside the chromaticity areas defined by the boundaries:

R ₁₂	yellow boundary	$y = 0,335$
R ₂₃	the spectral locus	
R ₃₄	the purple line	(its linear extension across the purple range of colours between the red and the blue extremities of the spectral locus).
R ₄₁	purple boundary:	$y = 0,980 - x$

With intersection points:

	x	y
R ₁	0,645	0,335
R ₂	0,665	0,335
R ₃	0,735	0,265
R ₄	0,721	0,259

2.11.2. Night-time colour of the light retro-reflected from a device excluding retro-reflective tires according to UN Regulation No. 88

2.11.2.1. "White" means the chromaticity coordinates (x,y)⁴ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

W ₁₂	blue boundary:	$y = 0,843 - 1,182 x$
W ₂₃	violet boundary	$y = 0,489 x + 0,146$
W ₃₄	yellow boundary	$y = 0,968 - 1,010 x$
W ₄₁	green boundary	$y = 1,442 x - 0,136$

With intersection points:

	x	y
W ₁	0,373	0,402
W ₂	0,417	0,350
W ₃	0,548	0,414
W ₄	0,450	0,513

2.11.2.2. "Yellow" means the chromaticity coordinates (x,y)⁴ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

Y ₁₂	green boundary	$y = x - 0,040$
Y ₂₃	the spectral locus	
Y ₃₄	red boundary	$y = 0,200 x + 0,268$
Y ₄₁	white boundary	$y = 0,970 - x$

With intersection points:

	x	y
Y ₁	0,505	0,465
Y ₂	0,520	0,480
Y ₃	0,610	0,390
Y ₄	0,585	0,385

2.11.2.3. "Amber" means the chromaticity coordinates (x,y)⁴ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

A ₁₂	green boundary	$y = 1,417 x - 0,347$
A ₂₃	the spectral locus	
A ₃₄	red boundary	$y = 0,390$
A ₄₁	white boundary	$y = 0,790 - 0,670 x$

With intersection points:

	x	y
A ₁	0,545	0,425
A ₂	0,557	0,442
A ₃	0,609	0,390

A_4	0,597	0,390
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2.11.2.4. "Red" means the chromaticity coordinates $(x,y)^4$ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

R_{12}	yellow boundary	$y = 0,335$
R_{23}	the spectral locus	
R_{34}	the purple line	
R_{41}	purple boundary	$y = 0,978 - x$

With intersection points:

	x	y
R_1	0,643	0,335
R_2	0,665	0,335
R_3	0,735	0,265
R_4	0,720	0,258

2.11.3. Day-time Colour of the light reflected from a device

2.11.3.1. "White" means the chromaticity coordinates $(x,y)^4$ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

W_{12}	violet boundary	$y = x - 0,030$
W_{23}	yellow boundary	$y = 0,740 - x$
W_{34}	green boundary	$y = x + 0,050$
W_{41}	blue boundary	$y = 0,570 - x$

With intersection points:

	x	y
W_1	0,300	0,270
W_2	0,385	0,355
W_3	0,345	0,395
W_4	0,260	0,310

2.11.3.2. "Yellow" means the chromaticity coordinates $(x,y)^4$ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

Y_{12}	red boundary	$y = 0,534 x + 0,163$
Y_{23}	white boundary	$y = 0,910 - x$
Y_{34}	green boundary	$y = 1,342 x - 0,090$
Y_{41}	the spectral locus	

With intersection points:

	x	y
Y_1	0,545	0,454
Y_2	0,487	0,423

Y_3	0,427	0,483
Y_4	0,465	0,534

2.11.3.3. "Red" means the chromaticity coordinates (x,y)⁴ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

R_{12}	red boundary	$y = 0,346 - 0,053 x$
R_{23}	purple boundary	$y = 0,910 - x$
R_{34}	yellow boundary	$y = 0,350$
R_{41}	the spectral locus	

With intersection points:

	x	y
R_1	0,690	0,310
R_2	0,595	0,315
R_3	0,560	0,350
R_4	0,650	0,350

2.11.4. Day-time colour of the fluorescent a device

2.11.4.1. "Red" means the chromaticity coordinates (x,y)⁴ of the light reflected that lie inside the chromaticity areas defined by the boundaries:

FR_{12}	red boundary	$y = 0,346 - 0,053 x$
FR_{23}	purple boundary	$y = 0,910 - x$
FR_{34}	yellow boundary	$y = 0,315 + 0,047 x$
FR_{41}	the spectral locus	

With intersection points:

	x	y
FR_1	0,690	0,310
FR_2	0,595	0,315
FR_3	0,569	0,341
FR_4	0,655	0,345

3. APPLICATION FOR APPROVAL

3.1. The application for approval of a vehicle type with regard to the installation of its lighting and light-signalling devices shall be submitted by the manufacturer or his duly accredited representative.

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

3.2.1. A description of the vehicle type with regard to the items mentioned in paragraphs 2.2.1.1. to 2.2.1.4. above, together with the restrictions on loading, particularly the maximum permissible load in the boot;

- 3.2.2. A list of the devices prescribed by the manufacturer for the lighting and light-signalling assembly. The list may include several types of device for each operation. Each type shall be duly identified (component, type-approval mark, name of manufacturer, etc.), in addition the list may include in respect of each function the additional annotation "or equivalent devices";
- 3.2.3. A layout drawing of the lighting and light-signalling equipment as a whole, showing the position of the various devices on the vehicle;
- 3.2.4. If necessary, in order to verify the conformity to the prescriptions of the present Regulation, layout drawing(s) for each individual lamp showing the illuminating surface as defined in paragraph 2.10.3., the light-emitting surface as defined in paragraph 2.10.2., the axis of reference as defined in paragraph 2.10.5. and the centre of reference as defined in paragraph 2.10.6. This information is not necessary in the case of the rear registration plate lamp (paragraph 2.5.5.);
- 3.2.5. A statement of the method used for the definition of the apparent surface (see paragraph 2.10.4.).
- 3.2.6. Where an AFS is fitted on the vehicle, the applicant shall submit a detailed description providing the following information:
 - 3.2.6.1. The lighting functions and modes for which the AFS has been approved;
 - 3.2.6.2. The related AFS control signals and their technical characteristics as defined according to Annex 10 to UN Regulation No. 123 or Annex 14 to UN Regulation No. 149.
 - 3.2.6.3. The provisions being applied to adapt automatically the front lighting functions and modes according to paragraph 6.22.7.4. of this Regulation;
 - 3.2.6.4. Special instruction, if any, for the inspection of the light sources and the visual observation of the beam;
 - 3.2.6.5. The documents according to paragraph 6.22.9.2. of this Regulation;
 - 3.2.6.6. The lamps that are grouped or combined with or reciprocally incorporated in the AFS;
 - 3.2.6.7. Lighting units which are designed to comply with the requirements of paragraph 6.22.5. of this Regulation.
- 3.2.7. For vehicles of M and N categories a description of the electric power supply conditions for the devices indicated in paragraphs 2.5.1., 2.5.2., 2.5.4., 2.5.6. and 2.5.7. above, including, if applicable, information on a special power supply/electronic light source control gear, or variable intensity control.
- 3.2.8. At the discretion of the manufacturer, a statement indicating whether lamps approved for and equipped with LED substitute light sources are allowed to be installed on the vehicle or not and, if this is allowed, which lamps.
- 3.3. An unladen vehicle fitted with a complete set of lighting and light-signalling equipment, as prescribed in paragraph 3.2.2. above, and representative of the vehicle type to be approved shall be submitted to the Technical Service responsible for conducting approval tests.
- 3.4. The document provided in Annex 1 to this Regulation shall be attached to the type-approval documentation.

4. APPROVAL

- 4.1. If the vehicle type submitted for approval pursuant to this Regulation meets the requirements of the Regulation in respect of all the devices specified in the list, 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 07, corresponding to the 07 series of amendments) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign this number to another vehicle type or to the same vehicle type submitted with equipment not specified in the list referred to in paragraph 3.2.2. above, subject to the provisions of paragraph 7 of this Regulation.
- 4.3. Notice of approval or of extension or refusal of approval or production definitively discontinued of a vehicle type/part 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.
- 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; ⁽⁵⁾
- 4.4.2. The number of this Regulation, followed by the letter "R", a dash and the approval number to the right of the circle prescribed in paragraph 4.4.1.
- 4.5. If the vehicle conforms to a vehicle type approved, under one or more other Regulations annexed to the Agreement, in the country which has granted approval under this Regulation, the symbol prescribed in paragraph 4.4.1. need not to 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.
- 4.6. The approval mark shall be clearly legible and be indelible.
- 4.7. The approval mark shall be placed close to or on the vehicle data plate affixed by the manufacturer.
- 4.8. Annex 2 to this Regulation gives examples of arrangements of approval marks.

5. GENERAL SPECIFICATIONS

- 5.1. The lighting and light-signalling devices shall be so fitted that under normal conditions of use as defined in paragraphs 2.3.10., 2.3.10.1. and 2.3.10.2. and notwithstanding any vibrations to which they may be subjected, they retain the characteristics prescribed by this Regulation and enable the vehicle to comply with the requirements of this Regulation. In particular, it shall not be possible for the lamps to be inadvertently maladjusted.
- 5.2. The illuminating lamps described in paragraphs 2.5.1., 2.5.2. and 2.5.10. shall be so installed that correct adjustment of their orientation can easily be carried out.

⁽⁵⁾ The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), document ECE/TRANS/WP.29/78/Rev. 6 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

- 5.2.1. In the case of headlamps fitted with measures to prevent discomfort to other road-users in a country where traffic operates on the side of the road opposite to that of the country for which the headlamp was designed, such measures shall be achieved automatically or by the vehicle user with the vehicle in the park condition without the need for special tools (other than those provided with the vehicle ⁽⁶⁾). Detailed instructions shall be provided by the vehicle manufacturer with the vehicle.
- 5.3. For all light-signalling devices, including those mounted on the side panels, the reference axis of the lamp when fitted to the vehicle shall be parallel to the bearing plane of the vehicle on the road; in addition it shall be perpendicular to the median longitudinal plane of the vehicle in the case of side retro-reflectors and of side-marker lamps and parallel to that plane in the case of all other signalling devices. In each direction a tolerance of $\pm 3^\circ$ shall be allowed. In addition, any specific instructions as regards fitting laid down by the manufacturer shall be complied with.
- 5.4. In the absence of specific instructions, the height and orientation of the lamps shall be verified with the vehicle unladen and placed on a flat, horizontal surface, in the condition defined in paragraphs 2.3.10., 2.3.10.1. and 2.3.10.2. and, in the case where an AFS is installed, with the system in its neutral state.
- 5.5. In the absence of specific instructions lamps constituting a pair shall:
- 5.5.1. Be fitted to the vehicle symmetrically in relation to the median longitudinal plane (this estimate to be based on the exterior geometrical form of the lamp and not on the edge of its illuminating surface referred to in paragraph 2.10.3.);
- 5.5.2. Be symmetrical to one another in relation to the median longitudinal plane, this requirement is not valid with regard to the interior structure of the lamp;
- 5.5.3. Satisfy the same colorimetric requirements and have substantially identical photometric characteristics. This shall not apply to a matched pair of Class F3 front fog lamps;
- 5.5.4. Have substantially identical photometric characteristics.
- 5.6. On vehicles whose external shape is asymmetrical the above requirements shall be satisfied so far as is possible.
- 5.7. Grouped, combined or reciprocally incorporated or single lamps
- 5.7.1. Lamps may be grouped, combined or reciprocally incorporated with one another provided that all requirements regarding colour, position, orientation, geometric visibility, electrical connections and other requirements, if any, are fulfilled.
- 5.7.1.1. The photometric and colorimetric requirements of a lamp shall be fulfilled when all other functions with which this lamp is grouped, combined or reciprocally incorporated are switched OFF.
- However, when a front or rear position lamp is reciprocally incorporated with one or more other function(s) which can be switched ON together with them, the requirements regarding colour of each of these other functions shall be fulfilled when the reciprocally incorporated function(s) and the front or rear position lamps are switched ON.
- 5.7.1.2. Stop lamps and direction-indicator lamps are not permitted to be reciprocally incorporated.

⁽⁶⁾ This does not apply to dedicated objects that may be added to the exterior of the headlamp.

5.7.1.3. Where stop lamps and direction-indicator lamps are grouped, the following conditions shall be met:

5.7.1.3.1. Any horizontal or vertical straight line passing through the projections of the apparent surfaces of these functions on a plane perpendicular to the reference axis, shall not intersect more than two borderlines separating adjacent areas of different colour;

5.7.1.3.2. Their apparent surfaces in the direction of the reference axis, based upon the areas bounded by the outline of their light emitting surfaces, do not overlap.

5.7.2. Single lamps

5.7.2.1. Single lamps as defined in paragraph 2.4.11.1., subparagraph (a), the apparent surface of which is composed of two or more distinct parts, shall be installed in such a way that:

- (a) Either the total area of the projection of the distinct parts of the apparent surface in the direction of the reference axis on a plane tangent to the exterior surface of the outer lens and perpendicular to the reference axis shall occupy not less than 60 per cent of the smallest quadrilateral circumscribing the projection of the said apparent surface in the direction of the reference axis; or
- (b) The minimum distance between the facing edges of two adjacent/tangential distinct parts of the apparent surface in the direction of the reference axis shall not exceed 75 mm when measured perpendicularly to the reference axis.

These requirements shall not apply to a single retro-reflector.

5.7.2.2. Single lamps as defined in paragraph 2.4.11.1., subparagraph (b) or (c), composed of two lamps marked "D" or two independent retro reflectors, shall be installed in such a way that:

- (a) Either the projection of the apparent surfaces in the direction of the reference axis of the two lamps or retro reflectors occupies not less than 60 per cent of the smallest quadrilateral circumscribing the projections of the said apparent surfaces in the direction of the reference axis; or
- (b) The minimum distance between the facing edges of the apparent surfaces in the direction of the reference axis of two lamps or two independent retro reflectors does not exceed 75 mm when measured perpendicularly to the reference axis.

5.7.2.3. Single lamps as defined in paragraph 2.4.11.1., subparagraph (d) shall fulfil the requirements of paragraph 5.7.2.1.

Where two or more lamps and/or two or more separate apparent surfaces are included into the same lamp body and/or have a common outer lens these shall not be considered as an interdependent lamp system.

However, a lamp in the shape of a band or strip may be part of an interdependent lamp system.

5.7.2.4. Two lamps or an even number of lamps in the shape of a band or strip shall be placed symmetrically in relation to the median longitudinal plane of the vehicle, extending on both sides to within at least 0.4 m of the extreme outer edge of the vehicle, and are not less than 0.8 m long; the illumination of such a surface shall be provided by not less than two light sources placed as close as possible to the ends; the light-emitting surface may be constituted by a number of juxtaposed elements on condition that these individual light-emitting surfaces, when projected on a transverse plane fulfil the requirements of paragraph 5.7.2.1.

5.8. The maximum height above the ground shall be measured from the highest point and the minimum height from the lowest point of the apparent surface in the direction of the reference axis.

Where the (maximum and minimum) height above the ground clearly meets the requirements of the Regulation, the exact edges of any surface need not be determined.

- 5.8.1. For the purposes of reducing the geometric visibility angles, the position of a lamp with regard to height above the ground, shall be measured from the H plane.
- 5.8.2. In the case of dipped-beam headlamp, the minimum height in relation to the ground is measured from the lowest point of the apparent surface in the direction of the reference axis independent of its utilization.
- 5.8.3. The position, as regards width, will be determined from that edge of the apparent surface in the direction of the reference axis which is the furthest from the median longitudinal plane of the vehicle when referred to the overall width, and from the inner edges of the apparent surface in the direction of the reference axis when referred to the distance between lamps.

Where the position, as regards width, clearly meets the requirements of the Regulation, the exact edges of any surface need not be determined.

- 5.9. In the absence of specific instructions, the photometric characteristics (e.g. intensity, colour, apparent surface, etc.) of a lamp shall not be intentionally varied during the period when the lamp is switched ON.
- 5.9.1. Direction-indicator lamps, the vehicle-hazard warning signal, amber side-marker lamps complying with paragraph 6.18.7. below, and the emergency stop signal shall be flashing lamps.
- 5.9.2. The photometric characteristics of any lamp may vary:
- (a) In relation to the ambient light;
 - (b) As a consequence of other lamps being switched ON or OFF; or
 - (c) When the lamps is being used to provide another lighting function; provided that any variation in the photometric characteristics is in compliance with the technical provisions for the lamp concerned.
- 5.9.3. The photometric characteristics of a direction indicator lamp of categories 1, 1a, 1b, 2a or 2b may be varied during a flash by sequential activation of light sources as specified in paragraph 5.6. of UN Regulation No. 6. or paragraph 5.6.11. of UN Regulation No. 148.

This provision shall not apply when direction indicator lamps of categories 2a and 2b are operated as emergency stop signal according to paragraph 6.23.1. of this Regulation.

- 5.10. No red light which could give rise to confusion shall be emitted from a lamp as defined in paragraph 2.1.5. in a forward direction and no white light which could give rise to confusion, shall be emitted from a lamp as defined in paragraph 2.1.5. in a rearward direction. No account shall be taken of lighting devices fitted for the interior lighting of the vehicle. In case of doubt, this requirement shall be verified as follows:
- 5.10.1. For the visibility of red light towards the front of a vehicle, with the exception of a red rearmost side-marker lamp, there shall be no direct visibility of the apparent surface of a red lamp if viewed by an observer moving within Zone 1 in a transverse plane situated 25 m in front of the vehicle (see Annex 4);
- 5.10.2. For the visibility of white light towards the rear of a vehicle, with the exception of reversing lamps and white side conspicuity markings, there shall be no direct visibility of the apparent surface of a white lamp if viewed by an observer moving within Zone 2 in a transverse plane situated 25 m behind the vehicle (see Annex 4);

- 5.10.3. In their respective planes, the zones 1 and 2 explored by the eye of the observer are bounded:
- 5.10.3.1. In height, by two horizontal planes 1 m and 2.2 m respectively above the ground;
- 5.10.3.2. In width, by two vertical planes which, forming to the front and to the rear respectively an angle of 15° outwards from the vehicle's median longitudinal plane, pass through the point or points of contact of vertical planes parallel to the vehicle's median longitudinal plane delimiting the vehicle's overall width; if there are several points of contact, the foremost shall correspond to the forward plane and the rearmost to the rearward plane.
- 5.11. The electrical connections shall be such that the front and rear position lamps, the end-outline marker lamps, if they exist, the side-marker lamps, if they exist, and the rear registration plate lamp can only be switched ON and OFF simultaneously.
- 5.11.1. This requirement does not apply while one or more of the following conditions exist:
- (a) Front and rear position lamps, as well as side-marker lamps when combined or reciprocally incorporated with said lamps, are switched ON as parking lamps;
 - (b) Side-marker lamps flash in conjunction with direction indicators;
 - (c) Daytime running lamps are switched ON;
 - (d) Front position lamps function is substituted under the provisions of paragraph 5.12.1. below.
- 5.11.2. In the case of an interdependent lamp system, all light sources shall be switched ON and OFF simultaneously.
- 5.12. The electrical connections shall be such that the main-beam and dipped-beam headlamps and the front fog lamps cannot be switched ON unless the lamps referred to in paragraph 5.11. are also switched ON. This requirement shall not apply, however, to main-beam or dipped-beam headlamps when their luminous warnings consist of the intermittent lighting up at short intervals of the main-beam headlamp or the intermittent lighting up at short intervals of the dipped-beam headlamp or the alternate lighting up at short intervals of the main-beam and dipped-beam headlamps.
- 5.12.1. The dipped-beam headlamps and/or the main-beam headlamps and/or the front fog lamps may substitute the function of the front position lamps, provided that:
- 5.12.1.1. Their electrical connections are such that in case of failure of any of these lighting devices the front position lamps are automatically switched ON again; and
- 5.12.1.2. The substituting lamp/function meets, for the respective position lamp, the requirements concerning:
- (a) The geometric visibility prescribed for the front position lamps in 6.9.5; and
 - (b) The minimum photometric values according to the angles of light distribution; and
- 5.12.1.3. Appropriate evidence demonstrating compliance with the requirements indicated in paragraph 5.12.1.2. above is provided in the test reports of the substituting lamp.
- 5.13. Tell-tale
- Where a closed-circuit tell-tale is prescribed by this Regulation it may be replaced by an "operating" tell-tale.

5.14. Concealable lamps

- 5.14.1. The concealment of lamps shall be prohibited, with the exception of the main-beam headlamps, the dipped-beam headlamps and the front fog lamps, which may be concealed when they are not in use.
- 5.14.2. In the event of any failure affecting the operation of the concealment device(s) the lamps shall remain in the position of use, if already in use, or shall be capable of being moved into the position of use without the aid of tools.
- 5.14.3. It shall be possible to move the lamps into the position of use and to switch them ON by means of a single control, without excluding the possibility of moving them into the position of use without switching them ON. However, in the case of grouped main-beam and dipped-beam headlamps, the control referred to above is required only to activate the dipped-beam headlamps.
- 5.14.4. It shall not be possible deliberately, from the driver's seat, to stop the movement of switched ON lamps before they reach the position of use. If there is a danger of dazzling other road users by the movement of the lamps, they may light up only when they have reached their position of use.
- 5.14.5. When the concealment device has a temperature of -30 °C to +50 °C the headlamps shall be capable of reaching the position of use within three seconds of initial operation of the control.

5.15. The colours of the light emitted by the lamps ⁽⁷⁾ are the following:

Main-beam headlamp:	White
Dipped-beam headlamp:	White
Front fog lamp:	White or selective yellow
Reversing lamp:	White
Direction-indicator lamp:	Amber
Hazard warning signal:	Amber
Stop lamp:	Red
Emergency stop signal :	Amber or red
Rear-end collision alert signal:	Amber
Rear registration plate lamp:	White
Front position lamp:	White
Rear position lamp:	Red
Rear fog lamp:	Red
Parking lamp:	White in front, red at the rear, amber if reciprocally incorporated in the side direction-indicator lamps or in the side-marker lamps.
Side-marker lamp:	Amber; however the rearmost side- marker lamp can be red if it is grouped or combined or reciprocally incorporated with the rear position lamp, the rear end-outline marker lamp, the rear fog lamp, the stop lamp or is grouped or has part of the light emitting surface in common with the rear retro-reflector.

⁽⁷⁾ Measurement of the chromaticity coordinates of the light emitted by the lamps is not part of this regulation.

End-outline marker lamp:	White in front, red at the rear
Daytime running lamp:	White
Rear retro-reflector, non- triangular:	Red
Rear retro-reflector, triangular:	Red
Front retro-reflector, non- triangular:	Identical to incident light ⁽⁸⁾
Side retro-reflector, non- triangular:	Amber; however the rearmost side retro-reflector can be red if it is grouped or has part of the light emitting surface in common with the rear position lamp, the rear end outline marker lamp, the rear fog lamp, the stop-lamp, the red rearmost side-marker lamp or the rear retro-reflector, non- triangular.
Cornering lamp:	White
Conspicuity marking:	White to the front; White or yellow to the side; Red or yellow to the rear. ⁽⁹⁾
Adaptive front-lighting systems (AFS):	White
Exterior courtesy lamp:	White
Manoeuvring lamp:	White

5.16. Number of lamps

5.16.1. The number of lamps mounted on the vehicle shall be equal to the number indicated in the individual specifications of this Regulation.

5.17. Any lamp may be installed on movable components provided that the conditions specified in paragraphs 5.18., 5.19. and 5.20. are fulfilled.

5.18. Rear position lamps, rear direction-indicators and rear retro-reflectors, triangular as well as non-triangular, may be installed on movable components only:

5.18.1. If at all fixed positions of the movable components the lamps on the movable components meet all the position, geometric visibility, colorimetric and photometric requirements for those lamps.

5.18.2. In the case where the functions referred to in paragraph 5.18. are obtained by an assembly of two lamps marked "D" (see paragraph 2.4.11.1.), only one of the lamps needs to meet the position, geometric visibility and photometric requirements for those lamps at all fixed positions of the movable components.

or

5.18.3. Where additional lamps for the above functions are fitted and are switched ON, when the movable component is in any fixed open position, provided that these additional lamps satisfy all the position, geometric visibility and photometric requirements applicable to the lamps installed on the movable component.

⁽⁸⁾ Also known as white or colourless retro-reflector.

⁽⁹⁾ Nothing in this Regulation shall preclude the Contracting Parties applying this Regulation from allowing the use of white conspicuity markings to the rear in their territories.

5.18.4. In the case where the functions referred to in paragraph 5.18. are obtained by an interdependent lamp system either of the following conditions shall apply:

(a) Should the complete interdependent lamp system be mounted on the moving component(s), the requirements of paragraph 5.18.1. shall be satisfied. However, additional lamps for the above functions may be switched ON, when the movable component is in any fixed open position, provided that these additional lamps satisfy all the position, geometric visibility, colorimetric and photometric requirements applicable to the lamps installed on the movable component;

or

(b) Should the interdependent lamp system be partly mounted on the fixed component and partly mounted on a movable component, with the exception of direction indicator lamps, the interdependent lamp(s) specified by the Applicant during the device approval procedure shall meet all the position, outwards geometric visibility, colorimetric and photometric requirements for those lamps, at all fixed positions of the movable component(s).

The inwards geometric visibility requirement(s) is(are) deemed to be satisfied if this(these) interdependent lamp(s) still conform(s) to the photometric values prescribed in the field of light distribution for the approval of the device, at all fixed positions of the movable component(s).

For direction indicator lamps, the interdependent lamp(s) specified by the Applicant during the device approval procedure shall meet all the position, geometric visibility, photometric and colorimetric requirements at all fixed positions of the movable component(s). This does not apply where, to fulfil or complete the geometric visibility angle, additional lamps are switched ON when the movable component is in any fixed open position, provided that these additional lamps satisfy all the position, photometric and colorimetric requirements applicable to the direction indicator lamps installed on the movable component.

5.19. When the movable components are in a position other than a "normal position of use", the devices installed on them shall not cause undue discomfort to road users.

5.20. When a lamp is installed on a movable component and the movable component is in the "normal position(s) of use", the lamp shall always return to the position(s) specified by the manufacturer in accordance with this Regulation. In the case of dipped-beam headlamps and front fog lamps, this requirement shall be considered satisfied if, when the movable components are moved and returned to the normal position 10 times, no value of the angular inclination of these lamps, relative to its support, measured after each operation of the movable component, differs by more than 0.15 per cent from the average of the 10 measured values. If this value is exceeded each limit specified in paragraph 6.2.6.1.1. shall then be modified by this excess to decrease the allowed range of inclinations when checking the vehicle according to Annex 6.

5.21. The apparent surface in the direction of the reference axis of front and rear position lamps, front and rear direction-indicator lamps and retro-reflectors shall not be hidden more than 50 per cent by any movable component, with or without a light-signalling device installed on it, in any fixed position different from the "normal position of use".

Fixed position of a movable component means the stable or natural rest position(s) of the movable component specified by the vehicle manufacturer, whether locked or not.

If the above requirement is not practicable:

5.21.1. Additional lamps satisfying all the position, geometric visibility, colorimetric and photometric requirements for the above indicated lamps shall be switched ON when the apparent surface in the direction of the reference axis of these lamps is more than 50 per cent hidden by the movable component;

- 5.21.2. A remark in the communication form (item 10.1. of Annex 1) shall inform other Administrations that more than 50 per cent of the apparent surface in the direction of the reference axis can be hidden by the movable components; and
- A notice in the vehicle shall inform the user that in certain position(s) of the movable components other road users shall be warned of the presence of the vehicle on the road; for example by means of a warning triangle or other devices according to national requirements for use on the road.
- 5.21.3. Paragraph 5.21.2. does not apply to retro-reflectors.
- 5.22. With the exception of retro-reflectors, a lamp even bearing an approval mark is deemed not to be present when it cannot be made to operate by the sole installation of a light source and/or a fuse.
- 5.23. Lamps approved with light source(s) according to UN Regulation No. 37, except when such light sources are used as non-replaceable light source(s) as defined in paragraph 2.9.1.2., shall be fitted in a vehicle in such a way that the light source can be correctly replaced without the need for expert assistance and without the need for special tools, other than those provided with the vehicle by the manufacturer. The vehicle manufacturer shall provide with the vehicle a detailed description of the procedure for replacement.
- 5.23.1. In the case where a light source module includes a holder for an approved replaceable light source according to Regulation No. 37, this light source shall be replaceable as required in paragraph 5.23. above.
- 5.24. Any temporary fail-safe replacement of the light-signalling function of a rear position lamp is allowed, provided that the replacement function in case of a failure is similar in colour, main intensity and position to the function that has ceased to operate and provided that the replacement device remains operational in its original safety function. During replacement, a tell-tale on the dashboard (paragraph 2.3.5. of this Regulation) shall indicate occurrence of a temporary replacement and need for repair.
- 5.25. Where an AFS is fitted, it shall be considered equivalent to a pair of dipped-beam headlamps and, if it provides main-beam function(s), it shall be considered equivalent to a pair of main-beam headlamps.
- 5.26. Rear direction-indicator lamps, rear position lamps, stop lamps (except stop lamps of category S4) and rear fog lamps with variable luminous intensity control are allowed, which respond simultaneously to at least one of the following external influences: ambient lighting, fog, snowfall, rain, spray, dust clouds, contamination of the light emitting surface, provided that their prescribed intensity relationship is maintained throughout variation transitions. No sharp variation of intensity shall be observed during transition. Stop lamps of category S4 may produce variable luminous intensity independent from the other lamps. It may be possible for the driver to set the functions above to luminous intensities corresponding to their steady category and to return them to their automatic variable category.
- 5.27. For vehicles of M and N categories the applicant shall demonstrate to the Technical Service responsible for type approval testing that the electric power supply conditions for the devices indicated in 2.5.1., 2.5.2., 2.5.4., 2.5.6. and 2.5.7. above comply, when the electrical system of the vehicle is in a constant voltage operating condition, representative for the relevant category of powered vehicle as specified by the applicant, with the following provisions:
- 5.27.1. The voltage supplied at the terminals of devices which, according to their type approval documentation, have been tested by the application of a special power supply/electronic light source control gear, or in a secondary operating mode or at a voltage requested by the applicant, shall not exceed the voltage specified for the relevant devices or functions as they have been approved.

- 5.27.2. In all cases of electric power supply conditions not covered by paragraph 5.27.1., the voltage at the terminals of the device(s) or function(s) shall not exceed 6.75 V (6 Volt-Systems), 13.5 V (12 Volt-Systems) or 28 V (24 Volt-Systems) by more than 3 per cent. The means of controlling the maximum voltage at the terminals of the device may, for convenience, be located within the body of the device.
- 5.27.3. The provisions of paragraphs 5.27.1. and 5.27.2. shall not apply to devices which include an electronic light source control gear or a variable intensity control being part of the device.
- 5.27.4. A report shall be attached to the approval documentation describing the methods used to demonstrate compliance and the results obtained.
- 5.28. General provisions relating to geometric visibility
- 5.28.1. There shall be no obstacle on the inside of the angles of geometric visibility to the propagation of light from any part of the apparent surface of the lamp observed from infinity. However, no account is taken of obstacles, if they were already presented when the lamp was type-approved.
- 5.28.2. If measurements are taken closer to the lamp, the direction of observation shall be shifted parallel to achieve the same accuracy.
- 5.28.3. If, when the lamp is installed, any part of the apparent surface of the lamp is hidden by any further parts of the vehicle, proof shall be furnished that the part of the lamp not hidden by obstacles still conforms to the photometric values prescribed for the approval of the device.
- 5.28.4. When the vertical angle of geometric visibility below the horizontal may be reduced to 5° (lamp at less than 750 mm above the ground measured according to the provisions of paragraph 5.8.1. above) the photometric field of measurements of the installed optical unit may be reduced to 5° below the horizontal.
- 5.28.5. In the case of an interdependent lamp system the geometric visibility requirements shall be fulfilled when all its interdependent lamps are operated together.
- 5.29. A LED module does not need to be replaceable, if so stated in the communication sheet of the component type approval.
- 5.30. All lamps (devices) shall, where applicable, be type approved according to the corresponding device UN Regulations as specified in the relevant subparagraphs of paragraph 6. of this Regulation when installed on a vehicle.
- 5.31. Lamps installed on a vehicle which is approved according to this Regulation and approved for one or more replaceable light source categories according to UN Regulations Nos. 37, 99 or 128, shall be fitted with light sources approved according to these light source categories only.
- This requirement does not concern light source modules, LED modules and non-replaceable light sources, except for when they are required to be approved by the applicable UN Regulation.
- 5.32. External status indicator
- One external status indicator for Vehicle Alarm System (VAS), Alarm System (AS) and immobilizer is allowed if:
- (a) The light intensity in any direction does not exceed 0.5 cd;
 - (b) The colour of the light emitted is white, red or amber;
 - (c) The area of the apparent surface is not larger than 20 cm².

Up to two external status indicators for Vehicle Alarm System (VAS), Alarm System (AS) and immobiliser are allowed on a vehicle provided that the apparent surface does not exceed 10 cm² per indicator.

5.33. A device type approved according to any preceding series of amendments to UN Regulations Nos. 148 and/or 149 and/or 150 is deemed equivalent to one approved according to the latest series of amendments to the pertinent UN Regulations Nos. 148 and/or 149 and/or 150, when the change indexes (defined in paragraph 2.1.6.) related to each individual lamp (function) do not differ. In this case such a device may be fitted on the vehicle to be type approved without any update of the device type approval documents and device markings.

5.34. The use of lamps approved for and equipped with LED substitute light source(s), is allowed exclusively in the case where the statement indicated in paragraph 3.2.8. is present and positive.

To verify that this statement is respected, both at the type approval and in the conformity of production verification, the presence of the marking on the lamps related to the use of LED substitute light source(s) shall be checked.

6. INDIVIDUAL SPECIFICATIONS

6.1. Main-beam headlamp (UN Regulations Nos. 98, 112 or 149)

6.1.1. Presence

Mandatory on motor vehicles. Prohibited on trailers.

6.1.2. Number

Two or four, type approved according to

(a) UN Regulation No. 98 or 112, excluding Class A headlamp;

or

(b) UN Regulation No. 149, Classes B and D headlamps only.

For vehicles of the category N₃: Two extra main-beam headlamps may be installed.

Where a vehicle is fitted with four concealable headlamps the installation of two additional headlamps shall only be authorized for the purpose of light-signalling, consisting of intermittent switching ON, at short intervals (see paragraph 5.1.2. above) in daylight.

6.1.3. Arrangement

No individual specifications.

6.1.4. Position

6.1.4.1. In width: No individual specifications.

6.1.4.2. In height: No individual specifications.

6.1.4.3. In length: At the front of the vehicle. This requirement shall be deemed to be satisfied if the light emitted does not cause discomfort to the driver either directly or indirectly through the devices for indirect vision and/or other reflecting surfaces of the vehicle.

6.1.5. Geometric visibility

The visibility of the illuminating surface, including its visibility in areas which do not appear to be illuminated in the direction of observation considered, shall be ensured within a divergent space defined by generating lines based on the perimeter of the illuminating surface and forming an angle of not less than 5° with the axis of reference of the headlamp. The origin of the angles of geometric visibility is the perimeter of the projection of the illuminating surface on a transverse plane tangent to the foremost part of the lens of the headlamp.

6.1.6. Orientation

Towards the front.

Not more than one main-beam headlamp on each side of the vehicle may swivel to produce bend lighting.

6.1.7. Electrical connections

6.1.7.1. Except when they are used to give intermittent luminous warnings at short intervals, the main-beam headlamps may be switched ON only when the dipped-beam headlamps are manually activated or the conditions for automatic switching ON of dipped-beam headlamps exist. Consequently, the main beam headlamps shall be switched OFF automatically when the dipped-beam headlamps are manually deactivated or the conditions for automatic switching ON of dipped-beam headlamps ceased to exist.

6.1.7.2. The control of the main-beam headlamps may be automatic regarding their switching ON and OFF, the control signals being produced by a sensor system which is capable of detecting and reacting to each of the following inputs:

- (a) Ambient lighting conditions;
- (b) The light emitted by the front lighting devices and front light-signalling devices of oncoming vehicles;
- (c) The light emitted by the rear light-signalling devices of preceding vehicles.

Additional sensor functions to improve performance are allowed.

For the purpose of this paragraph, "vehicles" means vehicles of categories L, M, N, O, T, as well as bicycles, such vehicles being equipped with retro-reflectors, with lighting and light-signalling devices, which are switched ON.

6.1.7.3. It shall always be possible to switch the main-beam headlamps ON and OFF manually and to manually deactivate the automatic control of the main-beam headlamps.

Moreover, the switching OFF of the main-beam headlamps and the deactivation of their automatic control shall be by means of a simple and immediate manual operation; the use of sub-menus is not allowed.

6.1.7.4. The main-beam headlamps may be switched ON either simultaneously or in pairs. In case the extra two main-beam headlamps are installed, as permitted under paragraph 6.1.2. for vehicles of the category N₃ only, no more than two pairs may be simultaneously lit. For changing over from the dipped to the main beam at least one pair of main-beam headlamps shall be switched ON. For changing over from the main-beam to the dipped-beam all main-beam headlamps shall be switched OFF simultaneously.

6.1.7.5. The dipped-beams may remain switched ON at the same time as the main beams.

6.1.7.6. Where four concealable headlamps are fitted their raised position shall prevent the simultaneous operation of any additional headlamps fitted, if these are intended to provide light signals consisting of intermittent switching ON at short intervals (paragraph 5.12.) in daylight.

6.1.8. Tell-tale

Circuit-closed tell-tale mandatory.

6.1.8.1. If the control of the main-beam headlamps is automatic as described in paragraph 6.1.7.1. above an indication shall be provided to the driver that the automatic control of the main-beam function is activated. This information shall remain displayed as long as the automatic operation is activated.

6.1.9. Other requirements

6.1.9.1. The aggregate maximum intensity of the main-beam headlamps which can be switched ON simultaneously shall not exceed 430 000 cd, which corresponds to a reference value of 100.

6.1.9.2. This maximum intensity shall be obtained by adding together the individual reference marks which are indicated on the several headlamps. The reference mark "10" shall be given to each of the headlamps marked "R" or "CR".

6.1.9.3. Automatic switching ON and OFF of the main-beam headlamps:

6.1.9.3.1. The sensor system used to control the automatic switching ON and OFF of the main-beam headlamps, as described in paragraph 6.1.7.1., shall comply with the following requirements:

6.1.9.3.1.1. The boundaries of the minimum fields in which the sensor is able to detect light emitted from other vehicles defined in paragraph 6.1.7.1. above are defined by the angles indicated below.

6.1.9.3.1.1.1. Horizontal angles: 15° to the left and 15° to the right.

Vertical angles:

Upward angle	5°		
Mounting height of the sensor (centre of sensor aperture above the ground)	Less than 2 m	Between 1,5 m and 2,5 m	Greater than 2,0 m
Downward angle	2°	2° to 5°	5°

These angles are measured from the centre of the sensor aperture relative to a horizontal straight line through its centre and parallel to the longitudinal median plane of the vehicle.

6.1.9.3.1.2. The sensor system shall be able to detect on a straight level road:

- (a) An oncoming power driven vehicle at a distance extending to at least 400 m;
- (b) A preceding power driven vehicle or a vehicle-trailers combination at a distance extending to at least 100 m;
- (c) An oncoming bicycle at a distance extending to at least 75 m, its illumination represented by a white lamp with a luminous intensity of 150 cd with a light emitting area of $10 \text{ cm}^2 \pm 3 \text{ cm}^2$ and a height above a ground of 0,8 m.

To verify compliance with (a) and (b) above, the oncoming and preceding power driven vehicle (or vehicle-trailer combination) shall have position lamps (if applicable) and dipped-beam headlamps switched ON.

6.1.9.3.2. The transition from main-beam to dipped-beam and vice versa according to the conditions indicated in paragraph 6.1.7.1. above may be performed automatically and shall not cause discomfort, distraction or glare.

6.1.9.3.3. The overall performance of the automatic control shall be verified by:

6.1.9.3.3.1. Means of simulation or other means of verification accepted by the Type Approval Authority, as provided by the applicant.

6.1.9.3.3.2. A test drive according to paragraph 1 in Annex 12. The performance of the automatic control shall be documented and checked against the applicant's description. Any obvious malfunctioning shall be contested (e. g. excessive angular movement or flicker).

6.1.9.3.4. The control of the main-beam headlamps may be such that the main-beam headlamps are switched ON automatically only when:

- (a) No vehicles, as mentioned in paragraph 6.1.7.1. above, are detected within the fields and distances according to paragraphs 6.1.9.3.1.1. and 6.1.9.3.1.2.; and
- (b) The detected ambient lighting levels are as prescribed in paragraph 6.1.9.3.5. below.

6.1.9.3.5. In the case where main-beam headlamps are switched ON automatically, they shall be switched OFF automatically when oncoming or preceding vehicles, as mentioned in paragraph 6.1.7.1. above, are detected within the fields and distances according to paragraphs 6.1.9.3.1.1. and 6.1.9.3.1.2.

Moreover, they shall be switched OFF automatically when the illuminance produced by ambient lighting conditions exceeds 7 000 lx.

Compliance with this requirement shall be demonstrated by the applicant, using simulation or other means of verification accepted by the Type Approval Authority. If necessary the illuminance shall be measured on a horizontal surface, with a cosine corrected sensor on the same height as the mounting position of the sensor on the vehicle. This may be demonstrated by the manufacturer by sufficient documentation or by other means accepted by the Type Approval Authority.

6.2. Dipped-beam headlamp (UN Regulations Nos. 98, 112 or 149)

6.2.1. Presence

Mandatory on motor vehicles. Prohibited on trailers.

6.2.2. Number

Two, type approved according to

- (a) UN Regulation No. 98 or 112, excluding Class A headlamp,
or
- (b) UN Regulation 149, Classes B and D headlamps only.

6.2.3. Arrangement

No special requirement.

6.2.4. Position

6.2.4.1. In width: that edge of the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane shall be not more than 400 mm from the extreme outer edge of the vehicle.

The inner edges of the apparent surfaces in the direction of the reference axes shall be not less than 600 mm apart. This does not apply, however, for M₁ and N₁ category vehicles; for all other categories of motor vehicles this distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

6.2.4.2. In height: not less than 500 mm and not more than 1 200 mm above the ground. For category N2G, N3G, M2G, M3G (off-road) vehicles ⁽¹⁰⁾ the maximum height may be increased to 1 500 mm.

6.2.4.3. In length: at the front of the vehicle. This requirement shall be deemed to be satisfied if the light emitted does not cause discomfort to the driver either directly, or indirectly through the devices for indirect vision and/or other reflecting surfaces of the vehicle.

6.2.5. Geometric visibility

Defined by angles α and β as specified in paragraph 2.10.7.:

α = 15° upwards and 10° downwards,

β = 45° outwards and 10° inwards.

The presence of partitions or other items of equipment near the headlamp shall not give rise to secondary effects causing discomfort to other road users .

6.2.6. Orientation

Towards the front

6.2.6.1. Vertical orientation

6.2.6.1.1. The initial downward inclination of the cut-off of the dipped-beam to be set in the unladen vehicle state with one person in the driver's seat shall be specified within an accuracy of 0,1 per cent by the manufacturer and indicated in a clearly legible and indelible manner on each vehicle close to either headlamp or the manufacturer's plate by the symbol shown in Annex 7.

The value of this indicated downward inclination shall be defined in accordance with paragraph 6.2.6.1.2.

6.2.6.1.2. Depending on the mounting height in metres (h) of the lower edge of the apparent surface in the direction of the reference axis of the dipped-beam headlamp, measured on the unladen vehicles, the vertical inclination of the cut-off of the dipped- beam shall, under all the static conditions of Annex 5, remain between the following limits and the initial aiming shall have the following values:

$h < 0,8$

Limits: between -0,5 per cent and -2,5 per cent

Initial aiming: between -1,0 per cent and -1,5 per cent

$0,8 < h < 1,0$

Limits: between -0,5 per cent and -2,5 per cent

Initial aiming: between -1,0 per cent and -1,5 per cent

Or, at the discretion of the manufacturer,

Limits: between -1,0 per cent and -3,0 per cent

Initial aiming: between -1,5 per cent and -2,0 per cent

The application for the vehicle type-approval shall, in this case, contain information as to which of the two alternatives is to be used,

⁽¹⁰⁾ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6, para. 2 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

$h > 1,0$

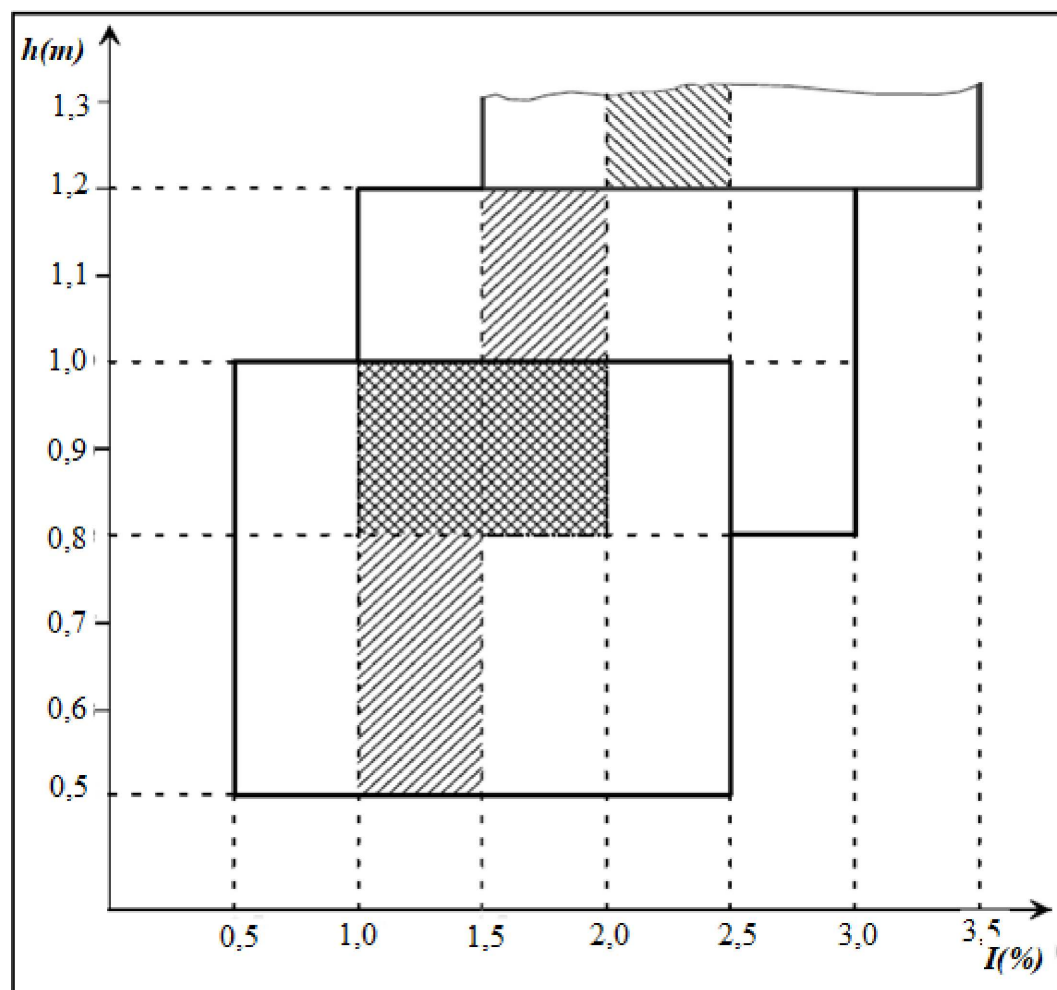
Limits: between -1,0 per cent and -3,0 per cent

Initial aiming: between -1,5 per cent and -2,0 per cent

The above limits and the initial aiming values are summarized in the diagram below.

For category N₃G (off-road) vehicles where the headlamps exceed a height of 1 200 mm, the limits for the vertical inclination of the cut-off shall be between: -1,5 per cent and -3,5 per cent.

The initial aim shall be set between: -2 per cent and -2,5 per cent.



6.2.6.2. Headlamp levelling device

6.2.6.2.1. In the case where a headlamp levelling device is necessary to satisfy the requirements of paragraphs 6.2.6.1.1. and 6.2.6.1.2., the device shall be automatic.

6.2.6.2.2. However, devices which are adjusted manually, either continuously or non-continuously, shall be permitted, provided they have a stop position at which the lamps can be returned to the initial inclination defined in paragraph 6.2.6.1.1. by means of the usual adjusting screws or similar means.

These manually adjustable devices shall be operable from the driver's seat.

Continually adjustable devices shall have reference marks indicating the loading conditions that require adjustment of the dipped-beam.

The number of positions on devices which are not continuously adjustable shall be such as to ensure compliance with the range of values prescribed in paragraph 6.2.6.1.2. in all the loading conditions defined in Annex 5.

For these devices also, the loading conditions of Annex 5 that require adjustment of the dipped-beam shall be clearly marked near the control of the device (Annex 8).

6.2.6.2.3. In the event of a failure of devices described in paragraphs 6.2.6.2.1. and 6.2.6.2.2., the dipped-beam shall not assume a position in which the dip is less than it was at the time when the failure of the device occurred.

6.2.6.3. Measuring procedure

6.2.6.3.1. After adjustment of the initial inclination, the vertical inclination of the dipped-beam, expressed in per cent, shall be measured in static conditions under all the loading conditions defined in Annex 5.

6.2.6.3.2. The measurement of the variation of dipped-beam inclination as a function of load shall be carried out in accordance with the test procedure set out in Annex 6.

6.2.6.4. Horizontal orientation

The horizontal orientation of one or both dipped-beam headlamps may be varied to produce bend lighting, provided that if the whole beam or the kink of the elbow of the cut-off is moved, the kink of the elbow of the cut-off shall not intersect the line of the trajectory of the centre of gravity of the vehicle at distances from the front of the vehicle which are larger than 100 times the mounting height of the respective dipped-beam headlamps.

6.2.7. Electrical connections

6.2.7.1. When changing from the main beam to the dipped-beam, all main-beams shall be switched OFF simultaneously.

6.2.7.2. The dipped-beam may remain switched ON at the same time as the main-beam.

6.2.7.3. In the case of dipped-beam headlamps according to UN Regulation Nos. 98 or 149 the gas-discharge light sources shall remain switched ON during the main-beam operation.

6.2.7.4. One additional light source or one or more LED module(s), located inside the dipped-beam headlamps or in a lamp (except the main-beam headlamp) grouped or reciprocally incorporated with the respective dipped-beam headlamps, may be activated to produce bend lighting, provided that the horizontal radius of curvature of the trajectory of the centre of gravity of the vehicle is 500 m or less. This may be demonstrated by the manufacturer by calculation or by other means accepted by the Type Approval Authority.

6.2.7.5. Dipped-beam headlamps may be switched ON or OFF automatically. However, it shall be always possible to switch these dipped-beam headlamps ON and OFF manually.

6.2.7.6. The dipped-beam headlamps shall be switched ON and OFF automatically relative to the ambient light conditions (e.g. switch ON during night-time driving conditions, tunnels, etc.) according to the requirements of Annex 13.

6.2.7.7. Without prejudice to paragraph 6.2.7.6., the dipped-beam headlamps may switch ON and OFF automatically relative to other factors such as time or ambient conditions (e.g. time of the day, vehicle location, rain, fog, etc.)

6.2.8. Tell-tale

6.2.8.1. Tell-tale optional

6.2.8.2. A visual tell-tale whether flashing or not is mandatory:

- (a) In the case where the whole beam or the kink of the elbow of the cut-off is moved to produce bend lighting; or
- (b) If one or more LED modules are used to produce the principal dipped-beam, except when they are wired so that the failure of any one LED module causes all of them to stop emitting light.

It shall be activated:

- (a) In the event of a malfunction of the displacement of the kink of the elbow of the cut-off; or
- (b) In case of a failure of any one of the LED module(s) producing the principal dipped-beam, except when they are wired so that the failure of any one LED module causes all of them to stop emitting light.

It shall remain activated while the failure is present. It may be cancelled temporarily, but shall be repeated whenever the device, which starts and stops the propulsion system, is switched ON and OFF.

6.2.9. Other requirements

The requirements of paragraph 5.5.2. shall not apply to dipped-beam headlamps.

Dipped-beam headlamps with a light source or LED module(s) producing the principal dipped-beam and having a total objective luminous flux which exceeds 2 000 lumen shall only be installed in conjunction with the installation of headlamp cleaning device(s) according to UN Regulation No. 45 ⁽¹⁾.

With respect to vertical inclination the provisions of paragraph 6.2.6.2.2. above shall not be applied for dipped-beam headlamps with a light source or LED module(s) producing the principal dipped beam and having an objective luminous flux which exceeds 2 000 lumens.

In the case of filament lamps for which more than one test voltage is specified, the objective luminous flux which produces the principal dipped-beam, as indicated in the communication form for the type approval of the device, is applied.

In the case of dipped-beam headlamps equipped with an approved light source, the applicable objective luminous flux is the value at the relevant test voltage as given in the relevant data sheet in the Regulation, according to which the applied light source was approved, without taking into account the tolerances to the objective luminous flux specified on this datasheet.

Only dipped-beam headlamps according to UN Regulation Nos. 98, 112 or 149 may be used to produce bend lighting.

If bend lighting is produced by a horizontal movement of the whole beam or the kink of the elbow of the cut-off, it shall be switched ON only if the vehicle is in forward motion; this shall not apply if bend lighting is produced for a right turn in right hand traffic (left turn in left hand traffic).

6.3. Front fog lamp (UN Regulation No. 19 or 149)

6.3.1. Presence

Optional on motor vehicles. Prohibited on trailers.

⁽¹⁾ Contracting Parties to the respective UN Regulations can still prohibit the use of mechanical cleaning systems when headlamps with plastic lenses, marked "PL", are installed.

6.3.2. Number

Two, complying with either the requirements of the 03 and subsequent series of amendments to UN Regulation No. 19 or the requirements of UN Regulation No. 149.

6.3.3. Arrangement

No special requirement.

6.3.4. Position

6.3.4.1. In width: that point on the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle.

6.3.4.2. In height:

Minimum: Not less than 250 mm above the ground.

Maximum: For M₁ and N₁ category vehicles: not more than 800 mm above the ground.

For all other categories except N₃G (off-road) ⁽¹²⁾ vehicles: not more than 1 200 mm above the ground.

For category N₃G vehicles: the maximum height may be increased to 1 500 mm.

No point on the apparent surface in the direction of the reference axis shall be higher than the highest point on the apparent surface in the direction of the reference axis of the dipped-beam headlamp.

6.3.4.3. In length: at the front of the vehicle. This requirement shall be deemed to be satisfied if the light emitted does not cause discomfort to the driver either directly, or indirectly through the devices for indirect vision and/or other reflecting surfaces of the vehicle.

6.3.5. Geometric visibility

Defined by angles α and β as specified in paragraph 2.10.7.:

α = 5° upwards and downwards,

β = 45° outwards and 10° inwards.

The presence of partitions or other items of equipment near the front fog lamp shall not give rise to secondary effects causing discomfort to other road users. ⁽¹³⁾

6.3.6. Orientation

Toward the front.

6.3.6.1. Vertical orientation

6.3.6.1.1. In the case of class "B" front fog lamps the vertical inclination of the cut-off to be set in the unladen vehicle state with one person in the driver's seat shall be -1.5 per cent or lower. ¹³

⁽¹²⁾ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6, para. 2 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

⁽¹³⁾ New vehicle types which do not comply with this provision may continue to be approved until 18 months after the entry into force of Supplement 4 to the 03 series of amendments.

6.3.6.1.2. In the case of class "F3" front fog lamps:

6.3.6.1.2.1. When the total objective luminous flux of the light source for each front fog lamp does not exceed 2 000 lumens:

6.3.6.1.2.1.1. The vertical inclination of the cut-off to be set in the unladen vehicle state with one person in the driver's seat shall be – 1.0 per cent or lower

6.3.6.1.2.2. When the total objective luminous flux of the light source for each front fog lamp exceeds 2 000 lumens:

6.3.6.1.2.2.1. Depending on the mounting height in metres (h) of the lower edge of the apparent surface in the direction of the reference axis of the front fog lamp, measured on the unladen vehicles, the vertical inclination of the cut-off shall under all the static conditions of Annex 5 automatically remain between the following values:

$h \leq 0,8$

Limits: between -1,0 per cent and -3,0 per cent

Initial aiming: between -1,5 per cent and -2,0 per cent

$h > 0,8$

Limits: between -1,5 per cent and -3,5 per cent

Initial aiming: between -2,0 per cent and -2,5 per cent,

6.3.6.1.2.2.2. The initial downward inclination of the cut-off to be set in the unladen vehicle state with one person in the driver's seat shall be specified within an accuracy of one decimal place by the manufacturer and indicated in a clearly legible and indelible manner on each vehicle close to either the front fog lamp or the manufacturer's plate or in combination with the indication referred to in paragraph 6.2.6.1.1. by the symbol shown in Annex 7 to this Regulation. The value of this indicated downward inclination shall be defined in accordance with paragraph 6.3.6.1.2.2.1.

6.3.6.2. Front fog lamp levelling device

6.3.6.2.1. Where a levelling device is fitted for a front fog lamp, independent or grouped with other front lighting and light signalling functions, it shall be such that the vertical inclination, under all the static loading conditions of Annex 5 of this Regulation, shall remain between the limits prescribed in paragraph 6.3.6.1.2.2.1.

6.3.6.2.2. In the case where the front fog lamp of category "F3" is part of the dipped-beam headlamp or is part of an AFS system, the requirements of paragraph 6.2.6. shall be applied during the use of the front fog beam as part of the dipped-beam.

In this case the levelling limits defined in paragraph 6.2.6. may be applied also when this front fog lamp is used as such.

6.3.6.2.3. The levelling device may also be used to automatically adapt the inclination of the front fog beam in relation to the prevailing ambient conditions, provided that the limits for the downward inclination specified in paragraph 6.3.6.1.2.2.1. are not exceeded.

6.3.6.2.4. In the case of a failure of the levelling device, the front fog beam shall not assume a position in which the cut off is less inclined than it was at the time when the failure of the device occurred.

6.3.7. Electrical connections

It shall be possible to switch the front fog lamps ON and OFF independently of the main-beam headlamps, the dipped-beam headlamps or any combination of main- and dipped-beam headlamps, unless:

- (a) The front fog lamps are used as part of another lighting function in an AFS; however, the switching ON of the front fog lamps function shall have the priority over the function for which the front fog lamps are used as a part, or
- (b) The front fog lamps cannot be simultaneously lit with any other lamps with which they are reciprocally incorporated as indicated by the relevant symbol (" / ") according to paragraph 10.1. of Annex 1 of UN Regulation No. 19. or item 9.5.1. of Annex 1 of UN Regulation No. 149.

6.3.8. Tell-tale

Circuit-closed tell-tale mandatory. An independent non-flashing warning light.

6.3.9. Other requirements

In the case where there is a positive indication in the communication form in Annex 1 of UN Regulation No. 19 or in Annex 1 of UN Regulation No. 149 the alignment and the luminous intensities of the Class "F3" front fog beam may be automatically adapted in relation to the prevailing ambient conditions. Any variations of the luminous intensities or alignment shall be performed automatically and in such a way that no discomfort, neither for the driver nor to other road users, is caused.

6.4. Reversing lamp (UN Regulation No. 23 or 148))

6.4.1. Presence

Mandatory on motor vehicles and on trailers of categories O₂, O₃ and O₄. Optional on trailers of category O₁.

6.4.2. Number

6.4.2.1. One device mandatory and a second device optional on motor vehicles of category M₁ and on all other vehicles with a length not exceeding 6 000 mm.

6.4.2.2. Two devices mandatory and two devices optional on all vehicles with a length exceeding 6 000 mm, except vehicles of category M₁.

6.4.3. Arrangement

No special requirement.

6.4.4. Position

6.4.4.1. In width: no special requirement.

6.4.4.2. In height: not less than 250 mm and not more than 1 200 mm above the ground. For category N2G, N3G, M2G, M3G (off-road) vehicles the maximum height may be increased to 1 400 mm.

6.4.4.3. In length: at the rear of the vehicle

However, if installed, the two optional devices mentioned in paragraph 6.4.2.2. may be fitted on the side of the vehicle, provided that the requirements of paragraphs 6.4.5.2. and 6.4.6.2. below are fulfilled.

6.4.5. Geometric visibility

6.4.5.1. Devices installed at the rear of the vehicle:

Defined by angles α and β , as specified in paragraph 2.10.7.:

$\alpha = 15^\circ$ upwards and 5° downwards,

$\beta = 45^\circ$ to right and to left if there is only one device,

45° outwards and 30° inwards if there are two.

6.4.5.2. Two optional devices mentioned in paragraph 6.4.2.2. if fitted on the side of the vehicle:

The geometric visibility is considered to be ensured if the reference axis of the respective device is directed outwards with an angle β not exceeding 15° relative to the median longitudinal plane of the vehicle. The vertical aim of the two optional devices may be directed downwards.

6.4.6. Orientation

6.4.6.1. Rearwards

6.4.6.2. In addition, if the two optional devices mentioned in paragraph 6.4.2.2., are fitted on the side of the vehicle, the provisions of paragraph 6.4.5.2. above shall apply.

6.4.7. Electrical connections

6.4.7.1. They shall be such that the lamp can be switched ON only if the reverse gear is engaged and if the device which controls the starting and stopping of the propulsion system is in such a position that operation of the propulsion system is possible. It shall not switch ON or remain ON if either of the above conditions is not satisfied.

6.4.7.2. Moreover, the electrical connections of the two optional devices mentioned in paragraph 6.4.2.2. shall be such that these devices cannot be switched ON unless the lamps referred to in paragraph 5.11. are switched ON.

The devices fitted on the side of the vehicle may be switched ON for slow manoeuvres in forward motion of the vehicle up to a maximum speed of 15 km/h, provided that the following conditions are fulfilled:

- (a) The devices shall be switched ON and OFF manually by a separate control;
- (b) If so switched ON, they may remain ON after reverse gear is disengaged;
- (c) They shall be automatically switched OFF if the forward speed of the vehicle exceeds 15 km/h, regardless of the position of the separate control; in this case they shall remain switched OFF until deliberately being switched ON again.

6.4.8. Tell-tale

Tell-tale optional.

6.4.9. Other requirements

None.

6.5. Direction-indicator lamp (UN Regulation No. 6 or 148)

6.5.1. Presence (see figure below)

Mandatory. Types of direction-indicator lamps fall into categories (1, 1a, 1b, 2a, 2b, 5 and 6) the assembly of which on one vehicle constitutes an arrangement ("A" and "B").

Arrangement "A" shall apply to all motor vehicles.

Arrangement "B" shall apply to trailers only.

6.5.2. Number

According to the arrangement.

6.5.3. Arrangements (see figure below)

A: Two front direction-indicator lamps of the following categories:

1 or 1a or 1b,

If the distance between the edge of the apparent surface in the direction of the reference axis of this lamp and that of the apparent surface in the direction of the reference axis of the dipped-beam headlamp and/or the front fog lamp, if there is one, is at least 40 mm;

1a or 1b,

If the distance between the edge of the apparent surface in the direction of the reference axis of this lamp and that of the apparent surface in the direction of the reference axis of the dipped-beam headlamp and/or the front fog lamp, if there is one, is greater than 20 mm and less than 40 mm;

1b,

If the distance between the edge of the apparent surface in the direction of the reference axis of this lamp and that of the apparent surface in the direction of the reference axis of the dipped-beam headlamp and/or the front fog lamp, if there is one, is less than or equal to 20 mm;

Two rear direction-indicator lamps (category 2a or 2b);

Two optional lamps (category 2a or 2b) on all vehicles in categories M₂, M₃, N₂, N₃.

Two side direction-indicator lamps of the categories 5 or 6 (minimum requirements):

5

For all M₁ vehicles;

For N₁, M₂ and M₃ vehicles not exceeding 6 metres in length.

6

For all N₂ and N₃ vehicles;

For N₁, M₂ and M₃ vehicles exceeding 6 metres in length.

It is permitted to replace category 5 side direction-indicator lamps by category 6 side direction-indicator lamps in all instances

Where lamps combining the functions of front direction-indicator lamps (categories 1, 1a, 1b) and side direction-indicator lamps (categories 5 or 6) are fitted, two additional side direction-indicator lamps (categories 5 or 6) may be fitted to meet the visibility requirements of paragraph 6.5.5.

B: two rear direction-indicator lamps (Categories 2a or 2b)

Two optional lamps (category 2a or 2b) on all vehicles in categories O₂, O₃ and O₄.

A maximum of three optional category 5 or one optional category 6 device per side on vehicles of category O₂ exceeding 9 m in length.

Where an AFS is fitted, the distance to be considered for the choice of the category is the distance between the front direction-indicator lamp and the closest lighting unit in its closest position contributing to or performing a passing-beam mode.

6.5.3.1. In addition, for vehicles of categories:

(a) M₂, M₃, N₂, and N₃ of above 6 m and up to including 9 m in length one additional category 5 device is optional;

(b) M₂, M₃, N₂, and N₃ exceeding 9 m in length three additional category 5 devices distributed as evenly as practicable along each side are mandatory;

- (c) O₃ and O₄ three category 5 devices distributed as evenly as practicable along each side are mandatory.

These requirements do not apply if there are at least three amber side marker lamps that flash in phase and simultaneously with the direction indicator lamps on the same side of the vehicle.

6.5.4. Position

- 6.5.4.1. In width: the edge of the apparent surface in the direction of the reference axis farthest from the median longitudinal plane of the vehicle shall not be more than 400 mm from the extreme outer edge of the vehicle. This condition shall not apply to the optional rear lamps.

The distance between the inner edges of the two apparent surfaces in the direction of the reference axes shall not be less than 600 mm.

This distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

- 6.5.4.2. In height: above the ground.

- 6.5.4.2.1. The height of the light-emitting surface of the side direction-indicator lamps of categories 5 or 6 shall not be:

Less than: 350 mm for M₁ and N₁ category of vehicles, and 500 mm for all other categories of vehicles, both measured from the lowest point; and

More than: 1 500 mm, measured from the highest point.

- 6.5.4.2.2. The height of the direction-indicator lamps of categories 1, 1a, 1b, 2a and 2b, measured in accordance with paragraph 5.8., shall not be less than 350 mm and not more than 1 500 mm.

- 6.5.4.2.3. If the structure of the vehicle does not permit these upper limits, measured as specified above, to be respected, and if the optional rear lamps are not installed, they may be increased to 2 300 mm for side direction-indicator lamps of categories 5 and 6, and to 2 100 mm for the direction-indicator lamps of categories 1, 1a, 1b, 2a and 2b.

- 6.5.4.2.4. If optional rear lamps are installed, they shall be placed at a height compatible with the applicable requirements of paragraph 6.5.4.1., the symmetry of the lamps, and at a vertical distance as large as the shape of the bodywork makes it possible, but not less than 600 mm above the mandatory lamps.

- 6.5.4.3. In length (see figure below)

The distance between the light-emitting surface of the side direction-indicator lamp (categories 5 and 6) and the transverse plane which marks the forward boundary of the vehicle's overall length, shall not exceed 1 800 mm.

However, this distance shall not exceed 2 500 mm:

- (a) For M₁ and N₁ category vehicles;
- (b) For all other categories of vehicles if the structure of the vehicle makes it impossible to comply with the minimum angles of visibility.

Optional category 5 side direction indicator lamps, shall be fitted, spaced evenly, along the length of the vehicle.

Optional category 6 side direction indicator lamp shall be fitted in the area between the first and last quartiles of the length of a trailer.

6.5.5. Geometric visibility

6.5.5.1. Horizontal angles: (see figure below)

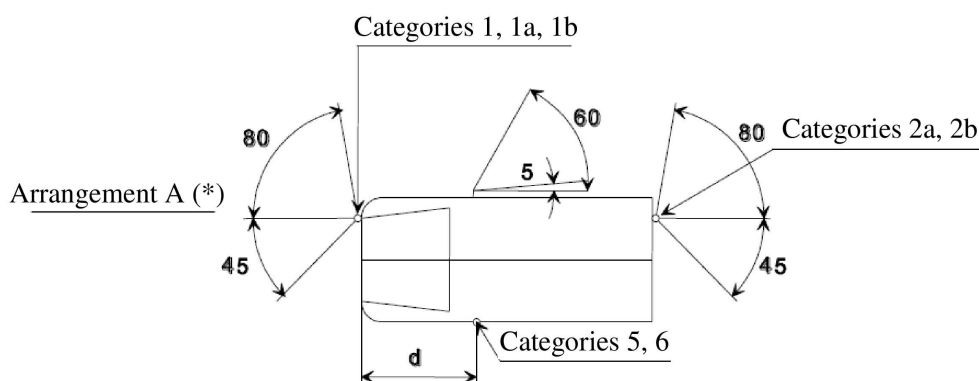
Vertical angles: 15° above and below the horizontal for direction indicator lamps of categories 1, 1a, 1b, 2a, 2b and 5.

However:

- (a) Where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1), the downward angle of 15° may be reduced to 5°;
- (b) Where an optional rear lamp is mounted above 2 100 mm (measured according to the provisions of paragraph 5.8.1. above) the upward angle of 15° may be reduced to 5°.

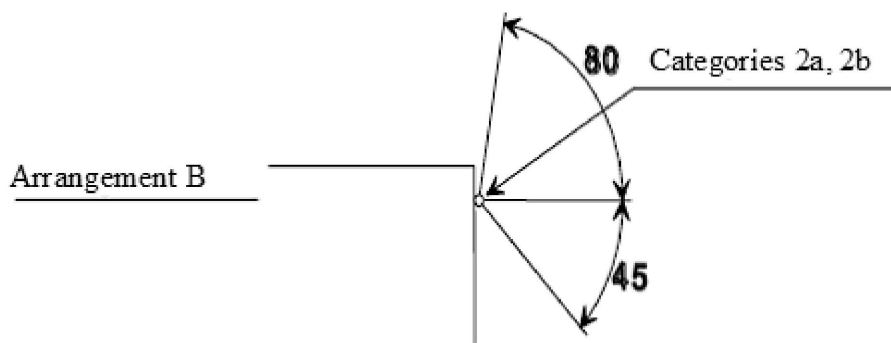
30° above and 5° below the horizontal for direction indicator lamps of category 6.

Figure (see paragraph 6.5.)



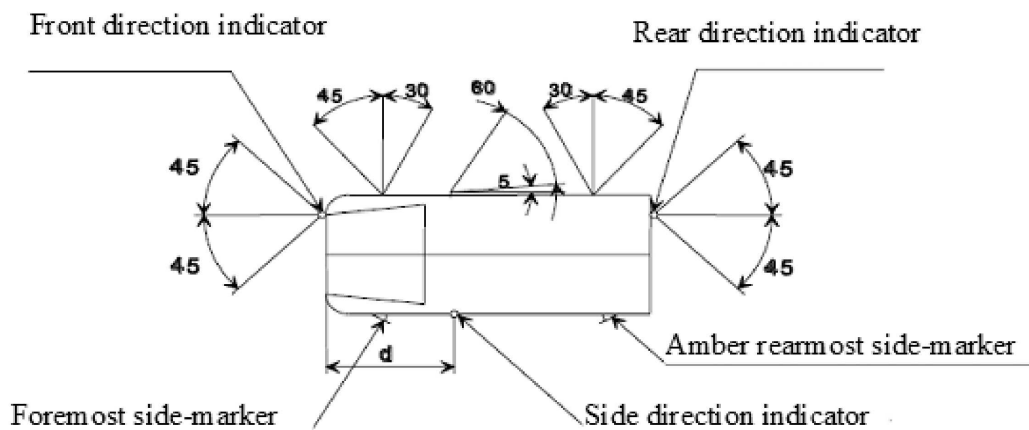
- (*) The value of 5° given for dead angle of visibility to the rear of the side direction-indicator is an upper limit $d \leq 1.80$ m (for M_1 and N_1 category vehicles $d \leq 2.50$ m).

For the direction indicator lamps of categories 1, 1a, 1b, 2a and 2b mounted below 750 mm (measured according to the provisions of paragraph 5.8.1), the inward angle of 45° may be reduced to 20° under the H plane.



6.5.5.2. Or, at the discretion of the manufacturer, for M_1 and N_1 category vehicles: Front and rear direction indicator lamps, as well as side-marker lamps (**).

Horizontal angles: (see figure below)



(**) The value of 5° given for the dead angle of visibility to the rear of the side direction-indicator is an upper limit. $d \leq 2.50$ m

However, for the direction indicator lamps of categories 1, 1a, 1b, 2a and 2b mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.

Vertical angles: 15° above and below the horizontal. However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1), the downward angle of 15° may be reduced to 5°.

To be considered visible, the lamp shall provide an unobstructed view of the apparent surface of at least 12.5 square centimetres, except for side direction-indicators of categories 5 and 6. The illuminating surface area of any retro-reflector that does not transmit light shall be excluded.

6.5.6. Orientation

According to the specifications for installation by the manufacturer, if any.

6.5.7. Electrical connections

Direction-indicator lamps shall switch ON independently of the other lamps. All direction-indicator lamps on one side of a vehicle shall be switched ON and OFF by means of one control and shall flash in phase.

On M_1 and N_1 vehicles less than 6 m in length, with an arrangement complying with paragraph 6.5.5.2. above, the amber side-marker lamps, when mounted, shall also flash at the same frequency (in phase) with the direction-indicator lamps.

6.5.8. Tell-tale

Operating tell-tale mandatory for direction-indicator lamps of categories 1, 1a, 1b, 2a and 2b. It may be visual or auditory or both. If it is visual it shall be a flashing light which, at least in the event of the malfunction of any of these direction-indicator lamps, is either extinguished, or remains alight without flashing, or shows a marked change of frequency. If it is entirely auditory it shall be clearly audible and shall show a marked change of frequency, at least in the event of the malfunction of any of these direction-indicator lamps.

It shall be activated by the signal produced according to paragraph 6.2.2. of UN Regulation No. 6 or according to paragraph 5.6.3. of UN Regulation No. 148 or another suitable way¹³.

If a motor vehicle is equipped to draw a trailer, it shall be fitted with a special visual operational tell-tale for the direction-indicator lamps on the trailer unless the tell-tale of the drawing vehicle allows the failure of any one of the direction-indicator lamps on the vehicle combination thus formed to be detected.

For the optional direction-indicator lamps on motor vehicles and trailers, operating tell-tale shall not be mandatory.

6.5.9. Other requirements

The light shall be a flashing light flashing 90 ± 30 times per minute.

Operation of the light-signal control shall be followed within not more than one second by the emission of light and within not more than one and one-half seconds by its first extinction. If a motor vehicle is equipped to draw a trailer, the control of the direction-indicator lamps on the drawing vehicle shall also operate the indicator lamps of the trailer. In the event of failure, other than short-circuit, of one direction-indicator lamp, the others shall continue to flash, but the frequency in this condition may be different from that prescribed.

6.6. Hazard warning signal

6.6.1. Presence

Mandatory.

The signal shall be given by simultaneous operation of the direction-indicator lamps in accordance with the requirements of paragraph 6.5. above.

All direction indicators of the category 1 (1, 1a, 1b) activated simultaneously shall operate in the same mode; i.e. static or sequential.

All direction indicators of the category 2 (2a, 2b) activated simultaneously shall operate in the same mode; i.e. static or sequential.

6.6.2. Number

As specified in paragraph 6.5.2.

6.6.3. Arrangement

As specified in paragraph 6.5.3.

6.6.4. Position

6.6.4.1. Width: As specified in paragraph 6.5.4.1.

6.6.4.2. Height: As specified in paragraph 6.5.4.2.

6.6.4.3. Length: As specified in paragraph 6.5.4.3.

6.6.5. Geometric visibility

As specified in paragraph 6.5.5.

6.6.6. Orientation

As specified in paragraph 6.5.6.

6.6.7. Electrical connections

6.6.7.1. The signal shall be operated by means of a separate manual control enabling all the direction-indicator lamps to flash in phase.

6.6.7.2. The hazard warning signal may be switched ON automatically in the event of a vehicle being involved in a collision or after the emergency stop signal has been switched OFF, as specified in paragraph 6.23. below. In such cases, it may be switched OFF manually.

In addition, the hazard warning signal may be switched ON automatically to indicate to other road-users the risk of imminent danger as defined by Regulations; in this case, the signal shall remain switched ON until it is manually or automatically switched OFF.

6.6.7.3. On M_1 and N_1 vehicles less than 6 m in length, with an arrangement complying with paragraph 6.5.5.2. above, the amber side-marker lamps, when mounted, shall also flash at the same frequency (in phase) with the direction-indicator lamps.

6.6.8. Tell-tale

Flashing circuit-closed tell-tale mandatory.

6.6.9. Other requirements

As specified in paragraph 6.5.9., if a power-driven vehicle is equipped to draw a trailer, the hazard warning signal control shall also be capable of bringing the direction-indicator lamps on the trailer into action. The hazard warning signal shall be able to function even if the device which starts or stops the propulsion system is in a position which makes it impossible to start the propulsion system.

6.7. Stop lamp (UN Regulation No.7 or 148)

6.7.1. Presence

Devices of S1 or S2 categories: mandatory on all categories of vehicles.

Devices of S3 or S4 category: mandatory on M_1 and N_1 categories of vehicles, except for chassis-cabs and those N_1 category vehicles with open cargo space; optional on other categories of vehicles.

6.7.2. Number

Two S1 or S2 category devices and one S3 or S4 category device on all categories of vehicles.

6.7.2.1. Except in the case where a category S3 or S4 device is installed, two optional category S1 or S2 devices may be installed on vehicles in categories M_2 , M_3 , N_2 , N_3 , O_2 , O_3 , and O_4 .

6.7.2.2. Only, when the median longitudinal plane of the vehicle is not located on a fixed body panel but separates one or two movable parts of the vehicle (e.g. doors), and lacks sufficient space to install a single device of the S3 or S4 category on the median longitudinal plane above such movable parts, either:

Two devices of the S3 or S4 category type "D" may be installed; or

One device of the S3 or S4 category may be installed offset to the left or to the right of the median longitudinal plane, or

An interdependent lamp system of category S3 or S4 may be installed.

6.7.3. Arrangement

No special requirement.

6.7.4. Position

6.7.4.1. In width:

For M_1 and N_1 category vehicles:

For S1 or S2 categories devices that point on the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle;

For the distance in between the inner edges of the apparent surfaces in the direction of the reference axes there is no special requirement.

For all other categories of vehicles:

For S1 or S2 categories devices the distance in between the inner edges of the apparent surfaces in the direction of the reference axes shall be not less than 600 mm. This distance may be reduced to 400 mm if the overall width of the vehicle is less than 1 300 mm.

For S3 or S4 category devices: the centre of reference shall be situated on the median longitudinal plane of the vehicle. However, in the case where the two devices of the S3 or S4 category are installed, according to paragraph 6.7.2., they shall be positioned as close as possible to the median longitudinal plane, one on each side of this plane.

In the case where one S3 or S4 category lamp offset from the median longitudinal plane is permitted according to paragraph 6.7.2., this offset shall not exceed 150 mm from the median longitudinal plane to the centre of reference of the lamp.

6.7.4.2. In height:

6.7.4.2.1. For S1 or S2 categories devices:

Above the ground, not less than 350 mm nor more than 1 500 mm (2 100 mm if the shape of the bodywork makes it impossible to keep within 1 500 mm and if the optional lamps are not installed).

If the optional lamps are installed, they shall be positioned at a height compatible with the requirements of the width and the symmetry of the lamps, and at a vertical distance as large as the shape of the bodywork makes it possible, but not less than 600 mm above the mandatory lamps.

6.7.4.2.2. For S3 or S4 categories devices:

The horizontal plane tangential to the lower edge of the apparent surface shall: either not be more than 150 mm below the horizontal plane tangential to the lower edge of the exposed surface of the glass or glazing of the rear window, or not be less than 850 mm above the ground.

However, the horizontal plane tangential to the lower edge of the apparent surface of a S3 or S4 category device shall be above the horizontal plane tangential to the upper edge of the apparent surface of S1 or S2 categories devices.

6.7.4.3. In length:

6.7.4.4. For S1 or S2 categories devices: at the rear of the vehicle.

6.7.4.5. For S3 or S4 categories devices: no special requirement.

6.7.5. Geometric visibility

Horizontal angle:

For S1 or S2 categories devices: 45° to the left and to the right of the longitudinal axis of the vehicle.

However, for the stop lamps of categories S1 and S2 mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.

For S3 or S4 categories devices: 10° to the left and to the right of the longitudinal axis of the vehicle;

Vertical angle:

For S1 or S2 categories devices: 15° above and below the horizontal.

However,

- (a) Where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°;
- (b) Where an optional lamp is mounted above 2 100 mm (measured according to the provisions of paragraph 5.8.1. above) the upward angle of 15° may be reduced to 5°.

For S3 or S4 categories devices: 10° above and 5° below the horizontal.

6.7.6. Orientation

Towards the rear of the vehicle.

6.7.7. Electrical connections

6.7.7.1. All stop lamps shall be switched ON simultaneously when the braking system provides the relevant signal defined in UN Regulations Nos. 13 and 13-H.

6.7.7.2. The stop lamps need not function if the device, which starts and/or stops the propulsion system, is in a position that makes it impossible for the propulsion system to operate.

6.7.8. Tell-tale

Tell-tale optional, however, a tell-tale indicating failure is mandatory if required by the component regulation.

Where the above tell-tale is fitted, this tell-tale shall be an operating tell-tale consisting of a non-flashing warning light which comes on in the event of the malfunctioning of the stop lamps.

6.7.9. Other requirements

6.7.9.1. The S3 or S4 category device may not be reciprocally incorporated with any other lamp.

6.7.9.2. The S3 or S4 category device may be installed outside or inside the vehicle.

6.7.9.2.1. In the case where it is installed inside the vehicle:

The light emitted shall not cause discomfort to the driver through the devices for indirect vision and/or other surfaces of the vehicle (i.e. rear window).

6.8. Rear registration plate lamp (UN Regulation No. 4 or 148)

6.8.1. Presence

Mandatory.

6.8.2. Number

Such that the device illuminates the site of the registration plate according to the type-approval documentation of the device.

6.8.3. Arrangement

Such that the device illuminates the site of the registration plate according to the type-approval documentation of the device.

6.8.4. Position

6.8.4.1. In width: Such that the device illuminates the site of the registration plate according to type-approval documentation of the device.

- 6.8.4.2. In height: Such that the device illuminates the site of the registration plate according to the type-approval documentation of the device.
- 6.8.4.3. In length: Such that the device illuminates the site of the registration plate according to the type-approval documentation of the device.
- 6.8.5. Geometric visibility
Such that the device illuminates the site of the registration plate according to the type-approval documentation of the device.
- 6.8.6. Orientation
Such that the device illuminates the site of the registration plate according to the type-approval documentation of the device.
- 6.8.7. Electrical connections
In accordance with paragraph 5.11.
- 6.8.8. Tell-tale
Tell-tale optional. If it exists, its function shall be carried out by the tell-tale required for the front and rear position lamps.
- 6.8.9. Other requirements
When the rear registration plate lamp is combined with the rear position lamp, reciprocally incorporated in the stop lamp or in the rear fog lamp, the photometric characteristics of the rear registration plate lamp may be modified during the entire time the stop lamp or the rear fog lamp is switched ON.
- 6.9. Front position lamp (UN Regulation No. 7 or 148)
- 6.9.1. Presence
Mandatory on all motor vehicles.
Mandatory on trailers over 1 600 mm wide.
Optional on trailers which are not more than 1 600 mm wide.
- 6.9.2. Number
Two.
- 6.9.3. Arrangement
No special requirement.
- 6.9.4. Position
- 6.9.4.1. In width: that point on the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle.

In the case of a trailer, that point on the apparent surface in the direction of the reference axis which is farthest from the median longitudinal plane shall not be more than 150 mm from the extreme outer edge of the vehicle.

The distance between the inner edges of the two apparent surfaces in the direction of the reference axes shall:

For M₁ and N₁ category vehicles: No special requirement;

For all other categories of vehicles: Not less than 600 mm. This distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

- 6.9.4.2. In height: above the ground, not less than 250 mm nor more than 1 500 mm (2 100 mm for O₁ and O₂ categories of vehicles, or if for any other categories of vehicles the shape of the bodywork makes it impossible to keep within 1 500 mm).
- 6.9.4.3. In length: no individual specification.
- 6.9.4.4. Where the front position lamp and another lamp are reciprocally incorporated, the apparent surface in the direction of the reference axis of the other lamp shall be used to verify compliance with the positioning requirements (paragraphs 6.9.4.1. to 6.9.4.3.).
- 6.9.5. Geometric visibility
- 6.9.5.1. Horizontal angle: 45° inwards and 80° outwards.
- However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.
- In the case of trailers, the angle inwards may be reduced to 5°.
- Vertical angle: 15° above and below the horizontal. However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°.
- 6.9.5.2. For M₁ and N₁ category vehicles, as an alternative to paragraph 6.9.5.1. above, at the discretion of the manufacturer or his duly accredited representative, and only if a front side-marker lamp is installed on the vehicle:
- Horizontal angle: 45° outwards to 45° inwards.
- However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.
- Vertical angle: 15° above and below the horizontal.
- However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°.
- To be considered visible, the lamp shall provide an unobstructed view of the apparent surface of at least 12.5 cm². The illuminating surface area of any retro-reflector that does not transmit light shall be excluded.
- 6.9.6. Orientation
- Forwards.
- 6.9.7. Electrical connections
- In accordance with paragraph 5.11.
- However, if a front position lamp is reciprocally incorporated with a direction-indicator the electrical connection of the front position lamp on the relevant side of the vehicle or the reciprocally incorporated part of it may be such that it is switched OFF during the entire time (both ON and OFF cycle) of operation of the direction-indicator lamp.
- 6.9.8. Tell-tale
- Circuit-closed tell-tale mandatory.
- This tell-tale shall be non-flashing and shall not be required if the instrument panel lighting can only switch ON simultaneously with the front position lamps.
- This requirement does not apply when light signalling system operates according to paragraph 6.19.7.4.
- However, a tell-tale indicating failure is mandatory if required by the component regulation.

6.9.9. Other requirements

6.9.9.1. If one or more infrared radiation generator(s) is (are) installed inside the front position lamp, it (they) is (are) allowed to be switched ON only when the headlamp on the same side of the vehicle is switched ON and the vehicle is in forward motion. In the event that the front position lamp or the headlamp on the same side fails, the infrared radiation generator(s) shall be automatically switched OFF.

6.9.9.2. In case an AFS providing a bending mode is installed, the front position lamp may be swivelled together with a lighting unit to which it is reciprocally incorporated.

6.10. Rear position lamp (UN Regulation No. 7 or 148)

6.10.1. Presence

Devices of R or R1 or R2 categories: Mandatory

6.10.2. Number

Two.

6.10.2.1. Except the case where end-outline marker lamps are installed, two optional position lamps may be installed on all vehicles in categories M₂, M₃, N₂, N₃, O₂, O₃, and O₄.

6.10.3. Arrangement

No special requirement.

6.10.4. Position

6.10.4.1. In width: that point on the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle. This condition shall not apply to the optional rear lamps.

The distance between the inner edges of the two apparent surfaces in the direction of the reference axes shall:

For M₁ and N₁ category vehicles: have no special requirement;

For all other categories of vehicles: be not less than 600 mm. This distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

6.10.4.2. In height: above the ground, not less than 350 mm nor more than 1 500 mm (2 100 mm if the shape of the bodywork makes it impossible to keep within 1 500 mm and if the optional lamps are not installed). If the optional lamps are installed, they shall be placed at a height compatible with the applicable requirements of paragraph 6.10.4.1., the symmetry of the lamps, and at a vertical distance as large as the shape of the bodywork makes it possible, but not less than 600 mm above the mandatory lamps.

6.10.4.3. In length: The rear of the vehicle.

6.10.5. Geometric visibility

6.10.5.1. Horizontal angle: 45° inwards and 80° outwards.

However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.

Vertical angle: 15° above and below the horizontal.

However,

- (a) Where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°;
- (b) Where an optional lamp is mounted above 2 100 mm (measured according to the provisions of paragraph 5.8.1. above) the upward angle of 15° may be reduced to 5°.

- 6.10.5.2. For M₁ and N₁ category vehicles, as an alternative to paragraph 6.10.5.1. above, at the discretion of the manufacturer or his duly accredited representative, and only if a rear side-marker lamp is installed on the vehicle,

Horizontal angle: 45° outwards to 45° inwards. However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.

Vertical angle: 15° above and below the horizontal.

However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°.

To be considered visible, the lamp shall provide an unobstructed view of the apparent surface of at least 12.5 square centimetres. The illuminating surface area of any retro-reflector that does not transmit light shall be excluded.

- 6.10.6. Orientation

Rearwards.

- 6.10.7. Electrical connections

In accordance with paragraph 5.11.

However, if a rear position lamp is reciprocally incorporated with a direction-indicator, the electrical connection of the rear position lamp on the relevant side of the vehicle or the reciprocally incorporated part of it may be such that it is switched OFF during the entire time (both ON and OFF cycle) of operation of the direction-indicator lamp.

- 6.10.8. Tell-tale

Circuit-closed tell-tale mandatory. It shall be combined with that of the front position lamps.

This requirement does not apply when light-signalling system operates according to paragraph 6.19.7.4.

However, a tell-tale indicating failure is mandatory if required by the component regulation.

- 6.10.9. Other requirements

None.

- 6.11. Rear fog lamp (UN Regulation No. 38 or 148)

- 6.11.1. Presence

Devices of F or F1 or F2 categories: Mandatory.

- 6.11.2. Number

One or two.

- 6.11.3. Arrangement

No special requirement.

6.11.4. Position

6.11.4.1. In width: if there is only one rear fog-lamp, it shall be on the opposite side of the median longitudinal plane of the vehicle to the direction of traffic prescribed in the country of registration, the centre of reference may also be situated on the median longitudinal plane of the vehicle.

6.11.4.2. In height: not less than 250 mm nor more than 1 000 mm above the ground. For rear fog lamps grouped with any rear lamp the maximum height may be increased to 1 200 mm. For categories N₂G, N₃G, M₂G, M₃G (off-road) vehicles the maximum height may be increased to 1 400 mm.

6.11.4.3. In length: at the rear of the vehicle.

6.11.5. Geometric visibility

Defined by angles α and β as specified in paragraph 2.10.7.:

α = 5° upwards and 5° downwards;

β = 25° to right and to left.

6.11.6. Orientation

Rearwards.

6.11.7. Electrical connections

These shall be such that:

6.11.7.1. The rear fog-lamp(s) cannot be switched ON unless the main beams, dipped-beams or front fog-lamps are switched ON;

6.11.7.2. The rear fog-lamp(s) can be switched OFF independently of any other lamp;

6.11.7.3. Either of the following applies:

6.11.7.3.1. The rear fog lamp(s) may continue to operate until the position lamps are switched OFF, and the rear fog lamp(s) shall then remain OFF until deliberately switched ON again;

6.11.7.3.2. A warning, at least audible, additional to the mandatory tell-tale (paragraph 6.11.8.) shall be given if the ignition is switched OFF or the ignition key is withdrawn and the driver's door is opened, whether the lamps in paragraph 6.11.7.1. are ON or OFF, whilst the rear fog lamp control is in the ON position.

6.11.7.4. Except as provided in paragraphs 6.11.7.1., 6.11.7.3. and 6.11.7.5., the operation of the rear fog lamp(s) shall not be affected by switching ON or OFF any other lamps.

6.11.7.5. The rear fog lamp(s) of a drawing motor vehicle may be automatically switched OFF while a trailer is connected and the rear fog lamp(s) of the trailer is (are) switched ON.

6.11.8. Tell-tale

Circuit-closed tell-tale mandatory. An independent non-flashing warning light.

6.11.9. Other requirements

In all cases, the distance between the rear fog-lamp and each stop-lamp shall be greater than 100 mm.

6.12. Parking lamp (UN Regulation No. 77 or 7 or 148)

- 6.12.1. Presence
On motor vehicles not exceeding 6 m in length and not exceeding 2 m in width, optional.
On all other vehicles, prohibited.
- 6.12.2. Number
According to the arrangement.
- 6.12.3. Arrangement
Either two lamps at the front and two lamps at the rear, or one lamp on each side.
- 6.12.4. Position
- 6.12.4.1. In width: that point on the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle.
Furthermore, if there are two lamps, they shall be on the sides of the vehicle.
- 6.12.4.2. In height:
For M₁ and N₁ category vehicles: no special requirement;
For all other categories of vehicles: above the ground, not less than 350 mm nor more than 1 500 mm (2 100 mm if the shape of the bodywork makes it impossible to keep within 1 500 mm).
- 6.12.4.3. In length: no special requirement.
- 6.12.5. Geometric visibility
Horizontal angle: 45° outwards, forwards and rearwards.
However, where a front or rear parking lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the inward angle of 45° may be reduced to 20° under the H plane.
Vertical angle: 15° above and below the horizontal.
However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°.
- 6.12.6. Orientation
Such that the lamps meet the requirements for visibility forwards and rearwards.
- 6.12.7. Electrical connections
The connection shall allow the parking lamp(s) on the same side of the vehicle to be switched ON independently of any other lamps.
The parking lamp(s) and, if applicable, the front and rear position lamps according to paragraph 6.12.9. below, shall be able to operate even if the device which starts the propulsion system is in a position which makes it impossible for the propulsion system to operate. A device which automatically switches OFF these lamps as a function of time is prohibited.
- 6.12.8. Tell-tale
Circuit-closed tell-tale optional. If there is one, it shall not be possible to confuse it with the tell-tale for the front and rear position lamps.

6.12.9. Other requirements

The functioning of this lamp may also be performed by simultaneously switching ON the front and rear position lamps on the same side of the vehicle. In this case, lamps that meet the requirements of front or rear position lamps are deemed to meet the requirements of parking lamps.

6.13. End-outline marker lamp (UN Regulation No. 7 or 148)

6.13.1. Presence

Devices of A or AM categories (visible from the front), and devices of R, R₁, R₂, RM₁ or RM₂ Categories (visible from the rear):

Mandatory on vehicles exceeding 2.10 m in width. Optional on vehicles between 1.80 and 2.10 m in width. On chassis-cabs the rear end-outline marker lamps are optional.

6.13.2. Number

Two visible from the front and two visible from the rear.

Additional lamps may be fitted as follows:

- (a) Two visible from the front;
- (b) Two visible from the rear.

6.13.3. Arrangement

No special requirement.

6.13.4. Position

6.13.4.1. In width:

Front and rear: as close as possible to the extreme outer edge of the vehicle. This condition is deemed to have been met when the point on the apparent surface in the direction of the reference axis which is farthest from the vehicle's median longitudinal plane is not more than 400 mm from the extreme outer edge of the vehicle.

6.13.4.2. In height:

Front: Motor vehicles - the horizontal plane tangential to the upper edge of the apparent surface in the direction of the reference axis of the device shall not be lower than the horizontal plane tangential to the upper edge of the transparent zone of the wind-screen.

Trailers and semi-trailers - at the maximum height compatible with the requirements relating to the width, design and operational requirements of the vehicle and to the symmetry of the lamps.

Rear: At the maximum height compatible with the requirements relating to the width, design and operational requirements of the vehicle and to the symmetry of the lamps.

The additional lamps, as specified in paragraph 6.13.2. (b), shall be fitted as far separated in height as practicable in respect to the mandatory ones, provided that their position is compatible with design/operational requirements of the vehicle and symmetry of the lamps.

6.13.4.3. In length, no special requirement.

The additional lamps, as specified in paragraph 6.13.2. (a), shall be fitted as close as practicable to the rear; this requirement shall be deemed to be satisfied if the distance between the additional lamps and the rear of the vehicle does not exceed 400 mm.

- 6.13.5. Geometric visibility
Horizontal angle: 80° outwards.
Vertical angle: 5° above and 20° below the horizontal.
- 6.13.6. Orientation
Such that the lamps meet the requirements for visibility forwards and rearwards.
- 6.13.7. Electrical connections
In accordance with paragraph 5.11.
- 6.13.8. Tell-tale
Tell-tale optional. If it exists, its function shall be carried out by the tell-tale required for the front and rear position lamps.
However, a tell-tale indicating failure is mandatory if required by the component regulation.
- 6.13.9. Other requirements
Provided that all other requirements are met, the mandatory or optional lamps, visible from the front and the mandatory or optional lamps visible from the rear on the same side of the vehicle may be combined into one device.
Two of the lamps visible from the rear may be grouped, combined or reciprocally incorporated in accordance with paragraph 5.7.
The position of an end-outline marker lamp in relation to corresponding position lamp shall be such that the distance between the projections on a transverse vertical plane of the points nearest to one another on the apparent surfaces in the direction of the respective reference axes of the two lamps considered is not less than 200 mm.
The additional lamps, as specified in paragraph 6.13.2. (a), used to mark the rear end outline of the vehicle, the trailer or the semi-trailer shall be fitted in such a way to make it visible within the fields of vision of the approved main rear-view devices for indirect vision.
- 6.14. Rear retro-reflector, non-triangular (UN Regulation No. 3 or 150)
- 6.14.1. Presence
Mandatory on motor vehicles.
Provided that they are grouped together with the other rear light-signalling devices, optional on trailers.
- 6.14.2. Number
Two, the performances of which shall conform to the requirements concerning Class IA or IB retro-reflectors in UN Regulation No. 3 or 150. Additional retro-reflecting devices and materials (including two retro-reflectors not complying with paragraph 6.14.4. below), are permitted provided they do not impair the effectiveness of the mandatory lighting and light-signalling devices.
- 6.14.3. Arrangement
No special requirement.
- 6.14.4. Position
- 6.14.4.1. In width: that point on the illuminating surface which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle.

The distance between the inner edges of the two apparent surfaces in the direction of the reference axes shall:

For M₁ and N₁ category vehicles: have no special requirement;

For all other categories of vehicles: be not less than 600 mm. This distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

- 6.14.4.2. In height: Above the ground, not less than 250 mm nor more than 900 mm (not more than 1 200 mm if grouped with any rear lamp(s), 1 500 mm if the shape of the bodywork makes it impossible to keep within 900 mm or 1 200 mm respectively).
- 6.14.4.3. In length: at the rear of the vehicle.
- 6.14.5. Geometric visibility
- Horizontal angle: 30° inwards and outwards.
- Vertical angle: 10° above and below horizontal.
- However, where a retro-reflector is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 10° may be reduced to 5°.
- 6.14.6. Orientation
- Rearwards.
- 6.14.7. Other requirements
- The illuminating surface of the retro-reflector may have parts in common with the apparent surface of any other lamp situated at the rear.
- 6.15. Rear retro-reflector, triangular (UN Regulation No. 3 or 150)
- 6.15.1. Presence
- Mandatory on trailers.
- Prohibited on motor vehicles.
- 6.15.2. Number
- Two, the performances of which shall conform to the requirements concerning Class IIIA or Class IIIB retro-reflectors in UN Regulation No. 3 or 150. Additional retro-reflecting devices and materials (including two retro-reflectors not complying with paragraph 6.15.4. below), are permitted provided they do not impair the effectiveness of the mandatory lighting and light-signalling devices.
- 6.15.3. Arrangement
- The apex of the triangle shall be directed upwards.
- 6.15.4. Position
- 6.15.4.1. In width: that point on the illuminating surface which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle.
- The inner edges of the retro-reflectors shall not be less than 600 mm apart. This distance may be reduced to 400 mm if the overall width of the vehicle is less than 1 300 mm.
- 6.15.4.2. In height: Above the ground, not less than 250 mm nor more than 900 mm (not more than 1 200 mm if grouped with any rear lamp(s), 1 500 mm if the shape of the bodywork makes it impossible to keep within 900 mm or 1 200 mm respectively).

- 6.15.4.3. In length: at the rear of the vehicle.
- 6.15.5. Geometric visibility
Horizontal angle: 30° inwards and outwards.
Vertical angle: 15° above and below the horizontal. However, where a retro-reflector is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 15° may be reduced to 5°.
- 6.15.6. Orientation
Rearwards.
- 6.15.7. Other requirements
The illuminating surface of the retro-reflector may have parts in common with the apparent surface of any other lamp situated at the rear.
- 6.16. Front retro-reflector, non-triangular (UN Regulation No. 3 or 150)
- 6.16.1. Presence
Mandatory on trailers.
Mandatory on motor vehicles having all forward facing lamps with reflectors concealable.
Optional on other motor vehicles.
- 6.16.2. Number
Two, the performances of which shall conform to the requirements concerning Class IA or IB retro-reflectors in UN Regulation No. 3 or 150. Additional retro-reflecting devices and materials (including two retro-reflectors not complying with paragraph 6.16.4. below), are permitted provided they do not impair the effectiveness of the mandatory lighting and light-signalling devices.
- 6.16.3. Arrangement
No special requirement.
- 6.16.4. Position
- 6.16.4.1. In width: that point on the illuminating surface which is farthest from the vehicle's median longitudinal plane shall not be more than 400 mm from the extreme outer edge of the vehicle.
In the case of a trailer, the point of the illuminating surface which is farthest from the vehicle's median longitudinal plane shall not be farther than 150 mm from the extreme outer edge of the vehicle.
The distance between the inner edges of the two apparent surfaces in the direction of the reference axes shall:
For M₁ and N₁ category vehicles: have no special requirement;
For all other categories of vehicles: be not less than 600 mm. This distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.
- 6.16.4.2. In height: above the ground, not less than 250 mm nor more than 900 mm (1 500 mm if the shape of the bodywork makes it impossible to keep within 900 mm).
- 6.16.4.3. In length: at the front of the vehicle.

6.16.5. Geometric visibility

Horizontal angle: 30° inwards and outwards. In the case of trailers, the angle inwards may be reduced to 10°. If because of the construction of the trailers this angle cannot be met by the mandatory retro-reflectors, then additional (supplementary) retro-reflectors shall be fitted, without the width limitation (paragraph 6.16.4.1. above), which shall, in conjunction with the mandatory retro-reflectors, give the necessary visibility angle.

Vertical angle: 10° above and below the horizontal. However, where a retro-reflector is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 10° may be reduced to 5°.

6.16.6. Orientation

Towards the front.

6.16.7. Other requirements

The illuminating surface of the retro-reflector may have parts in common with the apparent surface of any other lamp situated at the front.

6.17. Side retro-reflector, non-triangular (UN Regulation No. 3 or 150)

6.17.1. Presence

Mandatory: On all motor vehicles the length of which exceeds 6 m.

On all trailers.

Optional: On motor vehicles the length of which does not exceed 6 m.

6.17.2. Number

Such that the requirements for longitudinal positioning are complied with. The performances of these devices shall conform to the requirements concerning Class IA or IB retro-reflectors in UN Regulation No. 3 or 150. Additional retro-reflecting devices and materials (including two retro-reflectors not complying with paragraph 6.17.4. below), are permitted provided they do not impair the effectiveness of the mandatory lighting and light-signalling devices.

6.17.3. Arrangement

No special requirement.

6.17.4. Position

6.17.4.1. In width: no special requirement.

6.17.4.2. In height: Above the ground, not less than 250 mm nor more than 900 mm (not more than 1 200 mm if grouped with any lamp(s), 1 500 mm if the shape of the bodywork makes it impossible to keep within 900 mm or 1 200 mm respectively or if the presence of the device is not mandatory according to paragraph 6.17.1.).

6.17.4.3. In length: at least one side retro-reflector shall be fitted to the middle third of the vehicle, the foremost side retro-reflector being not further than 3 m from the front;

The distance between two adjacent side retro-reflectors shall not exceed 3 m. This does not, however, apply to M₁ and N₁ category vehicles.

If the structure, design or the operational use of the vehicle makes it impossible to comply with such a requirement, this distance may be increased to 4 m. The distance between the rearmost side retro-reflector and the rear of the vehicle shall not exceed 1 m. However, for motor vehicles the length of which does not exceed 6 m, it is sufficient to have one side retro-reflector fitted within the first third and/or one within the last third of the vehicle length.

For M₁ vehicles the length of which exceeds 6 m but does not exceed 7 m it is sufficient to have one side retro-reflector fitted not further than 3 m from the front and one within the last third of the vehicle length.

6.17.5. Geometric visibility

Horizontal angle: 45° to the front and to the rear.

Vertical angle: 10° above and below the horizontal. However, where a retro-reflector is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 10° may be reduced to 5°.

6.17.6. Orientation

Towards the side.

6.17.7. Other requirements

The illuminating surface of the side retro-reflector may have parts in common with the apparent surface of any other side lamp.

6.18. Side-marker lamps (UN Regulation No. 91 or 148)

6.18.1. Presence

Mandatory: On all vehicles the length of which exceeds 6 m, except for chassis-cabs.

The SM1 type of side-marker lamp shall be used on all categories of vehicles; however the SM2 type of side-marker lamps may be used on the M₁ category of vehicles.

In addition, on M₁ and N₁ category vehicles less than 6 m in length, side-marker lamps shall be used, if they supplement the reduced geometric visibility requirements of front position lamps conforming to paragraph 6.9.5.2. and rear position lamps conforming to paragraph 6.10.5.2.

Optional: On all other vehicles.

The SM1 or SM2 types of side-marker lamps may be used.

6.18.2. Minimum number per side

Such that the rules for longitudinal positioning are complied with.

6.18.3. Arrangement

No individual specifications.

6.18.4. Position

6.18.4.1. In width: no individual specifications.

6.18.4.2. In height: Above the ground, not less than 250 mm nor more than 1 500 mm (2 100 mm if the shape of the bodywork makes it impossible to keep within 1 500 mm).

6.18.4.3. In length: at least one side-marker lamp shall be fitted to the middle third of the vehicle, the foremost side-marker lamp being not further than 3 m from the front. The distance between two adjacent side-marker lamps shall not exceed 3 m. If the structure, design or the operational use of the vehicle make it impossible to comply with such a requirement, this distance may be increased to 4 m.

The distance between the rearmost side-marker lamp and the rear of the vehicle shall not exceed 1 m.

However, for vehicles the length of which does not exceed 6 m and for chassis-cabs it is sufficient to have one side-marker lamp fitted within the first third and/or within the last third of the vehicle length. For M₁ vehicles the length of which exceeds 6 m but does not exceed 7 m it is sufficient to have one side-marker lamp fitted not further than 3 m from the front and one within the last third of the vehicle length.

6.18.5. Geometric visibility

Horizontal angle: 45° to the front and to the rear; however for vehicles on which the installation of the side-marker lamps is optional this value can be reduced to 30°.

If the vehicle is equipped with side-marker lamps used to supplement the reduced geometric visibility of front and rear direction indicator lamps conforming to paragraph 6.5.5.2. above and/or position lamps conforming to paragraphs 6.9.5.2. and 6.10.5.2. above, the angles are 45° towards the front and rear ends of the vehicle and 30° towards the centre of the vehicle (see the figure in paragraph 6.5.5.2. above).

Vertical angle: 10° above and below the horizontal. However, where a lamp is mounted below 750 mm (measured according to the provisions of paragraph 5.8.1. above), the downward angle of 10° may be reduced to 5°.

6.18.6. Orientation

Towards the side.

6.18.7. Electrical connections

On M₁ and N₁ category vehicles less than 6 m in length amber side-marker lamps may be wired to flash, provided that this flashing is in phase and at the same frequency with the direction-indicator lamps at the same side of the vehicle.

On M₂, M₃, N₂, N₃, O₃ and O₄ vehicles mandatory amber side marker lamps may flash simultaneously with the direction-indicator lamps on the same side of the vehicle. However, where there are direction indicator lamps of category 5 installed according to paragraph 6.5.3.1. on the side of the vehicle these amber side marker lamps shall not flash.

6.18.8. Tell-tale

Tell-tale optional. If it exists its function shall be carried out by the tell-tale required for the front and rear position lamps.

6.18.9. Other requirements

When the rearmost side-marker lamp is combined with the rear position lamp reciprocally incorporated with the rear fog-lamp or stop lamp, the photometric characteristics of the side-marker lamp may be modified during the entire time of the rear fog lamp or stop lamp are switched ON.

Rear side-marker lamps shall be amber if they flash with the rear direction-indicator lamp.

6.19. Day-time running lamp (UN Regulation No. 87 or 148)

6.19.1. Presence

Mandatory on motor vehicles. Prohibited on trailers.

6.19.2. Number

Two.

6.19.3. Arrangement

No special requirement.

6.19.4. Position

6.19.4.1. In width: the distance between the inner edges of the apparent surfaces in the direction of the reference axes shall not be less than 600 mm.

This distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

6.19.4.2. In height: above the ground not less than 250 mm nor more than 1 500 mm.

6.19.4.3. In length: at the front of the vehicle. This requirement shall be deemed to be satisfied if the light emitted does not cause discomfort to the driver either directly or indirectly through the devices for indirect vision and/or other reflecting surfaces of the vehicle.

6.19.5. Geometric visibility

Horizontal: outwards 20° and inwards 20°.

Vertical: upwards 10° and downwards 10°.

6.19.6. Orientation

Towards the front.

6.19.7. Electrical connections

6.19.7.1. The daytime running lamps shall be switched ON automatically when the device which starts and/or stops the propulsion system is set in a position which makes it possible for the propulsion system to operate. However, the daytime running lamps may remain OFF while the following conditions exist:

6.19.7.1.1. The automatic transmission control is in the park position; or

6.19.7.1.2. The parking brake is in the applied position; or

6.19.7.1.3. Prior to the vehicle being set in motion for the first time after each manual activation of the device, which starts and/or stops the propulsion system.

6.19.7.2. The daytime running lamps may be switched OFF manually, provided that they switch ON automatically when the vehicle speed exceeds 15 km/h or when the vehicle has travelled more than 100 m, and that they remain ON until deliberately switched OFF again.

6.19.7.3. The daytime running lamp shall switch OFF automatically when the device which starts and/or stops the propulsion system is set in a position which makes it impossible for the propulsion system to operate or the front fog lamps or headlamps are switched ON, except when the latter are used to give intermittent luminous warnings at short intervals.

6.19.7.4. The lamps referred to in paragraph 5.11. may be switched ON when the daytime running lamps are switched ON. If this option is chosen, at least the rear position lamps shall be switched ON.

6.19.7.5. If the distance between the front direction-indicator lamp and the daytime running lamp is equal or less than 40 mm, the electrical connections of the daytime running lamp on the relevant side of the vehicle may be such that either:

(a) It is switched OFF; or

- (b) Its luminous intensity is reduced during the entire period (both ON and OFF cycle) of activation of a front direction-indicator lamp.

- 6.19.7.6. If a direction-indicator lamp is reciprocally incorporated with a daytime running lamp, the electrical connections of the daytime running lamp on the relevant side of the vehicle shall be such that the daytime running lamp is switched OFF during the entire period (both ON and OFF cycle) of activation of the direction-indicator lamp.
- 6.19.8. Tell-tale
Closed-circuit tell-tale optional, however a tell-tale indicating failure is mandatory if required by the component regulation.
- 6.19.9. Other prescriptions
No prescription.
- 6.20. Cornering lamp (UN Regulation No. 119 or 149)
- 6.20.1. Presence
Optional on motor vehicles.
- 6.20.2. Number
Two.
- 6.20.3. Arrangement
No special requirement.
- 6.20.4. Position
- 6.20.4.1. In width: one cornering lamp shall be located on each side of the vehicle's median longitudinal plane.
- 6.20.4.2. In length: not further than 1 000 mm from the front.
- 6.20.4.3. In height: minimum: Not less than 250 mm above the ground;
maximum: Not more than 900 mm above the ground.
However, no point on the apparent surface in the direction of the reference axis shall be higher than the highest point on the apparent surface in the direction of the reference axis of the dipped-beam headlamp.
- 6.20.5. Geometric visibility
Defined by angles α and β as specified in paragraph 2.10.7.:
 $\alpha = 10^\circ$ upwards and downwards,
 $\beta = 30^\circ$ to 60° outwards .
- 6.20.6. Orientation
Such that the lamps meet the requirements for geometric visibility.
- 6.20.7. Electrical connections
The cornering lamps shall be so connected that they cannot be switched ON unless the main-beam headlamps or the dipped-beam headlamps are switched ON at the same time.

- 6.20.7.1. The cornering lamp on one side of the vehicle may only be switched ON automatically when the direction-indicators on the same side of the vehicle are switched ON and/or when the steering angle is changed from the straight-ahead position towards the same side of the vehicle.

The cornering lamp shall be switched OFF automatically when the direction-indicator is switched OFF and/or the steering angle has returned in the straight-ahead position.

- 6.20.7.2. When the reversing lamp is switched ON, both cornering lamps may be switched ON simultaneously, independently from the steering wheel position or direction-indicator operation.

If so switched ON, both cornering lamps shall be switched OFF either:

- (a) When the reversing lamp is switched OFF;
- or
- (b) When the forward speed of the vehicle exceeds 15 km/h.

- 6.20.8. Tell-tale
None.

- 6.20.9. Other requirements
The cornering lamps shall not be switched ON at vehicle speeds above 40 km/h.

- 6.21. Conspicuity markings (UN Regulation No. 104 or 150)

- 6.21.1. Presence

- 6.21.1.1. Prohibited: on vehicles of categories M₁ and O₁.

- 6.21.1.2. Mandatory:

- 6.21.1.2.1. To the rear:

Full contour marking on vehicles exceeding 2 100 mm in width of the following categories:

- (a) N₂ with a maximum mass exceeding 7.5 tonnes and N₃ (with the exception of chassis-cabs, incomplete vehicles and tractors for semi-trailers);
- (b) O₃ and O₄ (with the exception of incomplete vehicles)

- 6.21.1.2.2. To the side:

- 6.21.1.2.2.1. Partial contour marking on vehicles exceeding 6 000 mm in length (including the drawbar for trailers) of the following categories:

- (a) N₂ with a maximum mass exceeding 7.5 tonnes and N₃ (with the exception of chassis-cabs, incomplete vehicles and tractors for semi-trailers);
- (b) O₃ and O₄ (with the exception of incomplete vehicles)

- 6.21.1.2.3. A line marking may be installed instead of the mandatory contour marking if the shape, structure, design or operational requirements of the vehicle make it impossible to install the mandatory contour marking.

- 6.21.1.2.4. If the exterior surfaces of the bodywork are partially constituted of flexible material, this line marking shall be installed on (a) rigid part(s) of the vehicle. The remaining portion of conspicuity markings may be fitted on the flexible material. If the exterior surfaces of the bodywork are constituted fully of flexible material, the line marking may be fitted on the flexible material.

- 6.21.1.2.5. In cases where the manufacturer, after verification by the Technical Service, can prove to the satisfaction of the Type Approval Authority that it is impossible, due to the operational requirements which may require special shape, structure or design of the vehicle, to comply with the requirements contained in paragraphs 6.21.2. to 6.21.7.5. below, then partial fulfilment of some of these requirements is acceptable. This is conditional upon a portion of the requirements being met where possible, and the application of conspicuity markings that partially meet requirements maximised on the vehicle structure. This may include fitting of additional brackets or plates containing material compliant with UN Regulation No. 104 or 150 where structure is available to ensure clear and uniform signalling compatible with the objective of conspicuity.

Where partial fulfilment is deemed acceptable, retro-reflective devices like retro-reflectors of class IVA of UN Regulation No. 3 or 150 or brackets containing retro-reflecting material compliant with photometric requirements of Class C of UN Regulation No. 104 or 150 may substitute part of the required conspicuity markings. In this case, at least one of these retro-reflective devices shall be installed per 1 500 mm.

The necessary information shall be indicated in the communication form.

- 6.21.1.3. Optional:

- 6.21.1.3.1. To the rear and to the side:

On all other categories of vehicles, not otherwise specified in paragraphs 6.21.1.1. and 6.21.1.2. above, including the cab of tractor units for semi-trailers and the cab of chassis-cabs.

Partial or full contour marking may be applied instead of mandatory line markings, and full contour marking may be applied instead of mandatory partial contour marking.

- 6.21.1.3.2. To the front:

Line marking on vehicles of categories O₂, O₃ and O₄.

Partial or full contour marking may not be applied to the front.

- 6.21.2. Number

According to the presence.

- 6.21.3. Arrangement

The conspicuity markings shall be as close as practicable to horizontal and vertical, compatible with the shape, structure, design and operational requirements of the vehicle; if this is not possible, the full or partial contour markings, when fitted, shall follow as close as practicable the contour of the outer shape of the vehicle.

Furthermore, the conspicuity markings shall be spaced as evenly as possible over the horizontal dimensions of the vehicle such that the total length and/or width of the vehicle can be identified.

- 6.21.4. Position

- 6.21.4.1. Width

- 6.21.4.1.1. The conspicuity marking shall be as close as practicable to the edge of the vehicle.

6.21.4.1.2. The cumulative horizontal length of the conspicuity marking elements, as mounted on the vehicle, shall equate to at least 70 per cent of the overall width of the vehicle, excluding any horizontal overlap of individual elements.

6.21.4.2. Length

6.21.4.2.1. The conspicuity marking shall be as close as practicable to the ends of the vehicle and reach to within 600 mm of each end of the vehicle.

6.21.4.2.1.1. For motor vehicles, each end of the vehicle, or in the case of tractors for semi-trailers each end of the cab ;

However, an alternative marking mode within 2 400 mm from the front end of the motor vehicle is allowed where a series of retro-reflectors of Class IVA of UN Regulation No. 3 or 150 or Class C of UN Regulation No. 104 or 150 are mounted followed by the required conspicuity marking as follows:

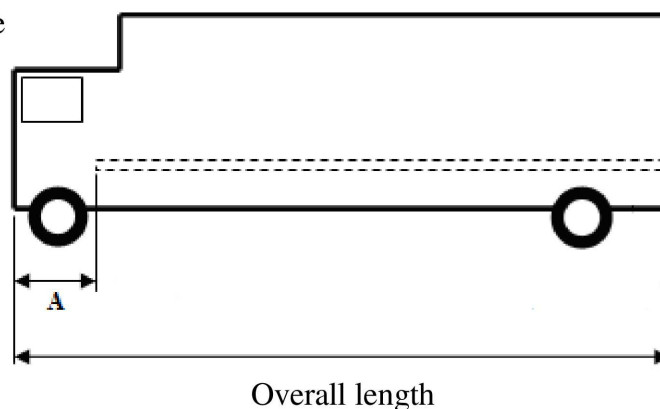
- (a) Retro-reflector size minimum 25 cm²;
- (b) One retro-reflector mounted not more than 600 mm from the front end of the vehicle;
- (c) Additional retro-reflectors spaced not more than 600 mm apart;
- (d) The distance between the last retro-reflector and the start of the conspicuity marking shall not exceed 600 mm;

6.21.4.2.1.2. For trailers, each end of the vehicle (excluding the drawbar).

6.21.4.2.2. The cumulative horizontal length of the conspicuity marking elements, as mounted on the vehicle, excluding any horizontal overlap of individual elements, shall equate to at least 70 per cent of:

6.21.4.2.2.1. For motor vehicles, length of vehicle, or in the case of tractors for semi-trailers, if fitted, the length of the cab; however, when using the alternative marking mode per paragraph 6.21.4.2.1.1., the distance beginning within 2 400 mm from the front end of vehicle to its rear end.

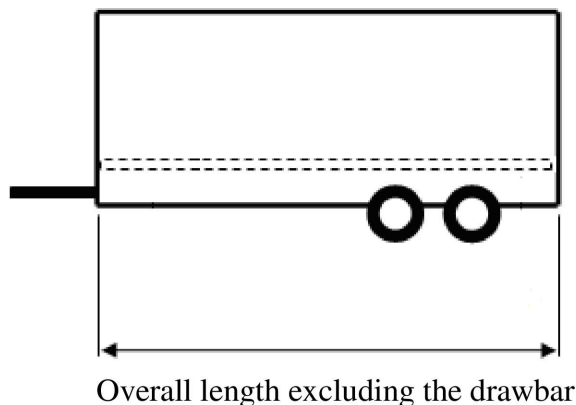
Motor vehicle



A is the distance between the foremost conspicuity marking and the front end of the vehicle. The maximum value of A is 2 400 mm (see paragraph 6.21.4.2.1.1.).

6.21.4.2.2.2. For trailers, the overall length of the vehicle (excluding the drawbar).

Trailer



6.21.4.3. Height

6.21.4.3.1. Line markings and contour markings lower element(s)

As low as practicable within the range:

Minimum: not less than 250 mm above the ground.

Maximum: not more than 1 500 mm above the ground.

However, a maximum mounting height of 2 500 mm may be accepted where the shape, structure, design or operational conditions of the vehicle prevent compliance with the maximum value of 1 500 mm or, if necessary, to fulfil the requirements of paragraphs 6.21.4.1.2., and 6.21.4.2.2., or the horizontal positioning of the line marking or the lower element(s) of the contour marking.

The necessary justification for installation of conspicuity material higher than 1 500 mm shall be indicated in the communication form.

6.21.4.3.2. Contour markings upper element(s):

As high as practicable, but within 400 mm of the upper extremity of the vehicle.

6.21.5. Visibility

The conspicuity marking shall be considered visible, if at least 70 per cent of the illuminating surface of the installed marking is visible when viewed by an observer positioned at any point within the observation planes defined below:

6.21.5.1. For rear and front conspicuity markings (see Annex 11, Figures 1a and 1b) the observation plane is perpendicular to the longitudinal axis of the vehicle situated 25 m from the extreme end of the vehicle and bounded by:

6.21.5.1.1. In height, by two horizontal planes 1 m and 3.0 m respectively above the ground;

6.21.5.1.2. In width, by two vertical planes which form an angle of 4° outwards from the vehicle's median longitudinal plane and which pass through the intersection of the vertical planes parallel to the vehicle's median longitudinal plane delimiting the vehicle's overall width, and the plane perpendicular to the longitudinal axis of the vehicle that delimits the end of the vehicle.

6.21.5.2. For side conspicuity markings (see Annex 11, Fig. 2) the observation plane is parallel to the longitudinal median plane of the vehicles situated 25 m from the extreme outer edge of the vehicle and bounded by:

6.21.5.2.1. In height, by two horizontal planes 1.0 m and 1.5 m respectively above the ground;

- 6.21.5.2.2. In width, by two vertical planes which form an angle of 4° outwards from a plane perpendicular to the vehicle's longitudinal axis and which pass through the intersection of the vertical planes perpendicular to the vehicle's longitudinal axis delimiting the vehicle's overall length and the extreme outer edge of the vehicle.
- 6.21.6. Orientation
- 6.21.6.1. To the side:
As close as practicable to being parallel to the median longitudinal plane of the vehicle, compatible with the shape, structure, design and operation requirements of the vehicle; if this is not possible, it shall follow as close as practicable the contour of the outer shape of the vehicle.
- 6.21.6.2. To the rear and to the front:
As close as practicable to being parallel to the transverse plane of the vehicle, compatible with the shape, structure, design and operation requirements of the vehicle, if this is not possible, it shall follow as close as practicable the contour of the outer shape of the vehicle.
- 6.21.7. Other requirements
- 6.21.7.1. Conspicuity markings shall be considered continuous if the distance between adjacent elements are as small as possible and do not exceed 50 per cent of the shortest adjacent element length. However, if the manufacturer can prove to the satisfaction of the Type Approval Authority that it is impossible to respect the value of 50 per cent, the distance between adjacent elements may be larger than 50 per cent of the shortest adjacent element, and it shall be as small as possible and not exceed 1 000 mm.
- 6.21.7.2. In the case of a partial contour marking, each upper corner shall be described by two lines at 90°, to each other and each at least 250 mm in length; if this is not possible, the marking shall follow as close as practicable the contour of the outer shape of the vehicle.
- 6.21.7.3. The distance between the conspicuity marking fitted to the rear of a vehicle and each mandatory stop lamp should be greater than 200 mm.
- 6.21.7.4. Where rear marking plates conforming either to the 01 series of amendments to UN Regulation No. 70 or to UN Regulation No. 150 are installed these may be considered, at the discretion of the manufacturer, as part of the conspicuity marking to the rear, for the purposes of calculating the length of the conspicuity marking and its proximity to the side of the vehicle.
- 6.21.7.5. The locations on the vehicle designated for conspicuity markings shall allow for the installation of markings of at least 60 mm in width.
- 6.22. Adaptive front lighting system (AFS) (UN Regulation No. 123 or 149)
Where not otherwise specified below, the requirements for main-beam headlamps (paragraph 6.1.) and for dipped-beam headlamps (paragraph 6.2.) of this Regulation apply to the relevant part of the AFS.
- 6.22.1. Presence
Optional on motor vehicles. Prohibited on trailers.
- 6.22.2. Number
One.

6.22.3. Arrangement

No special requirements.

6.22.4. Position

The AFS shall, prior to the subsequent test procedures, be set to the neutral state;

6.22.4.1. In width and height:

For a given lighting function or mode the requirements indicated in the paragraphs 6.22.4.1.1. through 6.22.4.1.4. below shall be fulfilled by those lighting units which are energized simultaneously for that lighting function or mode of a function, according to the applicant's description.

All dimensions refer to the nearest edge of the apparent surface(s) observed in the direction of the reference axis, of the lighting unit(s).

6.22.4.1.1. Two symmetrically placed lighting units shall be positioned at a height in compliance with the requirements of the relevant paragraphs 6.1.4. and 6.2.4., where "Two symmetrically placed lighting units" shall be understood to be two lighting units, one on each side of the vehicle, positioned such that the (geometric) centres of gravity of their apparent surfaces are at the same height and at the same distance from the vehicle's longitudinal median plane within a tolerance of 50 mm, each; their light emitting surfaces, illuminating surfaces, and light outputs, however, may differ.

6.22.4.1.2. Additional lighting units, if any, on either side of the vehicle shall be positioned at a distance not exceeding 140 mm ⁽¹⁴⁾ in horizontal direction (E in the figure) and 400 mm in vertical direction above or below (D in the figure) from the nearest lighting unit;

6.22.4.1.3. None of the additional lighting units described in paragraph 6.22.4.1.2. above shall be positioned lower than 250 mm (F in the figure) nor higher than indicated in paragraph 6.2.4.2. of this Regulation (G in the figure) above the ground;

6.22.4.1.4. Additionally, in width:

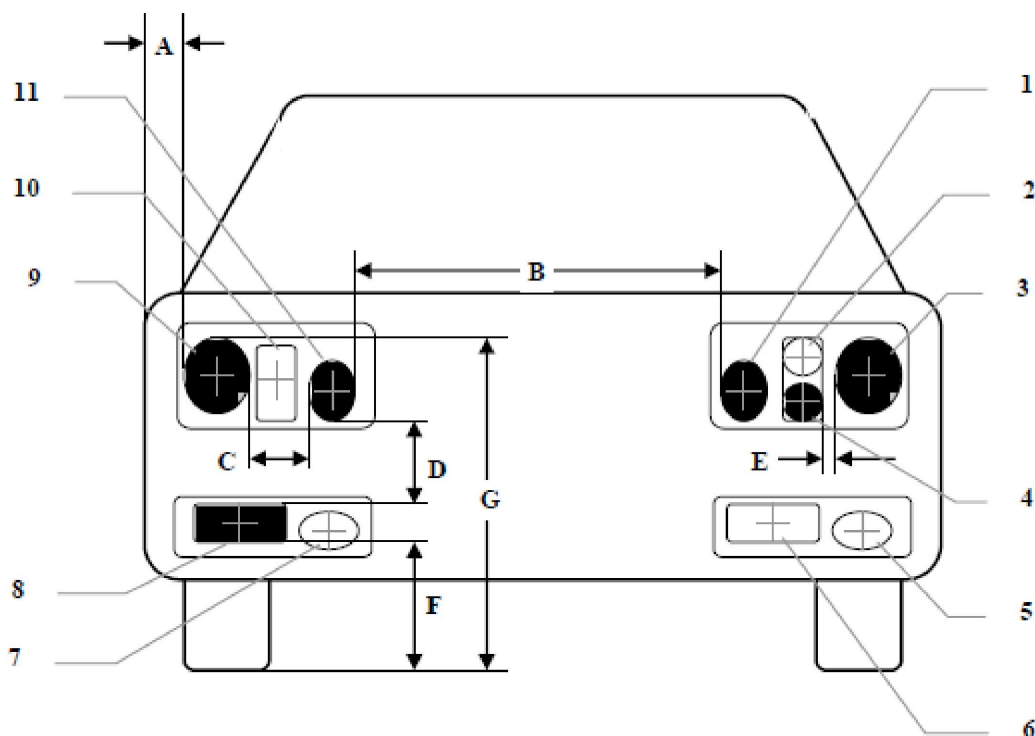
For each mode of the passing-beam lighting:

The outer edge of the apparent surface of at least one lighting unit on each side of the vehicle shall not be more than 400 mm from the extreme outer edge of the vehicle (A in the figure); and,

The inner edges of the apparent surfaces in the direction of the reference axes shall be not less than 600 mm apart. This does not apply, however, for M₁ and N₁ category vehicles; for all other categories of motor vehicles this distance may be reduced to 400 mm where the overall width of the vehicle is less than 1 300 mm.

⁽¹⁴⁾ In case of additional "two symmetrically placed lighting units" the horizontal distance may be 200 mm (C in the figure).

Apparent surfaces of lighting units 1 through 11 of an AFS (example)



Lighting units being simultaneously energized for a given lighting mode: ☐

No. 3 and 9: (two symmetrically placed lighting units)

No. 1 and 11: (two symmetrically placed lighting units)

No. 4 and 8: (two additional lighting units)

Lighting units not being energized for said lighting mode: ☐

No. 2 and 10: (two symmetrically placed lighting units)

No. 5: (additional lighting unit)

No. 6 and 7: (two symmetrically placed lighting units)

Horizontal dimensions in mm:

$$A \leq 400$$

$B \geq 600$, or, ≥ 400 if vehicle overall width $< 1\,300$ mm, however no requirement for category M_1 and N_1 vehicles

$$C \leq 200$$

$$E \leq 140$$

Vertical dimensions in mm:

$$D \leq 400$$

$$F \geq 250$$

$$G \leq 1\,200$$

6.22.4.2. In length:

All lighting units of an AFS shall be mounted at the front. This requirement is deemed to be satisfied if the light emitted does not cause discomfort to the driver either directly or indirectly through the devices for indirect vision and/or other reflecting surfaces of the vehicle.

6.22.5. Geometric visibility

On each side of the vehicle, for each lighting function and mode provided:

The angles of geometric visibility prescribed for the respective lighting functions according to paragraphs 6.1.5. and 6.2.5. of this Regulation, shall be met by at least one of the lighting units that are simultaneously energized to perform said function and mode(s), according to the description of the applicant. Individual lighting units may be used to comply with the requirements for different angles.

6.22.6. Orientation

Towards the front.

The AFS shall, prior to the subsequent test procedures, be set to the neutral state, emitting the basic passing-beam.

6.22.6.1. Vertical orientation:

- 6.22.6.1.1. The initial downward inclination of the cut-off of the basic passing-beam to be set in the unladen vehicle state with one person in the driver's seat shall be specified with a precision of 0,1 per cent by the manufacturer and indicated in clearly legible and indelible manner on each vehicle, close to either the front lighting system or the manufacturer's plate, by the symbol shown in Annex 7.

Where differing initial downward inclinations are specified by the manufacturer for different lighting units that provide or contribute to the cut-off of the basic passing-beam, these values of downward inclination shall be specified with a precision of 0,1 per cent by the manufacturer and indicated in clearly legible and indelible manner on each vehicle, close to either the relevant lighting units or on the manufacturers plate, in such a way that all the lighting units concerned can be unambiguously identified.

- 6.22.6.1.2. The downward inclination of the horizontal part of the "cut-off" of the basic passing-beam shall remain between the limits indicated in paragraph 6.2.6.1.2. of this Regulation under all the static loading conditions of the vehicle of Annex 5 to this Regulation; and the initial aiming shall be within the specified values.

- 6.22.6.1.2.1. In case the passing-beam is generated by several beams from different lighting units, the provisions according to paragraph 6.22.6.1.2. above apply to each said beam's "cut-off" (if any), which is designed to project into the angular zone, as indicated under item 9.3. of the communication form conforming to the model in Annex 1 to UN Regulation No. 123 or item 9.3.3. in Annex 1 to UN Regulation No. 149.

6.22.6.2. Headlamp levelling device

- 6.22.6.2.1. In the case where a headlamp levelling device is necessary to satisfy the requirements of paragraph 6.22.6.1.2., the device shall be automatic.

- 6.22.6.2.2. In the event of a failure of this device, the passing-beam shall not assume a position in which the dip is less than it was at the time when the failure of the device occurred.

6.22.6.3. Horizontal orientation:

For each lighting unit the kink of the elbow of the cut-off line, if any, when projected on the screen, shall coincide with the vertical line through the reference axis of said lighting unit. A tolerance of 0.5 degree to that side which is the side of the traffic direction shall be allowed. Other lighting units shall be adjusted according to the applicant's specification, as defined according to Annex 10 of UN Regulation No. 123 or Annex 14 of UN Regulation No. 149.

6.22.6.4. Measuring procedure:

After adjustment of the initial setting of beam orientation, the vertical inclination of the passing-beam or, when applicable, the vertical inclinations of all the different lighting units that provide or contribute to the cut-off(s) according to paragraph 6.22.6.1.2.1. above of the basic passing-beam, shall be verified for all loading conditions of the vehicle in accordance with the specifications in paragraphs 6.2.6.3.1. and 6.2.6.3.2. of this Regulation.

6.22.7. Electrical connections

6.22.7.1. Main-beam lighting (if provided by the AFS)

6.22.7.1.1. The lighting units for the main-beam may be switched ON either simultaneously or in pairs. For changing over from the dipped-beam to the main-beam at least one pair of lighting units for the main-beam shall be switched ON. For changing over from the main-beam to the dipped-beam all lighting units for the main-beam shall be switched OFF simultaneously.

6.22.7.1.2. The main-beam may be designed to be adaptive, subject to the provisions in paragraph 6.22.9.3., the control signals being produced by a sensor system which is capable of detecting and reacting to each of the following inputs:

- (a) Ambient lighting conditions;
- (b) The light emitted by the front lighting devices and front light-signalling devices of oncoming vehicles;
- (c) The light emitted by the rear light-signalling of preceding vehicles;

Additional sensor functions to improve performance are allowed.

For the purpose of this paragraph, "vehicles" means vehicles of categories L, M, N, O, T, as well as bicycles, such vehicles being equipped with retro-reflectors, with lighting and light-signalling devices, which are switched ON.

6.22.7.1.3. It shall always be possible to switch the main-beam headlamps, adaptive or non-adaptive, ON and OFF manually and to manually deactivate the automatic control.

Moreover, the switching OFF, of the main-beam headlamps and the deactivation of their automatic control shall be by means of a simple and immediate manual operation; the use of sub-menus is not allowed.

6.22.7.1.4. The dipped-beams may remain switched ON at the same time as the main beams.

6.22.7.1.5. Where four concealable lighting units are fitted their raised position shall prevent the simultaneous operation of any additional headlamps fitted, if these are intended to provide light signals consisting of intermittent switching ON at short intervals (see paragraph 5.12.) in daylight.

6.22.7.2. Passing-beam lighting:

- (a) The control for changing over to the dipped-beam shall switch OFF all main-beam headlamps or switch OFF all AFS lighting units for the main-beam simultaneously;
- (b) The dipped-beam may remain switched ON at the same time as the main-beams;
- (c) In the case of lighting units for the dipped-beam being equipped with gas discharge light sources, the gas-discharge light sources shall remain switched ON during the main-beam operation.

6.22.7.3. The dipped-beam headlamps switching ON and OFF shall fulfil the requirements for "Electrical connection" in paragraph 5.12. and 6.2.7. of this Regulation.

6.22.7.4. Automatic operation of the AFS

The changes within and between the provided classes and their modes of the AFS lighting functions as specified below, shall be performed automatically without causing discomfort, distraction or glare, neither for the driver nor for other road users.

The following conditions apply for the activation of the classes and their modes of the passing-beam and, where applicable, of the main-beam and/or the adaptation of the main-beam.

6.22.7.4.1. The class C mode(s) of the passing-beam shall be activated if no mode of another passing-beam class is activated.

6.22.7.4.2. The class V mode(s) of the passing-beam shall not operate unless one or more of the following conditions is/are automatically detected (V-signal applies):

- (a) Roads in built-up areas and the vehicle's speed not exceeding 60 km/h;
- (b) Roads equipped with a fixed road illumination, and the vehicle's speed not exceeding 60 km/h;
- (c) A road surface luminance of 1 cd/m² and/or a horizontal road illumination of 10 lx being exceeded continuously;
- (d) The vehicle's speed not exceeding 50 km/h.

6.22.7.4.3. The class E mode(s) of the passing-beam shall not operate unless the vehicle's speed exceeds 60 km/h and one or more of the following conditions is/are automatically detected:

- (a) The road characteristics correspond to motorway conditions ⁽¹⁵⁾ or the vehicle's speed exceeds 110 km/h (E-signal applies);
- (b) In case of a class E mode of the passing-beam which, according to the system's approval documents / communication sheet, complies with a "data set" of UN Regulation No. 123, Annex 3, Table 6, or of UN Regulation No. 149, Table 14 only.

Data set E1: The vehicle's speed exceeds 100 km/h (E1-signal applies);

Data set E2: The vehicle's speed exceeds 90 km/h (E2-signal applies);

Data set E3: The vehicle's speed exceeds 80 km/h (E3-signal applies).

6.22.7.4.4. The class W-mode(s) of the passing-beam shall not operate unless the front fog lamps, if any, are switched OFF and one or more of the following conditions is/are automatically detected (W-signal applies):

- (a) The wetness of the road has been detected automatically;
- (b) The windshield wiper is operating and its continuous or automatically controlled operation has occurred for a period of at least two minutes.

6.22.7.4.5. A mode of a class C, V, E, or W passing-beam shall not be modified to become a bending mode of said class (T-signal applies in combination with the signal of said passing-beam class according to paragraphs 6.22.7.4.1. through 6.22.7.4.4. above) unless at least one of the following characteristics (or equivalent indications) are evaluated:

- (a) The angle of lock of the steering;
- (b) The trajectory of the centre of gravity of the vehicle.

⁽¹⁵⁾ Traffic directions being separated by means of road construction, or, a corresponding lateral distance of opposing traffic is identified. This implies a reduction of undue glare from vehicles headlamps in opposing traffic.

In addition the following provisions apply:

- (i) A horizontal movement of the asymmetric cut-off side-wards from the longitudinal axis of the vehicle, if any, is allowed only when the vehicle is in forward motion ⁽¹⁶⁾ and shall be such that the longitudinal vertical plane through the kink of the elbow of the cut-off does not intersect the line of the trajectory of the centre of gravity of the vehicle at distances from the front of the vehicle which are larger than 100 times the mounting height of the respective lighting unit;
- (ii) One or more lighting units may be additionally energized only when the horizontal radius of curvature of the trajectory of the centre of gravity of the vehicle is 500 m or less.

6.22.7.5. It shall always be possible for the driver to set the AFS to the neutral state and to return it to its automatic operation.

6.22.8. Tell-tale:

6.22.8.1. The provisions of paragraphs 6.1.8. (for the main-beam headlamp) and 6.2.8. (for the dipped-beam headlamp) of this Regulation apply to the respective parts of an AFS.

6.22.8.2. A visual failure tell-tale for AFS is mandatory. It shall be non-flashing. It shall be activated whenever a failure is detected with respect to the AFS control signals or when a failure signal is received in accordance with paragraph 5.9. of UN Regulation No. 123. It shall remain activated while the failure is present. It may be cancelled temporarily but shall be repeated whenever the device which starts and stops the propulsion system is switched ON and OFF.

6.22.8.3. If the main-beam is adaptive, a visual tell-tale shall be provided to indicate to the driver that the adaptation of the main beam is activated. This information shall remain displayed as long as the adaptation is activated.

6.22.8.4. A tell-tale to indicate that the driver has set the system into a state according to paragraph 5.8. of UN Regulation No. 123 or paragraph 4.12. of UN Regulation No. 149 is optional .

6.22.9. Other requirements

6.22.9.1. An AFS shall be permitted only in conjunction with the installation of headlamp cleaning device(s) according to UN Regulation No. 45 ⁽¹⁷⁾ for at least those lighting units, which are indicated under item 9.2.3. of the communication form conforming to the model in Annex 1 to UN Regulation No. 123 or under item 9.3.2.3. in Annex 1 to UN Regulation No. 149, if the total objective luminous flux of the light sources of these units exceeds 2 000 lm per side, and which contribute to the Class C (basic) passing-beam.

6.22.9.2. Verification of compliance with AFS automatic operating requirements

6.22.9.2.1. The applicant shall demonstrate with *a concise description* or other means acceptable to the Type Approval Authority:

(a) The correspondence of the AFS control signals

- i) To the description required in paragraph 3.2.6. of this Regulation; and
- ii) To the respective AFS control signals specified in the AFS type approval documents; and

⁽¹⁶⁾ This provision does not apply for passing-beam lighting when bend lighting is produced for a right turn in right hand traffic (left turn in left-hand traffic).

⁽¹⁷⁾ Contracting Parties to the respective Regulations can still prohibit the use of mechanical cleaning systems when headlamps with plastic lenses, marked 'PL', are installed.

- (b) Compliance with the *automatic operating* requirements according to paragraphs 6.22.7.4.1. through 6.22.7.4.5. above.

6.22.9.2.2. To verify, whether, according to the paragraph 6.22.7.4., the AFS automatic operation of the passing-beam functions does not cause any discomfort, the technical service shall perform a test drive which comprises any situation relevant to the system control on the basis of the applicants description; it shall be notified whether all modes are activated, performing and de-activated according to the applicant's description; obvious malfunctioning, if any, shall be contested (e.g. excessive angular movement or flicker).

6.22.9.2.3. The overall performance of the automatic control shall be demonstrated by the applicant by documentation or by other means accepted by the Type Approval Authority. Furthermore the manufacturer shall provide a documentation package which gives access to the design of "the safety concept" of the system. This "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 mechanical or electrical failure which could cause any discomfort, distraction or glare, either to the driver or to oncoming and preceding vehicles. This description shall also give 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.

A list of all input and sensed variables shall be provided and the working range of these shall be defined. The possibility of a fall-back to the basic passing-beam (class C) function shall be a part of the safety concept.

The functions of the system and the safety concept, as laid down by the manufacturer, shall be explained. The 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.

For Type Approval purposes this documentation shall be taken as the basic reference for the verification process.

6.22.9.2.4. To verify, that the adaptation of the main-beam does not cause any discomfort, distraction or glare, neither to the driver nor to oncoming and preceding vehicles, the technical service shall perform a test drive according to paragraph 2. in Annex 12. This shall include any situation relevant to the system control on the basis of the applicant's description. The performance of the adaptation of the main-beam shall be documented and checked against the applicant's description. Any obvious malfunctioning shall be contested (e.g. excessive angular movement or flicker).

6.22.9.3. Adaptation of the main-beam

6.22.9.3.1. The sensor system used to control the adaptation of the main-beam, as described in paragraph 6.22.7.1.2., shall comply with the following requirements:

6.22.9.3.1.1. The boundaries of the minimum fields in which the sensor is able to detect light emitted from other vehicles as defined in paragraph 6.22.7.1.2. above are given by the angles indicated in paragraph 6.1.9.3.1.1. of this Regulation.

6.22.9.3.1.2. The sensor system sensitivity shall comply with the requirements in paragraph 6.1.9.3.1.2. of this Regulation.

- 6.22.9.3.1.3. The adaptive main-beam shall be switched OFF when the illuminance produced by ambient lighting conditions exceeds 7 000 lx.

Compliance with this requirement shall be demonstrated by the applicant, using simulation or other means of verification accepted by the Type Approval Authority. If necessary the illuminance shall be measured on a horizontal surface, with a cosine corrected sensor on the same height as the mounting position of the sensor on the vehicle. This may be demonstrated by the manufacturer by sufficient documentation or by other means accepted by the Type Approval Authority.

- 6.22.9.4. The aggregate maximum intensity of the lighting units that can be energized simultaneously to provide the main-beam lighting or its modes, if any, shall not exceed 430 000 cd, which corresponds to a reference value of 100.

This maximum intensity shall be obtained by adding together the individual reference marks indicated on the several installation units that are simultaneously used to provide the main-beam.

- 6.22.9.5. The means according to the provisions of paragraph 5.8. of UN Regulation No 123 or paragraph 4.12 of UN Regulation No. 149, which allow the vehicle to be used temporarily in a territory with the opposite direction of driving than that for which approval is sought, shall be explained in detail in the owner's manual.

6.23. Emergency stop signal

6.23.1. Presence

Mandatory on motor vehicles.

Optional on trailers.

The emergency stop signal shall be given by the simultaneous operation of all the stop or direction-indicator lamps fitted as described in paragraph 6.23.7.

6.23.2. Number

As specified in paragraph 6.5.2. or 6.7.2.

6.23.3. Arrangement

As specified in paragraph 6.5.3. or 6.7.3.

6.23.4. Position

As specified in paragraph 6.5.4. or 6.7.4.

6.23.5. Geometric visibility

As specified in paragraph 6.5.5. or 6.7.5.

6.23.6. Orientation

As specified in paragraph 6.5.6. or 6.7.6.

6.23.7. Electrical connections

- 6.23.7.1. All the lamps of the emergency stop signal shall flash in phase at a frequency of $4,0 \pm 1,0$ Hz.

- 6.23.7.1.1. However, if any of the lamps of the emergency stop signal to the rear of the vehicle use filament light sources the frequency shall be $4,0 +0,0/-1,0$ Hz.

- 6.23.7.2. The emergency stop signal shall operate independently of other lamps.

- 6.23.7.3. The emergency stop signal shall be switched ON and OFF automatically.

- 6.23.7.3.1. The emergency stop signal shall be switched ON only when the vehicle speed is above 50 km/h and the braking system is providing the emergency braking logic signal defined in UN Regulations Nos. 13 and 13-H.
- 6.23.7.3.2. The emergency stop signal shall be automatically switched OFF if the emergency braking logic signal as defined in UN Regulations Nos. 13 and 13-H is no longer provided or if the hazard warning signal is activated.
- 6.23.8. Tell-tale
Optional
- 6.23.9. Other requirements
- 6.23.9.1. Except as provided in paragraph 6.23.9.2. below, if a motor vehicle is equipped to tow a trailer, the control of the emergency stop signal on the motor vehicle shall also be capable of operating the emergency stop signal on the trailer.
- When the motor vehicle is electrically connected to a trailer, the operating frequency of the emergency stop signal for the combination shall be limited to the frequency specified in paragraph 6.23.7.1.1. However, if the motor vehicle can detect that filament light sources are not being used on the trailer for the emergency stop signal, the frequency may be that specified in paragraph 6.23.7.1.
- 6.23.9.2. If a motor vehicle is equipped to tow a trailer fitted with a service braking system of either continuous or semi-continuous type, as defined in Regulation No.13, it shall be ensured that a constant power supply is provided via the electrical connector for the stop lamps to such trailers while the service brake is applied.
- The emergency stop signal on any such trailer may operate independently of the towing vehicle and is not required to operate either at the same frequency as, or in phase with that on the towing vehicle.
- 6.24. Exterior courtesy lamp
- 6.24.1. Presence
Optional on motor vehicles
- 6.24.2. Number
Two, however further exterior courtesy lamps to illuminate steps and/or door handles are permitted. Each door handle or step shall be illuminated by not more than one lamp.
- 6.24.3. Arrangement
No special requirement, however the requirements of paragraph 6.24.9.3. apply.
- 6.24.4. Position
No special requirement.
- 6.24.5. Geometric visibility
No special requirement.
- 6.24.6. Orientation
No special requirement.
- 6.24.7. Electrical connections
No special requirement.

- 6.24.8. Tell-tale
No special requirement.
- 6.24.9. Other requirements
- 6.24.9.1. The exterior courtesy lamp shall not be switched ON unless the vehicle is stationary and one or more of the following conditions is satisfied:
(a) The propulsion system is stopped; or
(b) A driver or passenger door is opened; or
(c) A load compartment door is opened.
The provisions of paragraph 5.10. shall be met in all fixed positions of use.
- 6.24.9.2. Approved lamps emitting white light with the exception of main beam head lamps, day time running lamps and reversing lamps may be switched ON as courtesy lamp function. They may also be switched ON together with the exterior courtesy lamps and the condition of paragraphs 5.11. and 5.12. above may not apply.
- 6.24.9.3. The technical service shall, to the satisfaction of the Type Approval Authority, perform a visual test to verify that there is no direct visibility of the apparent surface of the exterior courtesy lamps, if viewed by an observer moving on the boundary of a zone on a transverse plane 10 m from the front of the vehicle, a transverse plane 10 m from the rear of the vehicle, and two longitudinal planes 10 m from each side of the vehicle; these four planes to extend from 1 m to 3 m above and perpendicular to the ground as shown in Annex 14.
At the request of the applicant and with the consent of the Technical Service this requirement may be verified by a drawing or simulation.
- 6.25. Rear-end collision alert signal
- 6.25.1. Presence
Optional
The rear-end collision alert signal shall be given by the simultaneous operation of all the direction indicator lamps fitted as described in paragraph 6.25.7.
- 6.25.2. Number
As specified in paragraph 6.5.2.
- 6.25.3. Arrangement
As specified in paragraph 6.5.3.
- 6.25.4. Position
As specified in paragraph 6.5.4.
- 6.25.5. Geometric visibility
As specified in paragraph 6.5.5.
- 6.25.6. Orientation
As specified in paragraph 6.5.6.
- 6.25.7. Electrical connections. Compliance with these requirements shall be demonstrated by the applicant, by simulation or other means of verification accepted by the Technical Service responsible for type approval.
- 6.25.7.1. All the lamps of the rear-end collision alert signal shall flash in phase at a frequency of 4,0 +/- 1,0 Hz.

- 6.25.7.1.1. However, if any of the lamps of the rear end collision alert signal to the rear of the vehicle use filament light sources the frequency shall be 4,0 +0,0/-1,0 Hz.
- 6.25.7.2. The rear-end collision alert signal shall operate independently of other lamps.
- 6.25.7.3. The rear-end collision alert signal shall be switched ON and OFF automatically.
- 6.25.7.4. The rear-end collision alert signal shall not be switched ON if the direction indicator lamps, the hazard warning signal or the emergency stop signal is activated.
- 6.25.7.5. The rear-end collision alert signal may only be switched ON under the following conditions:

V_r	switch ON
$V_r > 30 \text{ km/h}$	$TTC \leq 1,4$
$V_r \leq 30 \text{ km/h}$	$TTC \leq 1,4 / 30 \times V_r$

" V_r (Relative Speed)": means the difference in speed between a vehicle with rear-end collision alert signal and a following vehicle in the same lane.

"TTC (Time to collision)": means the estimated time for a vehicle with rear-end collision alert signal and a following vehicle to collide assuming the relative speed at the time of estimation remains constant.

- 6.25.7.6. The switch ON period of the rear-end collision alert signal shall be not more than 3 seconds.
- 6.25.8. Tell-tale
Optional
- 6.26. Manoeuvring lamps (UN Regulation No. 23 or 148)
- 6.26.1. Presence
Optional on motor vehicles.
- 6.26.2. Number
One or two (one per side)
- 6.26.3. Arrangement
No special requirement, however the requirements of paragraph 6.26.9. apply.
- 6.26.4. Position
No special requirement.
- 6.26.5. Geometric Visibility
No special requirement.
- 6.26.6. Orientation
Downwards, however the requirements of paragraph 6.26.9. apply.
- 6.26.7. Electrical Connections
Manoeuvring lamps shall be so connected that they cannot be switched ON unless the main-beam headlamps or the dipped-beam headlamps are switched ON at the same time.

The manoeuvring lamp(s) shall be switched ON automatically for slow manoeuvres up to 15 km/h provided that one of the following conditions is fulfilled:

- (a) Prior to the vehicle being set in motion for the first time after each manual activation of the propulsion system; or
- (b) Reverse gear is engaged; or
- (c) A camera based system which assists parking manoeuvres is operating.

The manoeuvring lamps shall be automatically switched OFF if the forward speed of the vehicle exceeds 15 km/h and they shall remain switched OFF until the switch ON conditions are met again.

6.26.8. Tell-tale

No special requirement.

6.26.9. Other requirements

6.26.9.1. The Technical Service shall, to the satisfaction of the Type Approval Authority, perform a visual test to verify that there is no direct visibility of the apparent surface of these lamps, if viewed by an observer moving on the boundary of a zone on a transverse plane 10 m from the front of the vehicle, a transverse plane 10 m from the rear of the vehicle, and two longitudinal planes 10 m from each side of the vehicle; these four planes to extend from 1 m to 3 m above and parallel to the ground as shown in Annex 14.

6.26.9.2. At the request of the applicant and with the consent of the Technical Service the requirement of 6.26.9.1 may be verified by a drawing or simulation or deemed to be satisfied if the installation conditions comply with paragraph 6.2.2. of UN Regulation No. 23 or paragraph 5.10.2. of UN Regulation No. 148, as noticed in the communication document in Annex 1, paragraph 9.

7. MODIFICATIONS AND EXTENSIONS OF APPROVAL OF THE VEHICLE TYPE OR OF THE INSTALLATION OF ITS LIGHTING AND LIGHT-SIGNALLING DEVICES

7.1. Every modification of the vehicle type, or of the installation of its lighting or light-signalling devices, or of the list referred to in paragraph 3.2.2. above, shall be notified to the Type Approval Authority which approved that vehicle type. The Authority 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 test report from the Technical Services responsible for conducting the tests.

7.2. Confirmation of extension or refusal of approval, specifying the alteration, shall be communicated by the procedure specified in paragraph 4.3. above to the Parties to the Agreement applying this Regulation.

7.3. The Type Approval 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.

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. Any vehicle approved pursuant to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set out in paragraphs 5. and 6. above.
- 8.2. The holder of the approval shall in particular:
 - 8.2.1. Ensure existence of procedures for effective quality control of the vehicle as regards all aspects relevant to compliance with the requirements set out in paragraphs 5. and 6. above;
 - 8.2.2. Ensure that for each type of vehicle at least the tests prescribed in Annex 9 to this Regulation or physical checks from which equivalent data may be derived are carried out;
- 8.3. The Type Approval Authority may carry out any test prescribed in this Regulation. These tests will be on samples selected at random without causing distortion of the manufacturers delivery commitments.
- 8.4. The Type Approval Authority shall strive to obtain a frequency of inspection of once per year. However, this is at the discretion of the Type Approval Authority and their confidence in the arrangements for ensuring effective control of the conformity of production. In the case where negative results are recorded, the Type Approval Authority shall ensure that all necessary steps are taken to re-establish the conformity of production as rapidly as possible.

9. PENALTIES FOR NON-CONFORMITY OF PRODUCTION

- 9.1. The approval granted in respect of a type of vehicle pursuant to this Regulation may be withdrawn if the requirements are not complied with or if a vehicle bearing the approval mark does not conform to the type approved.
- 9.2. 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.

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 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 a communication form conforming to the model in Annex 1 to this Regulation.

11. NAMES AND ADDRESSES OF TECHNICAL SERVICES RESPONSIBLE FOR CONDUCTING APPROVAL TESTS AND OF TYPE APPROVAL AUTHORITIES

The Contracting Parties to the 1958 Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities 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 General

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

12.1.2. As from the official date of entry into force of the most recent series of amendments, no Contracting Party applying this Regulation shall refuse national or regional type approval to a vehicle type approved under this Regulation as amended by this most recent series of amendments.

12.1.3. During the time period from the official date of entry into force of the most recent series of amendments and its mandatory application to new type approvals, 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 all the applicable preceding series of amendments.

12.1.4. Existing approvals under this Regulation granted before the date of mandatory application of the most recent series of amendment shall remain valid indefinitely and Contracting Parties applying this Regulation shall continue to recognize them and shall not refuse to grant extensions of approvals to them (except for what indicated in paragraph 12.1.6. below).

12.1.5. When the vehicle type approved to any of the preceding series of amendments meets the requirements of this Regulation as amended by the most recent series of amendments, the Contracting Party which granted the approval shall notify the other Contracting Parties applying this Regulation thereof.

12.1.6. Notwithstanding paragraph 12.1.4. above, Contracting Parties whose application of this Regulation comes into force after the date of entry into force of the most recent series of amendments are not obliged to accept approvals which were granted in accordance with any of the preceding series of amendments to this Regulation.

12.1.7. Until the United Nations Secretary-General is notified otherwise, Japan declares that in relation to the installation of lighting and light signalling devices, Japan will only be bound by the obligations of the Agreement to which this Regulation is annexed with respect to vehicles of categories M₁ and N₁.

12.2. Transitional provisions applicable to 03 series of amendments.

Contracting Parties applying this Regulation:

- (a) From 10 October 2007 (12 months after the date of entry into force), shall grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 03 series of amendments;
- (b) Up to 09 October 2009 (36 months after the date of entry into force) shall not refuse national or regional type approval of a vehicle type approved to any of the preceding series of amendments to this Regulation.
- (c) From 10 October 2009 (36 months after the entry into force) may refuse first national or regional entry into service of a vehicle of categories N₂ (with a maximum mass exceeding 7.5 tonnes), N₃, O₃ and O₄ exceeding 2 100 mm in width (for rear markings) and exceeding 6 000 mm in length (for side markings), except tractors for semi-trailers and incomplete vehicles, which do not meet the requirements of the 03 series of amendments to this Regulation.

- (d) Notwithstanding paragraph 12.1.4., from 10 October 2011 (60 months after the date of entry into force) shall no more recognize approvals to this Regulation granted to type of vehicles of categories N₂ (with a maximum mass exceeding 7.5 tons), N₃, O₃ and O₄ exceeding 2 100 mm in width (for rear markings) and exceeding 6 000 mm in length (for side markings), except tractors for semi-trailers and incomplete vehicle, under any preceding series of amendment, that ceases to be valid.
- (e) From 12 June 2010 (36 months from the entry into force of Supplement 3 to the 03 series of amendments) shall grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by Supplement 3 to the 03 series of amendments.
- (f) Up to 11 January 2010 (18 months after the official date of entry into force of Supplement 4 to the 03 series of amendments) shall continue to grant approvals to new vehicle types which do not meet the requirements on vertical orientation of front fog lamps (paragraph 6.3.6.1.1.) and/or on direction indicator operating tell-tale (paragraph 6.5.8.) and/or on daytime running lamps switching off (paragraph 6.19.7.3.).
- (g) Up to 10 October 2011 (60 month after the official date of entry into force) shall continue to grant approvals to new vehicle types which do not meet the requirements on cumulative length of conspicuity markings (paragraph 6.21.4.1.3.). ⁽¹⁸⁾

12.3. Transitional provisions applicable to 04 series of amendments.

Contracting Parties applying this Regulation:

- (a) From 07 February 2011 for vehicles of categories M₁ and N₁, and from 07 August 2012 for vehicles of other categories (respectively 30 and 48 months after the official date of entry into force) shall grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 04 series of amendments.
- (b) After 22 July 2009 (date of entry into force of Supplement 2 to the 04 series of amendments) shall continue to grant approvals to vehicle types which do not meet the requirements of paragraph 5.2.1. as amended by the Supplement 2 to 04 series of amendments if they are fitted with headlamps approved to Regulation No. 98 (prior to Supplement 9) or Regulation No. 112 (prior to Supplement 8).
- (c) From 24 October 2012 (36 months from the entry into force of Supplement 3 to the 04 series of amendments) shall grant approvals only if the vehicle type to be approved meets the requirements on voltage limitation of paragraphs 3.2.7. and 5.27 to 5.27.4. of this Regulation as amended by Supplement 3 to the 04 series of amendments.
- (d) Up to 07 February 2011 for vehicles of categories M₁ and N₁ and to 07 August 2012 for vehicles of other categories (respectively 30 and 48 months after the official date of entry into force of Supplement 2 to the 04 series of amendments) shall continue to grant approvals to new vehicle types which do not meet the requirements on switching OFF of daytime running lamps reciprocally incorporated with front direction indicator lamps (paragraph 6.19.7.6.).

12.3.1. Notwithstanding the transitional provisions above, Contracting Parties whose application of Regulation No. 112 comes into force after 07 August 2008 (date of entry into force of the 04 series of amendments to the present Regulation) are not obliged to accept approvals if the vehicle type to be approved does not meet the requirements of paragraph 6.1.2. and 6.2.2. of this Regulation as amended by the 04 series of amendments to this Regulation with regard to Regulation No. 112.

⁽¹⁸⁾ Note by the secretariat: for paragraph 6.21.4.1.3., please refer to the text of the 03 series of amendments as contained in document E/ECE/324/Rev.1/Add.47/Rev.6 - E/ECE/TRANS/505/Rev.1/Add.47/Rev.6

- 12.4. Transitional provisions applicable to 05 series of amendments.
Contracting Parties applying this Regulation:
- (a) From 30 January 2015 (48 months from the official date of entry into force) shall grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 05 series of amendments.
 - (b) Until 30 July 2016 for new vehicles types of categories M₁ and N₁ and until 30 January 2018 for new vehicle types of other categories (respectively 66 and 84 months after the official date of entry into force) shall grant approvals if the new vehicle type to be approved meets the requirements of one or more of paragraphs 6.2.7.6.2. or 6.2.7.6.3. to 6.2.7.6.3.3. instead of those of paragraph 6.2.7.6.1. of this Regulation as amended by the 05 series of amendments.
- 12.5. Transitional provisions applicable to 06 series of amendments.
Contracting Parties applying this Regulation:
From 18 November 2017 (60 month after the date of entry into force) shall grant approvals only if the vehicle type to be approved meets the requirements of this Regulation as amended by the 06 series of amendments.
- 12.6. Transitional provisions applicable to the 07 series of amendments
- 12.6.1. 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 or refuse to accept UN type approvals under this Regulation as amended by the 07 series of amendments.
 - 12.6.2. As of 6 July 2022, Contracting Parties applying this Regulation shall not be obliged to accept UN type approvals to the preceding series of amendments, first issued after 5 July 2022.
 - 12.6.3. Until 6 July 2024, Contracting Parties applying this Regulation shall accept UN type approvals to the preceding series of amendments and extensions thereof, first issued before 6 July 2022.
 - 12.6.4. As from 7 July 2024, Contracting Parties applying this Regulation shall not be obliged to accept UN type approvals, including any extensions, issued to the preceding series of amendments to this Regulation without emergency stop signal installed.
 - 12.6.5. Notwithstanding the transitional provisions above, Contracting Parties who start to apply this Regulation after the date of entry into force of the most recent series of amendments are not obliged to accept UN type approvals which were granted in accordance with any of the preceding series of amendments to this Regulation.
 - 12.6.6. Notwithstanding paragraph 12.6.4., Contracting Parties applying this Regulation shall continue to accept UN type approvals to the preceding series of amendments to this Regulation, for the vehicle types which are not affected by the changes introduced by the 07 series of amendments.
 - 12.6.7. Contracting Parties applying this Regulation shall not refuse to grant UN type approvals according to any preceding series of amendments to this Regulation or extensions thereof.
-

ANNEX 1

Communication

(maximum format: A4 (210 x 297 mm))



issued by: Name of administration

.....

.....

.....

concerning: ⁽²⁾

Approval granted

Approval extended

Approval refused

Approval withdrawn

Production definitively discontinued

of a type of vehicle with regard to the installation of lighting and light- signalling devices, pursuant to Regulation No. 48.

Approval No.: Extension No.:

1. Trade name or mark of the vehicle:
2. Manufacturer's name for the type of vehicle:
3. Manufacturer's name and address:
4. If applicable, name and address of the manufacturer's representative:
5. Submitted for approval on:
6. Technical Service responsible for conducting approval tests:
7. Date of test report:
8. Number of test report:
9. Concise description:

Lighting and light-signalling devices on the vehicle:

 - 9.1. Main-beam headlamps: yes/no²
 - 9.2. Dipped-beam headlamps: yes/no²
 - 9.3. Front-fog lamps: yes/no²
 Comments: Reciprocally incorporated in headlamp: yes/no²
 - 9.4. Reversing lamps: yes/no²
 - 9.5. Front direction-indicators: yes/no²
 - 9.6. Rear direction-indicators: yes/no²
 - 9.7. Side direction-indicators: yes/no²
 - 9.8. Hazard warning signal: yes/no²
 - 9.9. Stop-lamps: yes/no²
 - 9.9.1. Tell-tale indicating failure, as required by component regulation, fitted: yes/no²
 - 9.10. Rear registration plate
 illuminating device: yes/no²
 - 9.11. Front position lamps: yes/no²

9.11.1.	Tell-tale indicating failure, as required by component regulation, fitted:	yes/no ²	
9.12.	Rear position lamps:	yes/no ²	
9.12.1.	Tell-tale indicating failure, as required by component regulation, fitted:	yes/no ²	
9.13.	Rear fog-lamps:	yes/no ²	
9.14.	Parking lamps:	yes/ no ²	
9.15.	End-outline marker lamps:	yes/no ²	
9.15.1.	Tell-tale indicating failure, as required by component regulation, fitted:	yes/no ²	
9.16.	Rear retro-reflectors, non-triangular:	yes/no ²	
9.17.	Rear retro-reflectors, triangular:	yes/no ²	
9.18.	Front retro-reflectors, non-triangular:	yes/no ²	
9.19.	Side retro-reflectors, non-triangular:	yes/no ²	
9.20.	Side marker lamps:	yes/no ²	
9.21.	Daytime running lamps:	yes/no ²	
9.21.1.	Tell-tale indicating failure, as required by component regulation, fitted:	yes/no ²	
9.22.	Adaptive front lighting system (AFS): yes/no ²		
9.23.	Cornering lamps:	yes/no ²	
9.24.	Conspicuity markings:	Rear	Side
9.24.1.	Full contour markings:	yes/no ²	yes/no ²
9.24.2.	Partial contour markings:	yes/no ²	yes/no ²
9.24.3.	Line markings:	yes/no ²	yes/no ²
9.24.4.	Exemption regarding conspicuity marking according to paragraph 6.21.1.2.5.		
		Rear	
		yes/no ²	
		Comments:	
		Side	
		yes/no ²	
		Comments	
9.25.	Emergency stop signal:	yes/no ²	
9.26.	Manoeuvring lamps:	yes/no ²	
9.27.	Exterior courtesy lamps:	yes/no ²	
9.28.	Equivalent lamps:	yes/no ²	
9.29.	Maximum permissible load in the boot:		
9.30.	Lamps approved for and equipped with LED substitute light source(s) are allowed to be installed on this vehicle type: yes/no ² (?)		
10.	Comments:		

- 10.1. Any comments on movable components:
- 10.2. Method used for the definition of the apparent surface:
 (a) Boundary of the illuminating surface² or
 (b) Light-emitting surface²
- 10.3. Other comments (valid for right-hand or left-hand drive vehicles):
- 10.4. Comments concerning AFS (according to paragraphs 3.2.6. and 6.22.7.4. of this Regulation):
- 10.5. Comments regarding the extent of coverage of the conspicuity marking if it is less than the minimum value of 70 per cent required by paragraphs 6.21.4.1.2. and 6.21.4.2.2. of this Regulation.
- 10.6. For vehicles of M and N categories comments regarding the electrical supply conditions (according to paragraphs 3.2.7 and 5.27 of this Regulation)
- 10.7. Comments regarding conspicuity marking (according to paragraphs 6.21.1.2.5. and 6.21.4.3.1. of this Regulation)
- 10.8. Comments regarding conspicuity marking (Incomplete vehicle or Complete Vehicles according to paragraphs 6.21.1.2.1. and 6.21.1.2.2.1. of this Regulation):
- Incomplete vehicles: yes/no²
- Complete vehicles: yes/no²
- Completed vehicles: yes/no²
11. Position of the approval mark:
12. Reason(s) for extension (if applicable):
13. Approval granted/extended/refused/withdrawn²
14. Place:
15. Date:
16. Signature:
17. The following documents, bearing the approval number shown above, are available on request:

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

⁽²⁾ Strike out what does not apply.

⁽³⁾ If yes, list the applicable lamps.

ANNEX 2

Arrangements of approval marks*Model A*

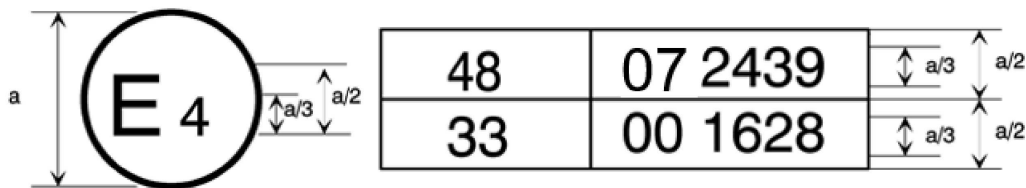
(See paragraph 4.4. of this Regulation)

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

The above approval mark affixed to a vehicle shows that the vehicle type concerned has, with regard to the installation of lighting and light-signalling devices, been approved in the Netherlands (E 4) pursuant to UN Regulation No. 48 as amended by the 07 series of amendments. The approval number indicates that the approval was granted in accordance with the requirements of UN Regulation No. 48 as amended by the 07 series of amendments.

Model B

(See paragraph 4.5. of this Regulation)

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

The above approval mark affixed to a vehicle shows that the vehicle type concerned has been approved in the Netherlands (E 4) pursuant to UN Regulation No. 48 as amended by the 07 series of amendments and UN Regulation No. 33. ⁽¹⁾ The approval number indicates that, at the dates when the respective approvals were given, UN Regulation No. 48 was amended by the 07 series of amendments and UN Regulation No. 33 was still in its original form.

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

ANNEX 3

Examples of lamp surfaces, axes, centres of reference, and angles of geometric visibility

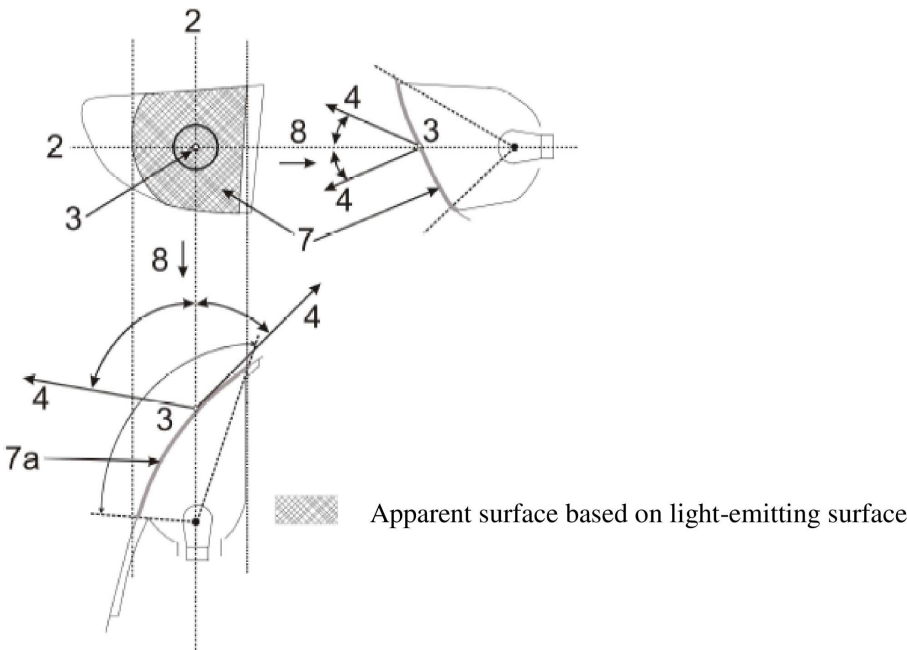
These examples show some arrangements to aid the understanding of the provisions and are not intended to be design restrictive .

KEY for all examples in this Annex:

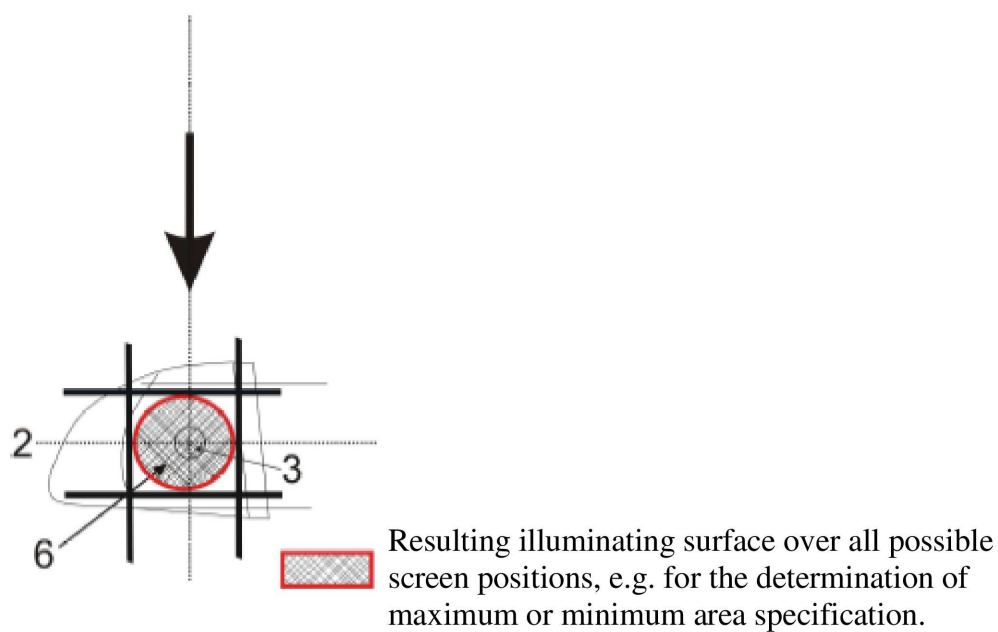
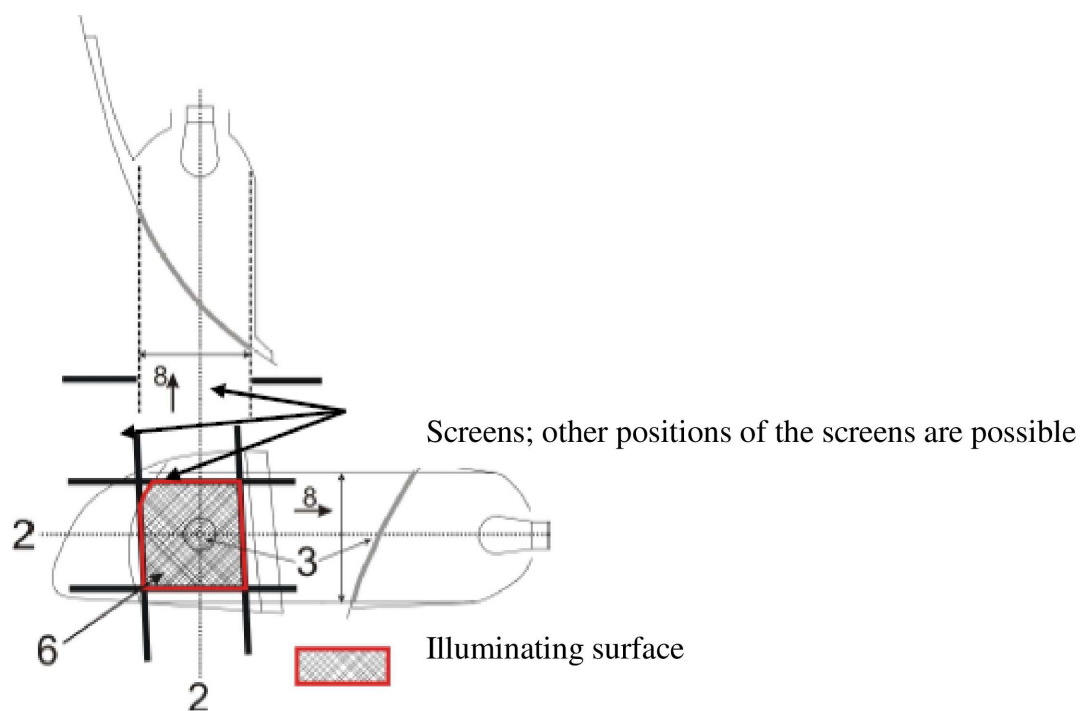
1. Illuminating surface	IO Inner optical part
2. Axis of reference	LG Light guide
3. Centre of reference	L Outer lens
4. Angle of geometric visibility	R Reflector
5. Light-emitting surface	S Light source
6. Apparent surface based on the illuminating surface	X Not part of this function
7a. Apparent surface based on the light-emitting surface according to paragraph 2.10.2. (a) (with outer lens)	F1 Function one
7b. Apparent surface based on the light-emitting surface according to paragraph 2.10.2. (b) (without outer lens)	F2 Function two
8. Direction of visibility	

Part 1

Light emitting surface of a light-signalling device other than a retro-reflector

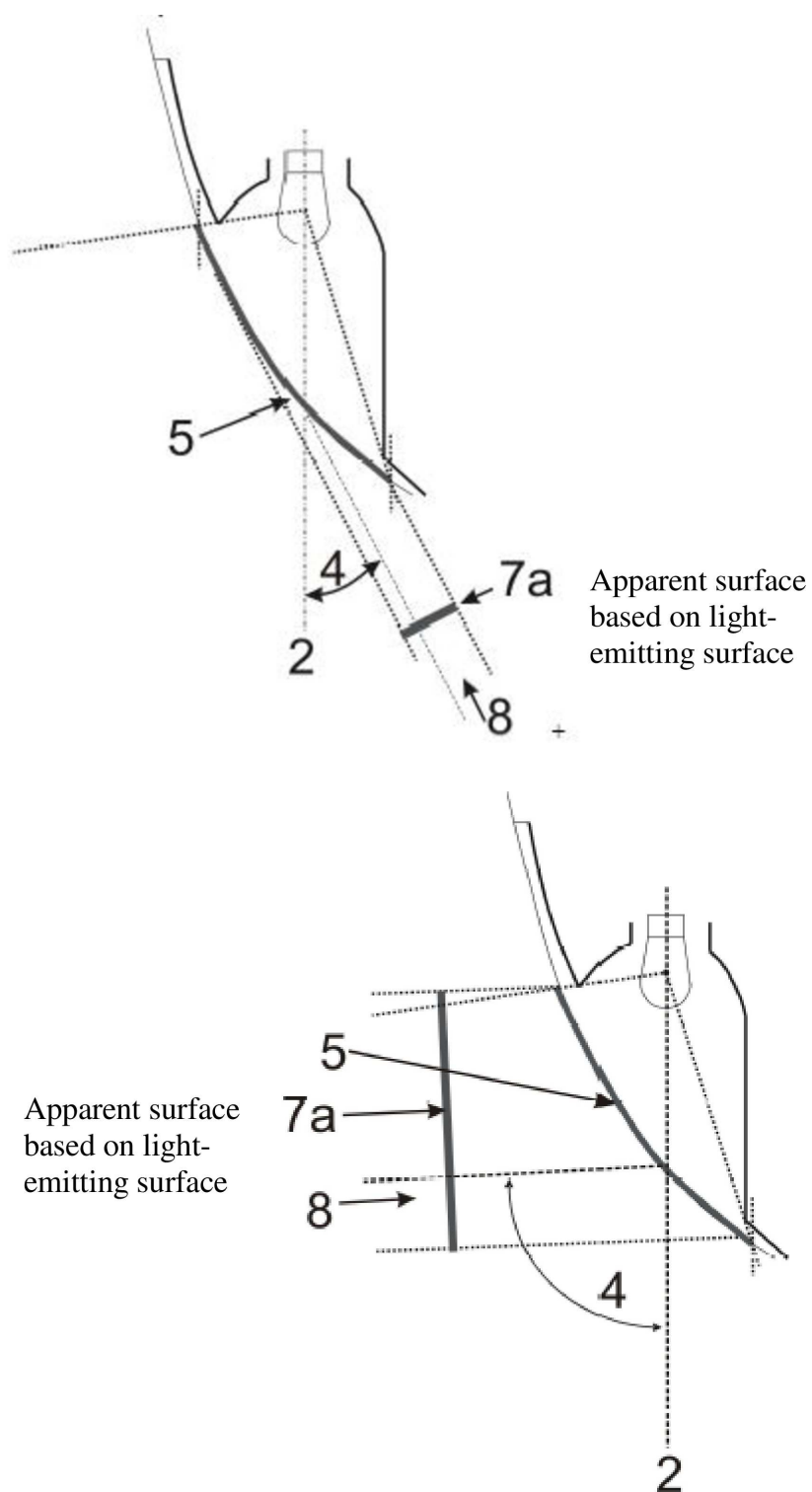


Part 2

Illuminating surface of a light-signalling device other than a retro-reflector

Part 4

Examples of apparent surface based on light emitting surface in different directions of geometric visibility

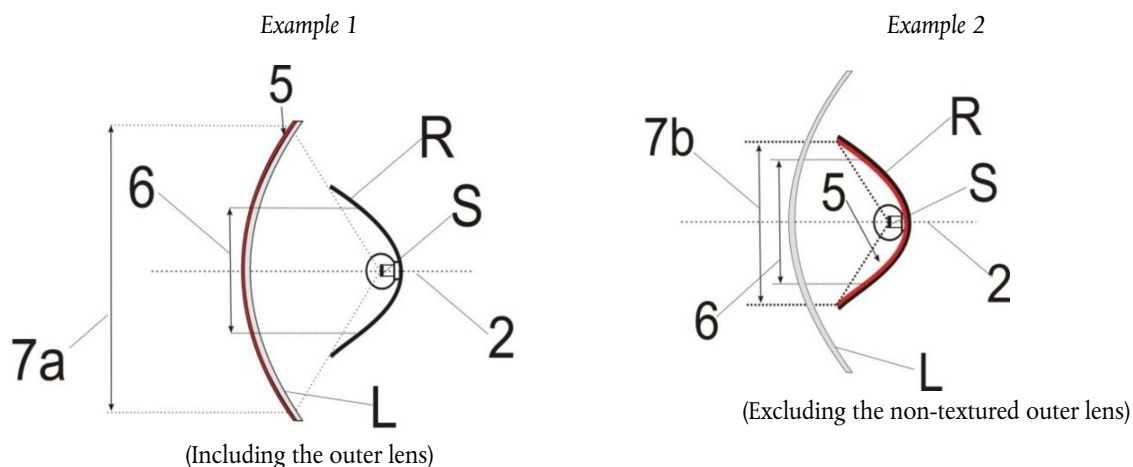


Part 5

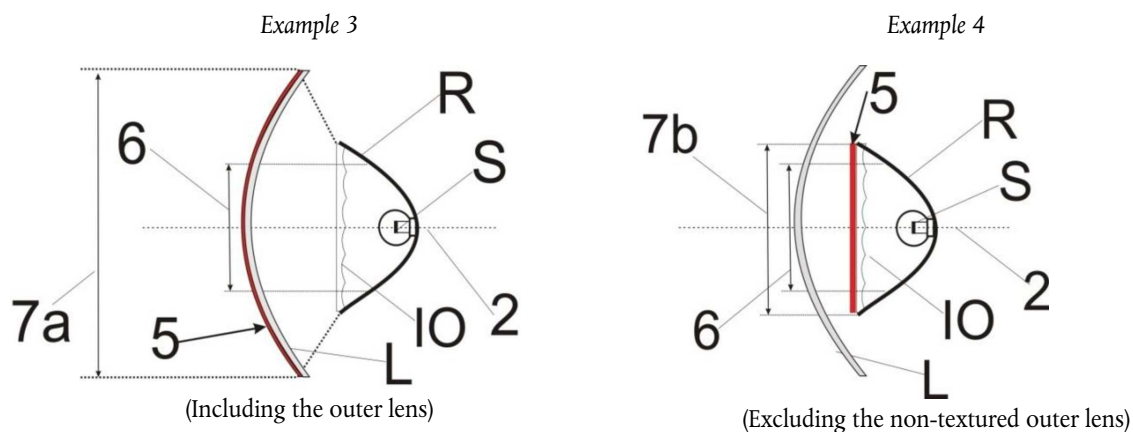
Example of illuminating surface in comparison with light-emitting surface in the case of a "single function lamp"

(see paragraphs 2.10.2. to 2.10.3. of this Regulation)

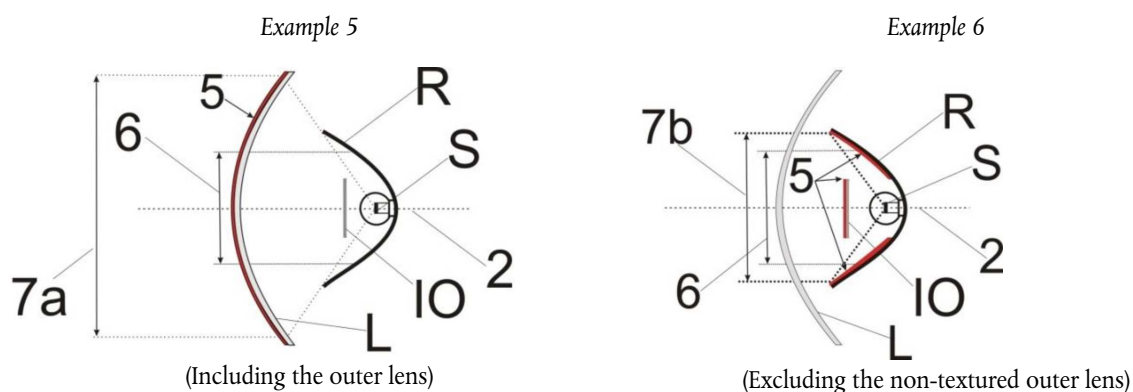
Examples of a light source with a reflector optic behind an outer lens:



Examples of a light source with a reflector optic with a inner lens behind an outer lens:

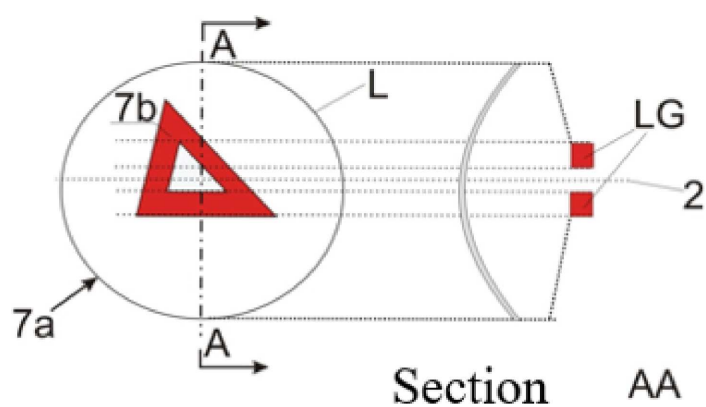


Examples of a light source with a reflector optic with a partial inner lens behind an outer lens:



Example of a light guide optic behind an outer lens:

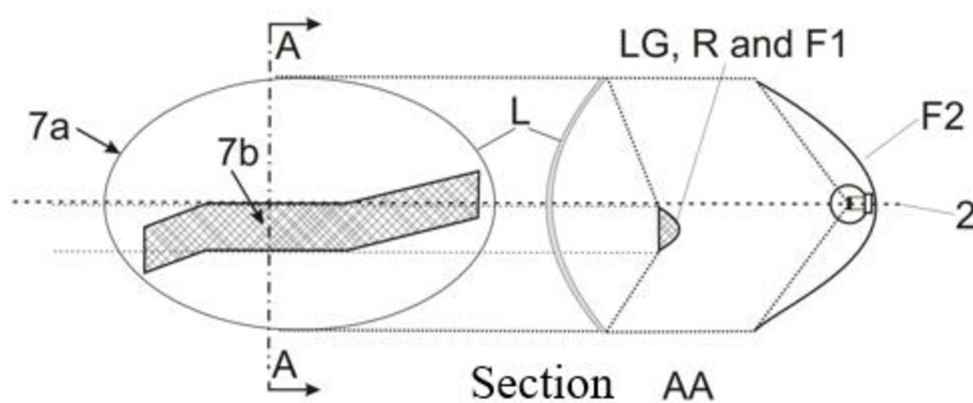
Example 7



 In the case where the non-textured outer lens is excluded, "7b" is the apparent surface according to paragraph 2.10.2. (b).

Example of a light guide optic or a reflector optic behind an outer lens:

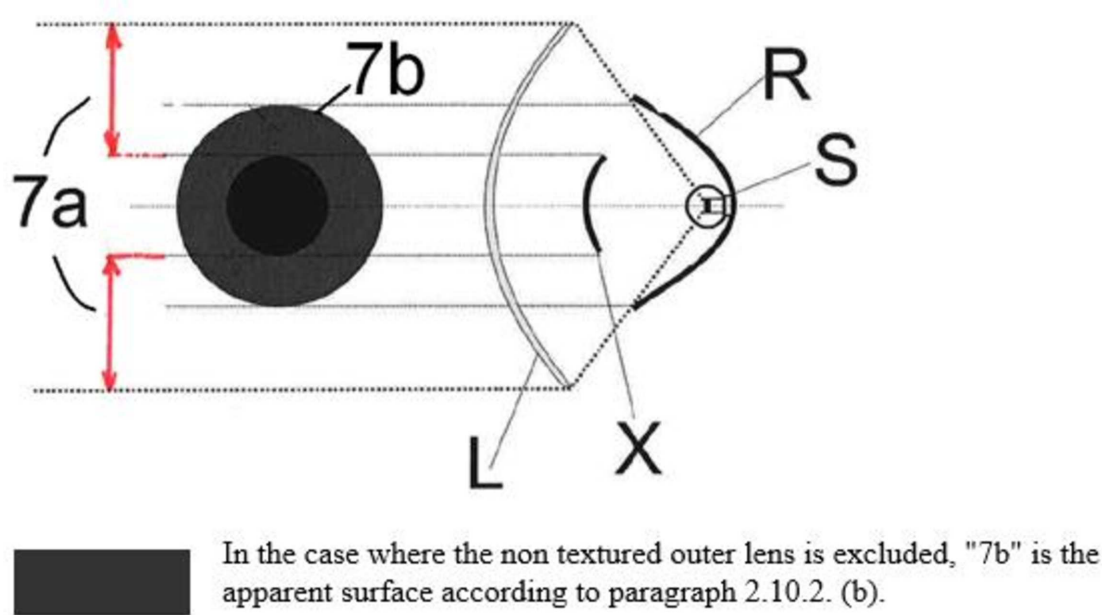
Example 8



 In the case where the non textured outer lens is excluded, "7b" is the apparent surface according to paragraph 2.10.2. (b), and F1 shall not transparent to F2

Example of a light source with a reflector optic in combination with an area which is not part of this function, behind an outer lens:

Example 9



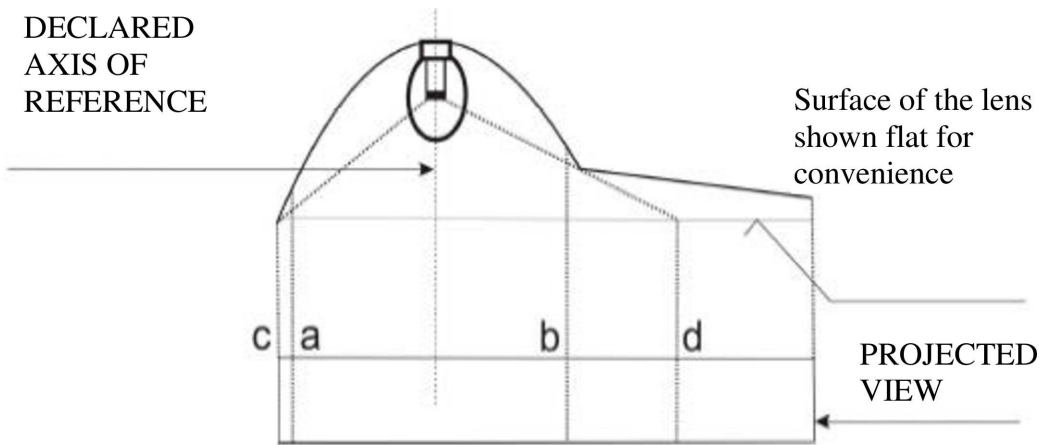
Part 6

Examples showing the determination of the light-emitting surface in comparison with illuminating surface

(See paragraphs 2.10.2. and 2.10.3. of this Regulation)

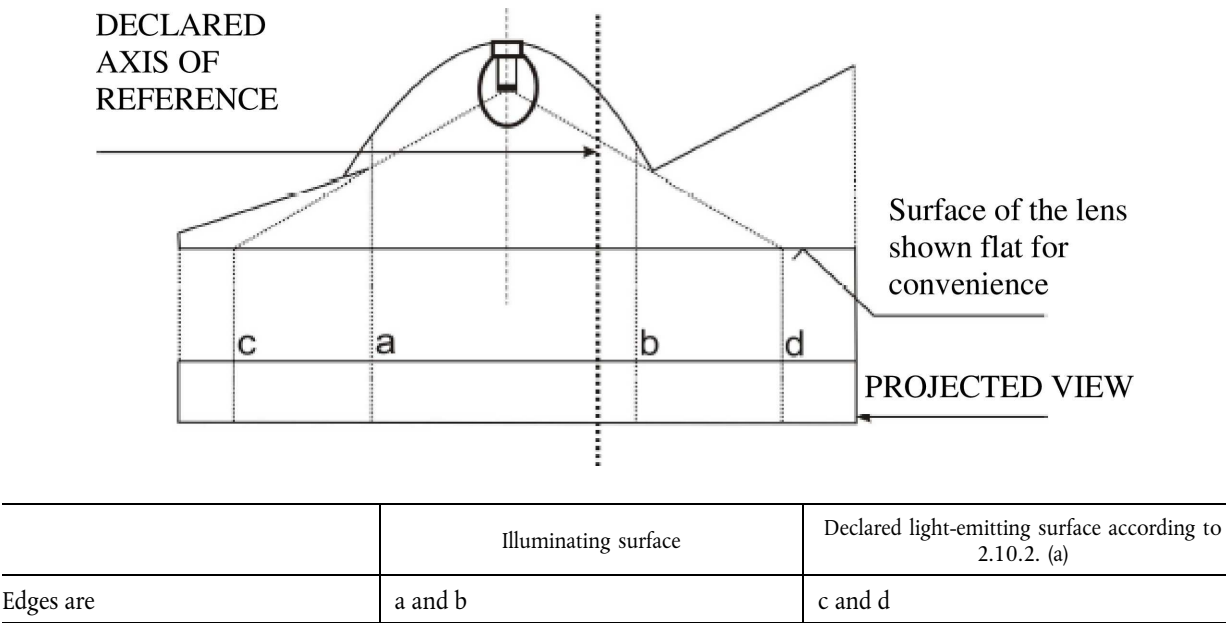
Note: Reflected light could / may contribute to the determination of the light emitting surface

Example A



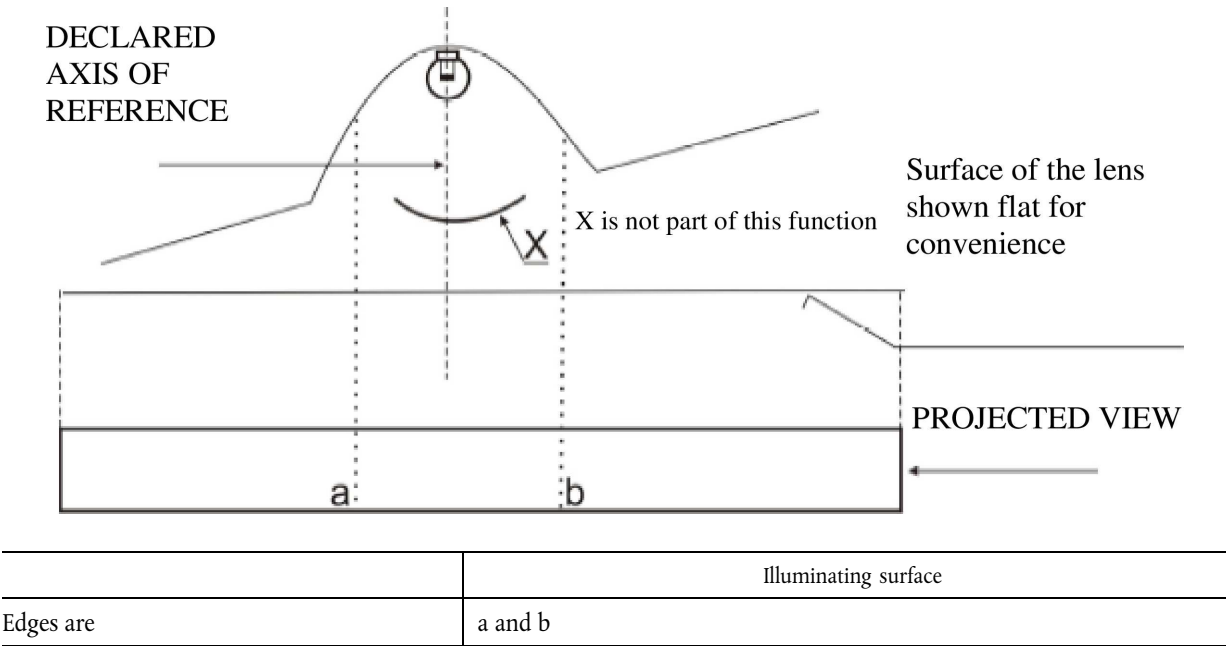
	Illuminating surface	Declared light-emitting surface according to 2.10.2. (a)
Edges are	a and b	c and d

Example B



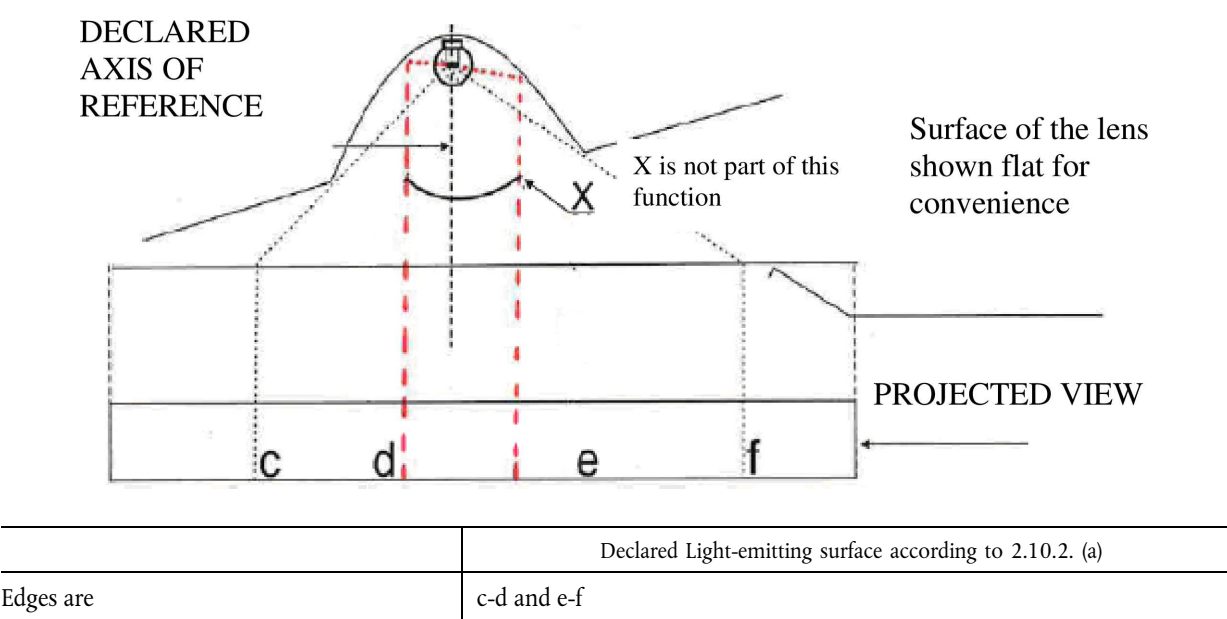
Example to determine the illuminating surface in combination with an area which is not part of the function:

Example C



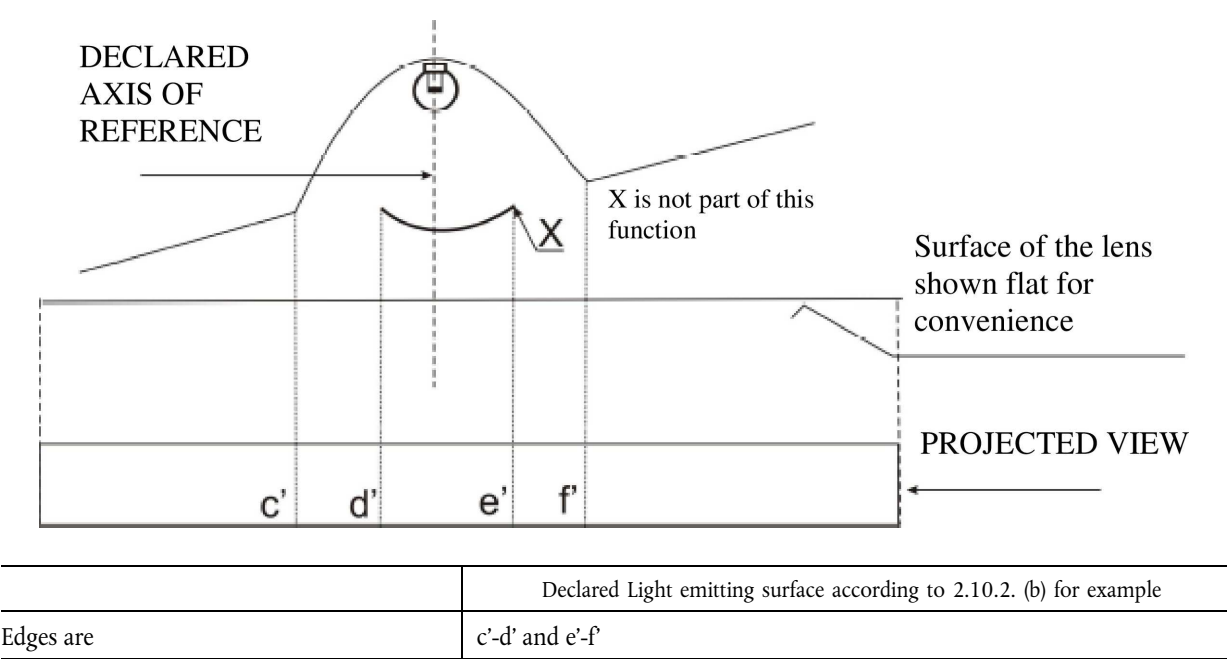
Example to determine a light emitting surface according to 2.10.2. (a) in combination with an area which is not part of the function:

Example D



Example to determine the apparent surface in combination with an area which is not part of the function and a non-textured outer lens (according to 2.10.2. (b)):

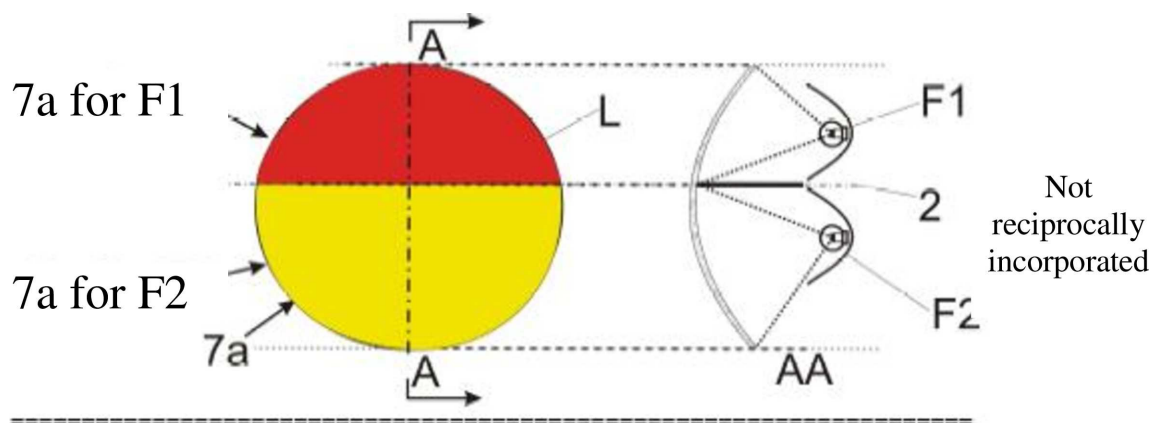
Example E



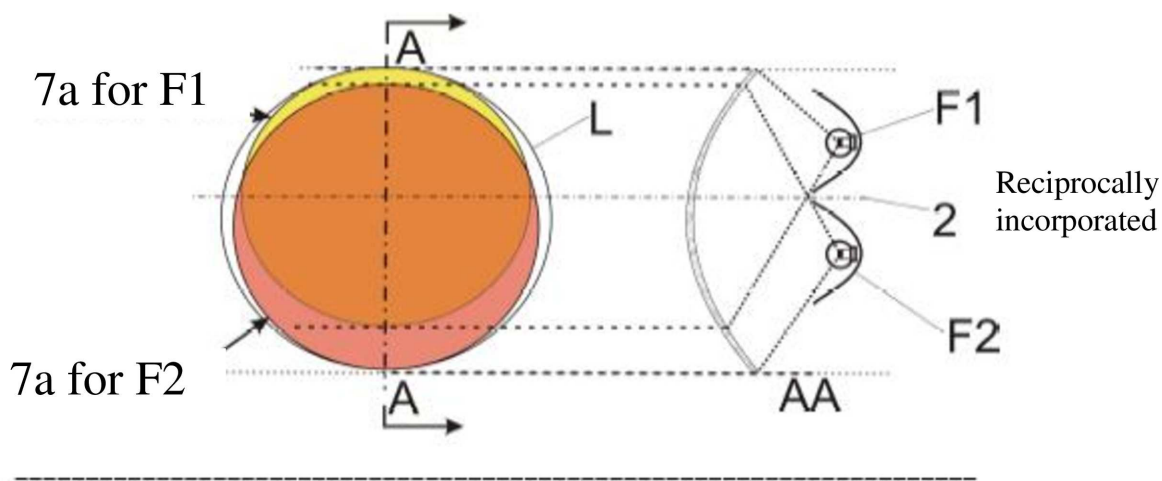
Part 7

Examples to enable a decision regarding the reciprocal incorporation of two functions

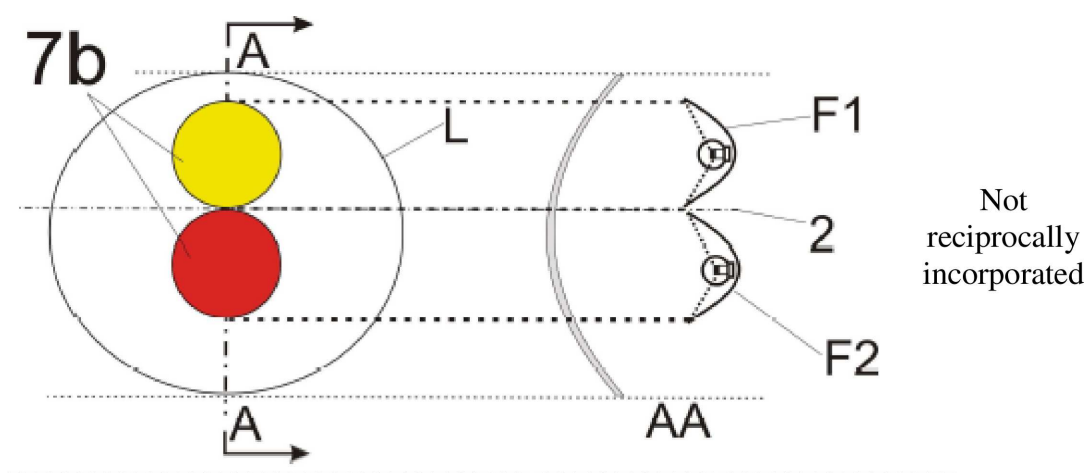
In the case with a textured outer lens and a wall in between:



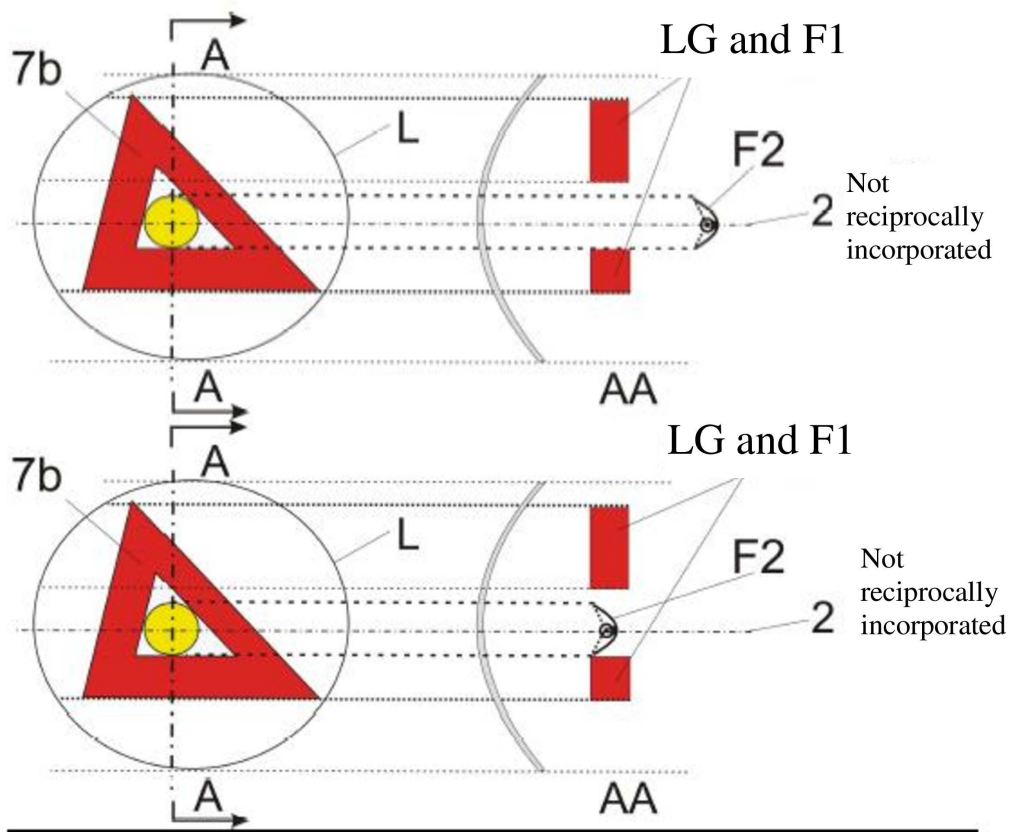
In the case with a textured outer lens:



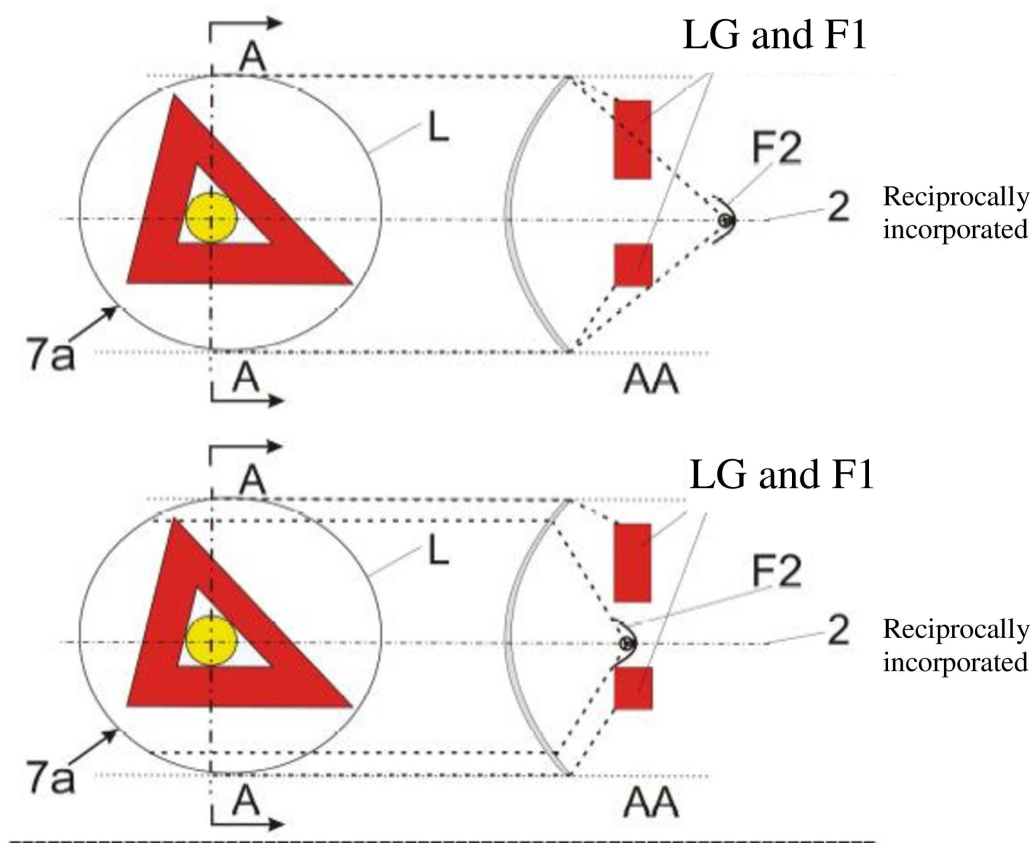
In the case where the non-textured outer lens is excluded:



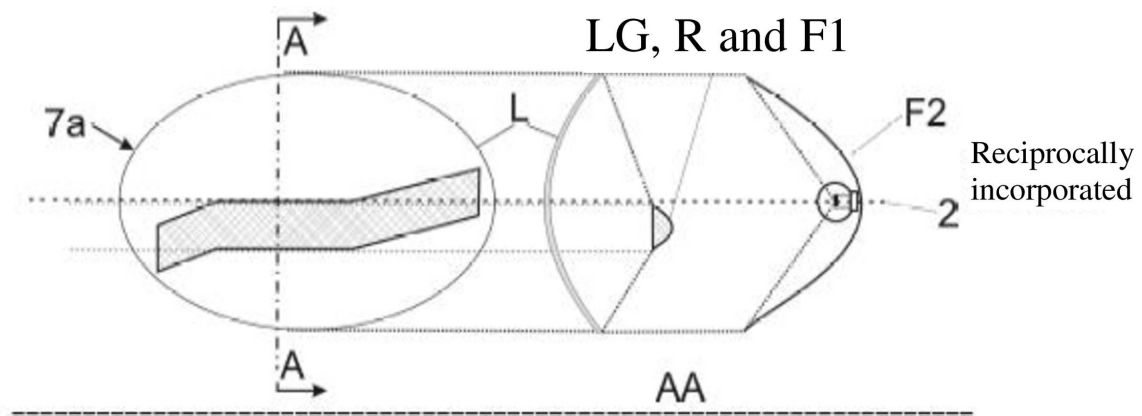
In the case where the non-textured outer lens is excluded:



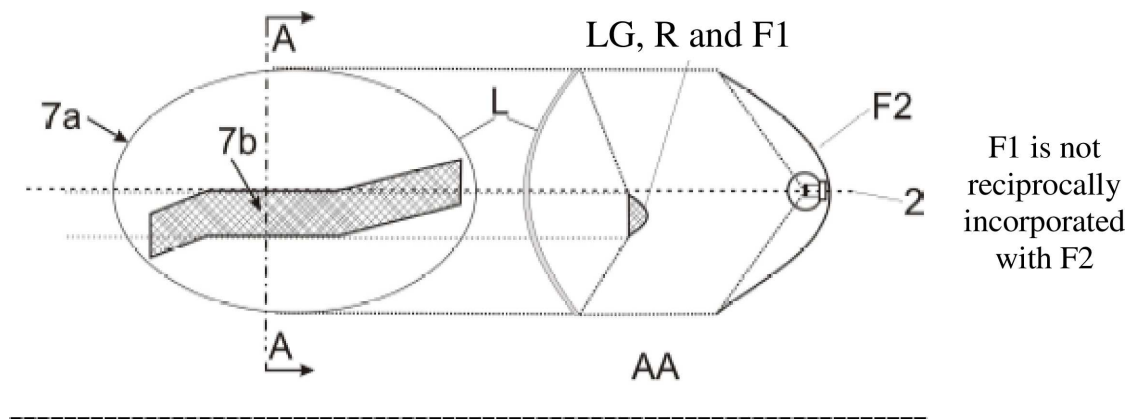
In the case where the outer lens (textured or not) is included:



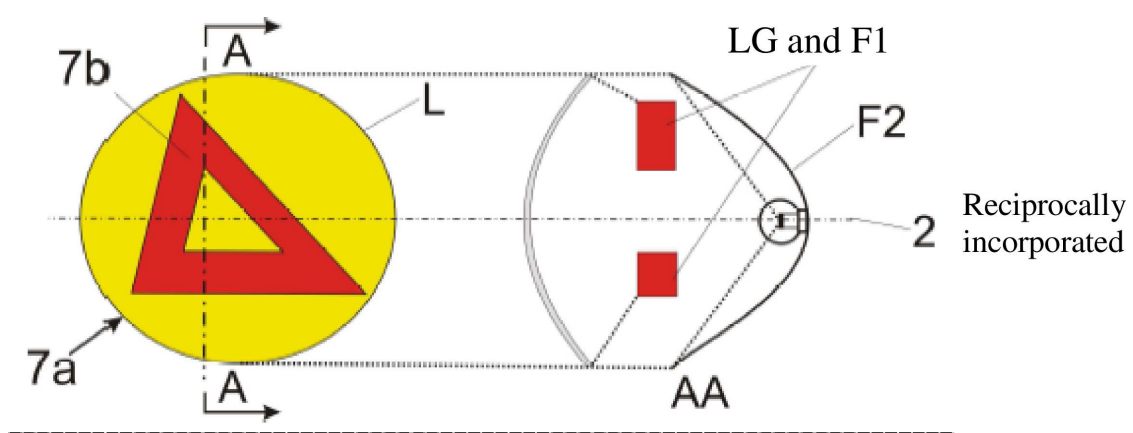
In the case where the outer lens (textured or not) is included:



In the case where the non-textured outer lens is excluded, "7b" is the apparent surface according to paragraph 2.10.2. and F1 shall not be transparent to F2:

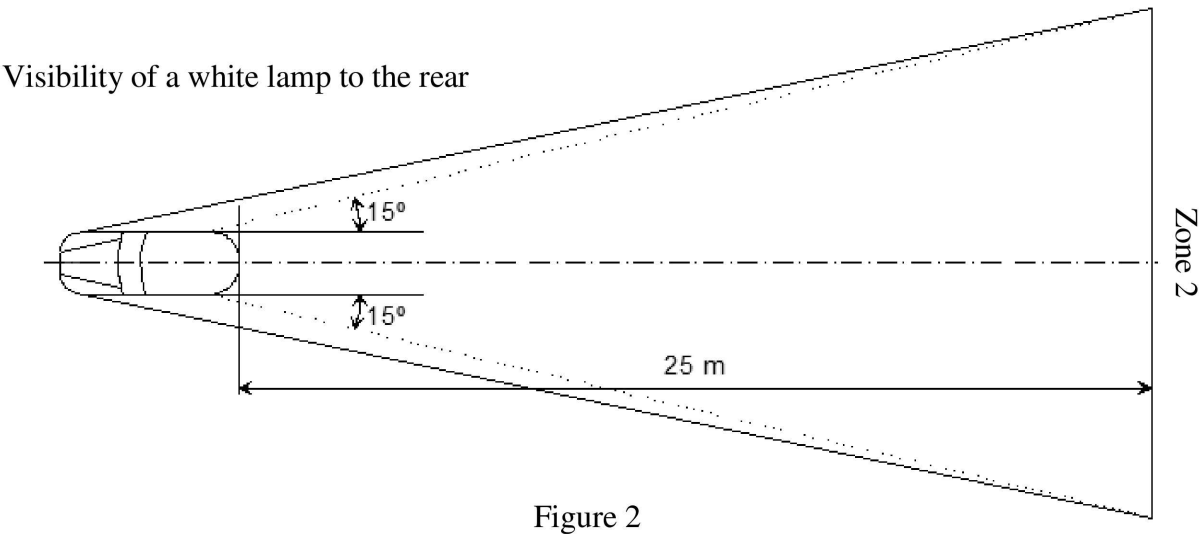
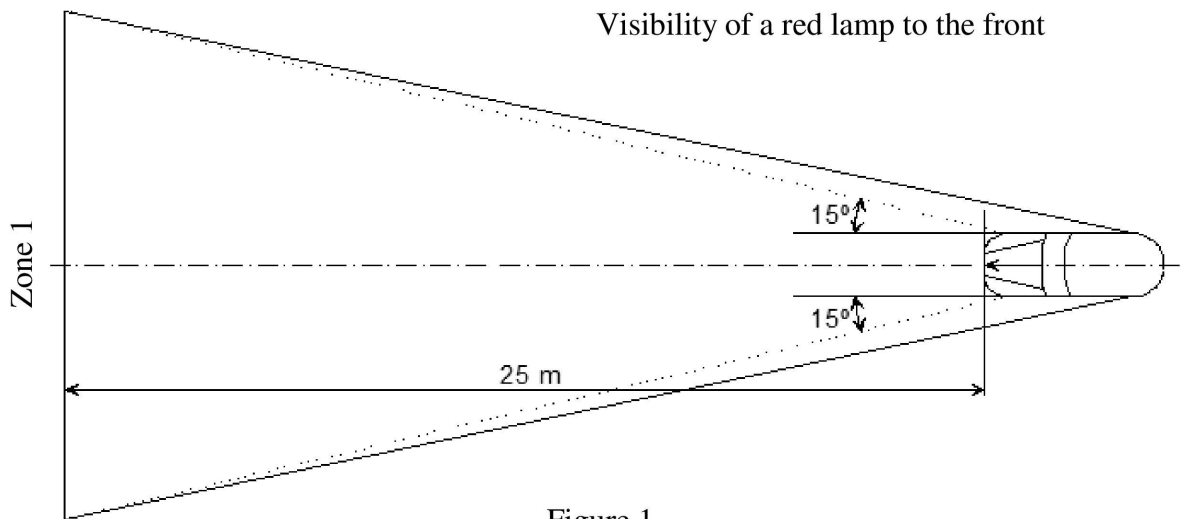


In the case where the non-textured outer lens is excluded or not:



ANNEX 4

Visibility of a red lamp to the front and visibility of a white lamp to the rear
(See paragraphs 5.10.1. and 5.10.2. of this Regulation)



ANNEX 5

States of loading to be taken into consideration in determining variations in the vertical orientation of the dipped-beam headlamps

Loading conditions on axles referred to in paragraphs 6.2.6.1. and 6.2.6.3.1.

1. For the following tests, the mass of the passengers shall be calculated on the basis of 75 kg per person.
2. Loading conditions for different types of vehicles:
 - 2.1. Vehicles in category M_1 : ⁽¹⁾
 - 2.1.1. The angle of the light beam of the dipped-beam headlamps shall be determined under the following load conditions:
 - 2.1.1.1. One person in the driver's seat;
 - 2.1.1.2. The driver, plus one passenger in the front seat farthest from the driver;
 - 2.1.1.3. The driver, one passenger in the front seat farthest from the driver, all the seats farthest to the rear occupied;
 - 2.1.1.4. All the seats occupied;
 - 2.1.1.5. All the seats occupied, plus an evenly distributed load in the luggage boot, in order to obtain the permissible load on the rear axle or on the front axle if the boot is at the front. If the vehicle has a front and a rear boot, the additional load shall be appropriately distributed in order to obtain the permissible axle loads. However, if the maximum permissible laden mass is obtained before the permissible load on one of the axles, the loading of the boot(s) shall be limited to the figure which enables that mass to be reached;
 - 2.1.1.6. Driver, plus an evenly distributed load in the boot, in order to obtain the permissible load on the corresponding axle.

However, if the maximum permissible laden mass is obtained before the permissible load on the axle, the loading of the boot(s) shall be limited to the figure which enables that mass to be reached.
 - 2.1.2. In determining the above loading conditions, account shall be taken of any loading restrictions laid down by the manufacturer.
 - 2.2. Vehicles in categories M_2 and M_3 :

The angle of the light beam from the dipped-beam headlamps shall be determined under the following loading conditions:

 - 2.2.1. Vehicle unladen and one person in the driver's seat;
 - 2.2.2. Vehicles laden such that each axle carries its maximum technically permissible load or until the maximum permissible mass of the vehicle is attained by loading the front and rear axles proportionally to their maximum technically permissible loads, whichever occurs first.

⁽¹⁾ As defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3.), document ECE/TRANS/WP.29/78/Rev.6, para. 2 - www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29resolutions.html

2.3. Vehicles in category N with load surfaces:

2.3.1. The angle of the light beam from the dipped-beam headlamps shall be determined under the following loading conditions;

2.3.1.1. Vehicle unladen and one person in the driver's seat;

2.3.1.2. Driver, plus a load so distributed as to give the maximum technically permissible load on the rear axle or axles, or the maximum permissible mass of the vehicle, whichever occurs first, without exceeding a front axle load calculated as the sum of the front axle load of the unladen vehicle plus 25 per cent of the maximum permissible payload on the front axle. Conversely, the front axle is so considered when the load platform is at the front.

2.4. Vehicles in category N without a load surface:

2.4.1. Drawing vehicles for semi-trailers:

2.4.1.1. Unladen vehicle without a load on the coupling attachment and one person in the driver's seat;

2.4.1.2. One person in the driver's seat: technically permissible load on the coupling attachment in the position of the attachment corresponding to the highest load on the rear axle.

2.4.2. Drawing vehicles for trailers:

2.4.2.1. Vehicle unladen and one person in the driver's seat;

2.4.2.2. One person in the driver's seat, all the other places in the driving cabin being occupied.

ANNEX 6

Measurement of the variation of dipped-beam inclination as a function of load

1. SCOPE

This annex specifies a method for measuring variations in motor vehicle dipped-beam inclination, in relation to its initial inclination, caused by changes in vehicle attitude due to loading.

2. DEFINITIONS

2.1. Initial inclination

2.1.1. Stated initial inclination

The value of the dipped-beam initial inclination specified by the motor vehicle manufacturer serving as a reference value for the calculation of permissible variations.

2.1.2. Measured initial inclination

The mean value of dipped-beam inclination or vehicle inclination measured with the vehicle in condition No. 1, as defined in Annex 5, for the category of vehicle under test. It serves as a reference value for the assessment of variations in beam inclination as the load varies.

2.2. Dipped-beam inclination

It may be defined as follows:

Either as the angle, expressed in milliradians, between the direction of the beam towards a characteristic point on the horizontal part of the cut-off in the luminous distribution of the headlamp and the horizontal plane,

Or by the tangent of that angle, expressed in percentage inclination, since the angles are small (for these small angles, 1 per cent is equal to 10 mrad).

If the inclination is expressed in percentage inclination, it can be calculated by means of the following formula:

$$\frac{(h_1 - h_2)}{L} \times 100$$

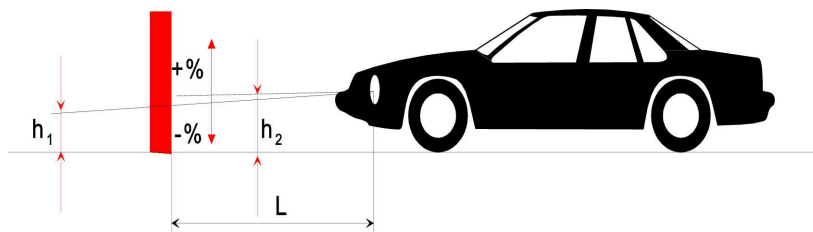
where:

- h_1 is the height above the ground, in millimetres, of the above-mentioned characteristic point, measured on a vertical screen perpendicular to the vehicle longitudinal median plane, placed at a horizontal distance L .
- h_2 is the height above the ground, in millimetres, of the centre of reference (which is taken to be the nominal origin of the characteristic point chosen in h_1);
- L is the distance, in millimetres, from the screen to the centre of reference.

Negative values denote downward inclination (see Figure 1).

Positive values denote upward inclination.

Figure 1

Dipped-beam downward inclination of a category M1 vehicle*Notes:*

1. This drawing represents a category M₁ vehicle, but the principle shown applies equally to vehicles of other categories.
2. Where the vehicle does not incorporate a headlamp levelling system, the variation in dipped-beam inclination is identical with the variation in the inclination of the vehicle itself.

3. MEASUREMENT CONDITIONS

- 3.1. If a visual inspection of the dipped-beam pattern on the screen or a photometric method is used, measurement shall be carried out in a dark environment (for example, a dark room) of sufficient area to allow the vehicle and the screen to be placed as shown in Figure 1. Headlamp centres of reference shall be at a distance from the screen of at least 10 m.
- 3.2. The ground on which measurements are made shall be as flat and horizontal as possible, so that the reproducibility of measurements of dipped-beam inclination can be assured with an accuracy of $\pm 0,5$ mrad ($\pm 0,05$ per cent inclination).
- 3.3. If a screen is used, its marking, position and orientation in relation to the ground and to the median longitudinal plane of the vehicle, shall be such that the reproducibility of the measurement of the dipped-beam inclination can be assured with an accuracy of $\pm 0,5$ mrad ($\pm 0,05$ per cent inclination).
- 3.4. During measurements, the ambient temperature shall be between 10 and 30 °C.

4. VEHICLE PREPARATION

- 4.1. Measurements shall be carried out on a vehicle which has travelled a distance of between 1 000 km and 10 000 km, preferably 5 000 km.
- 4.2. Tyres shall be inflated to the full-load pressure specified by the vehicle manufacturer. The vehicle shall be fully replenished (fuel, water, oil) and equipped with all the accessories and tools specified by the manufacturer. Full fuel replenishment means that the fuel tank shall be filled to not less than 90 per cent of its capacity.
- 4.3. The vehicle shall have the parking brake released and the gearbox in neutral.
- 4.4. The vehicle shall be conditioned for at least 8 h at the temperature specified in paragraph 3.4. above.
- 4.5. If a photometric or visual method is used, headlamps with a well-defined dipped-beam cut-off should preferably be installed on the vehicle under test in order to facilitate the measurements. Other means are allowed to obtain a more precise reading (for example, removal of the headlamp lens).

5. TEST PROCEDURE

5.1. General

The variations in either dipped-beam or vehicle inclination, depending on the method chosen, shall be measured separately for each side of the vehicle. The results obtained from both left and right headlamps under all the load conditions specified in Annex 5, shall be within the limits set out in paragraph 5.5. below. The load shall be applied gradually without subjecting the vehicle to excessive shocks.

5.1.1. Where an AFS is fitted, the measurements shall be carried out with the AFS in its neutral state.

5.2. Determination of the measured initial inclination

The vehicle shall be prepared as specified in paragraph 4. above and laden as specified in Annex 5 (first loading condition of the respective vehicle category). Before each measurement, the vehicle shall be rocked as specified in paragraph 5.4. below. Measurements shall be made three times.

5.2.1. If none of the three measured results differ by more than 2 mrad (0,2 per cent inclination) from the arithmetic mean of the results, that mean shall constitute the final result.

5.2.2. If any measurement differs from the arithmetic mean of the results by more than 2 mrad (0,2 per cent inclination), a further series of 10 measurements shall be made, the arithmetic mean of which shall constitute the final result.

5.3. Measurement methods

Any method may be used to measure variations of inclination provided that the readings are accurate to within $\pm 0,2$ mrad ($\pm 0,02$ per cent inclination).

5.4. Treatment of vehicle in each loading condition

The vehicle suspension and any other part likely to affect dipped-beam inclination shall be activated according to the methods described below.

However, the technical authorities and manufacturers may jointly propose other methods (either experimental or based upon calculations), especially when the test poses particular problems, provided such calculations are clearly valid.

5.4.1. M₁ category vehicles with conventional suspension

With the vehicle standing on the measuring site and, if necessary, with the wheels resting on floating platforms (which shall be used if their absence would lead to restriction of the suspension movement likely to affect the results of measurements), rock the vehicle continuously for at least three complete cycles, for each cycle, first the rear and then the front end of the vehicle is pushed down.

The rocking sequence shall end with the completion of a cycle. Before making the measurements, the vehicle shall be allowed to come to rest spontaneously. Instead of using floating platforms, the same effect can be achieved by moving the vehicle backwards and forwards for at least a complete wheel revolution.

5.4.2. M₂, M₃ and N category vehicles with conventional suspension

5.4.2.1. If the treatment method for category M₁ vehicles described in paragraph 5.4.1. is not possible, the method described in paragraphs 5.4.2.2. or 5.4.2.3. may be used.

5.4.2.2. With the vehicle standing on the measuring site and the wheels on the ground, rock the vehicle by temporarily varying the load.

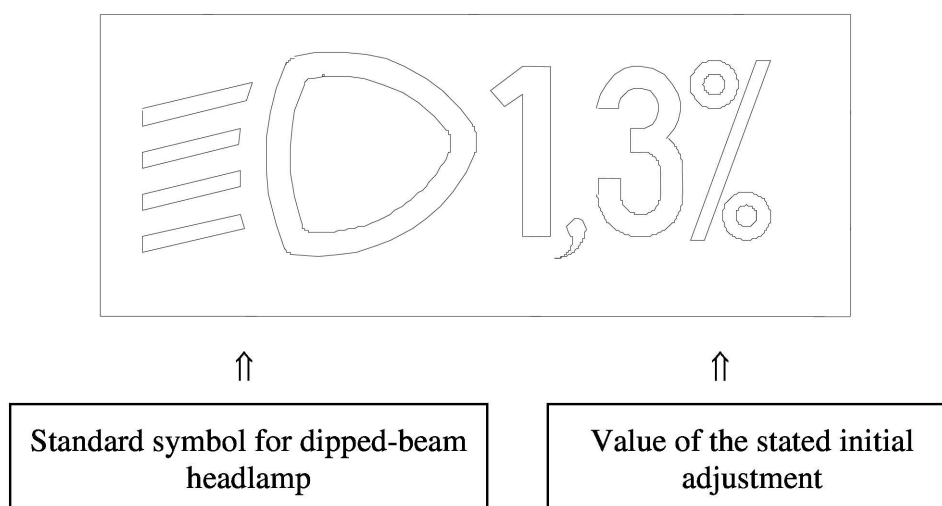
5.4.2.3. With the vehicle standing on the measuring site and the wheels on the ground, activate the vehicle suspension and all other parts which may affect the dipped-beam inclination by using a vibration rig. This can be a vibrating platform on which the wheels rest.

- 5.4.3. Vehicles with non-conventional suspension, where the propulsion system has to be running.
Before making any measurement wait until the vehicle has assumed its final attitude with the engine running.
- 5.5. Measurements
- The variation of the inclination of the dipped-beam shall be assessed for each of the different loading conditions in relation to the measured initial inclination determined in accordance with paragraph 5.2. above.
- If the vehicle is fitted with a manual headlamp-levelling system, the latter shall be adjusted to the positions specified by the manufacturer for given loading conditions (according to Annex 5).
- 5.5.1. To begin with, a single measurement shall be made in each loading condition. Requirements have been met if, for all the loading conditions, the variation in inclination is within the calculated limits (for example, within the difference between the stated initial inclination and the lower and upper limits specified for approval) with a safety margin of 4 mrad (0,4 per cent inclination).
- 5.5.2. If the result(s) of any measurement(s) does (do) not lie within the safety margin indicated in paragraph 5.5.1. or exceed(s) the limit values, a further three measurements shall be made in the loading conditions corresponding to this (these) result(s) as specified in paragraph 5.5.3.
- 5.5.3. For each of the above loading conditions:
- 5.5.3.1. If none of the three measured results differs by more than 2 mrad (0,2 per cent inclination) from the arithmetic mean of the results, that mean shall constitute the final result.
- 5.5.3.2. If any measurement differs from the arithmetic mean of the results by more than 2 mrad (0,2 per cent inclination), a further series of 10 measurements shall be made, the arithmetic mean of which shall constitute the final result.
- 5.5.3.3. If a vehicle is fitted with an automatic headlamp-levelling system which has an inherent hysteresis loop, average results at the top and bottom of the hysteresis loop shall be taken as significant values.
All these measurements shall be made in accordance with paragraphs 5.5.3.1. and 5.5.3.2.
- 5.5.4. Requirements have been met, if, under all loading conditions, the variation between the measured initial inclination determined in accordance with paragraph 5.2. and the inclination measured under each loading condition is less than the values calculated in paragraph 5.5.1. (without safety margin).
- 5.5.5. If only one of the calculated upper or lower limits of variation is exceeded, the manufacturer shall be permitted to choose a different value for the stated initial inclination, within the limits specified for approval.
-

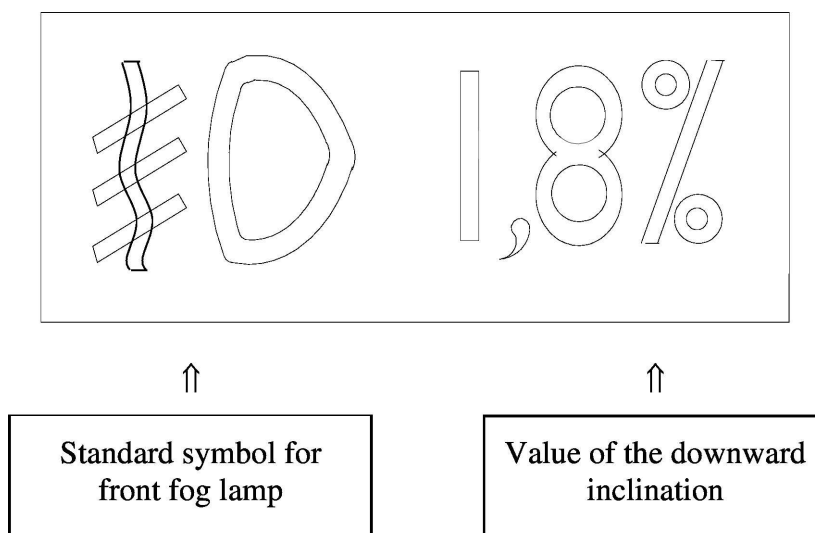
ANNEX 7

Indication of the downward inclination of the dipped-beam headlamps cut-off referred to in paragraph 6.2.6.1.1. and downward inclination of the front fog lamp cut-off referred to in paragraph 6.3.6.1.2. of this Regulation*Example 1*

The size of the symbol and characters is left to the discretion of the manufacturer.

*Example 2*

The size of the symbol and characters is left to the discretion of the manufacturer.



ANNEX 8

The controls for the headlamp-levelling devices referred to in paragraph 6.2.6.2.2. of this Regulation

1. SPECIFICATIONS

1.1. Downward inclination of the dipped-beam shall in all cases be produced in one of the following ways:

- (a) By moving a control downwards or to the left;
- (b) By rotating a control in a counter clockwise direction;
- (c) By depressing a button (push-pull control).

If several buttons are used to adjust the beam, the button which gives the greatest downward inclination shall be installed to the left or below the button(s) for other dipped-beam positions.

A rotary control which is installed edge-on, or with only the edge visible, should follow the operating principles of control of types (a) or (c).

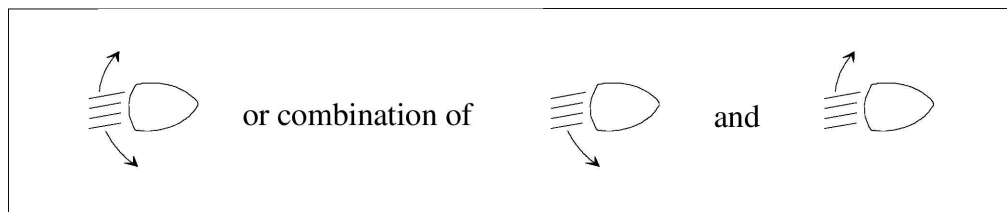
1.1.1. This control shall carry symbols indicating clearly the movements corresponding to the downward and upward inclination of the dipped-beam.

1.2. The "0" position corresponds to the initial inclination according to paragraph 6.2.6.1.1. of this Regulation.

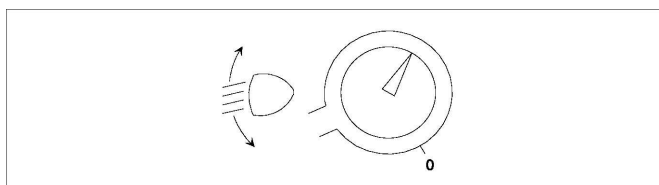
1.3. The "0" position which, according to paragraph 6.2.6.2.2. of this Regulation has to be a "stop position", need not necessarily be at the end of the scale.

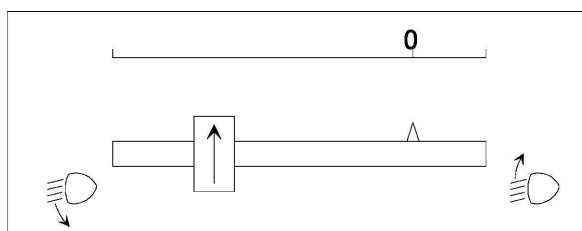
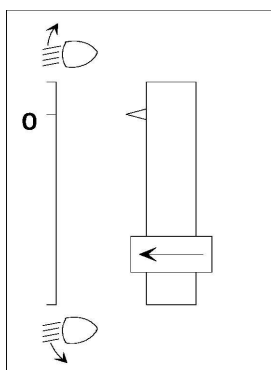
1.4. The marks used on control shall be explained in the owner's handbook.

1.5. Only the following symbols may be used to identify the controls:



Symbols employing five lines instead of four may also be used

Example 1

Example 2*Example 3*

ANNEX 9

Control of conformity of production

1. TESTS

1.1. Position of lamps

The position of lamps, as defined in paragraph 2.1.6. of this Regulation, in width, in height and in length shall be checked in accordance with the general requirements set out in paragraphs 2.10.2., 2.10.3., 2.10.4., 2.3.3. and 5.4. of this Regulation.

The values measured for the distances shall be such that the individual specifications applicable to each lamp are fulfilled.

1.2. Visibility of lamps

1.2.1. The angles of geometric visibility shall be checked in accordance with paragraph 2.10.7. of this Regulation .

The values measured for the angles shall be such that the individual specifications applicable to each lamp are fulfilled except that the limits of the angles may have an allowance corresponding to the $\pm 3^\circ$ variation permitted in paragraph 5.3. for the mounting of the light-signalling devices.

1.2.2. The visibility of red light towards the front and of white light towards the rear shall be checked in accordance with paragraph 5.10. of this Regulation.

1.3. Alignment of dipped-beam headlamps and class "F3" front fog lamps towards the front

1.3.1. Initial downward inclination

The initial downward inclination of the cut-off of the dipped-beam and the class "F3" front fog lamps shall be set to the plated figure as required and shown in Annex 7.

Alternatively the manufacturer shall set the initial aim to a figure that is different from the plated figure where it can be shown to be representative of the type approved when tested in accordance with the procedures contained in Annex 6 and in particular paragraph 4.1.

1.3.2. Variation of inclination with load

The variation of the dipped-beam downward inclination as a function of the loading conditions specified within this paragraph shall remain within the range:

0,2 per cent to 2,8 per cent	for headlamp mounting height $h < 0,8$;
0,2 per cent to 2,8 per cent	for headlamp mounting height $0,8 \leq h \leq 1,0$; or
0,7 per cent to 3,3 per cent	(according to the aiming range chosen by the manufacturer at the approval);
0,7 per cent to 3,3 per cent	for headlamp mounting height $1,0 < h \leq 1,2$ m;
1,2 per cent to 3,8 per cent	for headlamp mounting height $h > 1,2$ m.

In the case of a class "F3" front fog lamp with (a) light source(s) having a total objective luminous flux which exceeds 2 000 lumens, the variation of the downward inclination as a function of the loading conditions specified within this paragraph shall remain within the range:

0,7 per cent to 3,3 per cent	for front fog lamp mounting height $h \leq 0,8$;
1,2 per cent to 3,8 per cent	for front fog lamp mounting height $h > 0,8$ m.

The states of loading to be used shall be as follows, as indicated in Annex 5 of this Regulation, for every system adjusted accordingly.

- 1.3.2.1. Vehicles in category M₁:
 - Paragraph 2.1.1.1.
 - Paragraph 2.1.1.6. taking into account
 - Paragraph 2.1.2.
 - 1.3.2.2. Vehicles in category M₂ and M₃:
 - Paragraph 2.2.1.
 - Paragraph 2.2.2.
 - 1.3.2.3. Vehicles in category N with load surfaces:
 - Paragraph 2.3.1.1.
 - Paragraph 2.3.1.2.
 - 1.3.2.4. Vehicles in category N without load surfaces:
 - 1.3.2.4.1. Drawing vehicles for semi-trailers:
 - Paragraph 2.4.1.1.
 - Paragraph 2.4.1.2.
 - 1.3.2.4.2. Drawing vehicles for trailers:
 - Paragraph 2.4.2.1.
 - Paragraph 2.4.2.2.
 - 1.4. Electrical connections and tell-tales

The electrical connections shall be checked by switching on every lamp supplied by the electrical system of the vehicle.

The lamps and tell-tales shall function in accordance with the provisions set out in paragraphs 5.11. to 5.14. of this Regulation and with the individual specifications applicable to each lamp.
 - 1.5. Light intensities
 - 1.5.1. Main-beam headlamps

The aggregate maximum intensity of the main beam headlamps shall be checked by the procedure described in paragraph 6.1.9.2. of this Regulation. The value obtained shall be such that the requirement in paragraph 6.1.9.1. of this Regulation is fulfilled.
 - 1.6. The presence, number, colour, arrangement and, where applicable, the category of lamps shall be checked by visual inspection of the lamps and their markings.

These shall be such that the requirements set out in paragraphs 5.15. and 5.16. as well as in the individual specifications applicable to each lamp are fulfilled.
-

ANNEX 10

Reserved

ANNEX 11

Visibility of conspicuity markings to the rear, front and side of a vehicle

(See paragraph 6.21.5. of this Regulation)

Figure 1a

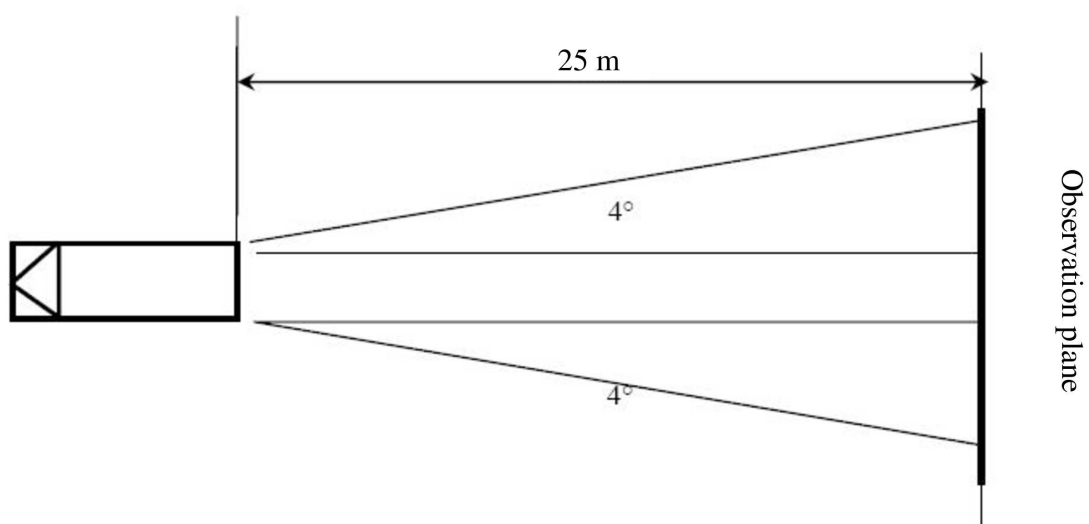
Rear

Figure 1b

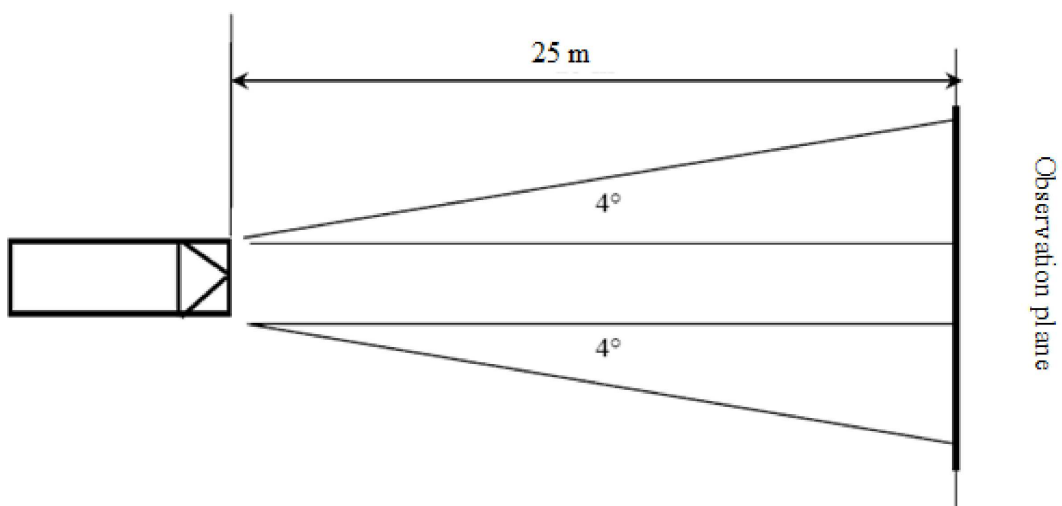
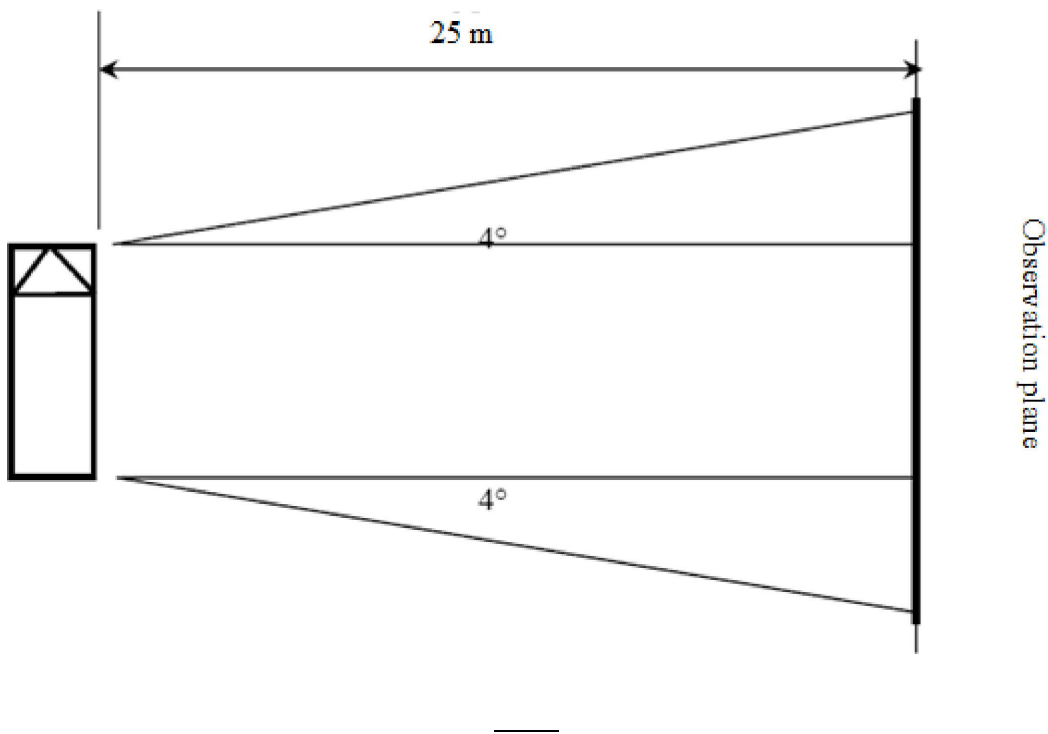
Front (trailers only)

Figure 2
Side



ANNEX 12

Test drive

1. Test drive specifications for the automatic control of the main-beam headlamps
 - 1.1. The test drive shall be carried out in clear atmosphere ⁽¹⁾ and with clean head-lamps
 - 1.2. The test course shall comprise test sections with traffic conditions, at speed corresponding to the relevant type of road, as described in Table 1 below:

Table 1

Test Section	Traffic conditions	Road type		
		Urban areas	Multi-lane road, e.g. motorway	Country road
	Speed	50 ± 10 km/h	100 ± 20 km/h	80 ± 20 km/h
	Average percentage of the full test course length	10 per cent	20 per cent	70 per cent
A	Single oncoming vehicle or single preceding vehicle in a frequency so that the main beam will switch ON and OFF.		X	X
B	Combined oncoming and preceding traffic situations, in a frequency so that the main beam will switch ON and OFF.		X	X
C	Active and passive overtaking manoeuvres, in a frequency so that the main beam will switch ON and OFF.		X	X
D	Oncoming bicycle, as described in paragraph 6.1.9.3.1.2.			X
E	Combined oncoming and preceding traffic situations	X		

- 1.3. Urban areas shall comprise roads with and without illumination.
- 1.4. Country roads shall comprise sections having two lanes and sections having four or more lanes and shall include junctions, hills and/or slopes, dips and winding roads.
- 1.5. Multi-lane roads (e.g. motorways) and country roads shall comprise sections having straight level parts with a length of more than 600 m. Additionally they shall comprise sections having curves to the left and to the right.
- 1.6. Dense traffic situations shall be taken into account.”
2. Test drive specifications for adaptive main-beam headlamps
 - 2.1. The test drive shall be carried out in clear atmosphere ⁽²⁾ and with clean head-lamps.

⁽¹⁾ Good visibility (meteorological optical range MOR > 2 000 m defined according to WMO, Guide to Meteorological Instruments and Methods of Observation, Sixth Edition, ISBN: 92-63-16008-2, pp 1. 9. 1/ 1. 9. 11, Geneva 1996).

⁽²⁾ Good visibility (meteorological optical range MOR > 2 000 m defined according to WMO, Guide to Meteorological Instruments and Methods of Observation, Sixth Edition, ISBN: 92-63-16008-2, pp 1. 9. 1/ 1. 9. 11, Geneva 1996)

- 2.2. The test course shall comprise test sections with traffic conditions, at speed corresponding to the relevant type of road, as described in Table 2 below:

Table 2

Test Section	Traffic conditions	Road type		
		Urban areas	Multi-lane road, e.g. motorway	Country road
	Speed	50 ± 10km/h	100 ± 20km/h	80 ± 20km/h
	Average percentage of the full test course length	10 per cent	20 per cent	70 per cent
A	Single oncoming vehicle or single preceding vehicle in a frequency so that the adaptive main beam will react to demonstrate the adaptation process.		X	X
B	Combined oncoming and preceding traffic situations, in a frequency so that the adaptive main beam will react to demonstrate the adaptation process.		X	X
C	Active and passive overtaking manoeuvres, in a frequency so that the adaptive main beam will react to demonstrate the adaptation process.		X	X
D	Oncoming bicycle, as described in paragraph 6.22.9.3.1.2.			X
E	Combined oncoming and preceding traffic situations	X		

- 2.3. Urban areas shall comprise roads with and without illumination.
- 2.4. Country roads shall comprise sections having two lanes and sections having four or more lanes and shall include junctions, hills and/or slopes, dips and winding roads.
- 2.5. Multi lane roads (e.g. motorways) and country roads shall comprise sections having straight level parts with a length of more than 600 m. Additionally they shall comprise of sections having curves to the left and to the right.
- 2.6. Dense traffic situations shall be taken into account
- 2.7. For the test sections A and B in the table above the engineers conducting the tests shall evaluate and record the acceptability of the performance of the adaptation process in relation to oncoming and preceding road users. This means that the test engineers shall be seated in the vehicle being tested and additionally be seated in the oncoming and preceding vehicles.

ANNEX 13

Automatic switching conditions dipped-beam headlamps

Automatic switching conditions dipped-beam headlamps ⁽¹⁾		
Ambient light outside the vehicle ⁽²⁾	Dipped-beam headlamps	Response time
less than 1 000 lux	ON	no more than 2 seconds
between 1 000 lux and 7 000 lux	at manufacturer's discretion	at manufacturer's discretion
more than 7 000 lux	OFF	more than 5 seconds, but no more than 300 seconds

⁽¹⁾ Compliance with these conditions shall be demonstrated by the applicant, by simulation or other means of verification accepted by the Type Approval Authority.

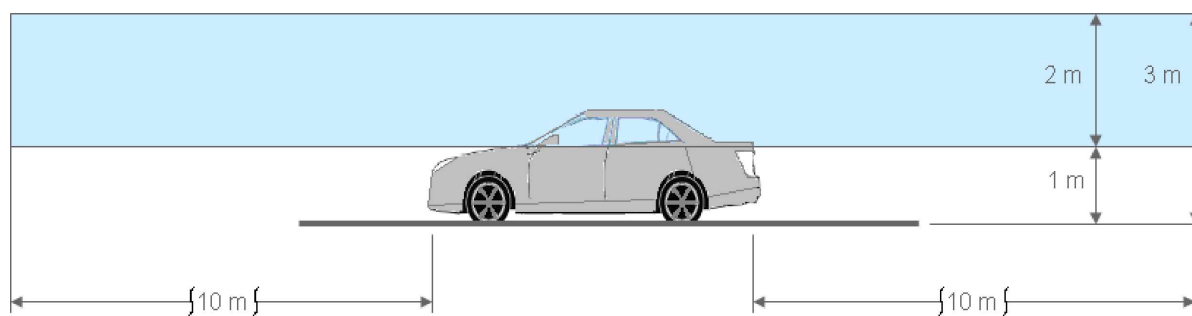
⁽²⁾ The illuminance shall be measured on a horizontal surface, with a cosine corrected sensor on the same height as the mounting position of the sensor on the vehicle. This may be demonstrated by the manufacturer by sufficient documentation or by other means accepted by the Type Approval Authority.

ANNEX 14

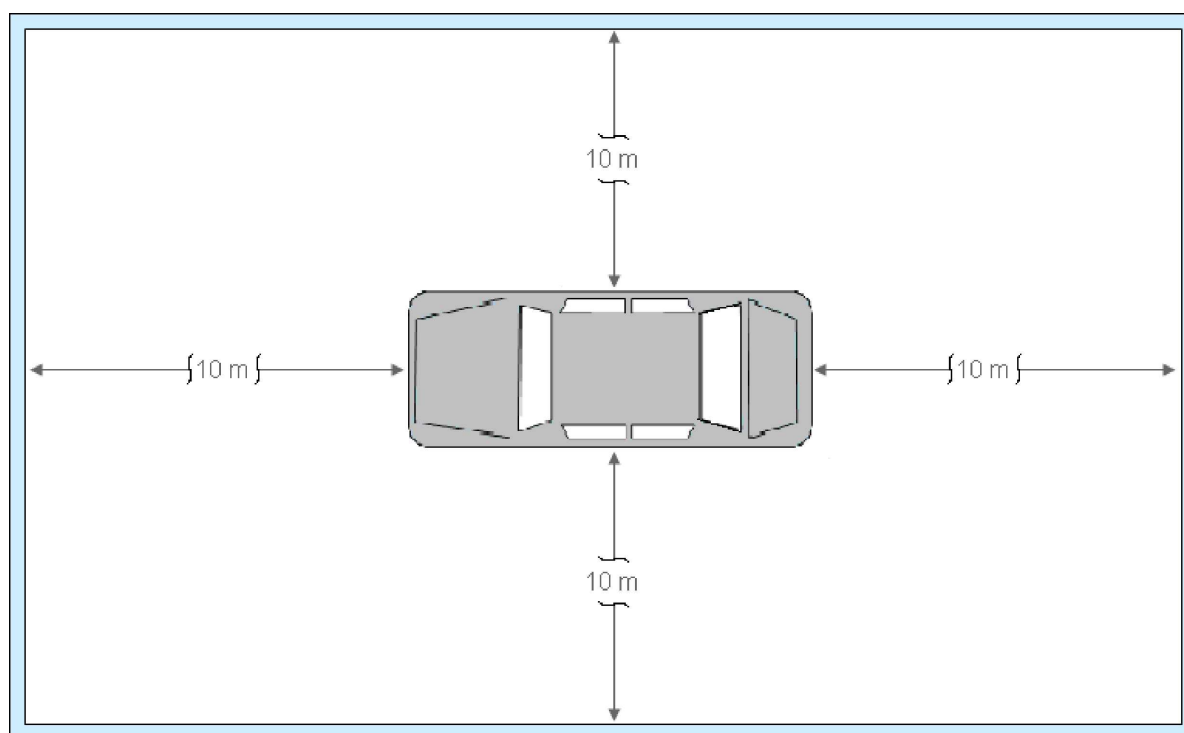
Observing area towards the apparent surface of manoeuvring and courtesy lamps

Zones of observation

This drawing shows the zone from one side, the other zones are from the front, the rear and from the other side of the vehicle

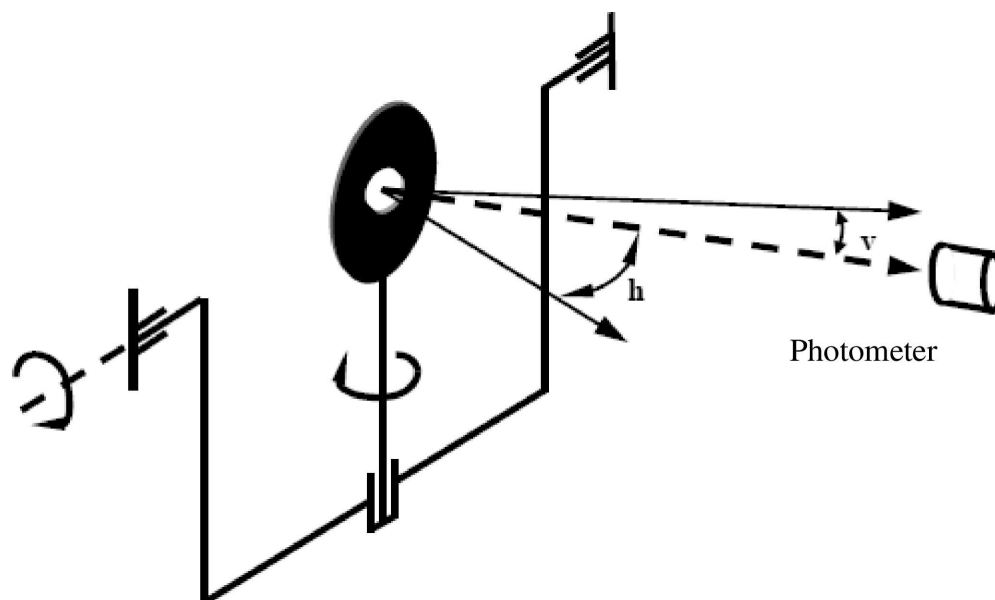


Boundaries of the zones



ANNEX 15

Gonio(photo)meter system used for the photometric measurements as defined in paragraph 2.10.9. of this Regulation



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>

UN Regulation No 148 – Uniform provisions concerning the approval of light-signalling devices (lamps) for power-driven vehicles and their trailers [2021/1719]

Incorporating all valid text up to:

Supplement 3 to the original version of the Regulation — Date of entry into force: 30 September 2021

This document is meant purely as documentation tool. The authentic and legally binding texts are:

- ECE/TRANS/WP.29/2018/157
- ECE/TRANS/WP.29/2019/81
- ECE/TRANS/WP.29/2020/32 and
- ECE/TRANS/WP.29/2021/45

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3. Administrative provisions
4. General technical requirements
5. Specific technical requirements
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- 5 Minimum requirements for sampling by an inspector
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INTRODUCTION

This Regulation combines the provisions of individual UN Regulations Nos. 4, 6, 7, 23, 38, 50, 77, 87 and 91 into a single Regulation, and is the outcome of the World Forum for Harmonization of Vehicle Regulations (WP.29) decision to simplify the lighting and light-signalling Regulations based on the initial proposal by the European Union and Japan.

The objective of this Regulation is to increase the clarity, to consolidate and streamline the complexity of requirements in UN Regulations Nos. 4, 6, 7, 23, 38, 50, 77, 87 and 91 and to prepare for the future transition to performance based requirements, by reducing the number of Regulations through an editorial exercise without changing any of the detailed technical requirements already in force up to the date of entry into force of this Regulation.

Although this Regulation departs from the traditional approach of having a separate Regulation for each lamp, by combining all light signalling lamps into a single Regulation, this simplified Regulation contains all provisions and operates according to the existing structure of series of amendments, their transitional provisions and supplements. The transitional provisions associated with a new series of amendments to this Regulation will be identified for each device as applicable, this also includes a list of devices and their applicable change indexes relating to the series of amendments.

It is expected that all Contracting Parties to the 1958 Agreement will adopt this Regulation and will provide detailed explanation in case they are not in a position to adopt particular lamps. These decisions will be registered in ECE/TRANS/WP.29/343 that records the status of the annexed Regulations and of the amendments.

Regarding the requirements for approval markings, this Regulation includes the requirements for the use of the "Unique Identifier" and is conditional upon access to a secure internet database established by UNECE (in accordance with Schedule 5 of the 1958 Agreement) where all type approval documentation is held. When the "Unique Identifier" is used there is no requirement for the lamps to carry the conventional type approval markings (E-mark). If it is technically not possible to use the "Unique Identifier" (e.g. if the access to the UNECE internet database cannot be secured or the database is not operational), the use of conventional type approval markings is required until the use of the "Unique Identifier" is enabled.

1. SCOPE

This Regulation applies to the following lamps:

Rear-registration plate illuminating lamps

Direction indicator lamps

Position lamps

Stop lamps

End-outline marker lamps

Reversing lamps

Manoeuvring lamps

Rear fog lamps

Parking lamps

Daytime running lamps

Side marker lamps

2. DEFINITIONS

For the purposes of this Regulation:

- 2.1. All the definitions given in the latest series of amendments to UN Regulation No. 48 in force at the time of application for type approval shall apply, unless otherwise specified in this Regulation or in the pertinent installation UN Regulations Nos. 53, 74 and 86.

2.2. "Lamps of different types" means lamps, which differ in such essential respects as:

- (a) The trade name or mark:
 - (i) Lamps bearing the same trade name or mark but produced by different manufacturers are considered as being of different types;
 - (ii) Lamps produced by the same manufacturer differing only by the trade name or mark are considered as being of the same type.
- (b) The characteristics of the optical system (levels of intensity, light distribution angles, inclusion or elimination of components capable of altering the optical effects by reflection, refraction, absorption and/or deformation during operation, etc.);
- (c) The category or categories of light source(s) used and/or the specific identification code (s) of the light source module(s);
- (d) The category of the lamp, if any;
- (e) The variable intensity control, if any;
- (f) The sequential activation of light sources, if any.

Nevertheless, direction indicators capable of being activated in different modes (sequential or not) without any modification of the optical characteristics of the lamp do not constitute "*Direction indicators of different types*".

A change of the colour of the light source or the colour of any filter does not constitute a change of type.

The use of LED substitute light source(s) does not constitute a change of type. However, paragraph 4.7.7. applies.

3. ADMINISTRATIVE PROVISIONS

3.1. Application for approval

3.1.1. The application for type approval shall be submitted by the holder of the trade name or mark or by his duly accredited representative.

3.1.2. It shall be accompanied by:

3.1.2.1. drawings, sufficiently detailed to permit identification of the type and, if applicable, of the category of the lamp, showing:

- (a) Geometrically in what position(s) the lamp (and if applicable for category S3 or S4 stop lamps the rear window) may be mounted on the vehicle;
- (b) The axis of observation to be taken as the axis of reference in the tests (horizontal angle $H = 0^\circ$, vertical angle $V = 0^\circ$); and the point to be taken as the centre of reference during the tests;
- (c) The limit of the apparent surface of the function(s);
- (d) The position and arrangement intended for the approval marking according to paragraph 3.3.2. or the "Unique Identifier";
- (e) In case of light-emitting diode (LED) module(s) also the space reserved for the specific identification code(s) of the module(s);
- (f) In the case of an interdependent lamp system, the interdependent lamp or the combination of interdependent lamps that fulfil the relevant requirements.

3.1.2.2. A brief technical description stating in particular, with the exception of lamps with non-replaceable light sources:

- (a) The category or categories of filament light source(s) prescribed; this filament light source category shall be one of those contained in Regulation No. 37;
- (b) The category or categories of LED light source(s) prescribed; this LED light source category shall be one of those contained in Regulation No. 128;
- (c) The light source module specific identification code;

- (d) In the case where, at the discretion of the applicant, the lamp also has to be approved with the LED substitute light source(s) according to Regulation No. 128, this shall be specified in the description;
 - (e) In the case of a category S3 or S4 stop lamp, which is intended to be mounted inside the vehicle, the technical description shall contain the specification of the optical properties (transmission, colour, inclination, etc.) of the rear window(s).
- 3.1.2.3. However, in the case of a type of lamp differing only by the trade name or mark from a type that has already been approved it is sufficient that the application is accompanied by:
- 3.1.2.3.1. A declaration by the lamp manufacturer that the type submitted is identical (except in the trade name or mark) with and has been produced by the same manufacturer as the type already approved, the latter being identified by its approval number;
 - 3.1.2.3.2. Two samples bearing the new trade name or mark or equivalent documentation.
- 3.1.2.4. In the case of a lamp with variable intensity, a concise description of the variable intensity control, an arrangement diagram and a specification of the characteristics of the system ensuring the two levels of intensity;
- 3.1.2.5. If applicable in the case of a non-replaceable filament light source(s) or light source module(s) equipped with non-replaceable filament light source(s), the documents according to paragraph 3.5.3.;
- 3.1.2.6. At the discretion of the applicant, the description may specify if the lamp may be installed on the vehicle with different inclinations of the reference axis in respect to the vehicle reference planes and to the ground, or rotate around its reference axis; these different conditions of installation shall be indicated in the communication form.
- 3.1.2.7. If not otherwise specified for the relevant lamp, the following samples:
- (a) Two complete samples of the lamp.

If application is made for the approval of lamps which are not identical but are symmetrical and suitable for mounting one on the left and one on the right side of the vehicle, the two samples submitted may be identical and be suitable for mounting only on the right or only on the left side of the vehicle;
 - (b) For a variable-intensity lamp, a sample of the variable intensity control or a generator providing the same signal(s).
- 3.1.2.8. In the case of a category S3 or S4 stop lamp which is intended to be mounted inside the vehicle, a sample plate or sample plates (in case of different possibilities) having the equivalent optical properties corresponding to those of the actual rear window(s).
- 3.2. Approval
- 3.2.1. A separate approval is required for each lamp listed in paragraph 1.
- 3.2.2. When two or more lamps are part of the same unit of grouped, combined or reciprocally incorporated lamps, approval may be granted only if each of these lamps satisfy the provisions set out in this Regulation or in another Regulation. Lamps not satisfying the provisions of any of those Regulations shall not be part of such unit of grouped, combined or reciprocally incorporated lamps.
- 3.2.3. If the type of lamp(s) submitted for approval in pursuance of paragraph 3.1. meets the requirements of this Regulation, approval shall be granted. All the devices of an interdependent lamp system must be submitted for type approval by the same applicant.
- 3.2.3.1. Notice of approval or of extension or refusal or withdrawal of approval or production definitely discontinued of a type of a lamp pursuant to this Regulation shall be communicated to the Contracting Parties to the 1958 Agreement which apply this Regulation, by means of a form conforming to the model in Annex 1;

- 3.2.3.2. An approval number shall be assigned to each type of lamp approved and shall be indicated for each lamp in the communication form in Annex 1.

A contracting party may assign the same approval number to light-signalling devices or systems incorporating a number of lamps but shall not assign the same number to another type of lamp of the same function.

- 3.2.4. The symbols identifying the light signalling lamp (function) for which type approval has been granted

Table 1

List of symbols

(full list is provided in Annex 1 "Communication")

Lamp (function)	Symbol	Paragraph
Daytime running lamp	RL	5.4.
Front direction indicator lamp to be installed at a distance of at least 20mm from passing beam headlamp or front fog lamp	1a	5.6.
Front direction indicator lamp to be installed at any distance from passing beam headlamp or front fog lamp	1b	5.6.
Front direction indicator lamp to be installed at a distance of at least 40 mm from passing beam headlamp or front fog lamp	1	5.6.
Direction indicators for the front of the category L vehicle for use at a distance of at least 75 mm from the passing beam headlamp	11	5.6.
Direction indicators for the front of the category L vehicle for use at a distance of at least 40 mm from the passing beam headlamp;	11a	5.6.
Direction indicators for the front of the category L vehicle for use at a distance of at least 20 mm from the passing beam headlamp;	11b	5.6.
Direction indicators for the front of the category L vehicle for use at any distance from the passing beam headlamp	11c	5.6.
Front end-outline marker lamp	AM	5.1.
Front position lamp for category L vehicle	MA	5.1.
Front position lamp	A	5.1.
Manoeuvring lamp	ML	5.10.
Parking lamp (Forward and rearward facing)	77R	5.3.
Rear direction indicator lamp (steady)	2a	5.6.
Rear direction indicator lamp (variable)	2b	5.6.
Rear direction indicator lamp for category L vehicle	12	5.6.
Rear end-outline marker lamp (steady)	RM1	5.2.
Rear end-outline marker lamp (variable)	RM2	5.2.
Rear fog lamp (steady)	F1	5.9.
Rear fog lamp (variable)	F2	5.9.
Rear position lamp for category L vehicle	MR	5.2.

Rear position lamp (steady)	R1	5.2.
Rear position lamp (variable)	R2	5.2.
Rear-registration plate illuminating lamp	L	5.11.
Rear-registration plate illuminating lamp for category L vehicle	LM1	5.11.
Reversing lamp (note: the letters A and R may be mingled)	AR	5.8.
Side direction indicator lamp for vehicles M ₁ and vehicles N ₁ , M ₂ and M ₃ up to 6 000 mm in length	5	5.6.
Side direction indicator lamp for vehicles N ₂ and N ₃ and vehicles N ₁ , M ₂ and M ₃ more than 6 000 mm in length	6	5.6.
Side marker lamp for all vehicle categories	SM1	5.7.
Side marker lamp for M ₁ vehicles	SM2	5.7.
Stop lamp (central high mounted) (steady)	S3	5.5.
Stop lamp (central high mounted) (variable)	S4	5.5.
Stop lamp for category L vehicle	MS	5.5.
Stop lamp (steady)	S1	5.5.
Stop lamp (variable)	S2	5.5.

The minimum value for “a” in part 1 of Annex 7 shall be 5 mm.

- 3.2.5. The applicable change indexes for each device relating to the series of amendments shall be as follows (see also paragraph 6.1.1.):

Table 2

Series of amendments and change index

Series of amendments to the Regulation	00		
Function (Lamp)	Change Index for the specific function (lamp)		
Daytime running lamp	0		
Front direction indicator lamp	0		
Front direction indicator lamp (Vehicle category L)	0		
Front end-outline marker lamp	0		
Front position lamp	0		
Front position lamp (Vehicle category L)	0		
Manoeuvring lamp	0		
Parking lamp	0		
Rear direction indicator lamp	0		
Rear direction indicator lamp (Vehicle category L)	0		
Rear end-outline marker lamp	0		
Rear fog lamp	0		
Rear position lamp	0		
Rear position lamp (Vehicle category L)	0		

Rear-registration plate illuminating lamp	0		
Rear-registration plate illuminating lamp (Vehicle category L)	0		
Reversing lamp	0		
Side direction indicator lamp	0		
Side marker lamp	0		
Stop lamp	0		
Stop lamp (Vehicle category L)	0		
Stop lamp (central high mounted)	0		

3.3. Approval mark

3.3.1. General provisions

3.3.1.1. Every device belonging to an approved type shall comprise a space of sufficient size for the Unique Identifier (UI) as referred to in the 1958 Agreement and other markings as defined in paragraph 3.3.4.2. to 3.3.4.6. or, if technically not possible, the approval marking with the additional symbols and other markings as defined in paragraphs 3.3.4.2. to 3.3.4.6.

3.3.1.2. Examples of the arrangement of the markings are shown in Annex 7.

3.3.2. The approval marking shall consist of:

3.3.2.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval.

3.3.2.2. The approval number prescribed in paragraph 3.2.3.2.

3.3.2.3. The symbols identifying the light signalling lamps prescribed in paragraph 3.2.4.

3.3.2.4. The number of this Regulation followed by the letter 'R' and the two digits indicating the series of amendments in force at the time of issue of the approval.

3.3.2.5. The following additional symbol (or symbols):

3.3.2.5.1. On lamps which cannot be mounted on either side of the vehicle indiscriminately, a horizontal arrow showing in which position the lamp is to be mounted.

3.3.2.5.1.1. The arrow shall be directed outwards from the vehicle in the case of:

- (a) Direction indicators categories 1, 1a, 1b, 2a, 2b, 11, 11a, 11b, 11c and 12;
- (b) Front or rear position lamps, front or rear end-outline marker lamps;
- (c) Reversing lamps in case of reduced light distribution of two reversing lamps.

3.3.2.5.1.2. The arrow shall be directed towards the front of the vehicle in the case of direction indicators of categories 5 and 6 and combined parking lamps

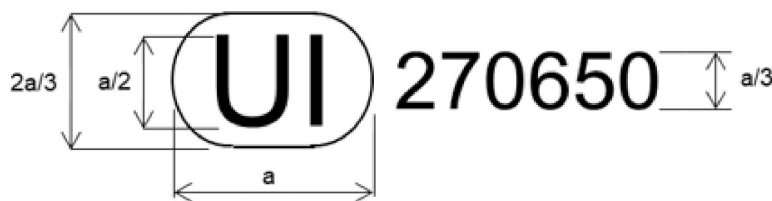
3.3.2.5.1.3. For direction indicators of category 6 an indication "R" or "L" shall be shown on the lamp, indicating the right or left side of the vehicle.

3.3.2.5.2. If applicable, to the right side of the symbol mentioned in paragraph 3.2.4.:

- (a) The additional letter "D", on lamps which may be used as part of an assembly of two independent lamps;
- (b) The additional letter "Y", on lamps which are used as part of an interdependent lamps system.

- 3.3.2.5.3. On lamps with reduced light distribution, see paragraph 1.3. of Annex 3, a vertical arrow starting from a horizontal segment and directed downwards.
- 3.3.2.5.4. The approval number shall be placed close to the circle prescribed in paragraph 3.3.2.1.
- 3.3.3. The approval marking may be replaced by the Unique Identifier (UI), if available. The Unique Identifier mark shall follow the format in the example shown below:

Figure 1

Unique identifier

$a \geq 8 \text{ mm}$

The above Unique Identifier marked on the lamp shows that the type concerned has been approved and that the relevant information on that type approval can be accessed on the UN secure internet database by using 270650 as the Unique Identifier.

3.3.4. Marking requirements

Lamps submitted for approval shall:

- 3.3.4.1. Comprise a space of sufficient size for the approval marking or the Unique Identifier.
- 3.3.4.1.1. In any case the approval marking or the Unique Identifier as well as the category or categories of LED substitute light source(s) prescribed, if any, shall be visible when the lamp is fitted on the vehicle or when a movable part such as the hood or boot lid or a door is opened.
- 3.3.4.1.2. The approval marking shall be placed on an inner or outer part (transparent or not) of the lamp which cannot be separated from the transparent part of the lamp emitting the light.
- 3.3.4.2. Bear the trade name or mark of the applicant; this marking shall be clearly legible and indelible.
- 3.3.4.3. With the exception of lamps with non-replaceable light sources, bear a clearly legible and indelible marking indicating:
- (a) The category or categories of light source(s) prescribed; in the case where the lamp has been approved for LED substitute light source(s), also the category or categories of the LED substitute light source(s); and/or
 - (b) The light source module specific identification code.
- 3.3.4.4. In the case of lamps with:
- (a) An electronic light source control gear; or
 - (b) A variable luminous intensity control; and/or
 - (c) A secondary operating mode; and/or
 - (d) Non-replaceable light sources; and/or
 - (e) Light source module(s);

Bear marking of the rated voltage or the range of voltage;

3.3.4.5. In the case of lamps with light source module(s) on the light source module(s) bear marking of:

- (a) The trade name or mark of the applicant;
- (b) The specific identification code of the module; This specific identification code shall comprise the starting letters "MD" for "MODULE" followed by the approval mark without the circle as prescribed in paragraph 3.3.2. or by the UI without the truncated circle as prescribed in paragraph 3.3.3.

In case several non-identical light source modules are used, followed by additional symbols or characters;

The approval mark or the UI does not have to be the same as the one on the lamp in which the module is used, but both marks shall be from the same applicant;

- (c) The rated voltage or the range of voltage.

3.3.4.6. An electronic light source control gear or variable luminous intensity control being part of the lamp, but not included into the lamp body, shall be marked with the name of the manufacturer and its identification number.

3.3.4.7. The markings in paragraphs 3.3.4.2. to 3.3.4.6. shall be affixed in an indelible and clearly legible manner on the lamp but do not need to fulfil the requirements of paragraph 3.3.4.1.1.

3.3.5. Grouped, combined or reciprocally incorporated lamps

3.3.5.1. Where grouped, combined or reciprocally incorporated lamps have been found to comply with the requirements of several UN Regulations, a single approval mark or UI may be affixed. The approval mark shall consist 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 or UI may be located anywhere on the grouped, combined or reciprocally incorporated lamps, provided that:

3.3.5.1.1. It is visible after their installation;

3.3.5.1.2. 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.

3.3.5.2. 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 under which approval has been granted.

3.3.5.3. Annex 7 gives examples of approval marks for grouped, combined or reciprocally incorporated lamps with all the above-mentioned additional symbols.

3.3.5.4. Lamps reciprocally incorporated with other lamps, of which the lens may also be used for other types of devices. The provisions laid down in paragraph 3.3.5. are applicable.

3.4. Modifications of a type of lamp for motor vehicles and their trailers and extension of approval

3.4.1. Every modification of a type of lamp shall be notified to the Type Approval Authority which approved the type. The Authority may then either:

3.4.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the lamp still complies with the requirements; or

3.4.1.2. Require a further test report from the technical service responsible for conducting the tests.

3.4.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 3.2.3.1. to the Contracting Parties to the 1958 Agreement applying this Regulation.

- 3.4.3. The Type Approval Authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Contracting Parties to the 1958 Agreement applying the UN Regulation under which the approval has been granted by means of a communication form conforming to the model in Annex 1.

3.5. Conformity of production

The conformity of production procedures shall comply with those set out in the 1958 Agreement, Schedule 1 (E/ECE/TRANS/505/Rev.3), with the following requirements:

- 3.5.1. Lamps shall be so manufactured as to conform to the type approved under this Regulation. The compliance with the requirements set forth in paragraphs 4. and 5. shall be verified as follows:
- 3.5.1.1. The minimum requirements for conformity of production control procedures set forth in Annex 4 shall be complied with;
- 3.5.1.1.1 In the case of daytime running lamp whose maximum luminous intensity does not exceed 700 cd as identified in Annex 1 700 cd shall be applied as maximum luminous intensity for conformity of production procedures set forth in Annex 4.
- 3.5.1.2. The minimum requirements for sampling by an inspector set forth in Annex 5 shall be complied with;
- 3.5.2. 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.
- 3.5.3. In the case of non-replaceable filament light source(s) or light source module(s) equipped with non-replaceable filament light source(s), the applicant shall annex to the type approval documentation a report, acceptable to the Authority responsible for type approval that demonstrates compliance of these non-replaceable filament light source with the requirements as specified in paragraph 4.11 of IEC 60809, Edition 3.
- 3.5.4. Testing with LED substitute light sources is exempted from conformity of production control.

3.6. Penalties for non-conformity of production

- 3.6.1. The approval granted may be withdrawn if the requirements in this Regulation are not met;
- 3.6.2. If a Contracting Party to the 1958 Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 1.

3.7. Production definitively discontinued

If the holder of the approval completely ceases to manufacture a lamp 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 Contracting Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1.

3.8. Names and addresses of Technical Services responsible for conducting approval tests, and of Type Approval Authorities

The Contracting Parties to the 1958 Agreement which apply the Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, or the definitive discontinuation of production issued in other countries, are to be sent.

3.9. Remarks concerning colours and particular devices in the case of end-outline marker lamps and parking lamps

The Contracting Parties to the 1958 Agreement to which this Regulation is annexed are not precluded by Article 3 of that Agreement from prohibiting, for lamps installed on vehicles registered by them, certain colours for which provision is made in this Regulation, or from prohibiting for all categories or for certain categories of vehicles registered by them stop lamps having only steady luminous intensity.

4. GENERAL TECHNICAL REQUIREMENTS

Each lamp submitted for approval shall conform to the requirements set forth in paragraphs 4. and 5.

4.1. The requirements contained in sections 5 "General specifications" and 6 "Individual specifications" (and in the Annexes referenced in the said sections) of UN Regulations Nos. 48, 53, 74 or 86, and their series of amendments in force at the time of application for the lamp type approval shall apply to this Regulation.

The requirements pertinent to each lamp and to the category/ies of vehicle on which the lamp is intended to be installed shall be applied, where its verification at the moment of lamp type approval is feasible.

4.2. The lamps must be so designed and constructed that in normal conditions of use, and notwithstanding the vibrations to which they may be subjected in such use, their satisfactory operation remains assured and they retain the characteristics prescribed by this Regulation.

4.3. Light sources:

4.3.1. In the case of replaceable light source(s):

4.3.1.1. The lamp shall only be equipped with light source(s) approved according to UN Regulation No. 37 and/or UN Regulation No. 128, provided that no restriction on the use is made in UN Regulation No. 37 and its series of amendments in force at the time of application for type approval or in UN Regulation No. 128 and its series of amendments in force at the time of application for type approval.

4.3.1.2. In the case of a light source category or categories or type(s) is restricted for use in lamps on vehicles in use and originally equipped with such lamps, the applicant for type approval of the lamp shall declare that the lamp is only intended for installation on those vehicles; this shall be noted in the communication form in Annex 1.

4.3.1.3. The design of the lamp shall be such that the light source(s) can be fixed in no other position but the correct one.

4.3.1.4. The light source(s) holder shall conform to the characteristics given in IEC Publication 60061. The holder data sheet relevant to the category of light source(s) prescribed applies.

Alternatively, where a category of LED substitute light source(s) is also prescribed, the holder data sheet relevant to the category of LED substitute light source(s) applies.

4.3.2. In the case of light source modules, it shall be checked that:

4.3.2.1. The design of the light source module(s) shall be such as:

(a) That each light source module can only be fitted in no other position than the designated and correct one and can only be removed with the use of tool(s);

(b) If there are more than one light source module used in the housing for a lamp, light source modules having different characteristics cannot be interchanged within the same lamp housing.

4.3.2.2. The light source module(s) shall be tamperproof.

4.3.2.3. A light source module shall be so designed that regardless of the use of tool(s), it shall not be mechanically interchangeable with any replaceable approved light source.

- 4.3.2.4. In the case of non-replaceable filament light source(s) or light source module(s) equipped with non-replaceable filament light source(s), the applicant shall annex to the type approval documentation a report, acceptable to the Authority responsible for type approval, that demonstrates compliance of these non-replaceable filament light source(s) with the requirements as specified in paragraph 4.11 of IEC 60809, Edition 3.
- 4.4. Independent and interdependent lamps
- 4.4.1. An assembly of two independent lamps to be type approved as lamp marked "D" is applicable to front and rear position lamps except for categories MA, MR, stop lamps except for category MS, front and rear end-outline marker lamps and direction indicator lamps except for categories 11, 11a, 11b, 11c and 12;
- 4.4.2. An interdependent lamp system to be type approved as lamps marked "Y" is applicable to front and rear position lamps, stop lamps, front and rear end-outline marker lamps, daytime running lamps and direction indicator lamps of categories 1, 1a, 1b, 2a, 2b.
- 4.5. Lamps as such or grouped, combined, reciprocally incorporated:
- 4.5.1. Lamps having been approved as front or rear position lamps, are deemed being also approved end-outline marker lamps.
- 4.5.2. Front and rear position lamps which are grouped or combined or reciprocally incorporated may also be used as end-outline marker lamps.
- 4.5.3. Position lamps or daytime running lamps, which are reciprocally incorporated with another function, using a common light source, and designed to operate permanently with an additional system to regulate the intensity of the light emitted, are permitted.
- 4.5.4. However, in the case of rear position lamp reciprocally incorporated with a stop lamp, the lamp shall either:
- (a) Be a part of a multiple light source arrangement; or
 - (b) Be intended for use in a vehicle equipped with a failure monitoring system for that function.
- In either case, a note shall be made within the communication document.
- 4.5.5. If the front position lamp incorporates one or more infrared radiation generators, the photometric and colour requirements for this front position lamp shall be met with and without the operation of the infrared radiation generator(s).
- 4.6. Failure provisions
- 4.6.1. Failure of a single lamp containing more than one light source
- 4.6.1.1. In a single lamp containing more than one light source, a group of light sources, wired so that the failure of any one of them causes all of them to stop emitting light, shall be considered to be one light source.
- 4.6.1.2. In case of failure of any one light source in a single lamp containing more than one light source, at least one of the following provisions shall apply:
- (a) The light intensity complies with the minimum intensity required in the pertinent table of standard light distribution in space as shown in Annex 3 and when all light sources are illuminated the maximum intensities shall not be exceeded; or
 - (b) A signal for activation of a tell-tale indicating failure, as indicated in paragraphs 6.4.8., 6.7.8., 6.9.8, 6.10.8., 6.11.8., 6.12.8., 6.13.8. and 6.18.8. of UN Regulation No. 48, is produced, provided that the luminous intensity in the axis of reference is at least 50 per cent of the minimum intensity required. In this case a note in the communication form states that the lamp is only for use on a vehicle fitted with a tell-tale indicating failure.

- 4.6.1.3. The requirements of paragraph 4.6.1.2. do not apply to daytime running lamps that shall comply with the requirements of paragraph 5.4.4.

However, the requirements of paragraph 4.6.1.1. are still applicable.

- 4.6.1.4. The requirements of paragraph 4.6.1.2. do not apply to direction indicator lamps. Direction indicator lamps of category 1, 1a, 1b, 2a and 2b shall comply with the requirements of paragraph 5.6.3.

However, the requirements of paragraph 4.6.1.1. are still applicable.

- 4.6.1.5. The requirements of paragraph 4.6.1.2. do not apply to registration plate lamps.

However, the requirements of paragraph 4.6.1.1. are still applicable.

- 4.6.1.6. The requirements of paragraph 4.6.1.2. (b) do not apply to stop- and position lamps for vehicles of category L.

However, the requirements of paragraph 4.6.1.1. and paragraph 4.6.1.2. (a) are still applicable.

- 4.6.2. In case of failure of the variable intensity control of:

- (a) A rear position lamp category R2 emitting more than the maximum value of category R1;
- (b) A rear end-outline marker lamp category RM2 emitting more than the maximum value of category RM1;
- (c) A stop lamp category S2 emitting more than the maximum value of category S1;
- (d) A stop lamp category S4 emitting more than the maximum value of category S3;
- (e) A direction indicator of category 2b emitting more than the maximum value of category 2a;
- (f) A rear fog lamp of category F2 emitting more than the maximum value of category F1.

Requirements of steady luminous intensity of the respective category shall be fulfilled automatically.

- 4.7. Test conditions

- 4.7.1. All measurements, photometric and colorimetric, shall be made:

- 4.7.1.1. In case of a lamp with replaceable light source, if not supplied by an electronic light source control gear or a variable intensity control, with an uncoloured or coloured standard light source of the category prescribed for the device, supplied with the voltage:

- (a) In the case of filament light source(s), that is necessary to produce the reference luminous flux required for that category of filament light source;
- (b) In the case of LED light source(s) of 6,75 V, 13,5 V or 28,0 V; the luminous flux value produced shall be corrected. The correction factor is the ratio between the objective luminous flux and the value of the luminous flux found at the voltage applied.

- 4.7.1.2. In the case of a light source, which is operated independently from vehicle supply voltage and fully controlled by the system, or in the case of a light source supplied by a special power supply, the test voltage as specified by the applicant shall be applied to the input terminals of the light source or 6,75 V, 13,5 V or 28,0 V shall be applied to the input terminals of that system/power supply. The test laboratory may require from the manufacturer this special power supply needed to supply the light sources.

- 4.7.1.3. In the case of a lamp equipped with non-replaceable light sources (filament light sources and other), with the light sources present in the lamp.

- 4.7.1.3.1. If operating directly under vehicle voltage system conditions all measurements on lamps equipped with non-replaceable light sources shall be made at 6,75 V, 13,5 V or 28,0 V, or at a voltage as specified by the applicant with respect to any other vehicle voltage system.

- 4.7.1.3.2. If operated independently from vehicle supply voltage and fully controlled by the system, or in the case of a light source supplied by a special power supply, the test voltage as specified in paragraph 4.7.1.3.1. shall be applied to the input terminals of that system/power supply. The test laboratory may require from the manufacturer this special power supply needed to supply the light sources.
- 4.7.1.4. In the case of a system that uses an electronic light source control gear or a variable intensity control being part of the lamp, the voltage declared by the manufacturer shall be applied to the input terminals of the lamp or, if not indicated, 6,75 V, 13,5 V or 28,0 V respectively.
- 4.7.1.5. In the case of a system that uses an electronic light source control gear or a variable intensity control not being part of the lamp, the voltage declared by the manufacturer shall be applied to the input terminals of the lamp.
- 4.7.2. However, in the case of light sources operated by a variable intensity control to obtain variable luminous intensity, photometric measurements shall be performed according to the applicant's description.
- 4.7.3. The test laboratory shall require from the manufacturer the light source control gear or a variable intensity control needed to supply the light source and the applicable functions.
- 4.7.4. The voltage to be applied to the lamp shall be noted in the communication form in Annex 1.
- 4.7.5. The limits of the apparent surface in the direction of the reference axis of a light-signalling lamp shall be determined. However, in the case of category 5 and 6 direction indicators, the limits of the light emitting surface shall be determined. This requirement shall not apply to rear-registration plate illuminating lamps.
- 4.7.6. In the case of a category S3 or S4 stop lamp, which is intended to be mounted inside the vehicle a sample plate or sample plates (in case of different possibilities) as supplied (see paragraph 3.1.2.8.) shall be positioned in front of the lamp to be tested, in the geometrical position(s) as described in the application drawing(s) (see paragraph 3.1.2.2.).
- 4.7.7. In the case where the lamp, at the discretion of the applicant, also has to be approved with LED substitute light source(s), all measurements, photometric and colorimetric, shall be repeated using the LED substitute light source(s) prescribed.
- 4.8. Photometric measurements
- 4.8.1. Measurement provisions
- 4.8.1.1. During photometric measurements, stray reflections shall be avoided by appropriate masking.
- 4.8.1.2. In case the results of measurements should be challenged, measurements shall be carried out in such a way as to meet the following requirements:
- 4.8.1.2.1. The distance of measurement shall be such that the law of the inverse of the square of the distance is applicable;
- 4.8.1.2.2. The measuring equipment shall be such that the angular aperture of the receiver viewed from the reference centre of the light is comprised between 10' and 1 degree;
- 4.8.1.2.3. The intensity requirement for a particular direction of observation shall be deemed to be satisfied if that requirement is met in a direction deviating by not more than one-quarter of a degree from the direction of observation.
- 4.8.1.3. In the case where the lamp may be installed on the vehicle in more than one or in a field of different positions the photometric measurements shall be repeated for each position or for the extreme positions of the field of the reference axis specified by the manufacturer.

4.8.2. Measurement methods

4.8.2.1. The photometric performance shall be checked in accordance with the relevant sub-paragraph of paragraph 4.7.

4.8.2.2. For multiple replaceable light sources:

When equipped with light source(s) at 6,75 V, 13,5 V or 28,0 V, the luminous intensity values produced shall be corrected. For these replaceable filament light sources the correction factor is the ratio between the reference luminous flux and the mean value of the luminous flux found at the voltage applied (6,75 V, 13,5 V or 28,0 V).

For LED light sources the correction factor is the ratio between the objective luminous flux and the mean value of the luminous flux found at the voltage applied (6,75 V, 13,5 V or 28,0 V).

The actual luminous fluxes of light source used shall not deviate more than 5 per cent from the mean value. Alternatively, and in case of filament light sources only, a standard filament light source may be used in turn, in each of the individual positions, operated at its reference flux, the individual measurements in each position being added together.

4.8.2.3. For lamps except those equipped with filament light source(s)

4.8.2.3.1. For reversing lamps and maneuvering lamps, the luminous intensities measured after one minute and after 10 minutes of operation, shall comply with the minimum and maximum requirements. The luminous intensity distribution after one and after 10 minutes of operation shall be calculated from the luminous intensity distribution measured after photometric stability has occurred by applying at each test point the ratio of luminous intensities measured at HV:

- (a) After one minute;
- (b) After 10 minutes; and
- (c) After photometric stability has occurred.

4.8.2.3.2. For all other lamps, the luminous intensities measured after 1min and after 30min of operation shall comply with the minimum and maximum requirements.

Operation of direction indicator lamps shall be done in flashing mode ($f = 1,5$ Hz, duty factor 50 per cent).

The luminous intensity distribution after 1min of operation can be calculated from the luminous intensity distribution after 30 min of operation by applying at each test point the ratio of luminous intensities measured at HV after 1 min and after 30 min of operation.

4.8.3. If not otherwise specified, each signalling lamp shall conform to the intensities of light emitted outside the reference axis and within the angular fields defined in the diagrams in Annex 2, the intensity of the light emitted by each of the two lamps supplied shall:

4.8.3.1. In each direction corresponding to the points in the pertinent light distribution table reproduced in Annex 3, be not less than the product of the minimum specified in the table of each function below, by the percentage specified in the said table of the direction in question;

4.8.3.2. In no direction within the space from which the light-signalling lamp is visible, exceed the maximum specified in the pertinent table of each function;

4.8.4. When an assembly of two independent lamps, to be type approved as lamps marked "D" and having the same function, is deemed to be a single lamp, it shall comply with the requirements for:

- (a) Maximum intensity if all lamps together are lit;
- (b) Minimum intensity if either lamp has failed.

4.8.5. An interdependent lamp system shall meet the requirements when all its interdependent lamps are operated together.

However:

- (a) If the interdependent lamp system providing the rear position lamp is partly mounted on the fixed component and partly mounted on a movable component, the interdependent lamp(s) specified by the applicant shall meet the outboard geometric visibility colorimetric and photometric requirement, at all fixed positions of the movable component(s). In this case, the inboard geometric visibility requirement is deemed to be satisfied if this (these) interdependent lamp(s) still conform to the photometric values prescribed in the field of light distribution for the approval of the device, at all fixed positions of the moveable component(s);
- (b) If the interdependent lamp system providing the rear direction indicator function is partly mounted on the fixed component and partly mounted on a movable component, the interdependent lamp(s) specified by the applicant shall meet the geometric visibility, colorimetric and photometric requirement, at all fixed positions of the movable component(s). This does not apply to interdependent direction indicator lamp(s) intended for fitting on vehicle(s) where, to fulfil or complete the geometric visibility angle, additional lamps are activated when the movable component is in any fixed open position, provided that these additional lamps satisfy all the position, photometric and colorimetric requirements applicable to the direction indicator lamps installed on the movable component.

4.8.6. The provisions of the relevant paragraphs of Annex 3 on local variations of intensity must be observed.

4.8.7. If not otherwise specified, the intensities shall be measured with the light source continuously alight and, in the case of lamps emitting red light, in coloured light.

4.8.8. In the case of lamps of categories R2, RM2, S2, S4, F2 and 2b, the time that elapses between energising the light source(s) and the light output measured on the reference axis to reach 90 per cent of the value measured in accordance with paragraph 5. shall be measured for the extreme levels of luminous intensity produced by the lamp. The time measured to obtain the lowest luminous intensity shall not exceed the time measured to obtain the highest luminous intensity.

4.8.9. The variable intensity control shall not generate signals which cause luminous intensities:

4.8.9.1. Outside the range specified in paragraph 5.; and

4.8.9.2. Exceeding the respective steady luminous intensity maximum specified in paragraph 5. for the specific lamp:

- (a) For systems depending only on daytime and night time conditions: under night time conditions;
- (b) For other systems: under standard conditions. ⁽¹⁾

4.8.10. Particulars of the methods of measurement to be used are given in Annex 3.

4.8.11. If a rear position lamp and/or a rear end-outline marker lamp is reciprocally incorporated with a stop lamp producing either steady or variable luminous intensity, the ratio between the luminous intensities actually measured of the two lamps when turned on simultaneously at the intensity of the rear position lamp or end-outline marker lamp when turned on alone should be at least 5: 1 in the field delimited by the straight horizontal lines passing through $\pm 5^\circ$ V and the straight vertical lines passing through $\pm 10^\circ$ H of the light distribution table.

⁽¹⁾ Good visibility (meteorological optical range MOR > 2 000 m defined according to WMO, Guide to Meteorological Instruments and Methods of Observation, Sixth Edition, ISBN: 92-63-16008-2, pp 1.9.1/1.9.11, Geneva 1996) and clean lens.

If the one or both of the two reciprocally incorporated lamps contain(s) more than one light source and is (are) considered as a single lamp, the values to be considered are those obtained with all sources in operation;

4.9. Colour of light emitted

The colour of the light emitted shall be measured inside the field of the light distribution grid defined for the specific function in the relevant paragraph of Annex 3. To check these colorimetric characteristics, the test procedure described in paragraph 4.7. shall be applied. Outside this field no sharp variation of colour shall be observed.

However, for lamps equipped with non-replaceable light sources, the colorimetric characteristics should be verified with the light sources present in the lamp, in accordance with relevant subparagraphs of paragraph 4.7.

5. SPECIFIC TECHNICAL REQUIREMENTS

5.1 technical requirements concerning front position lamps, (symbols A, MA) and front end-outline marker lamps, (symbols AM)

5.1.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 3.

Table 3

Luminous intensities for front position and front end-outline marker lamps

	Minimum luminous intensity in HV (values in cd)	Maximum luminous intensity in any direction when used as (values in cd)	
		A single lamp	A lamp marked "D" (paragraph 3.3.2.5.2.)
Front position lamps, front end-outline marker lamp, A or AM	4	140	70
Front position lamps (motorcycle), MA	4	140	N.A.
Front position lamps A incorporated in a headlamp or in a front fog lamp	4	140	N.A.

5.1.2. Outside the reference axis and within the angular fields defined in the diagrams in Part A of Annex 2, the intensity of the light emitted by each lamp must in each direction corresponding to the points in the table of standard light distribution reproduced in paragraph 2. of Annex 3, be not less than the minimum specified in paragraph 5.1.1., multiplied by the percentage specified in the said table of the direction in question.

5.1.3. Throughout the fields defined in the diagrams in Part A of Annex 2, the luminous intensity of the light emitted must be not less than 0,05 cd for front position lamps and front end-outline marker lamps;

5.1.4. The colour of the light emitted shall be white, however the lamp identified by symbol 'MA' may be amber.

5.2. Technical requirements concerning rear position lamps (symbols R1, R2, MR) and rear end-outline marker lamps (symbols RM1, RM2)

5.2.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 4.

Table 4

Luminous intensities for rear position and rear end-outline marker lamps

	Minimum luminous intensity in H-V (values in cd)	Maximum luminous intensity in any direction when used as (values in cd)	
		A single lamp	A lamp marked "D" (paragraph 3.3.2.5.2.)
Rear position lamps, rear end-outline marker lamp			
R1 or RM1 (steady)	4	17	8,5
MR	4	17	N.A.
R2 or RM2 (variable)	4	42	21

5.2.2. Outside the reference axis and within the angular fields defined in the diagrams in Part A of Annex 2, the intensity of the light emitted by each lamp must in each direction corresponding to the points in the table of standard light distribution reproduced in paragraph 2. of Annex 3, be not less than the minimum specified in paragraph 5.2.1., multiplied by the percentage specified in the said table for the direction in question.

5.2.3. However, a luminous intensity of 60 cd shall be permitted for rear position lamps reciprocally incorporated with stop lamps below a plane forming an angle of 5° with and downward from the horizontal plane;

5.2.4. Throughout the fields defined in the diagrams in Part A of Annex 2, the luminous intensity of the light emitted must be not less than 0,05 cd for rear position lamps and end-outline marker lamps,

5.2.5. The colour of light emitted shall be red.

This requirement shall also apply within the range of variable luminous intensity produced by:

- (a) Rear position lamps of category R2;
- (b) Rear end-outline marker lamps of category RM2.

5.3. Technical requirements concerning parking lamps (symbol 77R)

5.3.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 5.

Table 5

Luminous intensities for parking lamps

	Minimum luminous intensity in H-V (values in cd)	Maximum luminous intensity in any direction (values in cd)
Forward facing parking lamps	2	60
Rearward facing parking lamps	2	30

- 5.3.2. However, a luminous intensity of 60 cd shall be permitted for parking lamps directed to the rear incorporated with stop lamps below a plane forming an angle of 5° with and downward from the horizontal plane.
- 5.3.3. Outside the reference axis and within the angular fields defined in the diagrams in Part A of Annex 2, the intensity of the light emitted by each lamp shall, in each direction corresponding to the points in the table of standard light distribution reproduced in paragraph 2. of Annex 3, be not less than the minimum specified in paragraph 5.3.1., multiplied by the percentage specified in the said table for the direction in question.
- 5.3.4. Throughout the fields defined in the diagrams in Part B of Annex 2, the luminous intensity of the light emitted must be not less than 0,05 cd for front and rear parking lamps;
- 5.3.5. The colour of light emitted shall:
- (a) For forward facing parking lamps be white;
 - (b) For rearward facing parking lamps be red;
 - (c) For side facing parking lamps be amber.
- 5.4. Technical requirements concerning daytime running lamps (symbols RL)
- 5.4.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 6.

Table 6

Luminous intensities for daytime running lamps

	Minimum luminous intensity in H-V (values in cd)	Maximum luminous intensity in any direction (values in cd)
Daytime running lamps	400	1 200

- 5.4.2. Outside the reference axis the intensity of the light emitted by each lamp must, in each direction corresponding to the points in the table of standard light distribution reproduced in paragraph 2. of Annex 3, be not less than the minimum specified in paragraph 5.4.1., multiplied by the percentage specified in the said table of the direction in question.
- 5.4.3. Moreover, throughout the field defined in the diagram in Part A of Annex 2, the intensity of the light emitted shall not be less than 1,0 cd.
- 5.4.4. Light source failure
- 5.4.4.1. In the case of a daytime running lamp containing more than one light source, the daytime running lamp shall comply with the minimum intensity required and the maximum intensity shall not be exceeded when all light sources are activated.
- 5.4.4.2. In case of failure of any one light source in a single lamp containing more than one light source, one of the following provisions shall apply:
- (a) The light intensity at the points of standard light distribution defined in paragraph 2.2. of Annex 3 shall be at least 80 per cent of the minimum intensity required; or
 - (b) The light intensity in the axis of reference shall be at least 50 per cent of the minimum intensity required, provided that a note in the communication form states that the lamp is only for use on a vehicle fitted with an operating tell-tale.

- 5.4.5. The colour of the light emitted shall be white.
- 5.4.6. The area of the apparent surface in the direction of the axis of reference of the daytime running lamp shall be not less than 25 cm² and not more than 200 cm².
- 5.4.7. The daytime running lamp shall be subjected to the heat resistance test specified in Annex 6.
- 5.5 technical requirements concerning stop lamps (symbols S1, S2, S3, S4, MS)
- 5.5.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 7.

Table 7

Luminous intensities for stop lamps

Stop lamp of category	Minimum luminous intensity in H-V (values in cd)	Maximum luminous intensity in any direction when used as (values in cd)	
		A single lamp	A lamp marked "D" (paragraph 3.3.2.5.2.)
S1 (steady)	60	260	130
S2 (variable)	60	730	365
S3 (steady)	25	110	55
S4 (variable)	25	160	80
MS (steady)	40	260	N.A.

- 5.5.2. Outside the reference axis the intensity of the light emitted by each lamp shall, in each direction corresponding to the points in the table of standard light distribution reproduced in paragraph 2. of Annex 3 be not less than the minimum specified in paragraph 5.5.1., multiplied by the percentage specified in the said table of the direction in question.
- 5.5.3. Throughout the fields defined in the diagrams in Part A of Annex 2, the luminous intensity of the light emitted shall be not less than 0,3 cd for devices of categories S1, S3 and MS and for those of categories S2 and S4 by day; it shall not be less than 0,07 cd for devices of categories S2 and S4 by night.
- 5.5.4. The colour of the light emitted shall be red.
- In the case of a category S3 or S4 stop lamp, which is intended to be mounted inside the vehicle, the colorimetric characteristics shall be verified with the worst case combination(s) of lamp and rear window(s) or sample plate(s).
- These requirements shall also apply within the range of variable luminous intensity produced by stop lamps of categories S2 and S4.
- 5.6. Technical requirements concerning direction-indicator lamps (Symbols 1, 1a, 1b, 2a, 2b, 5, 6, 11, 11a, 11b, 11c, 12)
- 5.6.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 8 where the minimum luminous intensities shall be fulfilled:
- (a) In the case of direction indicators of categories 1, 1a, 1b, 2a, 2b, 11, 11a, 11b, 11c and 12 in the reference axis; or

- (b) In the case of direction indicators of categories 5 and 6 in direction A according to Annex 2.

Table 8

Luminous intensities for direction indicator lamps

Direction indicator lamp of category	Minimum luminous intensity (values in cd)	Maximum luminous intensity in any direction when used as (values in cd)	
		A single lamp	A lamp marked "D" (paragraph 3.3.2.5.2.)
1	175	1 000	500
1a	250	1 200	600
1b	400	1 200	600
2a (steady)	50	500	250
2b (variable)	50	1 000	500
5	0,6	280	140
6	50	280	140
11	90	1 000	N.A.
11a	175	1 000	N.A.
11b	250	1 200	N.A.
11c	400	1 200	N.A.
12	50	500	N.A.

- 5.6.2. Outside the reference axis the intensity of the light emitted by each lamp shall, in each direction corresponding to the points in the table of standard light distribution reproduced in:

- (a) Paragraph 2.1. of Annex 3 for categories 1, 1a, 1b, 2a, 2b, 11, 11a, 11b, 11c and 12.; or
 (b) Paragraph 2.4. of Annex 3 for category 6.

Be not less than the minimum specified in paragraph 5.6.1., multiplied by the percentage specified in the said table of the direction in question.

- 5.6.3. Failure provisions

For direction-indicator lamps of categories 1, 1a, 1b, 2a and 2b a signal for activation of the tell-tale prescribed in paragraph 6.5.8. of UN Regulation No. 48 or paragraph 6.3.8. of UN Regulation No. 53 shall be produced if (notwithstanding the provisions stated in paragraph 4.6.):

- (a) Any one light source has failed; or
 (b) In the case of a lamp designed for only two light sources, the intensity in the axis of reference is less than 50 per cent of the minimum intensity; or
 (c) As a consequence of a failure of one or more light sources, the intensity in one of the following directions as indicated in paragraph 2.1. of Annex 3, is less than the minimum intensity required:
- (i) $H=0^\circ$, $V=0^\circ$
 - (ii) $H=20^\circ$ to the outside of the vehicle, $V=+5^\circ$
 - (iii) $H=10^\circ$ to the inside of the vehicle, $V=0^\circ$.

5.6.4. Test procedure:

In divergence from paragraphs 4.8.3. and 4.8.3.1., for category 5 direction indicators, to the rear, a minimum value of 0,6 cd is required throughout the fields specified in Part A of Annex 2;

5.6.5. Throughout the fields defined in the diagrams in Part A of Annex 2, the intensity of the light emitted shall be not less than 0,7 cd for lamps of category 1b, not less than 0,3 cd for lamps of categories 1, 1a, 2a, 11, 11a, 11b, 11c, 12 and for those of category 2b by day; it shall not be less than 0,07 cd for lamps of category 2b by night;

5.6.6. In general, the intensities shall be measured with the light source(s) continuously alight.

However, depending on the construction of the lamp, for example, the use of light-emitting diodes (LED), or the need to take precautions to avoid overheating, it is allowed to measure the lamps in flashing mode.

(a) This shall be achieved by switching with a frequency of $f = 1,5 \pm 0,5$ Hz with the pulse width greater than 0,3 s, measured at 95 per cent peak light intensity. In all other cases the voltage as required in paragraph 4.7.1. shall be switched with a rise time and fall time shorter than 0,01 s; no overshoot is allowed;

(b) In the case of measurements taken in flashing mode the reported luminous intensity shall be represented by the maximum intensity.

5.6.7. In the case of lamps of category 2b the time that elapses between energizing the light source(s) and the light output measured on the reference axis to reach 90 per cent of the value measured in accordance with paragraph 5.6.2. shall be measured for the extreme levels of luminous intensity produced by the direction indicator. The time measured to obtain the lowest luminous intensity shall not exceed the time measured to obtain the highest luminous intensity.

5.6.8. The variable intensity control shall not generate signals which cause luminous intensities outside the range specified in paragraph 5.6.1. and exceeding the category 2a maximum specified in paragraph 5.6.1.:

(a) For systems depending only on daytime and night time conditions: under night time conditions;

(b) For other systems: under reference conditions as demonstrated by the manufacturer. ⁽²⁾

5.6.9. The colour of the light emitted shall be amber. This requirement shall also apply within the range of variable luminous intensity produced by rear direction indicator lamps of category 2b.

5.6.10. For any direction indicator lamp except those equipped with filament light source(s), the luminous intensities measured after one minute and after 30 minutes of operation in flashing mode ($f = 1,5$ Hz, duty factor 50 per cent), shall comply with the minimum and maximum requirements. The luminous intensity distribution after one minute of operation can be calculated by applying at each test point the ratio of luminous intensity measured in HV after one minute and after 30 minutes of operation as above described.

5.6.11. For direction indicator lamps of categories 1, 1a, 1b, 2a, 2b, 11, 11a, 11b, 11c or 12 the flash may be produced by sequential activation of their light sources if the following conditions are met:

(a) Each light source, after its activation, shall remain lit until the end of the ON cycle;

⁽²⁾ Good visibility (meteorological optical range MOR > 2 000 m defined according to WMO, Guide to Meteorological Instruments and Methods of Observation, Sixth Edition, ISBN: 92-63-16008-2, pp 1.9.1/1.9.11, Geneva 1996) and clean lens.

- (b) The sequence of activation of the light sources shall produce a signal which proceeds in a uniform progressive manner from inboard towards the outboard edge of the light emitting surface;
- (c) It shall be one signal with no interruption and no vertical oscillations (e.g. not more than one change of direction along the vertical axis). The distance between two adjacent/tangential distinct parts of the light emitting surface of the sequential direction indicator shall not exceed 50 mm, when measured perpendicularly to the reference axis, instead of the values defined in paragraph 5.7.2. of UN Regulation No. 48 or paragraph 5.7.2. of UN Regulation No. 86 or paragraph 5.6.2. of UN Regulation No. 53. These interruptions of the signal shall not create any overlap in the vertical axis between the different parts, from inboard towards the outboard of the vehicle, and shall not be used for any other lighting or light signalling functions;
- (d) The variation shall finish no more than 200 ms after the beginning of the ON cycle;
- (e) The orthogonal projection of the light emitting surfaces of the direction indicator in the direction of the axis of reference shall be circumscribed by a rectangle on a plane normal to the axis of reference and having its longer sides parallel to the H-plane. The ratio of the horizontal to the vertical sides shall not be less than 1,7.

Compliance to the conditions mentioned above shall be verified in flashing mode.

5.7. Technical requirements concerning side marker lamps (symbols SM1, SM2)

5.7.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 9.

Table 9

Luminous intensities for side marker lamps

Side marker lamp of category		SM1	SM2
Minimum intensity	In the axis of reference	4,0 cd	0,6 cd
	Within the specified angular field, other than above	0,6 cd	0,6 cd
Maximum intensity	Within the specified angular field	25,0 cd	25,0 cd
Angular field	Horizontal	±45 deg,	±30 deg,
	Vertical	±10 deg,	±10 deg,

In addition, for red side marker lamp, in the angular field from 60° to 90° in horizontal direction and ±20° in vertical direction towards the front of the vehicle, the maximum intensity is limited to 0,25 cd.

5.7.2. Outside the reference axis and within the angular fields defined in the diagrams in Part C of Annex 2, the intensity of the light emitted by each of the two side marker lamps supplied shall:

- (a) In each direction corresponding to the points in the light distribution table reproduced in paragraph 2.7. of Annex 3, be not less than the product of the minimum specified in paragraph 5.7.1. by the percentage specified in the said table for the direction in question;
- (b) In no direction within the space from which the side marker lamp is visible, exceed the maximum specified in paragraph 5.7.1.

5.7.3. For SM1 and SM2 categories of side marker lamps it may be sufficient to check only five points selected by the Type Approval Authority.

5.7.4. The colour of the light emitted shall be amber. However, it can be red, if the rearmost side marker lamp is grouped or combined or reciprocally incorporated with the rear position lamp, the rear end-outline marker lamp, the rear fog lamp, the stop lamp, or is grouped with or has part of the light emitting surface in common with the rear retro-reflector.

5.8. Technical requirements concerning reversing lamps (symbols AR)

5.8.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 10.

Table 10

Luminous intensities for reversing lamps

	Minimum luminous intensity in H-V (values in cd)	Maximum luminous intensity in any direction (values in cd)		
		in or above the h plane	below the h plane, down to 5°D	below 5°D
Reversing lamps	80	300	600	8 000

5.8.2. In every other direction of measurement shown in paragraph 2.5. of Annex 3, the luminous intensity shall be not less than the minima specified in that annex.

However, in the case where the reversing lamp is intended to be installed on a vehicle exclusively in a pair of devices, the photometric intensity may be verified only up to an angle of 30° inwards where a photometric value of at least 25 cd shall be satisfied.

This condition shall be clearly explained in the application for approval and relating documents (see paragraph 3.1.).

Moreover, in the case where the type approval will be granted applying the condition above, a statement in paragraph 9.1.3. of the communication form (see Annex 1) will inform that the device shall only be installed in a pair.

5.8.3 The colour of the light emitted shall be white.

5.9 Technical requirements concerning rear fog lamps (symbols F1, F2)

5.9.1. The light emitted by each of the two lamps supplied shall meet the requirements in Table 11.

Table 11

Luminous intensities for rear fog lamps

Rear fog lamps of category	Minimum luminous intensity along the axis HH and VV (values in cd)	Maximum luminous intensity in any direction (values in cd)
F1 (steady)	150	300
F2 (variable)	150	840

5.9.2. The minimum light intensity at all other points of standard light distribution is defined in paragraph 2.6. of Annex 3

5.9.3. The variable intensity control shall not generate signals which cause luminous intensities outside the range specified in paragraph 5.9.1. and exceeding the category F1 maximum specified in paragraph 5.9.1.:

- (a) For systems depending only on daytime and night time conditions: under night time conditions;
- (b) For other systems: under standard conditions ⁽³⁾

5.9.4. The apparent surface in the direction of the reference axis shall not exceed 140 cm².

5.9.5. The colour of the light emitted shall be red.

5.9.6. The rear fog lamp shall be subjected to the test specified in Annex 6.

5.10. Technical requirements concerning manoeuvring lamps (symbols ML)

5.10.1. The intensity of light emitted shall not exceed 500 cd in all directions in which the light can be observed, when installed in any mounting position specified by the applicant.

5.10.2. The lamp must be so designed that the light emitted directly towards the side, the front or the rear of the vehicle does not exceed 0,5 cd within the angular field as defined below.

- (a) The vertical minimum angle $\varphi_{\min}$ (in degrees) is:

$$\varphi_{\min} = \arctan (1 - \text{mounting height})/10; \text{ where } h \text{ is mounting height in m}$$

- (b) The vertical maximum angle $\varphi_{\max}$ (in degrees) is:

$$\varphi_{\max} = \varphi_{\min} + 11,3$$

The measurement shall be limited to a horizontal angle ranging from +90° to -90° with respect to the line which cuts the reference axis and which is perpendicular to the vertical longitudinal plane of the vehicle.

The measurement distance shall be 3,0 m minimum.

5.10.3. The colour of the light emitted shall be white.

5.11. Technical requirements concerning rear-registration plate illuminating lamps (symbol L, LM1)

5.11.1. The devices for the illumination of rear-registration plates of categories 1a, 1b, 1c, 2a and 2b shall be so constructed that the whole surface of the plate will be visible within the angles given in Part D of Annex 2.

5.11.2. Measuring procedure

The luminance measurements shall be made on a diffuse colourless surface with known diffuse reflection factor ⁽⁴⁾. The diffuse colourless surface shall have the dimensions of the registration plate or the dimension exceeding one measuring point. Its centre shall be placed in the centre of the positions of the measuring points.

This (These) diffuse colourless surface(s) shall be placed in the position normally occupied by the registration plate and 2 mm in front of its holder.

Luminance measurements shall be made perpendicularly to the surface of the diffuse colourless surface with the tolerance of 5° in each direction at the points shown in paragraph 3. of Annex 3, each point representing a circular area of 25 mm in diameter. The measured luminance shall be corrected for the diffuse reflection factor 1,0.

⁽³⁾ Good visibility (meteorological optical range MOR > 2 000 m defined according to WMO, Guide to Meteorological Instruments and Methods of Observation, Sixth Edition, ISBN: 92-63-16008-2, pp 1.9.1/1.9.11, Geneva 1996) and clean lens.

⁽⁴⁾ CIE Publication No.17 –1970, paragraph 45-20-040.

5.11.3. Photometric characteristics

At each of the points of measurement shown in paragraph 3. of Annex 3, the luminance B shall be at least

- (a) For categories 1a, 1b, 1c, 2a and 2b equal to 2,5 cd/m²;
- (b) For categories 1 and 2 equal to 2,0 cd/m².

The gradient of the luminance between the values B₁ and B₂, measured at any two points 1 and 2 selected from among those mentioned above, shall not exceed 2 x B₀/cm, B₀ being the minimum luminance measured at the various points, i.e.:

$$\frac{B_2 - B_1}{\text{distance 1 - 2 in cm}} \leq 2 \times B_0/\text{cm}$$

5.11.4. The colour of the light emitted shall be sufficiently colourless not to cause any appreciable change in the colour of the registration plate.

5.11.5. Incidence of the light

The manufacturer of the illuminating device shall specify one or more or a field of positions in which the device is to be fitted in relation to the space for the registration plate; when the lamp is placed in the position(s) specified by the manufacturer the angle of incidence of the light on the surface of the plate does not exceed 82° at any point on the surface to be illuminated, this angle being measured from the extremity of the device's illuminating area which is furthest from the surface of the plate. If there is more than one illuminating device, the foregoing requirement shall apply only to that part of the plate intended to be illuminated by the device concerned.

When the device has one outer edge of the illuminating surface that is parallel to the surface of the registration plate, the extremity of the illuminating surface of the device which is furthest from the surface of the plate is the middle point of the edge of the illuminating surface, which is parallel to the plate and is furthest from the surface of the plate.

The device must be so designed that no light is emitted directly towards the rear, with the exception of red light if the device is combined or grouped with a rear lamp.

6. TRANSITIONAL PROVISIONS

6.1 General

6.1.1. Contracting Parties applying this Regulation shall continue to accept UN type-approvals of the lamps (functions), to any of the preceding series of amendments to this Regulation, which are not affected by the changes introduced by the latest series of amendments.

To verify this, the change index applicable to the pertinent lamp (function) shall not differ from its change index as indicated in the latest series of amendments.

6.1.2. Contracting Parties applying this Regulation shall not refuse to grant extensions to UN type-approvals according to any preceding series of amendments to this Regulation.

ANNEX 1

Communication

(Maximum format: A4 (210 x 297 mm))

	issued by:	Name of Administration:	
			
			
			
Concerning: ⁽²⁾		Approval granted Approval extended Approval refused Approval withdrawn Production definitively discontinued	
of a type of lamp pursuant to UN Regulation No. 148			
Lamp: ⁽²⁾		Rear-registration plate illuminating lamp Direction indicator lamp Stop lamp Position lamp End-outline marker lamp Reversing lamp Manoeuvring lamp Rear fog lamp Parking lamp Daytime running lamp Side marker lamp	
Category of the lamp:		Change index:	
Approval No:		Unique Identifier (UI) (If applicable)	

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

⁽²⁾ Strike out what does not apply.

1. Trade name or mark of the lamp:
2. Manufacturer's name for the type of lamp:
3. Manufacturer's name and address:
4. If applicable, name and address of the 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. Concise description:
- 9.1. In case of
- 9.1.1. A rear-registration plate illuminating lamp:
- Geometrical conditions of installation (position(s) and inclination(s) of the device in relation to the space to be occupied by the registration plate and/or different inclinations of this space):.....
- 9.1.2. A direction indicator:
- Sequential activation of light sources: yes/no²
- 9.1.3. A reversing lamp:
- The lamp shall be installed on a vehicle only as part of a pair of lamps: yes/no²
- 9.1.4. A manoeuvring lamp:
- The maximum mounting height:
- 9.1.5. A daytime running lamp
- Maximum luminous intensity does not exceed 700 cd: yes/no
- 9.2. By light signalling function and category:
- For mounting either outside or inside or both²
- Colour of light emitted: red/white/amber/colourless²
- Number, category and kind of light source(s):
- Lamp approved for LED substitute light source(s): yes/no
- If yes, category of LED substitute light source(s):
- Voltage and wattage:
- Light source module: yes/no²
- Light source module specific identification code:
- Only for limited mounting height of equal to or less than 750 mm above the ground, if applicable: yes/no
- Geometrical conditions of installation and relating variations, if any:
- Application of an electronic light source control gear/variable intensity control:
- (a) Being part of the lamp: yes/no²
- (b) Being not part of the lamp: yes/no²
- Input voltage(s) supplied by an electronic light source control gear/variable intensity control:
- Electronic light source control gear/variable intensity control manufacturer and identification number (when the light source control gear is part of the lamp but is not included into the lamp body):
- Variable luminous intensity, if applicable: yes/no²
- Function(s) produced by an interdependent lamp forming part of an interdependent lamp system, if applicable:

- 9.3. The front position lamp², rear position lamp², stop lamp², end-outline marker lamp², daytime running lamp² is only for use on a vehicle fitted with a tell-tale indicating failure: yes/no²
- 10. Position of the approval mark:
- 11. Reason(s) for extension (if applicable):
- 12. Approval granted/extended/refused/withdrawn²:
- 13. Approval granted for devices to be used on vehicles already in use only, yes/no ²
- 14. Place:
- 15. Date:
- 16. Signature:
- 17. The list of documents deposited with the Type Approval Authority which has granted approval is annexed to this communication and may be obtained on request.
.....
.....
.....
.....
.....

ANNEX 2

Light distribution in space, horizontal and vertical

The angles shown in these arrangements are correct for lamps to be mounted on the right side of the vehicle.

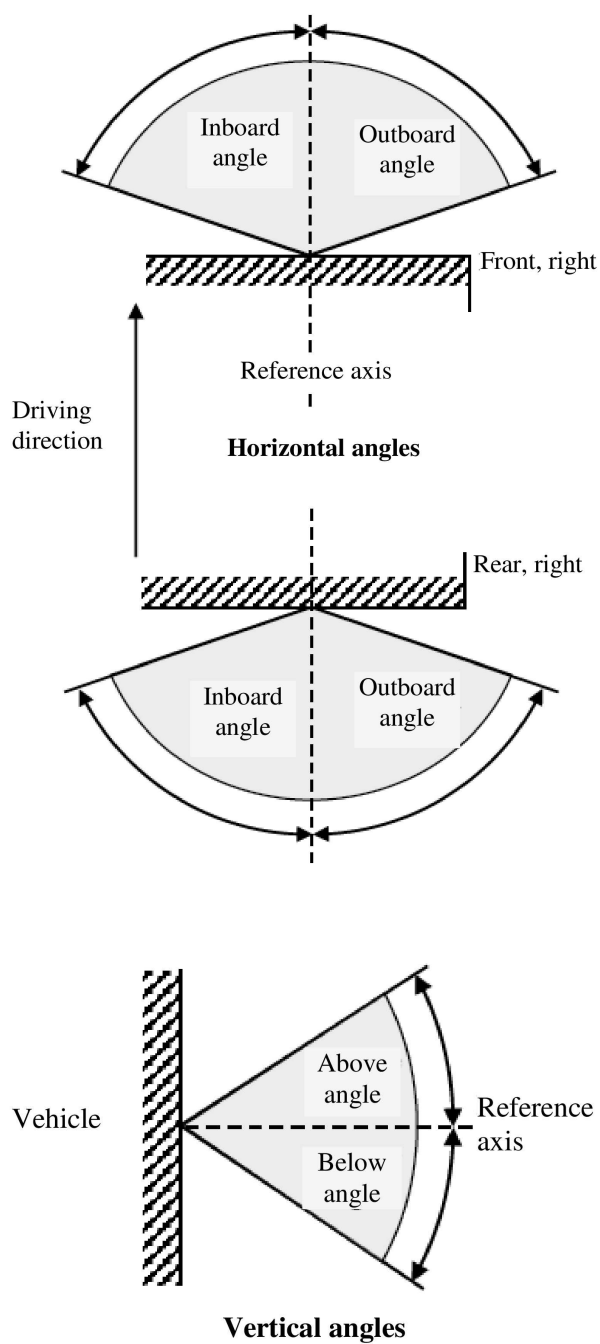
*Part A***Position, end-outline marker, stop, front and rear direction indicators, daytime running and front and rear parking lamps***Figures A2-I***Light-distribution in space, horizontal and vertical**

Table A2-1

Light-distribution in space, horizontal and vertical

Lamp	Minimum horizontal angles (inboard / outboard)	Minimum vertical angles (above / below)	Additional information
Front direction indicator (1, 1a, 1b)	45° / 80° 20° / 80° ⁽¹⁾	15° / 15° 15° / 5° ⁽²⁾	-
Rear direction indicator (2a, 2b)	45° / 80° 20° / 80° ⁽¹⁾	15° / 15° 15° / 5° ⁽²⁾ 5° / 15° ⁽³⁾	-
Front direction indicator (11, 11a, 11b, 11c)	20° / 80°	15° / 15° 15° / 5° ⁽²⁾	-
Front position singular (MA)	80° / 80°	15° / 10°	-
Rear position singular (MR)		15° / 5° ⁽²⁾	-
Front position pair (MA)	20° / 80°	15° / 10° 15° / 5° ⁽²⁾	-
Rear position pair (MR)	20° / 80°	15° / 10° 15° / 5° ⁽²⁾	-
Stop singular (MS)	45° / 45°	15° / 10° 15° / 5° ⁽²⁾	-
Stop pair (MS)	0°/45°	15° / 10° 15° / 5° ⁽²⁾	-
Front position (A)	45° / 80°	15° / 15°	-
Rear position (R, R1, R2)	20° / 80° ⁽¹⁾	15° / 5° ⁽²⁾ 5° / 15° ⁽³⁾	-
Front parking (77R)	0° / 45°	15° / 15°	-
Rear parking (77R)		15° / 5° ⁽²⁾	-
Front end-outline marker (AM)	0° / 80°	15° / 15° 15° / 5° ⁽²⁾	-
Rear end-outline marker (RM1, RM2)		5° / 15° ⁽³⁾	-
Stop lamp (S1, S2)	45° / 45° 20° / 45° ⁽¹⁾	15° / 15° 15° / 5° ⁽²⁾ 5° / 15° ⁽³⁾	-
High mounted stop lamp (S3, S4)	10° / 10°	10° / 5°	-
Daytime running lamps (RL)	20° / 20°	10° / 5°	-

⁽¹⁾ Reduced angles used only below the H-plane for lamps mounted with the H-plane below 750 mm.

⁽²⁾ For lamps to be installed with the H-plane of the lamp at a mounting height of less than 750 mm.

⁽³⁾ Optional lamps to be installed with the H-plane of the lamp at a mounting height of more than 2 100 mm.

Part B

Side direction indicators and side parking lamps ⁽¹⁾

Figures A2-II

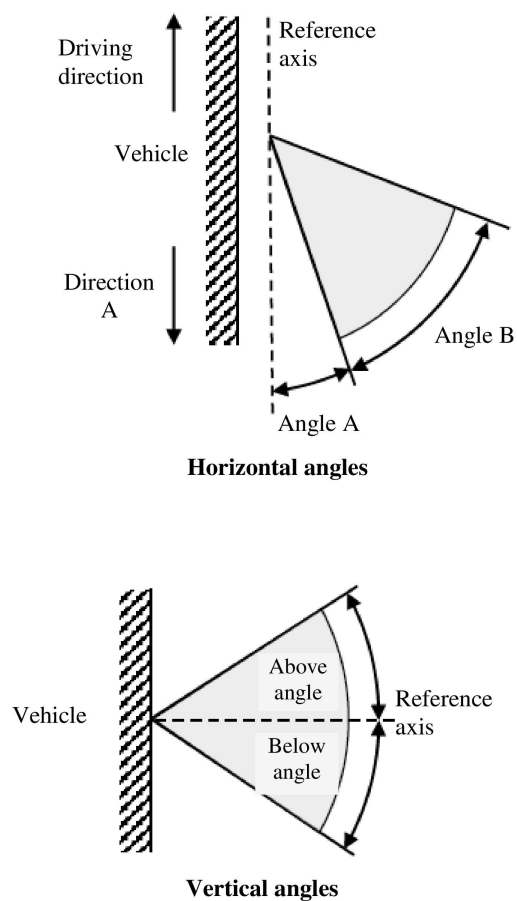
Light-distribution in space, horizontal and vertical

Table A2-2

Light-distribution in space, horizontal and vertical

Lamp	Horizontal angles (A/B)	Min. vertical angles (above/below)	Additional information
Side direction indicators (5)	5° / 55°	15° / 15° 15° / 5° ²	Horizontal angles apply to direction A
Side direction indicators (6)	5° / 55°	30° / 5°	
Side parking ⁴	0° / 45°	15° / 15° 15° / 5° ²	Horizontal angles apply to front and rear

⁽¹⁾ Side parking lamps are a combination of front and rear facing parking lamps.

Part C

Side marker lamps

Figures A2-III

Light-distribution in space, horizontal and vertical

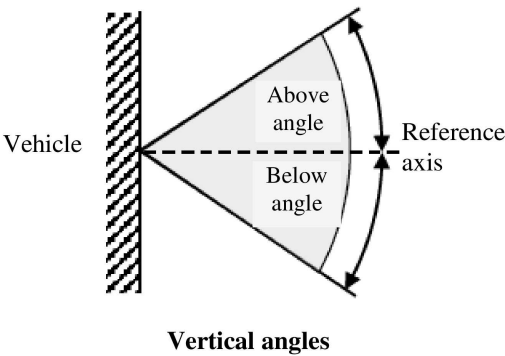
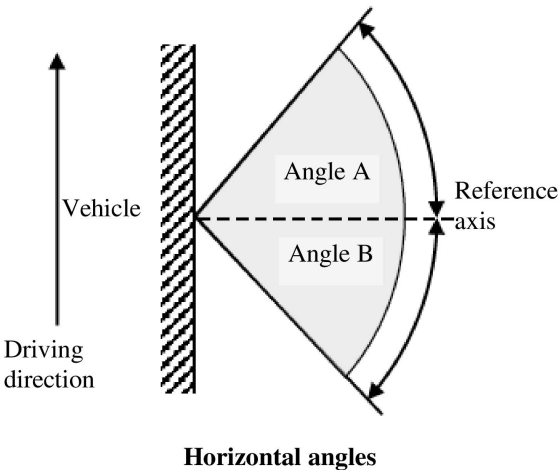


Table A2-3

Light-distribution in space, horizontal and vertical

Lamp	Min. horizontal angles (A/B)	Min. vertical angles (above/below)	Additional information
Side marker (SM1)	45° / 45°	10° / 10° 10° / 5° ²	
Side marker (SM2)	30° / 30°	10° / 10° 10° / 5° ²	

Part D

Rear-registration plate illuminating lamp, field of visibility

Figures A2-IV

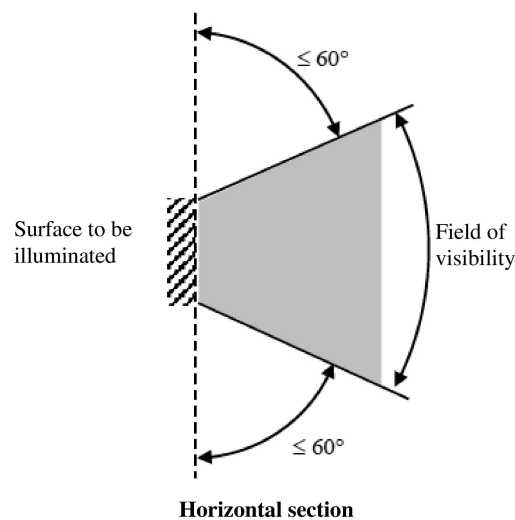
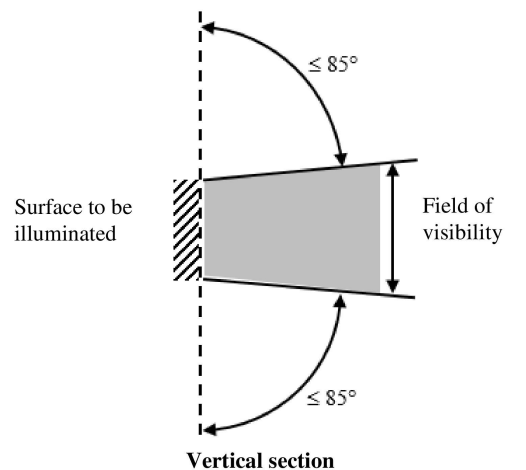
Light-distribution in space, horizontal and vertical

Table A2-4

Light-distribution in space, horizontal and vertical

1. The field-of-visibility angles shown above relate only to the relative positions of the illuminating device and the space for the registration plate.
2. The field of visibility of the registration plate when mounted on the vehicle remains subject to the relevant national regulations.
3. The angles shown take account of the partial occultation caused by the illuminating device. They must be adhered to in the directions in which there is most occultation. The illuminating devices must be such as to reduce the areas partly occulted to the minimum strictly necessary.

ANNEX 3

Standard light distributions

1. If not otherwise specified:

1.1. The direction $H = 0^\circ$ and $V = 0^\circ$ corresponds to the reference axis. (On the vehicle, it is horizontal, parallel to the median longitudinal plane of the vehicle and oriented in the required direction of visibility.) It passes through the centre of reference. Unless specified otherwise, the values shown in Figures A3-I to A3-XV give, for the various directions of measurement, the minimum intensities as a percentage of the minimum intensities required.

1.2. Within the field of light distribution schematically shown as a grid, the light pattern should be substantially uniform, i.e. the light intensity in each direction of a part of the field formed by the grid lines shall meet at least the lowest minimum value being shown on the grid lines surrounding the questioned direction as a percentage.

However, in the case of reversing lamps, if visual examination of a lamp appears to reveal substantial local variations of intensity, a check shall be made to ensure that no intensity measured between two of the directions of measurement referred to above is below 50 per cent of the lower minimum intensity of the two prescribed for these directions of measurement.

1.3. However, in the case where one of the following lamps is intended to be installed at a mounting height (using the H plane specified by the manufacturer) equal to or less than 750 mm above the ground, the photometric intensity is verified only up to an angle of 5° downwards:

- (a) Front and rear direction indicators lamps;
- (b) Front and rear position lamps;
- (c) Front and rear end-outline marker lamps;
- (d) Parking lamps;
- (e) Stop lamps of category S1, S2 and MS;
- (f) Side marker lamps;

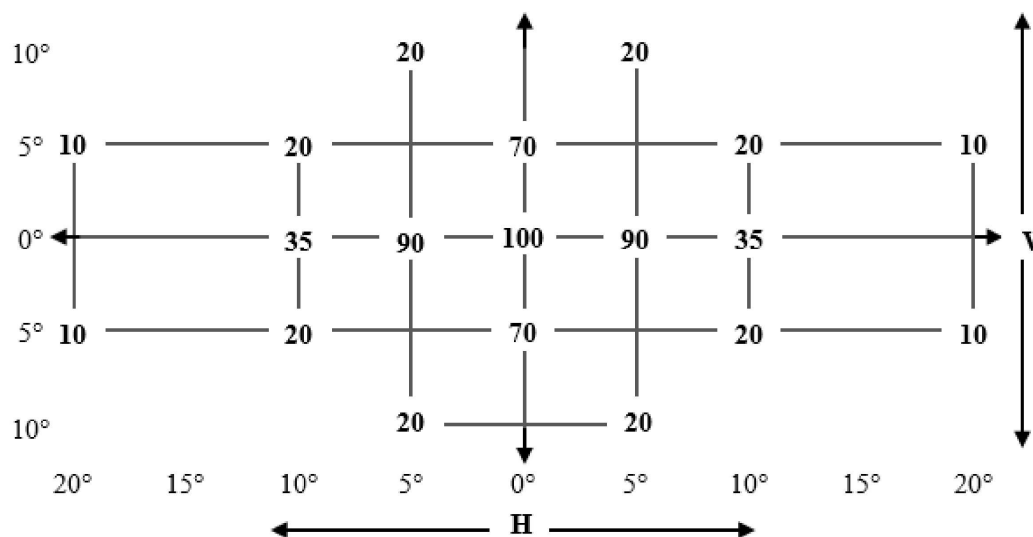
2. Standard light distribution.

2.1. Standard light distribution for front and rear position lamps, parking lamps, front and rear end-outline marker lamps, stop lamps (S1, S2 and MS) and direction indicator lamps of categories 1, 1a, 1b, 2a, 2b, 11, 11a, 11b, 11c, 12.

The values shown give, for the various directions of measurement, the minimum intensities as a percentage of the minimum intensities required (see Tables 3, 4, 5, 7 and 8).

Figure A3-I

Standard light distribution for front and rear position-, parking-, end-outline marker-, stop- and direction indicator lamps

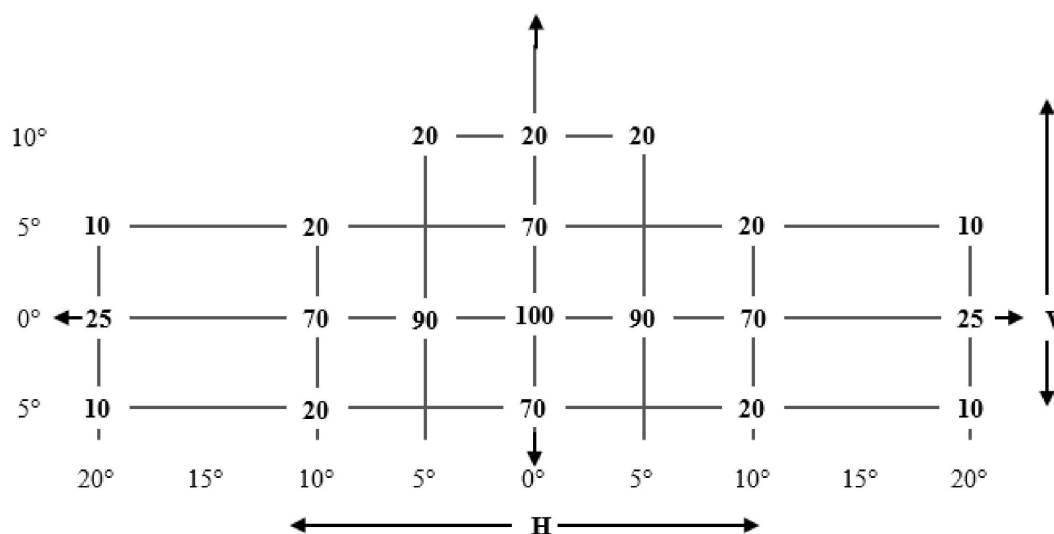


2.2. Standard light distribution for daytime running lamps

The values shown give, for the various directions of measurement, the minimum intensities as a percentage of the minimum intensity required (see Table 6).

Figure A3-II

Light distribution for daytime running lamps

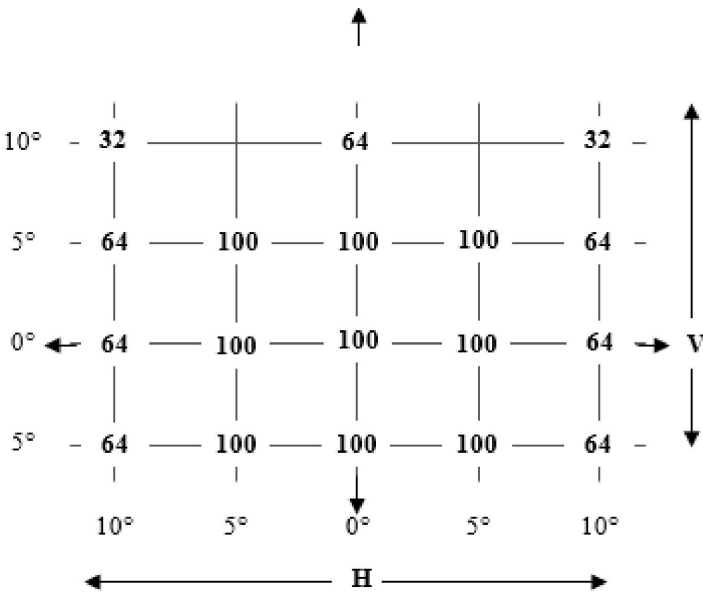


2.3. Standard light distribution for category S3 and S4 stop lamps

The values shown give, for the various directions of measurement, the minimum intensities as a percentage of the minimum intensities required (see Table 7).

Figure A3-III

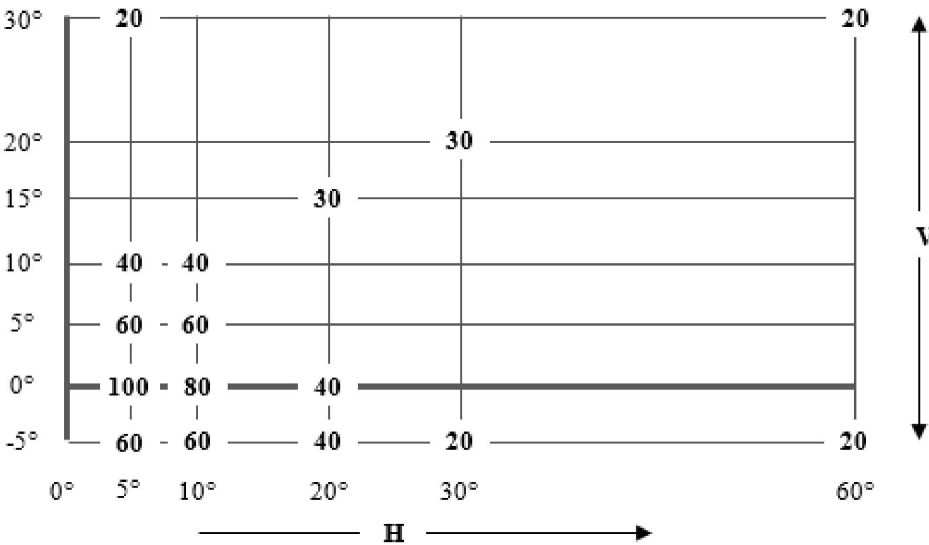
Light distribution for S3 and S4 stop lamps



- 2.4. Standard light distribution for direction indicators lamps of category 6
- The reference axis, $H = 5^\circ$ and $V = 0^\circ$, corresponds to the direction A as prescribed in Annex 2.
- The values shown give, for the various directions of measurement, the minimum intensities as a percentage of the minimum intensity required (see Table 8).

Figure A3-IV

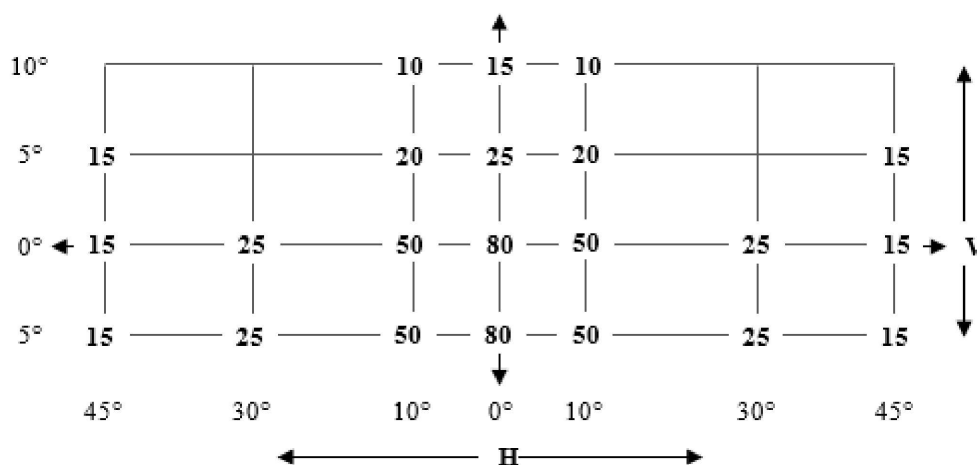
Light distribution for direction indicator lamps category 6



(outer side of the vehicle)

- 2.5. Standard light distribution for reversing lamps
- The measuring points expressed in degrees of angle with the axis of reference and values of the minimum intensities of the light emitted.

Figure A3-V

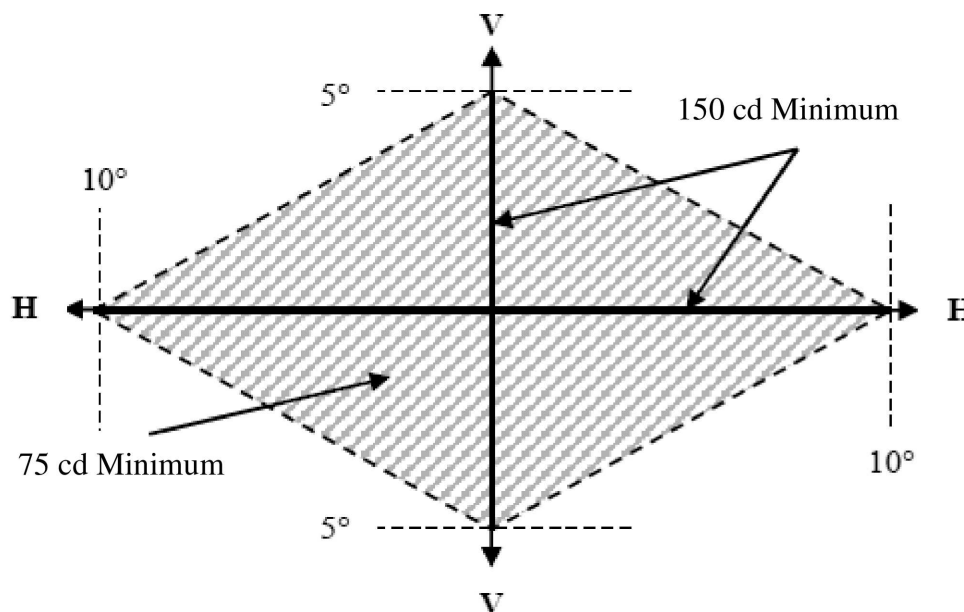
Light distribution for reversing lamps

The values inside figure A3-V are in cd.

The directions $H = 0^\circ$ and $V = 0^\circ$ correspond to the axis of reference. On the vehicle they are horizontal, parallel to the median longitudinal plane of the vehicle and oriented in the required direction of visibility. They pass through the centre of reference. The values shown in figure A3-V give, for the various directions of measurement, the minimum intensities in cd.

2.6. Standard light distribution for rear fog lamps

Figure A3-VI

Light distribution for rear fog lamps

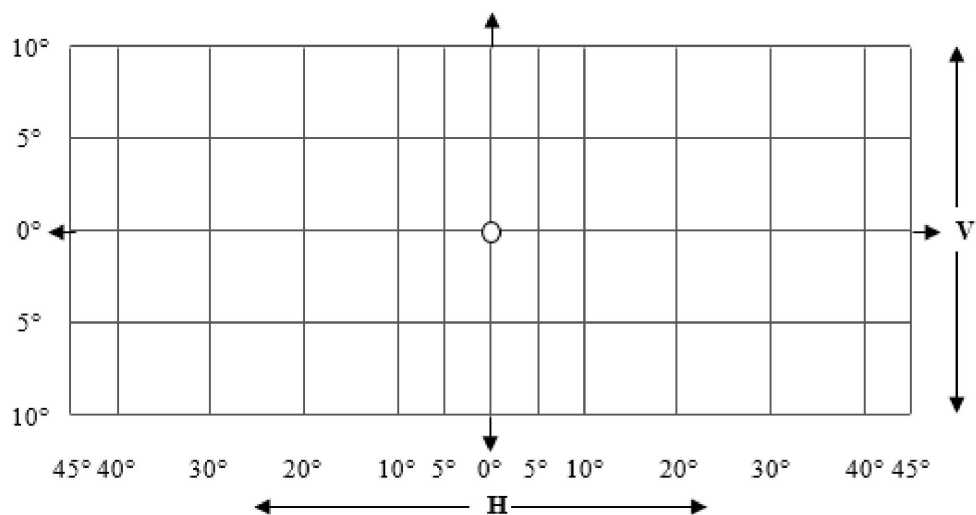
If visual examination of a light appears to reveal substantial local variations of intensity, a check shall be made to ensure that, outside the axes, no intensity measured within the rhombus defined by the extreme directions of measurement is below 75 cd (see figure above).

2.7. Standard light distribution for side marker lamps

2.7.1. SM1 category of side marker lamps

Figure A3-VII

Light distribution for side marker lamps SM1



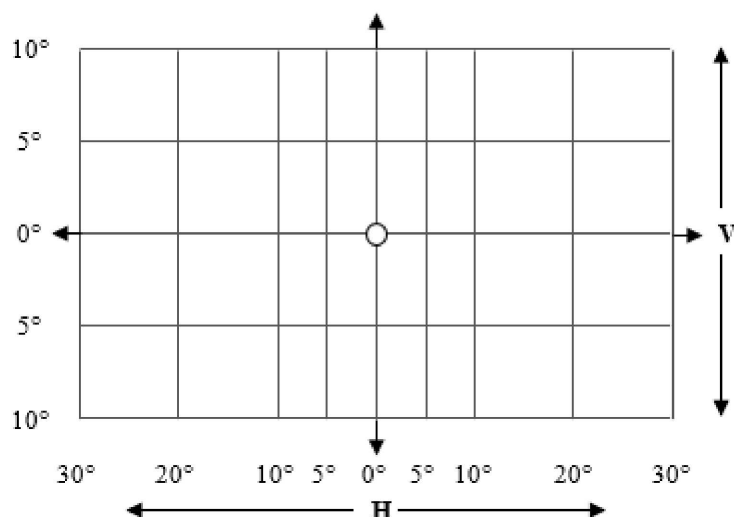
Minimum values: 0,6 cd at any point other than the reference axis, at which it shall be 4,0 cd

Maximum values: 25,0 cd at any point

2.7.2. SM2 category of side marker lamps

Figure A3-VIII

Light distribution for side marker lamps SM2



Minimum values: 0,6 cd at any point

Maximum values: 25,0 cd at any point

2.7.3. SM1 and SM2 category of side marker lamps

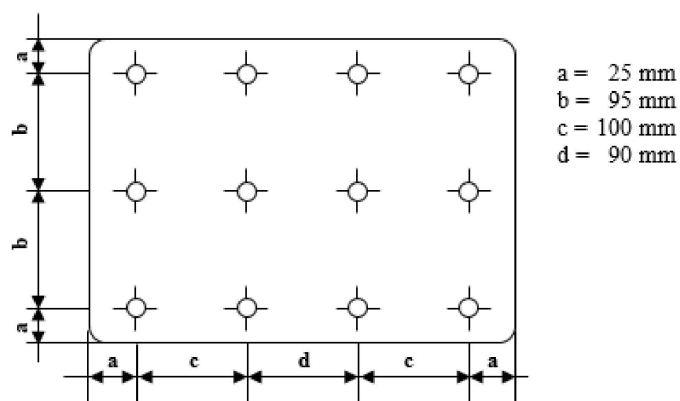
For SM1 and SM2 category of side marker lamps it may be sufficient to check only five points selected by the Type Approval Authority.

3. Measurement points for rear-registration plate illuminating lamps (see paragraph 5.11.3.)

3.1. Category 1a - tall plate (340 x 240 mm)

Figure A3-IX

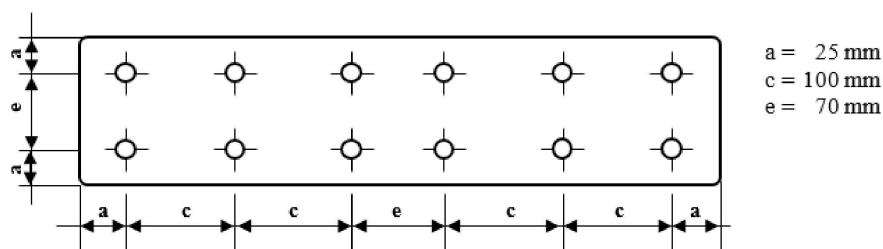
Measuring points for plate size 340 x 240 mm



3.2. Category 1b - wide plate (520 x 120 mm)

Figure A3-X

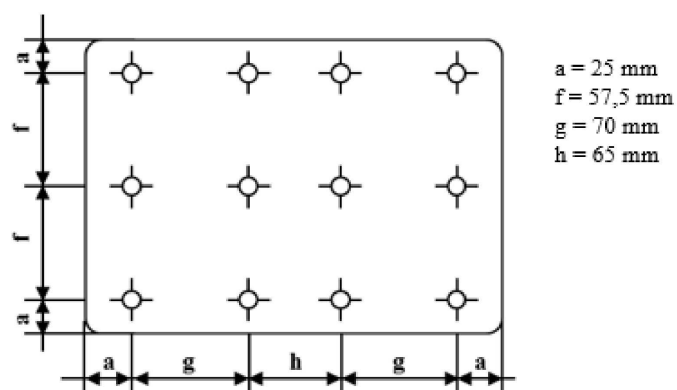
Measuring points for plate size 520 x 120 mm



3.3. Category 1c - plate for agricultural or forestry tractors (255 x 165 mm)

Figure A3-XI

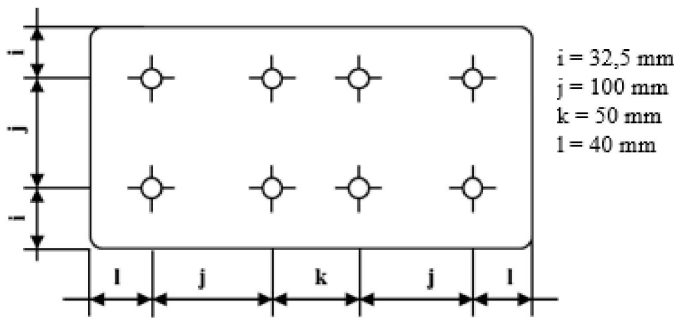
Measuring points for plate size 255 x 165 mm



3.4. Category 2a – small plate (330 x 165 mm)

Figure A3-XII

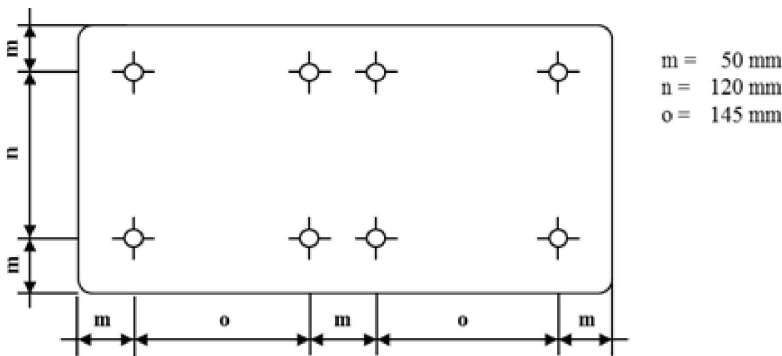
Measuring points for plate size 330 x 165 mm



3.5. Category 2b – wide plate (440 x 220 mm)

Figure A3-XIII

Measuring points for plate size 440 x 220 mm

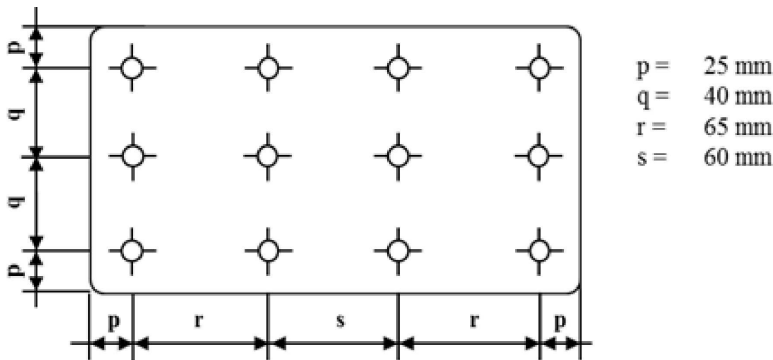


Note: In the case of devices for illuminating two or all of the plates, the measurement points used are obtained by combining the corresponding drawings above in accordance with the outline indicated by the maker or manufacturer; however, if two measurement points are less than 30 mm apart, only one shall be used.

3.6. Category 1 (240 x 130 mm) for vehicles of category L

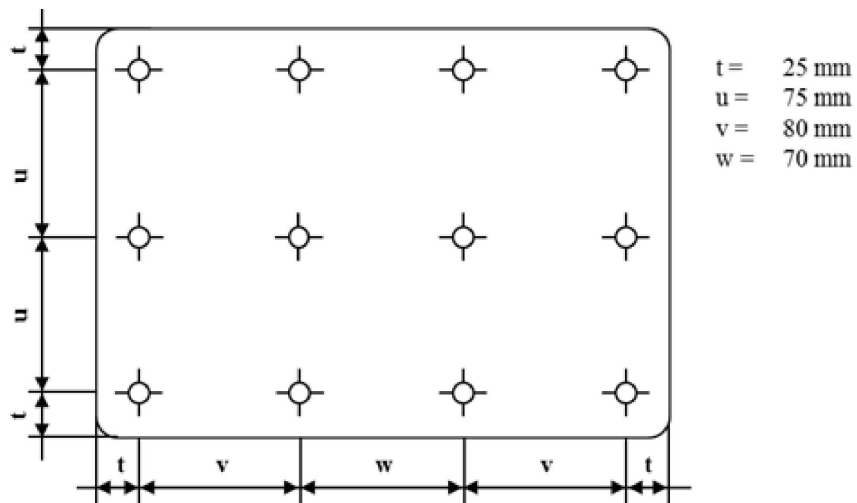
Figure A3-XIV

Measuring points for plate size 240 x 130 mm



3.7. Category 2 (280 x 200 mm) for vehicles of category L

Figure A3-XV

Measuring points for plate size 280 x 200 mm

ANNEX 4

Minimum requirements for conformity of production control procedures

1. GENERAL

1.1. The conformity requirements shall be considered satisfied from a mechanical and geometric standpoint, if the differences do not exceed inevitable manufacturing deviations within the requirements of this Regulation.

1.2. With respect to photometric performances, the conformity of mass-produced lamps shall not be contested if, when testing photometric performances of any lamp chosen at random according to paragraph 4.7. of this Regulation.

1.2.1. No measured value deviates unfavourably by more than 20 per cent from the values prescribed in this Regulation. For the minimum values required throughout the fields specified in Annexes 2 and 3 the respective maximum deviations of the measured values shall correspond to the values shown in Table A4-1:

Table A4-1

20 and 30 per cent values for CoP

Required minimum value	Equivalent 20 per cent	Equivalent 30 per cent
cd	cd	cd
0,7	0,5	0,3
0,6	0,4	0,2
0,3	0,2	0,1
0,07	0,05	0,03
0,05	0,03	0,02

1.2.1.1. For rear-registration plate illuminating lamps:

With respect to the gradient of luminance the unfavourable deviation shall be:

Table A4-2

20 and 30 per cent values for CoP, Rear-registration plate illuminating lamps

Unfavourable deviation		
2,5 x Bo/cm	comparable to	20 per cent
3,0 x Bo/cm	comparable to	30 per cent

1.2.2. If, in the case of a lamp equipped with a replaceable light source and if results of the test described above do not meet the requirements, tests on lamps shall be repeated using another standard light source.

1.3. The chromaticity coordinates shall be complied with when tested under conditions of paragraph 4.7. of this Regulation.

1.4. In the case of non-replaceable filament light source(s) or light source module(s) equipped with non-replaceable filament light source, at any conformity of production check:

1.4.1. the holder of the type approval shall demonstrate the use in normal production and show the identification of the non-replaceable filament light source(s) as indicated in the type approval documentation;

- 1.4.2. in the case where doubt exists in respect to compliance of the non-replaceable filament light source(s) with lifetime requirements and/or, in the case of colour coated filament light sources, with colour endurance requirements, as specified in paragraph 4.11 of IEC 60809, Edition 3, conformity shall be checked as specified in paragraph 4.11 of IEC 60809, Edition 3.
2. MINIMUM REQUIREMENTS FOR VERIFICATION OF CONFORMITY BY THE MANUFACTURER
- For each type of lamp, the holder of the type approval shall carry out at least the following tests, at appropriate intervals. The tests shall be carried out in accordance with the provisions 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 and colorimetric characteristics.
- 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 measurements made by a competent authority.
- 2.2.4. In all cases the reference methods shall be those of this Regulation, particularly for the purpose of administrative verification and sampling.
- 2.3. Nature of sampling
- Samples of lamps shall be selected at random from the production of a uniform batch. A uniform batch means a set of lamps 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 and colorimetric characteristics
- The sampled lamp shall be subjected to photometric measurements for the minimum values at the points listed in Annex 3. and the required chromaticity coordinates.
- 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 the acceptability of his products in order to meet the requirements laid down for verification of conformity of products in paragraph 3.5.1. of this Regulation.
- The criteria governing the 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 5 would be 0,95.
-

ANNEX 5

Minimum requirements for sampling by an inspector

1. GENERAL PROVISIONS

- 1.1. The conformity requirements shall be considered satisfied from a mechanical and a geometric standpoint, in accordance with the requirements of this Regulation, if any, if the differences do not exceed inevitable manufacturing deviations.
- 1.2. With respect to photometric performance, the conformity of mass-produced lamps shall not be contested if, when testing the photometric performances set forth in paragraph 4.7. of this Regulation of any lamp chosen at random:
 - (a) No measured value deviates from the values prescribed in paragraph 1.2.1. in Annex 4.
 - (b) If, in the case of a lamp equipped with a replaceable light source and if results of the test described above do not meet the requirements, tests on lamps shall be repeated using another standard light source.
- 1.3. Lamps with apparent defects are disregarded.
- 1.4. The chromaticity coordinates shall be complied when tested under conditions of paragraph 4.7. of this Regulation.

2. FIRST SAMPLING

Four lamps are selected at random. The first sample of two is marked A, the second sample of two is marked B.

- 2.1. The conformity of mass-produced lamps shall not be contested if the deviation of any specimen of samples A and B (all four lamps) is not more than 20 per cent.

In the case, that the deviation of both lamps of sample A is not more than 0 per cent the measurement can be terminated.
- 2.2. The conformity of mass-produced lamps shall be contested if the deviation of at least one specimen of samples A or B is more than 20 per cent.

The manufacturer shall be requested to bring its production in line with the requirements (alignment) and a repeated sampling according to paragraph 3 shall be carried out within two months' time after the notification. The samples A and B shall be retained by the Technical Service until the entire CoP process is finished.

3. FIRST REPEATED SAMPLING

A sample of four lamps is selected at random from stock manufactured after alignment. The first sample of two is marked C, the second sample of two is marked D.

- 3.1. The conformity of mass-produced lamps shall not be contested if the deviation of any specimen of samples C and D (all four lamps) is not more than 20 per cent.

In the case, that the deviation of both lamps of sample C is not more than 0 per cent the measurement can be terminated.
- 3.2. The conformity of mass-produced lamps shall be contested if the deviation of at least one specimen of samples C or D is:
 - 3.2.1. More than 20 per cent but the deviation of all specimens of these samples is not more than 30 per cent.

The manufacturer shall be requested again to bring its production in line with the requirements (alignment).

A second repeated sampling according to paragraph 4 shall be carried out within two months' time after the notification. The samples C and D shall be retained by the Technical Service until the entire COP process is finished.

3.2.2. One specimen of samples C or D is more than 30 per cent. In this case the approval shall be withdrawn and paragraph 5 shall be applied.

4. SECOND REPEATED SAMPLING

A sample of four lamps is selected at random from stock manufactured after alignment. The first sample of two is marked E, the second sample of two is marked F.

4.1. The conformity of mass-produced lamps shall not be contested if the deviation of any specimen of samples E and F (all four lamps) is not more than 20 per cent. In the case, that the deviation of both lamps of sample E is not more than 0 per cent the measurement can be terminated.

4.2. The conformity of mass-produced lamps shall be contested if the deviation of at least one specimen of samples E or F is more than 20 per cent. In this case the approval shall be withdrawn and paragraph 5 shall be applied.

5. APPROVAL WITHDRAWN

As required according to paragraphs 4.1. and 4.2., approval shall be withdrawn according to paragraph 3.6. of this Regulation.

ANNEX 6

Heat resistance test for rear fog lamps and daytime running lamps

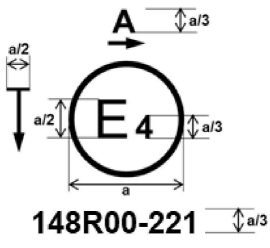
1. The lamp shall be subjected to a one-hour test of continuous operation following a warm-up period of 20 minutes. The ambient temperature shall be $23\text{ °C} \pm 5\text{ °C}$. The light source used shall be a light source of the category specified for the lamp, and shall be supplied with a current at a voltage such that it gives the specified average power at the corresponding test voltage. However, for lamps equipped with non-replaceable light sources (filament light sources and other), the test shall be made with the light sources present in the lamp, in accordance with paragraph 5.4.1. of this Regulation.
 2. Where only the maximum power is specified, the test shall be carried out by regulating the voltage to obtain a power equal to 90 per cent of the specified power. The specified average or maximum power referred to above shall in all cases be chosen from the voltage range of 6, 12 or 24 V at which it reaches the highest value; for lamps equipped with non-replaceable light sources the test conditions set in paragraph 5.9.1. of this Regulation shall be applied.
 - 2.1. In the case of light sources operated by an electronic control gear to obtain variable luminous intensity, the test shall be carried out under the conditions given at minimum 90 per cent of the higher luminous intensity.
 3. After the lamp has been stabilized at the ambient temperature, no distortion, deformation, cracking or colour modification shall be perceptible. In case of doubt the intensity of light shall be measured according to paragraph 5. of this Regulation. At that measurement the values shall reach at least 90 per cent of the values obtained before the heat resistance test on the same lamp.
-

ANNEX 7

Arrangement of approval marks

The following approval mark arrangements are given merely as examples and any other arrangement made in accordance with paragraph 3.3. of this Regulation is acceptable.

1. Approval mark of a single light signalling lamp

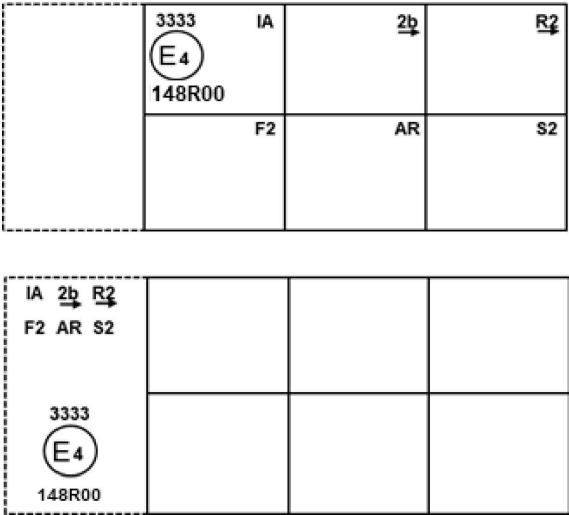
Figure A7-I Marking example 1  148R00-221 a = see para. 3.2.4. of this Regulation	The lamp bearing the approval mark shown on the left is a front position lamp (A) approved in the Netherlands (E4), under approval number 221 pursuant to this Regulation (148R). The number (00) mentioned after 148R indicates that approval was granted in accordance with the requirements of this Regulation as set in the original series of amendments. The horizontal arrow indicates the outwards of the vehicle. The vertical arrow starting from a horizontal segment and directed downwards indicates a lamp with reduced light distribution (vertically downwards and/or horizontally below the H plane).
Figure A7-II Marking example 2 A F3 PL  148R00 3223 149R00	The lamp bearing the approval mark shown on the left is a combination of a front position lamp (A) and a front fog lamp (F3) with a plastic lens (PL) approved in France (E2), under approval number 3223 pursuant to this Regulation (148R) and the UN Regulation for Road Illumination Devices (149R). The number (00) mentioned after 148R and after 149R indicates that approval was granted in accordance with the requirements of the pertinent Regulation as set in the original series of amendments

2. Approval mark of grouped, combined or reciprocally incorporated lamps

Note: The vertical and horizontal lines schematize the shape of the light-signalling lamp. These lines are not part of the approval mark.

Figure A7-III

Marking example 3



These examples of approval marks represent two possible solutions for the marking of a light signalling lamp where two or more lamps are part of the same assembly of grouped, combined or reciprocally incorporated lamps

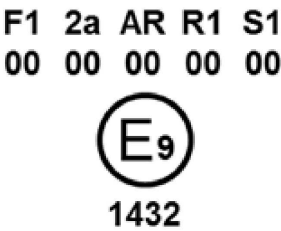
They indicate that the lamp was approved in the Netherlands (E4) under approval number 3333 and comprises:

- (a) A retro-reflector of class 1A;
- (b) A rear direction indicator lamp with variable luminous intensity (category 2b). The horizontal arrow shows in what position this device, which cannot be mounted on either side of the vehicle indiscriminately, is to be mounted;
- (c) A rear position lamp with variable luminous intensity (R2). The horizontal arrow indicates the side on which the required photometric specifications are met up to an angle of 80° H;
- (d) A rear fog lamp with variable luminous intensity (F2);
- (e) A reversing lamp (AR);
- (f) A stop lamp with variable luminous intensity (S2).

All these lamps (functions) are approved in accordance with the original series of amendments to this Regulation (148R) as indicated by the number (00) mentioned after 148R.

3. Approval mark of a lamp where the lens is intended to be used in different types of lamps

Figure A7-IV



This example corresponds to the marking of a lens intended to be used in different types of light signalling lamps. The approval marks indicate that the lamp was approved in Spain (E9) under approval number 1432 and may comprise all listed different functions.

The main body of the lamp shall bear the only valid approval mark.

4. Identification code of light source modules

Figure A7-V

Light source module marking

MD E3 17325

The light source module bearing the identification code shown above has been approved together with a lamp approved in Italy (E3) under approval number 17325.

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>

UN Regulation No 149 – Uniform provisions concerning the approval of road illumination devices (lamps) and systems for power-driven vehicles [2021/1720]

Incorporating all valid text up to:

Supplement 3 to the original version of the Regulation — Date of entry into force: 30 September 2021

This document is meant purely as documentation tool. The authentic and legally binding texts are:

- ECE/TRANS/WP.29/2018/158/Rev.1
- ECE/TRANS/WP.29/2019/82
- ECE/TRANS/WP.29/2019/125
- ECE/TRANS/WP.29/2020/33 and
- ECE/TRANS/WP.29/2021/46

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INTRODUCTION

This Regulation combines the provisions of the individual UN Regulations Nos. 19, 98, 112, 113, 119 and 123 into a single regulation, and is the outcome of the WP.29 decision to simplify the UN lighting and light-signalling regulations based on the initial proposal by the European Union and Japan.

The objective of this Regulation is to increase the clarity, consolidate and streamline the complexity of requirements in UN Regulations Nos. 19, 98, 112, 113, 119 and 123 and prepare for the future transition to performance based requirements, by reducing the number of regulations through an editorial exercise without changing any of the detailed technical requirements already in force up to the date of entry into force of this Regulation.

Although this Regulation departs from the traditional approach of having a separate regulation for each device, by combining all road illumination devices into a single regulation, this simplified regulation contains all provisions and operates according to the existing structure of series of amendments, their transitional provisions and supplements. The transitional provisions associated with a new series of amendments of this Regulation will be identified for each device as applicable, this also includes a list of devices and their applicable change indexes relating to the series of amendments.

It is expected that all Contracting Parties to the 1958 Agreement will adopt this Regulation and shall provide detailed explanation in case they are not in a position to adopt particular devices. These decisions will be registered in ECE/TRANS/WP.29/343 that records the status of the annexed regulations and of the amendments.

Regarding the requirements for approval markings, this Regulation includes the requirements for the use of the "Unique Identifier" and is conditional upon access to the UN secure internet database (in accordance with Schedule 5 of the 1958 Agreement ⁽¹⁾) where all type approval documentation is held. When the "Unique Identifier" is used there is no requirement for the devices to carry the conventional type approval markings (E-mark). If it is technically not possible to use the "Unique Identifier" (e.g. if the access to the UN internet database cannot be secured or the UN secure internet database is not operative) the use of conventional type approval markings is required until the use of the "Unique Identifier" is enabled.

1. SCOPE

This Regulation applies to the following road illumination devices:

Headlamps emitting a driving-beam and/or an asymmetrical passing-beam for vehicles of categories L, M, N and T

Adaptive front-lighting systems (AFS) for vehicles of categories M and N

Headlamps emitting a driving-beam and/or a symmetrical passing-beam for vehicles of categories L and T

Front fog lamps for vehicles of categories L₃, L₄, L₅, L₇, M, N and T

Cornering lamps for vehicles of categories M, N and T

2. DEFINITIONS

For the purpose of this Regulation:

2.1. All the definitions given in the latest series of amendments to UN Regulation No. 48 in force at the time of application for type approval shall apply, unless otherwise specified in this Regulation or in the pertinent installation UN Regulations Nos. 53, 74 and 86.

2.2. "Road illumination devices of different types" means road illumination devices which differ in such essential respects as:

⁽¹⁾ Agreement concerning the Adoption of Harmonized Technical United Nations Regulations 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 United Nations Regulations (E/ECE/TRANS/505/Rev.3)

- 2.2.1. The trade name or mark:
- (a) Lamps bearing the same trade name or mark but produced by different manufacturers shall be considered as being of different types;
 - (b) Lamps produced by the same manufacturer differing only by the trade name or mark shall be considered as being of the same type;
- 2.2.2. The characteristics of the optical system;
- 2.2.3. The inclusion or elimination of components capable of altering the optical effects by reflection, refraction, absorption and/or deformation during operation;
- 2.2.4. Suitability for right-hand or left-hand traffic or for both traffic systems;
- 2.2.5. For headlamps: the kind of beam produced (passing beam, driving beam or both);
- 2.2.6. For AFS: the front-lighting function(s), mode(s) and classes produced;
- 2.2.7. For AFS: the characteristic(s) of the signal(s), specified for the system;
- 2.2.8. The category of light source(s) used and/or the LED module specific identification code(s);
- 2.2.9. 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.
3. ADMINISTRATIVE PROVISIONS
- 3.1. Application for approval
- 3.1.1. The application for type approval shall be submitted by the holder of the trade name or mark or by his duly accredited representative.
- 3.1.2. The application shall be accompanied by the following documents (in triplicate) and sample(s):
- 3.1.2.1. drawings, sufficiently detailed to permit identification of the type and, if applicable, of the class of the lamp, showing:
- (a) Geometrically in what position(s) the lamp(s) and/or the lighting units may be mounted on the vehicle in relation to ground and vehicle longitudinal median plane;
 - (b) The axis of observation to be taken as the axis of reference in the tests (horizontal angle $H = 0^\circ$, vertical angle $V = 0^\circ$) or in the case of lighting units showing each of them in vertical (axial) section and in front elevation, with main details of the optical design including the axis/axes of reference; and the point to be taken as the centre of reference during the tests;
 - (c) The limit of the apparent surface of the function(s);
 - (d) The position and arrangement intended for the approval mark or the "Unique Identifier";
 - (e) In case of LED module(s) also the space reserved for the specific identification code(s) of the module(s);
 - (f) A frontal view, with details of lens ribbing if any, and the cross section and any optical features, of the lens, if applicable;

3.1.3. A brief technical description stating in particular:

- (a) In the case of lamps with replaceable light sources, the category or categories of light source(s) prescribed; this light source category(s) shall be one of those contained in UN Regulations Nos. 37, 99 or 128
- (b) In the case of lamps with replaceable light source modules, the light source module specific identification code;
- (c) The make and type of supply and operating device(s), if any and if not being part of an installation unit;
- (d) If the device (lamp) is equipped with an adjustable reflector, the mounting position(s) of the lamp in relation to the ground and the longitudinal median plane of the vehicle;

3.1.3.1. In the case of a headlamp, it shall specify:

- (a) Whether the headlamp is intended to provide both a passing-beam and a driving-beam or only one of these beams;
- (b) If the headlamp is intended to provide a passing-beam, whether it is designed for both left-hand and right-hand traffic or for either left-hand or right-hand traffic only;
- (c) To which Class the headlamp belongs;
- (d) In the case of LED module(s) this shall include:
 - (i) A brief technical specification of the LED module(s);
 - (ii) A drawing with dimensions and the basic electrical and photometric values and the objective luminous flux and for each LED module a statement whether it is replaceable or not;
 - (iii) In case of electronic light source control gear, information on the electrical interface necessary for approval testing;

3.1.3.2. In the case of an AFS, it shall specify:

- (a) The lighting function(s) and their modes to be provided by the system; ⁽²⁾
- (b) The lighting units contributing to each of them ⁽³⁾ and the signals ⁽⁴⁾ with the technical characteristics relevant to their operation;
- (c) Which categories ⁽³⁾ of the bending mode requirements apply, if any;
- (d) Which additional data set(s) of Class E passing-beam provisions according to Table 14 of paragraph 5.3.2., if any;
- (e) Which set(s) of Class W passing-beam provisions according to paragraph 5.3.2., if any;
- (f) Which lighting units ⁽³⁾ provide or contribute to one or more passing-beam cut-off(s);
- (g) The indication(s) ⁽³⁾ according to the provisions of paragraph 5.3.5.1. with respect to paragraph 6.22. of UN Regulation No. 48;
- (h) Which lighting units are designed to provide the minimum passing-beam illumination according to paragraph 5.3.2.8.1.;
- (i) Mounting and operation requirements for test purposes;
- (j) Any other relevant information;

⁽²⁾ To be indicated in a form conforming to the model of Annex 1.

⁽³⁾ Agreement concerning the Adoption of Harmonized Technical United Nations Regulations 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 United Nations Regulations (E/ECE/TRANS/505/Rev.3)

⁽⁴⁾ To be indicated in a form conforming to the model of Annex 14.

- (k) In the case of LED module(s) this shall include:
 - (i) A brief technical specification of the LED module(s);
 - (ii) A drawing with dimensions and the basic electrical and photometric values and the objective luminous flux and for each LED module a statement whether it is replaceable or not;
 - (iii) In case of electronic light source control gear, information on the electrical interface necessary for approval testing;
 - (l) Any other front-lighting or front light signalling function(s), provided by any lamp(s) being grouped, combined or reciprocally incorporated to the lighting units of the system, for which approval is sought; sufficient information for identification of the respective lamp(s) and indication of the Regulation(s), according to which they are intended to be (separately) approved;
- 3.1.3.3. In the case of adaptation of the driving-beam, which lighting units ⁽ⁱ⁾ provide or contribute to the gradual adaptation of the driving-beam and of the sensor system along with the technical characteristics relevant to their operation.
- 3.1.3.3.1. The safety concept as laid down in the documentation, which, to the satisfaction of the Technical Service responsible for type approval tests:
- (a) Describe the measures designed into the system to ensure compliance with the provisions of paragraphs 4.1.1.2.1. and 5.3.2.5.4.; and
 - (b) Indicates the instructions for their verification according to paragraph 5.3.2.6.; and/or
 - (c) Gives access to the relevant documents demonstrating the system's performance concerning sufficient reliability and safe operation of the measures specified according to paragraph 3.1.3.3.1. a), e.g. FMEA ("Failure Mode and Effect Analysis"), FTA ("Fault Tree Analysis") or any similar process appropriate to system safety considerations.
- 3.1.3.4. If not otherwise specified, two complete samples, 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.
- 3.1.3.5. For all lamps with plastic outer lenses, except for cornering lamps, samples of the plastic material of which the lenses are made (see Annex 8).
- 3.1.3.6. In the case of an AFS System, one set of samples of the system, for which approval is sought, including the mounting devices, supply and operating devices, and signal generators if any;
- 3.1.3.7. In the case of a type of lamp differing only by the trade name or mark from a type that has already been approved it is sufficient that the application is accompanied by:
- 3.1.3.7.1. A declaration by the lamp manufacturer that the type submitted is identical (except in the trade name or mark) with and has been produced by the same manufacturer as the type already approved, the latter being identified by its approval number;
 - 3.1.3.7.2. Two samples bearing the new trade name or mark or equivalent documentation.
- 3.2. Approval
- 3.2.1. If the devices submitted for approval in pursuance of paragraph 3.1. meet the requirements of this Regulation approval shall be granted.

⁽ⁱ⁾ To be indicated in a form conforming to the model of Annex 1.

- 3.2.2. An approval number shall be assigned to each type approved and shall be marked on the device following the requirements of paragraph 3.3. The same Contracting Party shall not assign the same number to another type of device covered by this Regulation.
- 3.2.3. Notice of approval or of extension or refusal or withdrawal of approval of a type of a device pursuant to this Regulation shall be communicated to the Contracting Parties to the 1958 Agreement which apply this Regulation, by means of a form conforming to the model in Annex 1.
- 3.2.4. If approval is sought for an AFS which is not intended to be included as part of the approval of a vehicle type according to UN Regulation No. 48,
- 3.2.4.1. The applicant shall submit sufficient documentation to prove the capability of the system to comply with the provisions of paragraph 6.22. of UN Regulation No. 48 when correctly installed, and
- 3.2.4.2. The system shall be approved according to UN Regulation No. 10.
- 3.2.4.3. The symbols identifying the road illumination function for which type approval has been granted.

Table 1

**List of symbols/combinations (full list is provided in Annex 1
"Communication")**

Lamp (function)	Symbol
Driving beam headlamp of Class A	R
Passing beam headlamp of Class A (asymmetrical)	C
Driving beam headlamp of Class B	HR
Passing beam headlamp of Class B (asymmetrical)	HC
Driving beam headlamp of Class D (GDL)	DR
Passing beam headlamp of Class D (GDL asymmetrical)	DC
Adaptive Front lighting System (AFS): basic passing beam	XC ⁽⁶⁾
Adaptive Front lighting System (AFS): motorway passing beam	XCE ⁽⁷⁾
Adaptive Front lighting System (AFS): town passing beam	XCV ⁽⁶⁾
Adaptive Front lighting System (AFS): adverse weather passing beam	XCW ⁽⁶⁾
Adaptive Front lighting System (AFS): driving beam	XR ⁽⁶⁾
Passing beam headlamp of Class AS (symmetrical)	C-AS
Passing beam headlamp of Class BS (symmetrical)	C-BS
Passing beam headlamp of Class CS (symmetrical)	WC-CS
Passing beam headlamp of Class DS (symmetrical)	WC-DS
Passing beam headlamp of Class ES (GDL symmetrical)	WC-ES
Driving beam headlamp of Class BS	R-BS

⁽⁶⁾ In the case of a single installation unit the symbol "XC" is marked only once.

⁽⁷⁾ In the case of more installation units each providing one or more AFS function(s) each unit is marked with the symbol "X" followed by the identification symbol(s) of the specific AFS function(s) provided.

Lamp (function)	Symbol
Driving beam headlamp of Class CS	WR-CS
Driving beam headlamp of Class DS	WR-DS
Driving beam headlamp of Class ES (GDL)	WR-ES
Front fog lamp Class F3	F3
Cornering lamp	K

The minimum value for “a” in part 1 of Annex 13 shall be at least 5 mm for front fog lamps and cornering lamps and, for all other devices, at least 5 mm in case of with plastic lenses and at least 8 mm in case of glass lenses.

- 3.2.4.4. The applicable change indexes for each device relating to the series of amendments shall be as follows (see also paragraph 6.1.1.):

Table 2

Series of amendments and change index

Series of amendments to the Regulation	00		
Function (Lamp)	Change Index for the specific function (lamp)		
Driving beam headlamp of Class A	0		
Passing beam headlamp of Class A (asymmetrical)	0		
Driving beam headlamp of Class B	0		
Passing beam headlamp of Class B (asymmetrical)	0		
Driving beam headlamp of Class D (GDL)	0		
Passing beam headlamp of Class D (GDL asymmetrical)	0		
Adaptive Front lighting System (AFS): basic passing beam	0		
Adaptive Front lighting System (AFS): motorway passing beam	0		
Adaptive Front lighting System (AFS): town passing beam	0		
Adaptive Front lighting System (AFS): adverse weather passing beam	0		
Adaptive Front lighting System (AFS): driving beam	0		
Passing beam headlamp of Class AS (symmetrical)	0		
Passing beam headlamp of Class BS (symmetrical)	0		
Passing beam headlamp of Class CS (symmetrical)	0		
Passing beam headlamp of Class DS (symmetrical)	0		
Passing beam headlamp of Class ES (GDL symmetrical)	0		
Driving beam headlamp of Class BS	0		
Driving beam headlamp of Class CS	0		
Driving beam headlamp of Class DS	0		
Driving beam headlamp of Class ES (GDL)	0		

Series of amendments to the Regulation	00		
Function (Lamp)	Change Index for the specific function (lamp)		
Front fog lamp Class F3	0		
Cornering lamp	0		

3.3. Approval mark

3.3.1. General provisions

3.3.1.1. Every device belonging to an approved type shall comprise a space of sufficient size for the Unique Identifier (UI) as referred to in the 1958 Agreement and other markings as defined in paragraph 3.3.2.6. or, if technically not possible, the approval marking with the additional symbols and other markings as defined in paragraph 3.3.2. respectively.

3.3.1.2. Examples of the arrangement of the markings are shown in Annex 13.

3.3.1.3. The space for the UI or the approval mark shall be shown in the drawings mentioned in paragraph 3.1.2.

3.3.1.4. The UI or the approval mark with the additional symbols, shall be clearly legible and indelible. It may be placed on an inner or outer part (transparent or not) of the lamp which cannot be separated from the transparent part of the lamp emitting the light. In any case the marking shall be visible when the lamp is fitted on the vehicle or when a movable part such as the hood or boot lid or a door is opened.

3.3.1.5. In the case of grouped, combined or reciprocally incorporated lamps a single UI or approval mark may be applied, provided that all the grouped, combined or reciprocally incorporated lamps satisfy the pertinent Regulation and that the following requirements are also fulfilled:

- (a) Requirements of paragraph 3.3.2. apply;
- (b) 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;
- (c) The symbols for each lamp, appropriate to each Regulation under which approval has been granted, shall be marked:
 - (i) Either on the appropriate light-emitting surface;
 - (ii) Or in a group, in such a way that each lamp of the grouped, combined or reciprocally incorporated lamps may be clearly identified;
- (d) 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 pertinent Regulation.

3.3.1.6. In the case of different types of lamps complying with the requirements of several Regulations, which use the same outer lens having the same or different colour, a single approval mark may be used provided that:

- (a) The symbols for each lamp, appropriate to each Regulation under which approval has been granted, are marked in conformity to paragraph 3.3.2.;
- (b) The main body of the lamp shall bear the approval mark of the actual function(s);
- (c) 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 pertinent Regulation.

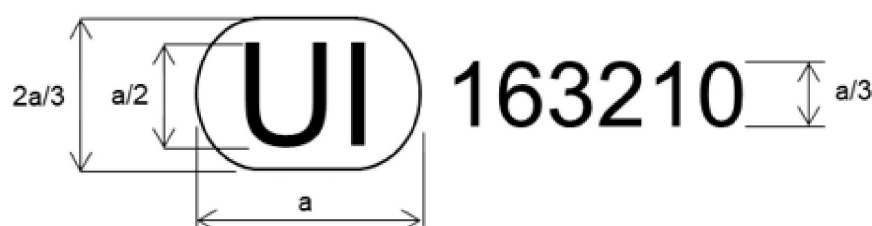
- 3.3.1.7. In the case of lamps grouped, combined or reciprocally incorporated with other lamps the lens of which may also be used for other types of lamps the provisions of paragraph 3.3. apply.
- 3.3.2. The approval marking shall consist of:
- 3.3.2.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval. ⁽⁸⁾
- 3.3.2.2. The approval number prescribed in paragraph 3.2.2.
- 3.3.2.3. The number of this Regulation followed by the letter 'R' and the two digits indicating the series of amendments in force at the time of issue of the approval.
- 3.3.2.4. Additional symbols for headlamps, AFS and front fog lamps:
- 3.3.2.4.1. In the case of headlamps/AFS installation unit 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;
- 3.3.2.4.2. In the case of headlamps/AFS installation unit designed to meet the requirements of both traffic systems by means of an appropriate adjustment of the setting of the optical unit or the light source(s) or LED module(s), a horizontal arrow with a head on each end, the heads pointing respectively to the left and to the right;
- 3.3.2.4.3. Front fog lamps of Class F3 having asymmetric light distribution and which must not be indiscriminately mounted on either side of the vehicle, shall bear an arrow pointing to the outside of the vehicle;
- 3.3.2.4.4. In the case of front fog lamps, headlamps and AFS installation unit incorporating a lens of plastic material, the group of letters "PL" to be affixed near the symbols identifying the lighting;
- 3.3.2.4.5. In the case of headlamps/AFS installation unit meeting the requirements of the driving-beam, an indication, placed near the circle surrounding the letter "E", of the maximum luminous intensity expressed by a reference mark (I_M), as defined in paragraph 5.1.3.6.
- In the case of grouped or reciprocally incorporated driving-beam headlamps/AFS lighting unit, indication of the maximum luminous intensity of the driving-beams as a whole shall be expressed as above.
- 3.3.2.4.6. In the case of headlamps/AFS installation unit so designed that the light source(s) 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 symbol indicating the headlamp producing the passing beam in the approval mark.
- 3.3.2.4.6.1. This requirement shall not apply to headlamps meeting the requirements of Class D headlamps which are so designed that the passing beam and the driving beam are provided by the same gas-discharge light source.
- 3.3.2.4.7. In the case of AFS, a score above the letter(s) indicates that the AFS function(s) is(are) provided by more than one installation unit on that side of the system.

⁽⁸⁾ The distinguishing numbers of the Contracting Parties to the 1958 Agreement are reproduced in Annex 3 to the Consolidated Resolution on the Construction of Vehicles (R.E.3) (ECE/TRANS/WP.29/78/Rev.6).

- 3.3.2.5. The approval number and the 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 the same direction.
- 3.3.2.6. Other markings
- Road illumination functions or systems shall bear, in indelible and clearly legible manner, the trade name or mark of the applicant and the following markings:
- 3.3.2.6.1. In the case of devices including a passing beam designed to satisfy the requirements both of right-hand and of left-hand traffic, markings indicating the two settings of the optical unit on the vehicle or of the light source 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;
- 3.3.2.6.2. In the case of lamps with replaceable light source(s) or with replaceable light source modules, a marking indicating:
- (a) The category or categories of light source(s) prescribed for headlamps of Classes AS, BS, CS, DS, ES and cornering lamps; and/or
 - (b) The light source module specific identification code; and /or
 - (c) The rated voltage(s), the rated wattage(s) and specific identification code of LED module(s) for headlamps, front fog lamps and AFS;
- 3.3.2.6.3. In the case of lamps with light source module(s), a marking on the light source module(s) indicating:
- (a) The trade name or mark of the applicant;
 - (b) The specific identification code of the module. This specific identification code shall comprise the starting letters "MD" for "MODULE" followed by the approval mark without the circle as prescribed in paragraph 3.3.2.1.; this identification code shall be shown in the drawings mentioned in paragraph 3.1.2. The approval mark does not have to be the same as the one on the lamp in which the module is used, but both marks shall be from the same applicant;
 - (c) In case of cornering lamps, the rated voltage or the range of voltage.
- In the case where the light-source module(s) is non-replaceable, it does not need to be marked.
- 3.3.2.6.4. In the case of cornering lamps with:
- (a) An electronic light source control gear; or
 - (b) Non-replaceable light sources; and/or
 - (c) Light source module(s);
- marking of the rated voltage or range of voltage;
- 3.3.2.6.5. On an electronic light source control gear:
- 3.3.2.6.5.1. In case of headlamps, AFS systems and front fog lamps:
- 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.
- 3.3.2.6.5.2. In case of cornering lamps:
- An electronic light source control gear being part of the lamp but not included into the lamp body shall bear the name of the manufacturer and its identification number.

- 3.3.2.6.6. In the case of AFS, front fog lamps and headlamps except Class AS, BS, CS, DS and ES meeting the requirements of Annex 7 only when supplied with a voltage of 12V, a marking consisting of the Number 24 crossed out by an oblique cross (X) near the holders of the light source(s);
- 3.3.2.6.7. In the case of a headlamp having additional lighting unit(s) for vehicles of categories L and T:
- 3.3.2.6.7.1. The headlamps producing the principal passing beam shall bear specific identification code of the additional lighting unit(s) mentioned in paragraph 3.3.2.6.7.2.2.
- 3.3.2.6.7.2. Additional lighting unit(s) shall bear the trade name or mark of the applicant and the following markings:
- 3.3.2.6.7.2.1. In the case of light source(s), their category(ies), and/or
- In the case of LED module(s), the rated voltage and rated wattage and the specific identification code(s) of the LED module(s).
- 3.3.2.6.7.2.2. The specific identification code(s) of the additional lighting unit(s). This marking shall be clearly legible and indelible.
- This specific identification code shall be comprised of starting letters "ALU" for "Additional Lighting Unit" followed by approval marking without the circle and in the case where several non-identical additional lighting units are used, additional symbols or characters shall follow. This specific identification code shall be shown in the drawings. The approval marking does not have to be the same as the one on the lamp in which the additional lighting unit(s) is used, but both markings shall be from the same applicant.
- 3.3.3. The approval marking may be replaced by the Unique Identifier (UI), if available. The Unique Identifier mark shall follow the format in the example shown below:

Figure 1

Unique Identifier (UI)

$a \geq 8 \text{ mm}$

The above Unique Identifier (UI) marked on the lamp shows that the type concerned has been approved and that the relevant information on that type approval can be accessed on the UN secure internet database by using 163210 as the Unique Identifier.

- 3.4. Modifications of a road illumination device and extension of approval
- 3.4.1. Every modification of a type of lamp shall be notified to the Type Approval Authority which approved the type. The Authority may then either:
- 3.4.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the lamp still complies with the requirements; or

- 3.4.1.2. Require a further test report from the technical service responsible for conducting the tests.
- 3.4.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 3.2.3. to the Contracting Parties to the 1958 Agreement applying this Regulation.
- 3.4.3. The Type Approval Authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Contracting Parties to the 1958 Agreement applying this Regulation under which the approval has been granted by means of a communication form conforming to the model in Annex 1 to this Regulation.
- 3.5. Conformity of production
- The conformity of production procedures shall comply with those set out in the 1958 Agreement, Schedule 1 (E/ECE/TRANS/505/Rev.3), with the following requirements:
- 3.5.1. Road illumination devices approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraphs 4.16. and 5.
- 3.5.1.1. The minimum requirements for conformity of production control procedures set forth in Annex 2 shall be complied with;
- 3.5.1.2. The minimum requirements for sampling by an inspector set forth in Annex 3 shall be complied with;
- 3.5.2. The Type Approval 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.
- 3.5.3. For devices in accordance with paragraph 5.6. only (Cornering Lamps) and in the case of non-replaceable filament light source(s) or light source module(s) equipped with non-replaceable filament light source(s), the applicant shall annex to the type approval documentation a report (by the light source manufacturer indicated in the type approval documentation), acceptable to the Authority responsible for type approval that demonstrates compliance of these non-replaceable filament light source with the requirements as specified in paragraph 4.11 of IEC 60809, Edition 3.
- 3.5.4. Road illumination devices with apparent defects are disregarded.
- 3.5.5. The reference mark is disregarded.
- 3.5.6. The measuring points in Table 8 Part B are disregarded.
- 3.5.7. The measuring points 8 to 15 in Table 35 are disregarded.
- 3.6. Penalties for non-conformity of production
- 3.6.1. The approval granted in respect of a device pursuant to this Regulation may be withdrawn if the foregoing requirements are not met;
- 3.6.2. If a Contracting Party to the Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of a communication form conforming to the model in Annex 1.

3.7. Production definitively discontinued

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 Contracting Parties to the 1958 Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1.

3.8. Names and addresses of Technical Services responsible for conducting approval tests, and of Type Approval Authorities

The Contracting Parties to the 1958 Agreement which apply a UN Regulation shall communicate to the United Nations Secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, or the definitive discontinuation of production issued in other countries, are to be sent.

4. GENERAL TECHNICAL REQUIREMENTS

Lamps submitted for approval shall conform to the requirements set forth in paragraphs 4 and 5.

The requirements contained in sections 5 "General specifications" and 6 "Individual specifications" (and in the Annexes referenced in the said sections) of UN Regulations No. 48, 53, 74 or 86, and their series of amendments in force at the time of application for the lamp type approval shall apply to this Regulation.

The requirements pertinent to each lamp and to the category/ies of vehicle on which the lamp is intended to be installed shall be applied, where its verification at the moment of lamp type approval is feasible.

4.1. The lamps must be so designed and constructed that under normal conditions of use and notwithstanding the vibrations to which they may be subjected in such use, their satisfactory operation remains assured and they retain the characteristics prescribed by this Regulation.

4.2. Lamps 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, one or more additional LED light source(s), or one or more additional LED module(s) being part of a lamp producing a passing beam.

4.3. Lamps shall be fitted with a device enabling them to be so adjusted on the vehicles as to comply with the rules applicable to them. In case of the headlamps of classes AS, BS, CS, DS and ES, such a device may or may not provide horizontal adjustment, provided that the headlamps are so designed that they can maintain a proper horizontal aiming even after the vertical aiming adjustment. 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 lamp setting can be adjusted by other means.

4.4. Where a lamp producing a principal passing-beam and a lamp producing a driving-beam, each equipped with its own light source(s) or LED module(s), the adjusting device shall enable the principal passing-beam and the driving-beam to be adjusted individually.

However, these provisions shall not apply to assemblies whose reflectors are indivisible.

4.5. Light sources

4.5.1. Restrictions on light sources

4.5.1.1. The lamp shall only be equipped with light source(s) approved according to UN Regulations Nos. 37, 99 and/or 128, provided that no restriction on the use is made in UN Regulation No. 37 and its series of amendments in force at the time of application for type approval or in UN Regulation No. 99 and its series of amendments in force at the time of application for type approval or in UN Regulation No. 128 and its series of amendments in force at the time of application for type approval, and/or LED module(s), and/or light source module(s) (for cornering lamps only) and/or non-replaceable light source (for cornering lamps only).

4.5.1.2. Front fog lamps, irrespective of whether the light sources can be replaced or not, shall only be equipped with one or more light sources approved according to:

- (a) UN Regulation No. 37, or
- (b) UN Regulation No. 99, or
- (c) UN Regulation No. 128,

And/or, one or more LED modules where the requirements of Annex 9 shall apply; compliance with these requirements shall be tested.

4.5.1.3. Headlamps of class D shall only be equipped with:

4.5.1.3.1. In case of the principal passing beam, one gas-discharge light source. A maximum of two additional light sources are permitted for the passing beam as follows:

- (a) One additional filament light source approved according to UN Regulation No. 37, one or more additional LED light source(s) approved according to UN Regulation No. 128 or one or more additional LED module(s) may be used inside the passing beam headlamp to contribute to bend lighting.
- (b) One additional filament light source approved according to UN Regulation No. 37, one or more additional LED light source(s) approved according to UN Regulation No. 128 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 gas discharge light source. In the event that the gas-discharge light source fails, this additional filament light source, LED light source(s) and/or LED module(s) shall be automatically switched off.

In the event of failure of an additional filament or LED light source or LED module, the headlamp shall continue to fulfil the requirements of the passing beam.

4.5.1.3.2. In case of the driving beam, one or more filament light sources approved according to UN Regulation No. 37, one or more gas-discharged light source approved according to UN Regulation No. 99, one or more LED light sources approved according to UN Regulation No. 128 and/or LED module(s). Where more than one light source is used to provide the driving beam, these light sources shall be operated simultaneously.

It is also possible that a part of the driving beam produced by one of these light sources will be used exclusively for short time signals (flash to pass) as declared by the applicant. This shall be indicated in the relevant drawing and a remark shall be made in the communication form.

4.5.1.4. Headlamps of classes A and B shall only be equipped with:

4.5.1.4.1. In case of the principal passing beam, one filament light source approved according to UN Regulation No. 37, one or more LED light source(s) approved according to UN Regulation No. 128 or one or more LED module(s). Additional light sources are permitted for the passing beam as follows:

- (a) One additional filament light source approved according to UN Regulation No. 37, one or more additional LED light source(s) approved according to UN Regulation No. 128, or one or more additional LED module(s) may be used inside the passing beam headlamp to contribute to bend lighting;

- (b) One additional filament light source approved according to Regulation No. 37, one or more additional LED light source(s) approved according to UN Regulation No. 128 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 passing beam. In the event that the principal light beam fails, this/these additional light source(s) and/or LED module(s) shall be automatically switched off.

In the event of failure of an additional filament light source, one or more additional LED light source(s) or one or more additional LED module(s), the headlamp shall continue to fulfil the requirements of the passing beam.

- 4.5.1.4.2. In case of the driving beam, irrespective of the type of light source (LED module(s) or filament or LED light source(s)) used to produce the principal passing-beam, one or more filament light sources approved according to UN Regulation No. 37, one or more LED light source(s) approved according to UN Regulation No. 128 or one or more LED module(s).
- 4.5.1.5. Headlamps of classes AS, BS, CS, DS shall only be equipped with:
 - 4.5.1.5.1. In case of the principal passing beam, one or two filament light sources approved according to UN Regulation No. 37, one or more LED light source(s) approved according to UN Regulation No. 128 and/or one or more LED module(s). In the case of the use of additional light source(s) and/or additional lighting unit(s) to provide bend lighting, only filament light sources approved according to UN Regulation No. 37, LED light sources approved according to UN Regulation No. 128 and/or LED modules(s) shall be used.
 - 4.5.1.5.2. In case of the driving beam, irrespective of the type of light source (LED module(s) or filament or LED light source(s)) used to produce the principal passing-beam, one or more filament light sources approved according to UN Regulation No. 37, one or more LED light sources approved according to UN Regulation No. 128 or one or more LED module(s).
- 4.5.1.6. Headlamps of class ES shall only be equipped with:
 - 4.5.1.6.1. In case of the principal passing beam, one gas-discharge light source approved according to UN Regulation No. 99, one or more LED light source(s) approved according to UN Regulation No. 128 or one or more LED module(s). In the case of the use of additional light source(s) and/or additional lighting unit(s) to provide bend lighting, only filament light sources approved according to UN Regulation No. 37, LED light sources approved according to UN Regulation No. 128 and/or LED modules(s) shall be used.
 - 4.5.1.6.2. In case of the driving beam, irrespective of the type of light source (LED module(s) or gas-discharge or LED light source(s)) used to produce the principal passing-beam, one or more gas-discharged light sources approved according to UN Regulation No. 99, one or more LED light sources approved according to UN Regulation No. 128 or one or more LED module(s).
- 4.5.1.7. Cornering lamps shall only be equipped with one or a combination of:
 - (a) Filament light sources approved according to UN Regulation No. 37;
 - (b) LED light sources approved according to UN Regulation No. 128;
 - (c) LED module(s);
 - (d) Light Source module(s);
 - (e) Non-replaceable light source.
- 4.5.1.8. AFS of classes C, E, V, W, R shall only be equipped with one or a combination of:
 - (a) Filament light sources approved according to UN Regulation No. 37;
 - (b) Gas-discharge light sources approved according to UN Regulation No. 99;

(c) LED light sources approved according to UN Regulation No. 128;

(d) LED module(s).

However, the class C (basic) passing beam shall be equipped only with replaceable light sources or replaceable or non-replaceable LED modules.

4.5.2. General requirements for light sources

4.5.2.1. In case a light source category or categories or type(s) is restricted for use in lamps on vehicles in use and originally equipped with such lamps, the applicant for type approval of the lamp shall declare that the lamp is only intended for installation on those vehicles; this shall be noted in the communication form

4.5.2.2. In case of replaceable light source(s),

(a) The design of the lamp shall be such that the light source(s) can be fixed in no other position but the correct one;

(b) The light source(s) holder shall conform to the characteristics given in IEC Publication 60061. The holder data sheet relevant to the category of light source(s) used, applies.

4.5.2.3. Electronic light source control gear(s), if applicable, shall be considered to be part of the lamp; they may be part of the LED module(s).

4.5.2.4. The headlamp of class D and/or class ES and its ballast system or light source control gear shall not generate radiated or power line disturbances, which cause a malfunction of other electric/electronic systems of the vehicle. ⁽⁹⁾

4.5.2.5. Front fog lamps, designed to operate permanently with an additional system to control the intensity of the light emitted, or which are reciprocally incorporated with another function, using a common light source, and designed to operate permanently with an additional system to control the intensity of the light emitted, are permitted.

4.5.2.6. Except for AFS and cornering lamps, in case of a lamp incorporating one or more light source(s) or LED module(s) producing the principal passing-beam or the front fog beam and having a total objective luminous flux which exceeds 2 000 lumens, a reference shall be made in the communication form in Annex 1.

In case of an AFS incorporating light sources and/or LED module(s) producing the basic passing beam and having a total objective luminous flux of the lighting units as indicated under item 9.3.2.3. of the communication form which exceeds 2 000 lumen per side, a reference shall be made in the communication form in Annex 1.

The objective luminous flux of LED modules shall be measured as described in paragraph 5. of Annex 9.

4.5.2.7. A LED module shall be:

(a) Only removable from its device with the use of tools, unless it is stated in the communication form that the LED module is non-replaceable; and

(b) So designed that regardless of the use of tool(s), it is not mechanically interchangeable with any replaceable approved light source.

4.5.3. Specific requirements for light sources

4.5.3.1. In case of cornering lamps equipped with light source module(s), the design of the light source module(s) shall be such as:

(a) That each light source module(s) can only be fitted in no other position than the designated and correct one and can only be removed with the use of tool(s);

⁽⁹⁾ Compliance with the requirements for electromagnetic compatibility is relevant to the vehicle type.

- (b) If there are more than one light source module(s) used in the housing for a device, light source module(s) having different characteristics cannot be interchanged within the same lamp housing;
- (c) The light source module(s) shall be tamperproof;
- (d) A light source module(s) shall be so designed that regardless of the use of tool(s), it shall not be mechanically interchangeable with any replaceable approved light source.

4.5.3.2. For headlamps, AFS and front fog lamp equipped with LED light source(s) and/or LED module(s):

4.5.3.2.1. Electronic light source control gear(s) associated with the operation of LED module(s), if applicable, shall be considered to be part of the lamp; they may be part of the LED module(s).

4.5.3.2.2. The lamp and the LED module(s) themselves shall comply with the relevant requirements specified in Annex 9 to this Regulation. The compliance with the requirements shall be tested.

4.5.3.2.3. In case of the headlamp of classes A, B, D and AFS, the total objective luminous flux of all LED light sources and/or LED modules producing the principal passing beam and measured as described in paragraph 5. of Annex 9 (LED modules only) shall be equal or greater than 1 000 lumens.

4.5.3.2.4. In case of the headlamp of classes AS, BS, CS and DS, the total objective luminous flux of all LED light sources and/or LED modules producing the principal passing beam and measured as described in paragraph 5. of Annex 9 (LED modules only) shall be within the following limits.

Table 3

“Classes AS, BS, CS and DS - Passing beam minimum and maximum limits for luminous flux”

	Headlamps Class AS	Headlamps Class BS	Headlamps Class CS	Headlamps Class DS
Passing beam minimum	150 lumen	350 lumen	500 lumen	1 000 lumen
Passing beam maximum	900 lumen	1 000 lumen	2 000 lumen	2 000 lumen

4.5.3.2.5. In case of headlamps of class ES, the total objective luminous flux of all LED light sources and/or LED modules producing the principal passing beam and measured as described in paragraph 5. of Annex 9 shall be within the following limits:

Table 4

“Class ES - Passing beam minimum limit for luminous flux”

	Headlamps Class ES
Passing beam minimum	2 000 lumen

4.5.3.2.6. In the case of a replaceable LED module the removal and replacement of this LED module, as described in Annex 9, paragraph 1.4.1. shall be demonstrated to the satisfaction of the Technical Service.

4.5.3.2.7. UN Regulation No. 48 defines that LED modules may contain holders for other light sources.

4.5.3.3. In case of headlamps of classes AS, BS, CS and DS, the reference luminous flux at 13,2 V of each filament light source for the principal passing beam does not exceed 900 lm for classes AS and BS and 2 000 lm for classes CS and DS.

4.6. Testing of the lamp

Depending on the light source used, the following conditions shall apply.

4.6.1. In the case of replaceable filament light sources:

4.6.1.1. In the case of filament light sources operating directly under vehicle voltage system conditions:

The lamp shall be checked by means of colourless standard (étalon) filament light sources as specified in UN Regulation No. 37.

During the testing of the lamp, except for cornering lamps, the power supply to the filament light source(s) shall be regulated so as to obtain the reference luminous flux at 13,2 V as indicated on the relevant data sheet of UN Regulation No. 37.

During the testing of cornering lamps, the power supply to the filament light source(s) shall be regulated so as to obtain the reference luminous flux at 13,2 V or 13,5 V as indicated on the relevant data sheet of UN Regulation No. 37.

However, if a filament light source of category H9 or H9B is used for the principal passing-beam, the applicant may choose the reference luminous flux at 12,2 V or 13,2 V as indicated in the relevant data sheet of UN Regulation No. 37 and a reference stating which voltage was chosen for type approval shall be made in item 9 in the communication form of Annex 1.

4.6.1.2. In order to protect the standard (étalon) filament light source during the process of photometric measurement it is permissible to carry out the measurements at a luminous flux that differs from the reference luminous flux at 13,2 V. If the Technical Service chooses to carry out measurements in such a manner, the luminous intensity shall be corrected by multiplying the measured value by the individual factor F_{lamp} of the standard (étalon) filament light source in order to verify the compliance with the photometric requirements where:

$$F_{\text{lamp}} = \Phi_{\text{reference}} / \Phi_{\text{test}}$$

$\Phi_{\text{reference}}$ is the reference luminous flux at 13,2 V as specified in the relevant data sheet of UN Regulation No. 37

Φ_{test} is the actual luminous flux used for the measurement.

However, where the reference luminous flux of 12,2 V as specified in the data sheet for the category H9 or H9B is chosen, this procedure is not permitted.

4.6.2. In the case of a gas-discharge light source:

A standard light source shall be used as specified in UN Regulation No. 99, which has been aged during at least 15 cycles, in accordance with paragraph 4. of Annex 4 to UN Regulation No. 99.

During testing of the lamp the voltage at the terminals of the ballast or at the terminals of the light source in case the ballast is integrated with the light source shall be regulated to maintain 13,2 V for a 12 V system, or at the vehicle voltage as specified by the applicant, with a tolerance of $\pm 0,1$ V.

The objective luminous flux of the gas-discharge light source may differ from that specified in UN Regulation No. 99. In this case, the luminous intensity values shall be corrected accordingly.

4.6.3. In the case of replaceable LED light sources:

The lamp shall be checked by means of a standard light source as specified in UN Regulation No. 128.

During testing of the lamp, the voltage supplied to the light source(s) shall be regulated to maintain 13,2 V or 13,5 V (optionally for cornering lamps only) for a 12 V system or 28 V for a 24 V system, or at the vehicle voltage as specified by the applicant, with a tolerance of $\pm 0,1$ V.

The luminous intensity values produced shall be corrected. The correction factor is the ratio between the objective luminous flux and the value of the luminous flux found at the voltage applied. In the case of more than one LED light source, the mean value of the correction factors shall be applied, while each individual correction factor shall not deviate more than 5 per cent from this mean value.

4.6.4. In the case of LED modules:

All measurements on lamps equipped with LED module(s) shall be made at 6,3 V, 13,2 V or 28,0 V respectively, if not otherwise specified within this Regulation. LED modules operated by an electronic light source control gear shall be measured with the input voltage as specified by the applicant or with a supply and operating device which replace this control gear for the photometric test.

4.6.5. In the case of non-replaceable light sources, only, if allowed according to the requirements of paragraph 4:

All measurements on lamps equipped with non-replaceable light sources shall be made at 6,3 V or 6,75 V (optionally for cornering lamps only), 13,2 V or 13,5 V (optionally for cornering lamps only) or 28,0 V or at other vehicle voltage as specified by the applicant. The test laboratory may require from the applicant the special power supply needed to supply the light sources. The test voltages shall be applied to the input terminals of the lamp.

4.6.6. In the case of a lamp that uses a light source control gear being part of the lamp, the voltage declared by the applicant shall be applied to the input terminals of that lamp.

4.6.7. In the case of a lamp that uses a light source control gear not being part of the lamp the voltage declared by the applicant shall be applied to the input terminals of that light source control gear. The test laboratory shall require from the applicant the special light source control gear needed to supply the light source and the applicable functions. The identification of that light source control gear if applicable and/or the voltage applied, including the tolerances, shall be noted in the communication form in Annex 1.

4.6.8. In the case of headlamps or AFS equipped with different kinds of light sources, the part of the lamp equipped:

- (a) With replaceable filament light sources shall be tested according to paragraph 4.6.1.;
- (b) With a gas-discharge light source shall be tested according to paragraph 4.6.2.;
- (c) With replaceable LED light sources shall be tested according to paragraph 4.6.3.;
- (d) With LED modules shall be tested according to paragraph 4.6.4.

and then added to the previous result obtained from the light sources tested.

4.7. Testing of light transmitting components made of plastic material (except for cornering lamps and headlamps of classes AS).

4.7.1. If the outer lens of the lamp is made of plastic material tests shall be done according to the requirements in Annex 8.

4.7.2. The UV resistance of light transmitting components located inside a front fog lamp and made of plastic material shall be tested according to Annex 8, paragraph 3.4.

4.7.2.1. The test prescribed in paragraph 4.7.2. is not necessary if low-UV type light sources as specified either in the relevant UN Regulation or in Annex 9 are used, or if provisions are taken, to shield the relevant lamp components from UV radiation, e.g. by glass filters.

4.8. The sharpness and linearity of the cut-off, if applicable, shall be tested according to the requirements in Annex 5 or 6 respectively.

4.9. Except for cornering lamps, complementary tests shall be done according to the requirements in Annex 7 to ensure that in use there is no excessive change in photometric performance.

4.10. Lamps with asymmetrical "cut-off" line 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 light source(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 light source(s) producing the principal passing-beam, the components for attaching this light source(s) to the reflector must be so designed and made so that, in each of its two settings, this light source(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.

4.11. Testing of mechanical or electromechanical structures

4.11.1. On headlamps or a system 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 and lighting unit(s) for these purposes shall be so constructed that:

4.11.1.1. 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.

4.11.2. Headlamps of classes A, B and D:

4.11.2.1. In the case of failure, the luminous intensity above the line H-H shall not exceed the values of a passing-beam according to paragraph 5.2.; in addition, on headlamps designed to provide a passing and/or a driving-beam to become a bend lighting, a minimum luminous intensity of at least 2 500 cd. shall be fulfilled in test point 25 V (VV line, 1,72D).

4.11.2.2. Either the principal passing-beam or the driving-beam shall always be obtained without any possibility of the mechanism stopping in between two positions;

- 4.11.3. Headlamps of classes AS, BS, CS, DS and ES:
- 4.11.3.1. Except for additional light source(s) and additional lighting unit(s) used to produce bend lighting, in the case of failure it must be possible to obtain automatically a passing beam or a state with respect to the photometric conditions which yields values not exceeding 1 200 cd in Zone 1 and at least 2 400 cd at 0,86D-V by such means as e.g. switching off, dimming, aiming downwards, and/or functional substitution;
- 4.11.3.2. Except for additional light source(s) and additional lighting unit(s) used to produce bend lighting, either the passing beam or the driving beam shall always be obtained without any possibility of the mechanism stopping in between the two positions;
- 4.11.4. AFS:
- 4.11.4.1. Except in the case of adaptation of the driving-beam, either the passing-beam or the driving-beam shall always be obtained, without any possibility of remaining in an intermediate or undefined state; if this is not possible, such a state must be covered by the provisions according to paragraph 4.11.4.2.;
- 4.11.4.2. In the case of failure it must be possible to obtain automatically a passing-beam or a state with respect to the photometric conditions which yields values not exceeding 1 300 cd in the zone III b as defined in paragraph 5.3 and at least 3 400 cd in a point of "segment $I_{\max}$ ", by such means as e.g. switching off, dimming, aiming downwards, and/or functional substitution;
- 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.
- 4.11.5. The user cannot, with ordinary tools, change the shape or position of the moving parts, or influence the switching device.
- 4.12. Illumination configuration of lamps with asymmetrical "cut-off" line only for different traffic conditions
- 4.12.1. In the case of lamps 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 ⁽¹⁰⁾. Such measures may be:
- (a) Occulting a part of the outer 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.
- 4.12.2. Following the application of the measures described in paragraph 4.12.1. the following requirements regarding the luminous intensity of the lamp shall be met with the adjustment left unchanged compared to that for the original traffic direction:
- 4.12.2.1. Passing-beam designed for right-hand traffic and adapted to left-hand traffic:
- at 0,86 D-1,72 L at least 2 500 cd;
 - at 0,57 U-3,43 R not more than 880 cd.
- 4.12.2.2. Passing-beam designed for left-hand traffic and adapted to right-hand traffic:
- at 0,86 D-1,72 R at least 2 500 cd;

⁽¹⁰⁾ Instructions on the installation of lamps fitted with the measures are given in UN Regulation No. 48.

at 0,57 U-3,43 L not more than 880 cd.

- 4.13. If applicable, the lamp shall be so made that, if a light source and/or a LED module has failed, a failure signal in order to comply with the relevant provisions of UN Regulation No. 48 is provided.
- 4.14. The component(s) to which a replaceable light source is assembled shall be so made that the light source fits easily and, even in darkness, can be fitted in no position but the correct one.
- 4.15. For photometric adjustment and measuring conditions, see Annex 4.
- 4.15.1 In the case of lamps with replaceable light sources, the lamp shall be considered acceptable if it meets the requirements of paragraph 5. with at least one standard (étalon) light source, which may be submitted with the lamp.
- 4.16. Colour of light emitted:
- The colour of the light emitted shall be white for all lamps. However, for front fog lamps the colour of the light emitted may be selective yellow if requested by the applicant.
- For cornering lamps the colour of the light emitted inside the field of the light distribution grid defined in Annex 4, Figure A4-XII shall be white. Outside this field, no sharp variation of colours shall be observed.
- 4.16.1. The colorimetric characteristics of the lamps incorporating LED modules shall be measured according to paragraph 4.3.2. of Annex 9.
- 4.17. In the case of headlamps or AFS with adjustable reflector the requirements of paragraphs 5.1. to 5.4. are applicable for each mounting position indicated according to paragraph 3.1.3. For verification the following procedure shall be used:
- 4.17.1. Each applied position is realized 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/system or part(s) thereof is then moved into such a position that the light pattern on the screen corresponds to the relevant aiming prescriptions;
- 4.17.2. With the reflector/system or part(s) thereof initially fixed according to paragraph 4.17.1., the device or part(s) thereof must meet the relevant photometric requirements of paragraphs 5.1. to 5.4.;
- 4.17.3. Additional tests shall be made after the reflector/system or part(s) thereof 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/ systems or part(s) thereof adjusting device. Having re-aimed the headlamp/system or part(s) thereof 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:
- passing-beam: for headlamp points B 50 L and 75 R (B 50 R and 75 L, respectively);
for AFS points B 50 L and 75 R, or 50 R if applicable;
for class AS, BS, CS, DS, and ES, points HV and 0,86 D-V;
- driving-beam: I_M and point HV (percentage of I_M).
- 4.17.4. If the applicant has indicated more than one mounting position, the procedure of paragraphs 4.17.1. to 4.17.3. shall be repeated for all other positions;

- 4.17.5. If the applicant has not asked for special mounting positions, the headlamp/system or part(s) thereof shall be aimed for measurements of paragraphs 5.1. to 5.4. with the relevant adjusting device(s) in its mean position. The additional test of paragraph 4.17.3. shall be made with the reflector/system or part(s) thereof moved into its extreme positions (instead of $\pm 2^\circ$) by means of the relevant adjusting device(s).

5. SPECIFIC TECHNICAL REQUIREMENTS

- 5.1. Technical requirements concerning driving-beam of the Class A, B, D (GDL), BS, CS, DS or ES (GDL) (symbols "R", "HR", "DR", "XR", "R-BS", "WR-CS", "WR-DS" or "WR-ES")

- 5.1.1. In the case of a road illumination device designed to provide a driving-beam and a passing-beam, measurements of the luminous intensity of the driving-beam shall be taken with the same alignment as for measurements under paragraphs 5.2. to 5.4.

In the case of a road illumination device providing a driving-beam only, it shall be so adjusted that the area of maximum luminous intensity is centred on the point of intersection of lines H-H and V-V; such a device needs to meet only the requirements referred to in paragraph 5.1.3.

For devices where more than one light source is used to provide the driving-beam, these light sources shall be operated simultaneously to determine the maximum value of the luminous intensity (I_M).

It is also possible that a part of the driving beam produced by one of these light sources will be used exclusively for short time signals "flash to pass" as declared by the applicant. This shall be indicated in the relevant drawing and a remark shall be made in the communication form.

- 5.1.2. Irrespective of the type of light source used to produce the principal passing-beam, several light sources are allowed to be used for each individual driving-beam.

- 5.1.3. Requirements for the luminous intensity distribution of the driving-beams:

- 5.1.3.1. Referring to Figure A4-II the luminous intensity distribution of the driving-beam shall meet the following requirements.

Table 5

Luminous intensity requirements for driving-beam

		Class A Headlamp	Class B Headlamp	Class D Headlamp
Test point	Angular coordinates Degrees	Required luminous intensity cd	Required luminous intensity cd	Required luminous intensity cd
		Min	Min	Min
I_M		27 000	40 500	43 800
H-5L	0,0; 5,0 L	3 400	5 100	6 250
H-2.5L	0,0; 2,5 L	13 500	20 300	25 000
H-2.5R	0,0; 2,5 R	13 500	20 300	25 000
H-5R	0,0; 5,0 R	3 400	5 100	6 250

- 5.1.3.2. Referring to Figure A4-III the luminous intensity distribution of a primary driving-beam shall meet the following requirements.

Table 6

Luminous intensity distribution of a primary driving-beam

Test point number	Test point angular coordinates - degrees (*)	Required luminous intensity [cd]					
		Class BS		Class CS		Class DS, ES	
		MIN	MAX	MIN	MAX	MIN	MAX
1	H-V	16 000	—	20 000	—	30 000	—
2	H-2,5°R and 2,5°L	9 000	—	10 000	—	20 000	—
3	H-5°R and 5°L	2 500	—	3 500	—	5 000	—
4	H-9°R and 9°L	—	—	2 000	—	3 400	—
5	H-12°R and 12°L	—	—	600	—	1 000	—
6	2°U-V	—	—	1 000	—	1 700	—
	MIN luminous intensity of the maximum (I_M)	20 000	—	25 000	—	40 000	—
	MAX luminous intensity of the maximum (I_M)	—	215 000	—	215 000	—	215 000

(*) 0,25° tolerance allowed independently at each test point for photometry unless indicated otherwise.

5.1.3.3.

Referring to Figure A4-IV the luminous intensity distribution of a secondary driving-beam shall meet the following requirements.

Table 7

Luminous intensity distribution of a secondary driving-beam

Test point number	Test point angular coordinates - degrees (*)	Required luminous intensity [cd]					
		Class BS		Class CS		Classes DS, ES	
		MIN	MAX	MIN	MAX	MIN	MAX
1	H-V	16 000	—	20 000	—	30 000	—
2	H-2,5°R and 2,5°L	9 000	—	10 000	—	20 000	—
3	H-5°R and 5°L	2 500	—	3 500	—	5 000	—
6	2°U-V	—	—	1 000	—	1 700	—
	MIN luminous intensity of the maximum (I_M)	20 000	—	25 000	—	40 000	—
	MAX luminous intensity of the maximum (I_M)	—	215 000	—	215 000	—	215 000

(*) 0,25° tolerance allowed independently at each test point for photometry unless indicated otherwise.

5.1.3.4. Except for classes BS, CS, DS and ES, the point of intersection (HV) of lines h h and v v shall be situated within the isocandela 80 per cent of maximum luminous intensity ($I_{\max}$)

5.1.3.5. The maximum value (I_M) shall in no circumstances exceed 215 000 cd.

5.1.3.6. The reference mark (I'_M) of the maximum luminous intensity shall be obtained by the ratio:

$$I'_M = I_M / 4\ 300$$

This value shall be rounded off to the value 5 – 7,5 – 10 – 12,5 – 17,5 – 20 – 25 – 27,5 – 30 – 37,5 – 40 – 45 – 50.

5.1.3.7. Four seconds after ignition of a driving-beam of Classes D or ES, equipped with a gas discharge light source with the ballast not integrated with the light source, and that has not been operated for 30 minutes or more at least 37 500 cd shall be attained at point HV, for a headlamp producing driving beam only.

The power supply shall be sufficient to secure the required rise of the high current pulse

5.2. Technical requirements concerning headlamps to provide a passing-beam of the Class A, B and D (GDL) (symbols "C", "HC" and "DC")

5.2.1. The headlamp shall be aimed according to Annex 5, paragraph 1.2.

If, however, vertical adjustment cannot be performed repeatedly to the required position within the allowed tolerances, the instrumental method of Annex 5, paragraph 2. shall be applied to test compliance with the required minimum quality of the "cut-off" line and to perform the beam vertical adjustment.

5.2.1.1. When so aimed, the headlamp shall:

- (i) If its approval is sought solely for provision of a passing-beam ⁽¹⁾, comply with the requirements set out in paragraph 5.2.2.;
- (ii) If it is intended to provide both a passing-beam and a driving-beam, comply with the requirements set out in paragraphs 5.2.2. and 5.1.

5.2.1.2. Where a headlamp so aimed does not meet the requirements set out in paragraphs 5.2.2. and 5.1., its alignment may be changed according to the provisions in Annex 5, paragraph 1.2.3.

5.2.2. The passing-beam shall meet the luminous intensities at the test points referred to in Table 8 and in Figures A4-V or A4-VI.

Passing-beam headlamps with gas-discharge light sources shall meet these luminous intensities only after more than 10 minutes after ignition.

5.2.2.1. Four seconds after ignition of a passing-beam of Class D, equipped with a gas discharge light source with the ballast not integrated with the light source, and that has not been operated for 30 minutes or more at least 6 250 cd shall be attained at point 50V for headlamps producing passing-beam only or alternately passing- and driving- beam functions.

The power supply shall be sufficient to secure the required rise of the high current pulse.

⁽¹⁾ Such a special "passing beam" headlamp may incorporate a driving beam not subject to requirements.

Table 8

Luminous intensities of passing-beam (all intensities expressed in cd)

Headlamps for RH traffic(**), Passing beam of					Class A		Class B		Class D		
		See beam pattern in Annex 4			Figure A4-V		Figure A4-V		Figure A4-VI		
			Position in degrees								
			horizontal		vertical						
Part A	No.	Element	at/from	to	at	min	max	min	max	min	max
	1	B50L	3,43 L		0,57 U		350		350		350
	2	BR	2,50 R		1,00 U		1 750		1 750		
	3	Zone III (see Part C)					625		625		625
	4	50R	1,72 R		0,86 D	5 100		10 100		12 500	
	5	75R	1,15 R		0,57 D	5 100		10 100		12 500	
	6	50V	V		0,86 D			5 100		7 500	
	7	50L	3,43 L		0,86 D	3 550	13 200(*)	6 800	13 200(*)		18 480
	8	75L	3,43 L		0,57 D		10 600		10 600		
	9	25L1	3,43 L		1,72 D						18 800
	10	25L2	9,00 L		1,72 D	1 250		1 700		2 500	
	11	25R1	9,00 R		1,72 D	1 250		1 700		2 500	
	12	25L3	15,0 L		1,72 D					1 250	
	13	25R2	15,0 R		1,72 D					1 250	
	14	15L	20,0 L		2,86 D					625	
	15	15R	20,0 R		2,86 D					625	
		Segment I A to B	5,15 L	5,15 R	0,86 D					3 750	
		C-D	2,50 R		1,00 U						1 750
		Segment III and under	9,37 L	8,50 R	4,29 D						12 500
		Zone IV	5,15 L to 5,15 R – 0,86 D to 1,72 D			1 700		2 500			
		Zone I	9,00 L to 9,00 R – 1,72 D to 4,00 D				17 600		< 2I(**)		
		I _{max} R	Vertical above 1,72D, right of V-V line								43 800
	I _{max} L	Left of V-V line								31 300	

Headlamps for RH traffic(***)								
Part B	Test point		Angular coordinates Degrees			Required luminous intensity in cd		
	B1		4,00 U – 8,00 L			Points B1+B2+B3 190 min.		
	B2		4,00 U – 0					
	B3		4,00 U – 8,00 R					
	B4		2,00 U – 4,00 L			Points B4+B5+B6 375 min.		
	B5		2,00 U – 0					
	B6		2,00 U – 4,00 R					
	B7		0 – 8,00 L			65 min.		
	B8		0 – 4,00 L			125 min.		
Zone III (bounded by the following coordinates in degree)								
Part C	8,00 L	8,00 L	8,00 R	8,00 R	6,00 R	1,50 R	V-V	4,00 L
	1,00 U	4,00 U	4,00 U	2,00 U	1,50 U	1,50 U	H-H	H-H

Notes: In the Table 8, Part A, B and C:

Letter L means that the point is located on the left of VV line.

Letter R means that the point is located on the right of VV line.

Letter U means the point is located above HH line.

Letter D means the point or segment is located below HH line.

(*) In case where a headlamp in which LED modules are producing a passing-beam in conjunction with an electronic light source control gear, the measured value shall not be more than 18 500 cd.

(**) Actual measured value at points 50 R / 50 L respectively.

(***) For left-hand traffic, the letter R shall be replaced by letter L and vice versa.

5.2.3. There shall be no lateral variations detrimental to good visibility in any of the zones I, III and IV.

5.2.4. Headlamps designed to meet the requirements of both right-hand and left-hand traffic shall, in each of the two setting positions of the optical unit, light source(s) or LED module(s) producing the principal passing-beam, meet the requirements set forth above for the corresponding direction of traffic.

5.2.5. The requirements in paragraph 5.2.2. shall also apply to headlamps designed to provide bend lighting and/or that include the additional light source(s) or LED module(s) referred to in paragraph 5.2.6.2. 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°.

5.2.5.1. If bend lighting is obtained by:

5.2.5.1.1. 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 reaimed horizontally, e.g. by means of a goniometer;

- 5.2.5.1.2. 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;
- 5.2.5.1.3. Means of additional light source(s) or LED module(s) without moving horizontally the kink of the elbow of the cut-off, measurements shall be carried out with this/these light source(s) or LED module(s) activated.
- 5.2.6. Only one filament light source, one gas-discharge light source, one or more LED light source(s) 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:
 - 5.2.6.1. One additional filament light source according to UN Regulation No. 37, one or more additional LED light source(s) according to UN Regulation No. 128 or one or more additional LED module(s) may be used inside the passing-beam headlamp to contribute to bend lighting;
 - 5.2.6.2. One additional filament light source according to UN Regulation No. 37, one or more additional LED light source(s) according to UN Regulation No. 128 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;
 - 5.2.6.3. In the event of failure of an additional filament light source, one or more additional LED light source(s) or one or more additional LED module(s), the headlamp shall continue to fulfil the requirements of the passing-beam.
- 5.3. Technical requirements concerning adaptive front-lighting systems (AFS) (symbols “XC”, “XCE”, “XCV”, “XCW” and “XR”)
 - 5.3.1. General provisions
 - 5.3.1.1. Each system shall provide a Class C passing-beam according to paragraph 5.3.2.4. and one or more passing-beam(s) of additional class(es); it may incorporate one or more additional modes within each class of passing-beam and the front-lighting functions according to paragraph 5.3.3. and/or 3.1.3.2.1.
 - 5.3.1.2. The system shall provide automatic modifications, such, that good road illumination is achieved and no discomfort is caused, neither to the driver nor to other road users.
 - 5.3.1.3. The system shall be considered acceptable if it meets the relevant photometric requirements of paragraphs 5.3.2. and 5.3.3.
 - 5.3.1.4. Photometric measurements shall be performed according to the applicant's description:
 - 5.3.1.4.1. At neutral state;
 - 5.3.1.4.2. At V-signal, W-signal, E-signal, T-signal whichever apply;
 - 5.3.1.4.3. If applicable, at any other signal(s) and combinations of them, according to the applicant's specification.
 - 5.3.1.4.4. In case of a headlamp using a gas-discharge light source with the ballast not integrated with the light source, four seconds after ignition of a headlamp that has not been operated for 30 minutes or more;

- 5.3.1.4.4.1. At least 37 500 cd shall be attained at point HV, for a system producing driving-beam only.
- 5.3.1.4.4.2. At least 3 100 cd shall be attained at point 50 V when the Class C passing-beam is activated, for systems producing passing-beam only or alternately producing passing-beam and driving-beam functions as described in paragraphs 4.11.1. and 4.11.4.
- 5.3.1.4.4.3. In either case the power supply shall be sufficient to secure the required rise of the high current pulse.
- 5.3.2. Provisions concerning the passing-beam
- The system shall, prior to the subsequent test procedures, be set to the neutral state, emitting the Class C passing-beam.
- 5.3.2.1. For each side of the system (vehicle) the passing-beam in its neutral state shall produce from at least one lighting unit a "cut-off" as defined in Annex 5 or,
- 5.3.2.1.1. The system shall provide other means, e.g. optical features or temporary auxiliary beams, allowing for unambiguous and correct aiming.
- 5.3.2.1.2. Annex 5 does not apply to the traffic-change function as described in paragraph 4.12.
- 5.3.2.2. The system or part(s) thereof shall be aimed according to the requirements of paragraph 1. of Annex 5 so that the position of the cut-off complies with the requirements indicated in the Table 10.
- If, however, vertical adjustment cannot be performed repeatedly to the required position within the allowed tolerances, the instrumental method of Annex 5, paragraph 2. shall be applied to test compliance with the required minimum quality of the "cut-off" line and to perform the beam vertical adjustment.
- 5.3.2.3. When so aimed, the system or part(s) thereof,
- (a) If its approval is sought solely for provision of the passing-beam, needs to comply with the requirements set out in the relevant paragraphs below;
- (b) If it is intended to provide additional lighting or light signalling functions according to the scope of this Regulation, it shall comply in addition with the requirements set out in the relevant paragraphs below, if not being adjustable independently.
- 5.3.2.4. When emitting a specified mode of the passing-beam, the system shall meet the requirements in the respective section (C, V, E, W) of part A of Table 9 (photometric values) and in Table 10 ($I_{\max}$ and "cut-off" positions), as well as paragraph 1 ("cut-off" requirements) of Annex 5.
- 5.3.2.5. A bending mode may be emitted, provided that:
- 5.3.2.5.1. The system meets the respective requirements of part B of Table 9 (photometric values) and item B of Table 10 ("cut-off" provisions), when measured according to the procedure indicated in paragraph 5.3.4., relevant to the category (either category 1 or category 2) of the bending mode, for which approval is sought;
- 5.3.2.5.2. When the T-signal corresponds to the vehicle's smallest turn radius to the left (or right), the sum of the luminous intensity values provided by all contributors of the right or the left side of the system shall be at least 2 500 cd at one or more points in the zone extending from H-H to 2 degrees below H-H and from 10 to 45 degrees left (or right).

5.3.2.5.3. If approval is sought for a category 1 bending mode, the use of the system is restricted to vehicles where provisions are taken such that the horizontal position of the "kink" of the "cut-off" which is provided by the system, complies with the relevant provisions of paragraph 6.22.7.4.5. (i) of UN Regulation No. 48;

5.3.2.5.4. If approval is sought for a category 1 bending mode, the system is designed so that, in the case of a failure affecting the lateral movement or modification of the illumination, it must be possible to obtain automatically either photometric conditions corresponding to paragraph 5.3.2.4. or a state with respect to the photometric conditions which yields values not exceeding 1 300 cd in the zone IIIb, as defined in Table 11, and at least 3 400 cd in a point of "segment I_{max}";

However, this is not needed if, for positions relative to the system reference axis up to 5 degrees left, at 0,3 degree up from H-H, and greater than 5 degrees left, at 0,57 degree up, a value of 880 cd is in no case exceeded.

5.3.2.6. The system shall be checked on the basis of the relevant instructions of the manufacturer, indicated in the safety concept according to paragraph 3.1.3.3.1.

5.3.2.7. A system or part(s) thereof, designed to meet the requirements of both right-hand and left-hand traffic must, in each of the two setting positions according to paragraph 4.10. meet the requirements specified for the corresponding direction of traffic.

5.3.2.8. The system shall be so made that:

5.3.2.8.1. Any specified passing-beam mode provides at least 2 500 cd at point 50 V from each side of the system;
The mode(s) of the Class V passing-beam are exempted from this requirement;

5.3.2.8.2. Other modes:

When signal inputs according to paragraph 5.3.1.4.3. apply, the requirements of the paragraph 5.3.2. shall be fulfilled.

Table 9

Passing-beam photometric requirements in conjunction with Figure A4-VII

Part A

Tabled requirements expressed in cd			Position / deg.			Passing beam							
			horizontal		vertical	Class C		Class V		Class E		Class W	
	No.	Element	At/ from	to	at	min	max	min	max	min	max	min	max
Part A	1	B 50 L	L 3,43	-	U 0,57	50 ⁽⁴⁾	350	50	350	50	625 ⁽⁷⁾	50	625
	3	BR	R 2,50	-	U 1,00	50 ⁽⁴⁾	1 750	50	880	50	1 750	50	2 650
	4	Segment BRR	R 8,00	R 20	U 0,57	50 ⁽⁴⁾	3 550	-	880	-	3 550	-	5 300
	5	Segment BLL	L 8,00	L 20	U 0,57	50 ⁽⁴⁾	625	-	880	-	880	-	880
	6	P	L 7,00	-	H	63	-	-	-	-	-	63	-
	7	Zone III	As specified in Table 11			-	625	-	625	-	880	-	880

8a	S 50+S 50 LL +S 50 RR ⁽⁵⁾	-	-	U 4,00	190 ⁽⁶⁾	-	-	-	190 ⁽⁶⁾	-	190 ⁽⁶⁾	-
9a	S 100+S 100 LL+S 100 RR ⁽⁵⁾	-	-	U 2,00	375 ⁽⁶⁾	-	-	-	375 ⁽⁶⁾	-	375 ⁽⁶⁾	-
10	50 R	R 1,72	-	D 0,86	-	-	5 100	-	-	-	-	-
11	75 R	R 1,15	-	D 0,57	10 100	-	-	-	15 200	-	20 300	-
12	50 V	V	-	D 0,86	5 100	-	5 100	-	10 100	-	10 100	-
13	50 L	L 3,43	-	D 0,86	3 550	13 200 ⁽⁸⁾	3 550	13 200 ⁽⁸⁾	6 800	-	6 800	26 400 ⁽⁸⁾
14	25 LL	L 16,00	-	D 1,72	1 180	-	845	-	1 180	-	3 400	-
15	25 RR	R 11,00	-	D 1,72	1 180	-	845	-	1 180	-	3 400	-
16	Segment 20 and below	L 3,50	V	D 2,00	-	-	-	-	-	-	-	17 600 ⁽²⁾
17	Segment 10 and below	L 4,50	R 2,00	D 4,00	-	12 300 ⁽¹⁾	-	12 300 ⁽¹⁾	-	12 300 ⁽¹⁾	-	7 100 ⁽²⁾
18	I _{max} ⁽³⁾	-	-	-	16 900	44 100	8 400	44 100	16 900	79 300 ⁽⁷⁾	29 530	70 500 ⁽²⁾

Part B (bending mode): Table 9 applies, however with the lines Nos. 1, 7, 13 and 18 being replaced by those listed hereunder

Part A	1	B50L	L 3,43	-	U 0,57	50 ⁽⁴⁾	530		530			790
	7	Zone III	As specified in Table 11			-	880	-	880	-	880	880
	13	50 L	L 3,43	-	D 0,86	1 700	-	3 400	-	3 400	-	-
	18	I _{max}	-	-	-	10 100	44 100	5 100	44 100	10 100	79 300 ⁽⁷⁾	20 300

Notes: In the Table 9, Part A and B:

- ⁽¹⁾ Max 15 900 cd, if the system is designed to provide also a Class W passing-beam.
- ⁽²⁾ Requirements according to the provisions indicated in Table 12 apply in addition.
- ⁽³⁾ Position requirements according to the provisions of Table 10 ("Segment I_{max}").
- ⁽⁴⁾ The contribution of each side of the system (for segment BLL and BRR: of at least one point), when measured according to the provisions of Annex 4 shall not be less than 50 cd.
- ⁽⁵⁾ Position requirements according to the provisions of Table 13.
- ⁽⁶⁾ One pair of position lamps, being incorporated with the system or being intended to be installed together with the system may be activated according to the indications of the applicant.
- ⁽⁷⁾ Requirements according to the provisions indicated in Table 14 apply in addition.
- ⁽⁸⁾ The max. value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 10

Passing-beam elements angular position/extend, additional requirements

	Beam part designation and requirement	Class C passing-beam		Class V passing-beam		Class E passing-beam		Class W passing-beam	
		Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.
A	Angular position / extend in degrees for segment $I_{\max}$ The maximum luminous intensity in "Segment $I_{\max}$ " as indicated in this Table shall be within the limits as prescribed in Table 9, No. 18.	0,5L to 3R	0,3D to 1,72 D		0,3D to 1,72 D	0,5L to 3R	0,1D to 1,72D	0,5L to 3R	0,3D to 1,72 D
B	The "cut-off" and part(s) of shall: (a) comply with the requirements of paragraph 1. of Annex 5 and								
	(b) be positioned with its "flat horizontal part"		at V = 0,57 D		not above 0,57 D not below 1,3 D		not above 0,23 D ⁽¹⁾ not below 0,57 D		not above 0,23 D not below 0,57 D

Note to Table 10:

⁽¹⁾ Requirements according to the provisions indicated in Table 9 apply in addition.

Table 11

Passing-beam zones III, defining corner points

Angular position in degrees	Corner point No,	1	2	3	4	5	6	7	8
Zone III a for Class C or Class V Passing Beam	horizontal	8 L	8 L	8 R	8 R	6 R	1,5 R	V-V	4 L
	vertical	1 U	4 U	4 U	2 U	1,5 U	1,5 U	H-H	H-H
Zone III b for Class W or Class E Passing Beam	horizontal	8 L	8 L	8 R	8 R	6 R	1,5 R	0,5 L	4 L
	vertical	1 U	4 U	4 U	2 U	1,5 U	1,5 U	0,34 U	0,34 U

Table 12

Additional provisions for Class W passing-beam, expressed in cd

Definition and requirements for segments E, F1, F2, and F3 (not shown in Table 9 and Figure A4-VII of Annex 4).

Not more than 175 cd is allowed: a) on a segment E extending at U 10 deg from L 20 to R 20 deg and b) on three vertical segments F1, F2 and F3 at horizontal positions L10 degrees, V and R 10 degrees, each extending from U 10 to U 60 degrees.

Alternative/ Additional set of requirements for $I_{\max}$, segment 20 and segment 10:

Table 9 Part A or B applies, however with the max requirements in lines No. 16, 17 and 18 being replaced by those indicated hereunder.

If, according to the applicants specification according to paragraph 3.1.3.2.(e) a Class W passing-beam is designed to produce on segment 20 and below it not more than 8 800 cd and on segment 10 and below it not more than 3 550 cd, the design value for $I_{\max}$ of that beam shall not exceed 88 100 cd.

Table 13

Overhead sign requirements, angular position of measurement points

Point designation	S 50 LL	S 50	S 50 RR	S 100 LL	S 100	S 100 RR
Angular position in degrees	4 U / 8 L	4 U / V-V	4 U / 8 R	2 U / 4 L	2 U / V-V	2 U / 4 R

Table 14

Additional provisions for Class E passing-beam

Table 9, Part A or B and Table 10 apply, however with the lines No.1 and 18 of Table 9 and item B of Table 10 being replaced as indicated hereunder

Designation	Line 1 of Table 9, Part A or B	No.18 of Table 9, Part A or B	Item B of Table 10
Data Set	EB 50 L in cd	$I_{\max}$ in cd	cut-off flat part aimed in degrees
	max	max	not above
E1	530	70 500	0,34 D
E2	440	61 700	0,45 D
E3	350	52 900	0,57 D

Table 15

Requirements concerning the adaptation of the driving-beam according to paragraph 5.3.3.7.

Part A	Test point	Position / Deg,		Max, intensity (**)
		Horizontal	Vertical	(cd)
	Line 1 Left Oncoming vehicle at 50 m in the case of right-hand traffic	4,8°L to 2°L	0,57°Up	625
	Line 1 Right Oncoming vehicle at 50 m in the case of left-hand traffic	2°R to 4,8°R	0,57°Up	625
	Line 2 Left Oncoming vehicle at 100 m in the case of right-hand traffic	2,4°L to 1°L	0,3°Up	1 750
	Line 2 Right Oncoming vehicle at 100 m in the case of left-hand traffic	1°R to 2,4°R	0,3°Up	1 750
	Line 3 Left Oncoming vehicle at 200 m in the case of right-hand traffic	1,2°L to 0,5°L	0,15°Up	5 450
	Line 3 Right Oncoming vehicle at 200 m in the case of left-hand traffic	0,5°R to 1,2°R	0,15°Up	5 450
	Line 4 Preceding vehicle at 50 m in the case of right-hand traffic	1,7°L to 1,0°R	0,3°Up	1 850
		>1,0° R to 1,7°R		2 500
	Line 4 Preceding vehicle at 50 m in the case of left-hand traffic	1,7°R to 1,0°L		1 850
		>1,0° L to 1,7°L		2 500
	Line 5 Preceding vehicle at 100 m in the case of right-hand traffic	0,9° L to 0,5°R	0,15°Up	5 300
		>0,5°R to 0,9°R		7 000
	Line 5 Preceding vehicle at 100 m in the case of left-hand traffic	0,9° R to 0,5°L		5 300
		>0,5°L to 0,9°L		7 000
	Line 6 Preceding vehicle at 200 m in the case of left-hand traffic and right-hand traffic	0,45°L to 0,45°R	0,1°Up	16 000
Part B	Test Point	Position /degrees (*)		Min. Intensity (**)
		Horizontal	Vertical	(cd)
	50R	1,72 R	D 0,86	5 100
	50V	V	D 0,86	5 100
	50L	3,43 L	D 0,86	2 550
	25LL	16 L	D 1,72	1 180
	25RR	11 R	D 1,72	1 180

(*) Angular positions are indicated for right-hand traffic.

(**) The photometric requirements for each single measuring point (angular position) of this lighting function apply to half of the sum of the respective measured values from all lighting units of the system applied for this function.

Each of the lines defined in part A of Table 15, in conjunction with the test points as prescribed in part B of Table 15 shall be measured individually corresponding to the signal provided by the signal generator.

In the case where the passing-beam, which meets the requirements of paragraph 5.3.2., is continuously operated in conjunction with the adaptation of the driving-beam, the photometric requirements in Part B of the Table 15 shall not be applied.

5.3.3. Provisions concerning the driving-beam

The system shall, prior to the subsequent test procedures, be set to the neutral state.

5.3.3.1. The lighting unit(s) of the system shall be adjusted, according to the instructions of the manufacturer, such that the area of maximum illumination is centred on the point (HV) of intersection of the lines H-H and V-V;

5.3.3.1.1. Any lighting unit(s) which is/are not independently adjustable, or, for which the aiming was done with respect to any measurements under paragraphs 5.3.2., shall be tested in its/their unchanged position.

5.3.3.2. When measured according to the provisions laid down in paragraph 5.1. the luminous intensity shall meet the requirements of Class B in Table 5 and of paragraph 5.1.3.4.

5.3.3.3. The illumination or part thereof emitted by an AFS may be automatically laterally moved (or modified to obtain an equivalent effect), provided that:

5.3.3.3.1. The system meets the requirements of the paragraphs 5.1.3.1. class B and 5.1.3.4. above with each lighting unit measured according to the relevant procedure indicated in paragraph 5.3.4.

5.3.3.4. The system shall be so made that:

5.3.3.4.1. The lighting unit(s) of the right side and of the left side each provide at least 16 200 cd at the point HV:

5.3.3.5. If the specified beam requirements are not met, a re-aiming of the beam position within 0,5 degree up or down and/or 1 degree to the right or left, with respect to its initial aiming is allowed; in the revised position all photometric requirements shall be met. These provisions do not apply to lighting units as indicated under paragraph 5.3.3.1.1.

5.3.3.6. In the case of adaptation of the driving-beam function the system shall meet the requirements of the above paragraphs only when it is in the maximum condition of activation.

5.3.3.7. During adaptation, the driving-beam function shall meet the requirements for all the cases of right-hand and left-hand traffic specified in Part A of Table 15. These requirements shall be verified during the type approval testing in conjunction with a signal generator to be provided by the applicant. This signal generator shall reproduce the signals provided by the vehicle and cause the adaptation of the driving-beam and in particular shall represent the settings so that the photometric compliance can be verified.

- 5.3.3.7.1. If the driving-beam function meets the requirements in Part A of Table 15 specified for line 1 to line 3 for oncoming and preceding vehicles (symmetrical beam) the relevant information shall be noticed in the communication document in Annex 1.
- 5.3.3.7.2. If the requirements of paragraph 5.3.3.7. can be met for right-hand traffic or left-hand traffic only, the relevant information shall be reported in the communication document in Annex 1.
- 5.3.4. Measurement conditions with respect to bending modes
- 5.3.4.1. In the case of a system or part(s) thereof, which provide a bending mode, the requirements of paragraphs 5.3.2. (passing-beam), and /or 5.3.3. (driving-beam) apply for all states, corresponding to the turn radius of the vehicle. For verification with respect to the passing-beam and the driving-beam the following procedure shall be used:
- 5.3.4.1.1. The system shall be tested in the neutral state (central/straight), and, in addition in the state(s) corresponding to the smallest turn radius of the vehicle in both directions using the signal generator, if applicable.
- 5.3.4.1.1.1. Compliance with the requirements of paragraphs 5.3.2.5.2. and 5.3.2.5.4. shall be checked for both category 1 and category 2 bending modes without additional horizontal re-aim.
- 5.3.4.1.1.2. Compliance with the requirements of paragraphs 5.3.2.5.1. and 5.3.3., whichever applies, shall be checked:
- (a) In case of a category 2 bending mode: without additional horizontal re-aim;
 - (b) In case of a category 1 or a driving-beam bending mode: after having horizontally re-aimed the relevant installation unit (by means of the goniometer for example) in the corresponding opposite direction.
- 5.3.4.1.2. When testing a category 1 or category 2 bending mode, for a turn radius of the vehicle other than specified in paragraph 5.3.4.1.1. it shall be observed whether the light distribution is substantially uniform and no undue glare occurs. If this cannot be confirmed the compliance with the requirement laid down in Table 9 shall be checked.
- 5.3.5. Other provisions
- 5.3.5.1. It shall be stated by means of a form conforming to the model in Annex 1, which lighting unit(s) provide a "cut-off" as defined in Annex 5, that projects into a zone extending from 6 degrees left to 4 degrees right and upwards from a horizontal line positioned at 0,8 degrees down.
- 5.3.5.2. It shall be stated by means of a form conforming to the model in Annex 1, which Class E passing-beam mode(s), if any, comply with a "data set" of Table 14.
- 5.3.6. Photometric requirements for conformity of production
- 5.3.6.1. General
- The general requirements for the Production Conformity tests are defined in Annex 2 and Annex 3. Additionally the specific tests described in relation to the photometric requirements concerning adaptive front-lighting systems (AFS) shall apply as described below.
- These requirements apply only for the entire system and apply to half of the sum of the respective measured values from all lighting units of the system applied for this function or mode, or, from all lighting units as indicated in the respective requirement.

As an alternative to the re-alignment procedure as described in paragraph 1.2.3. of Annex 2, the intensity requirement of column A, B or C of Tables 17 to 32 for a particular direction of observation shall be deemed to be satisfied if that requirement is met in a direction deviating by not more than one-quarter of a degree from the direction of observation.

5.3.6.2. Passing Beam Photometric Requirements

Table 16

Decision Table

	"Multiple Modes"- Condition (*) if more than one mode of the applicable Class exist only the mode which represents the worst condition has to be tested in non-bending mode in accordance with the requirements of the corresponding table indicated below	"Bending Modes" - Condition if the system uses the same functional units to obtain bending modes for more than one class:	
		Yes	No
Class C	Table 17 (*)		
Category 1 bending mode	→	(**) the bending modes shall only be tested in the Class which represents the worst condition	Table 18
Category 2 bending mode		Test category 2 bending mode according to Table 19	
Class V Non Bending Mode	Table 20 (*)		
Class V Category 1 bending mode	→	see (**)	Table 21
Class V Category 2 bending mode			Table 22
Class W Non-bending mode	Table 23 (*)		
Class W Category 1 bending mode	→	see (**)	Table 24
Class W Category 2 bending mode			Table 25
Class E	if more than one mode of Class E exists only the mode Class E which relates to the highest cut-off position has to be tested in non-bending mode according to corresponding Table 26 to Table 29	No additional testing of Category 1 and/or Category 2 is necessary	

5.3.6.3. Driving Beam Photometric Requirements

5.3.6.3.1. Driving Beam – Neutral State

If there is more than one mode of the driving beam only the mode corresponding to the neutral state shall be tested for CoP according to Table 30

5.3.6.3.1.1. Driving Beam –bending mode –if applicable:

If the system uses the same functional units to obtain bending modes for more than one class, no further testing of the bending modes of Category 1 and/or Category 2) is necessary

If not, the system shall be tested according to Table 31.

5.3.6.3.2. Adaptive Driving Beam–if applicable:

During adaptation, the driving-beam function shall meet the requirements for all the cases of Right-Hand and/or Left-Hand traffic specified in Part A of Table 32

If the system uses the same functional units for the adaptation of the driving beam only Line 1 and Line 4 of Table 32 have to be measured.

In the case where the passing beam, which meets the requirements of 5.3.6.2 is continuously operated in conjunction with the adaptation of the driving beam, the photometric requirements in Part B Table 32 shall not be applied.

Table 17

Class C – Neutral State – System Requirements

Class C – non-bending mode		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd.		horizontal				vertical		≅ 0% CoP		≅ 20% CoP		≅ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57	50	350	25	520	10	605
3	BR	R	2,5			U	1	50	1 750	25	2 100	10	2 275
4	Point BRR	R	8			U	0,57	50	3 550	25	4 260	10	4 615
5	Point BLL	L	8			U	0,57	50	625	25	880	10	1 005
7	Line III	L	4	V	V	H			625		880		1 005
8a	S50+S50LL+S50RR ⁽³⁾					U	4	190 ⁽²⁾	1 875	95 ⁽²⁾	2 250	45 ⁽²⁾	2 440
9a	S100+S100LL+S100RR ⁽³⁾					U	2	375 ⁽²⁾	1 875	185 ⁽²⁾	2 250	90 ⁽²⁾	2 440
10	50 R	R	1,72			D	0,86		44 100		52 920		57 330
11	75 R	R	1,15			D	0,57	10 100	44 100	8 080	52 920	7 070	57 330
12	50 V	V				D	0,86	5 100	44 100	4 080	52 920	3 570	57 330
13	50 L	L	3,43			D	0,86	3 550	13 200 ⁽⁴⁾	2 840	15 840 ⁽⁴⁾	2 485	17 160 ⁽⁴⁾
14	25 LL	L	16			D	1,72	1 180	44 100	944	52 920	826	57 330
15	25 RR	R	11			D	1,72	1 180	44 100	944	52 920	826	57 330
17	Line 10	L	4,5	R	2,0	D	4		12 300 ⁽¹⁾		14 760 ⁽¹⁾		15 990 ⁽¹⁾

Notes to Table 17:

- ⁽¹⁾ Shall be multiplied by 1,3, if the system is designed to provide also a class W passing beam.
- ⁽²⁾ One pair of position lamps, being incorporated with the system or being intended to be installed together with the system may be activated according to the indications of the applicant.
- ⁽³⁾ Position requirements according to the provisions of Figure A4-VII.
- ⁽⁴⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 18

Class C – Bendlight – Category 1 – System Requirements

Class C – Bendlight Cat. 1		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		530		700		785
3	BR	R	2,5			U	1		1 750		2 100		2 275
4	Point BRR	R	8			U	0,57		3 550		4 260		4 615
5	Point BLL	L	8			U	0,57		625		880		1 005
7	Line III	L	4	V	V	H			880		1 135		1 260
10	50 R	R	1,72			D	0,86		44 100		52 920		57 330
11	75 R	R	1,15			D	0,57	10 100	44 100	8 080	52 920	7 070	57 330
12	50 V	V				D	0,86	5 100	44 100	4 080	52 920	3 570	57 330
13	50 L	L	3,43			D	0,86	1 700	13 200 ⁽¹⁾	2 840	15 840 ⁽¹⁾	2 485	17 160 ⁽¹⁾

Note to Table 18:

- ⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 19

Class C – Bendlight – Category 2 – System Requirements

Class C – Bendlight Cat. 2		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		530		700		785
3	BR	R	2,5			U	1		1 750		2 100		2 275
4	Line BRR	R	8	R	20	U	0,57		3 550		4 260		4 615

Class C – Bendlight Cat. 2		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
5	Line BLL	L	8	L	20	U	0,57		625		880		1 005
7	Line III	L	4	V	V	H			880		1 135		1 260

Table 20

Class V – non-bending mode – System Requirements

Class V -non-bending mode		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		350		520		605
3	BR	R	2,5			U	1		880		1 135		1 260
4	Point BRR	R	8			U	0,57		880		1 135		1 260
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III	L	4	V	V	H			625		880		1 005
10	50 R	R	1,72			D	0,86	5 100	44 100	4 080	52 920	3 570	57 330
13	50 L	L	3,43			D	0,86	3 550	13 200 ⁽¹⁾	2 840	15 840 ⁽¹⁾	2 485	17 160 ⁽¹⁾

Note to Table 20:

⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 21

Class V – Bendlight – Category 1 – System Requirements

Class V – Bendlight Cat. 1		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		530		700		785
3	BR	R	2,5			U	1		880		1 135		1 260
4	Point BRR	R	8			U	0,57		880		1 135		1 260
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III	L	4	V	V	H			880		1 135		1 260
10	50 R	R	1,72			D	0,86	5 100	44 100	4 080	52 920	3 570	57 330
13	50 L	L	3,43			D	0,86	1 700	13 200 ⁽¹⁾	2 840	15 840 ⁽¹⁾	2 485	17 160 ⁽¹⁾

Note to Table 21:

- ⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, of the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 22

Class V – Bendlight – Category 2 – System Requirements

Class V – Bendlight Cat. 2		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		530		700		785
3	BR	R	2,5			U	1		880		1 135		1 260
4	Line BRR	R	8	R	20	U	0,57		880		1 135		1 260
5	Line BLL	L	8	L	20	U	0,57		880		1 135		1 260
7	Line III	L	4	V	V	H			880		1 135		1 260

Table 23

Class W – Non-bending mode – System Requirements

Class W – non-bending mode		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		625		880		1 005
3	BR	R	2,5			U	1		2 650		3 180		3 445
4	Point BRR	R	8			U	0,57		5 300		6 360		6 890
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260
11	75 R	R	1,15			D	0,57	20 300	70 500 ⁽¹⁾	16 240	84 600 ⁽¹⁾	14 210	91 650 ⁽¹⁾
13	50 L	L	3,43			D	0,86	6 800	26 400 ⁽²⁾	5 440	31 680 ⁽²⁾	4 760	34 320 ⁽²⁾
14	25 LL	L	16			D	1,72	3 400	70 500 ⁽¹⁾	2 720	84 600 ⁽¹⁾	2 380	91 650 ⁽¹⁾
15	25 RR	R	11			D	1,72	3 400	70 500 ⁽¹⁾	2 720	84 600 ⁽¹⁾	2 380	91 650 ⁽¹⁾
16	Segment 20	L	3,5	V		D	2		17 600 ¹		21 120 ⁽¹⁾		22 880 ⁽¹⁾
17	Segment 10	L	4,5	R	2,0	D	4		12 300 ⁽¹⁾		14 760 ⁽¹⁾		15 990 ⁽¹⁾
	Line E	L	20	R	20	U	10		175		260		300

Notes to Table 23:

- ⁽¹⁾ If, according to the applicants specification according to paragraph 3.1.3.2. (e) of this Regulation a class W passing beam is designed to produce on segment 20 and below it not more than 8 800 cd (10 560 cd corresponds to 20% CoP, 11 440 cd corresponds to 30% CoP) and on segment 10 and below it not more than 3 550 cd (4 260 cd corresponds to 20% CoP and 4 615 cd corresponds to 30% CoP), the design value for $I_{\max}$ of that beam shall not exceed 88 100 cd (105 720 corresponds to 20% CoP, 114 530 cd corresponds to 30% CoP).
- ⁽²⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 24

Class W – Bendlight – Category 1 – System Requirements

Class W – Bendlight Cat. 1		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		790		960		1 045
3	BR	R	2,5			U	1		2 650		3 180		3 445
4	Point BRR	R	8			U	0,57		5 300		6 360		6 890
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260
11	75 R	R	1,15			D	0,57	20 300	70 500 ¹	16 240	84 600 ¹	14 210	91 650 ⁽¹⁾
13	50 L	L	3,43			D	0,86	3 400	13 200 ⁽²⁾	2 720	15 840 ⁽²⁾	2 380	17 160 ⁽²⁾

Notes to Table 24:

- ⁽¹⁾ If, according to the applicants specification according to paragraph 3.1.3.2 (e) of this Regulation a class W passing beam is designed to produce on segment 20 and below it not more than 8 800 cd (10 560 cd corresponds to 20% CoP, 11 440 cd corresponds to 30% CoP) and on segment 10 and below it not more than 3 550 cd (4 260 cd corresponds to 20% CoP and 4 615 cd corresponds to 30% CoP), the design value for $I_{\max}$ of that beam shall not exceed 88 100 cd (105 720 corresponds to 20% CoP, 114 530 cd corresponds to 30% CoP).
- ⁽²⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 25

Class W – Bendlight – Category 2 – System Requirements

Class W – Bendlight Cat. 2		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		790		960		1 045
3	BR	R	2,5			U	1		2 650		3 180		3 445
4	Line BRR	R	8	R	20	U	0,57		5 300		6 360		6 890
5	Line BLL	L	8	L	20	U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260

Table 26

Class E – Non-bending mode

Class E - non-bending mode		Position/deg						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		625		880		1 005
3	BR	R	2,5			U	1		1 750		2 100		2 275
4	Point BRR	R	8			U	0,57		3 550		2 100		2 275
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260
11	75 R	R	1,15			D	0,57	15 200	79 300	12 160	95 160	10 640	103 090
12	50 V	V				D	0,86	10 100	79 300	8 080	95 160	7 070	103 090
13	50 L	L	3,43			D	0,86	6 800	79 300 ⁽¹⁾	5 440	95 160 ⁽¹⁾	4 760	103 090 ⁽¹⁾

Note to Table 26:

⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 27

Class E1 – Non-bending mode State

Class E1 – non-bending mode		Position/degrees						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		530		700		785
3	BR	R	2,5			U	1		1 750		2 100		2 275
4	Point BRR	R	8			U	0,57		3 550		2 100		2 275
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260
11	75 R	R	1,15			D	0,57	15 200	70 500	12 160	84 600	10 640	91 650
12	50 V	V				D	0,86	10 100	70 500	8 080	84 600	7 070	91 650
13	50 L	L	3,43			D	0,86	6 800	70 500 ⁽¹⁾	5 440	84 600 ⁽¹⁾	4 760	91 650 ⁽¹⁾

Note to Table 27:

⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form

Table 28

Class E2 – Non-bending mode

Class E2 – non-bending mode		Position/degrees						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		440		610		695
3	BR	R	2,5			U	1		1 750		2 100		2 275
4	Point BRR	R	8			U	0,57		3 550		2 100		2 275
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260
11	75 R	R	1,15			D	0,57	15 200	61 700	12 160	74 040	10 640	80 210
12	50 V	V				D	0,86	10 100	61 700	8 080	74 040	7 070	80 210
13	50 L	L	3,43			D	0,86	6 800	61 700 ⁽¹⁾	5 440	74 040 ⁽¹⁾	4 760	80 210 ⁽¹⁾

Note to Table 28:

- ⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 29

Class E3 – Non-bending mode

Class E3 - non-bending mode		Position/degrees						Column A		Column B		Column C	
Tabled requirements expressed in cd		horizontal				vertical		$\triangleq$ 0% CoP		$\triangleq$ 20% CoP		$\triangleq$ 30% CoP	
No	Element	at/	from	to		at		min	max	min	max	min	max
1	B50L	L	3,43			U	0,57		350		520		605
3	BR	R	2,5			U	1		1 750		2 100		2 275
4	Point BRR	R	8			U	0,57		3 550		2 100		2 275
5	Point BLL	L	8			U	0,57		880		1 135		1 260
7	Line III b	L	4	L	0,5	U	0,34		880		1 135		1 260
11	75 R	R	1,15			D	0,57	15 200	52 900	12 160	63 480	10 640	68 770
12	50 V	V				D	0,86	10 100	52 900	8 080	63 480	7 070	68 770
13	50 L	L	3,43			D	0,86	6 800	52 900 ⁽¹⁾	5 440	63 480 ⁽¹⁾	4 760	68 770 ⁽¹⁾

Note to Table 29:

- ⁽¹⁾ The maximum value may be multiplied by 1,4, if it is guaranteed according to the manufacturer's description that this value will not be exceeded in use, either by means of the system or, if the system's use is confined to vehicles, providing a corresponding stabilization/limitation of the system's supply, as indicated in the communication form.

Table 30

Class R – Driving – Neutral State – System Requirements

		Column A		Column B		Column C	
Driving Beam Straight Ahead Test Point	Angular Coordinates (degrees)	Required luminous intensity (cd) $\triangleq$ 0% CoP		Required luminous intensity (cd) $\triangleq$ 20% CoP		Required luminous intensity (cd) $\triangleq$ 30% CoP	
		Min	Max	Min	Max	Min	Max
HV	H,V	32 400	215 000	26 000	258 000	23 000	279 500
H-5L	0,0, 5,0 L	5 100	215 000	4 080	258 000	3 570	279 500
H-2.5L	0,0, 2,5 L	20 300	215 000	16 240	258 000	14 210	279 500
H-2.5R	0,0, 2,5 R	20 300	215 000	16 240	258 000	14 210	279 500
H-5R	0,0, 5,0 R	5 100	215 000	4 080	258 000	3 570	279 500

Table 31

Class R – Driving Beam Bendlight – System Requirements

		Column A		Column B		Column C	
Driving Beam Bendlight Test Point	Angular Coordinates (degrees)	Required luminous intensity (cd) $\triangleq$ 0% CoP		Required luminous intensity (cd) $\triangleq$ 20% CoP		Required luminous intensity (cd) $\triangleq$ 30% CoP	
		Min	Max	Min	Max	Min	Max
HV	H,V	32 400	215 000	26 000	258 000	23 000	279 500
H-5L	0,0, 5,0 L	5 100	215 000	4 080	258 000	3 570	279 500
H-2.5L	0,0, 2,5 L	20 300	215 000	16 240	258 000	14 210	279 500
H-2.5R	0,0, 2,5 R	20 300	215 000	16 240	258 000	14 210	279 500
H-5R	0,0, 5,0 R	5 100	215 000	4 080	258 000	3 570	279 500

Table 32

Class R – Adaptive Driving Beam – COP Values

	Test Point	Position/Deg.		Column A	Column B	Column C
		Horizontal	Vertical	Max, Intensity (**) $\triangleq$ 0% CoP (cd)	Max, Intensity (**) $\triangleq$ 20% CoP (cd)	Max, Intensity (**) $\triangleq$ 30% CoP (cd)
Part A	Line 1 Left Oncoming vehicle at 50 m in the case of Right-Hand Traffic	4,8°L to 2°L	0,57°Up	625	880	1 003
	Line 1 Right Oncoming vehicle at 50 m in the case of Left-Hand Traffic	2°R to 4,8°R	0,57°Up	625	880	1 003
	Line 2 Left Oncoming vehicle at 100 m in the case of Right-Hand Traffic	2,4°L to 1°L	0,3°Up	1 750	2 100	2 275
	Line 2 Right Oncoming vehicle at 100 m in the case of Left-Hand Traffic	1°R to 2,4°R	0,3°Up	1 750	2 100	2 275
	Line 3 Left Oncoming vehicle at 200 m in the case of Right-Hand Traffic	1,2°L to 0,5°L	0,15°Up	5 450	6 540	7 085
	Line 3 Right Oncoming vehicle at 200 m in the case of Left-Hand Traffic	0,5°R to 1,2°R	0,15°Up	5 450	6 540	7 085
	Line 4 Preceding vehicle at 50 m in the case of Right-Hand Traffic	1,7°L to 1,0°R	0,3°Up	1 850	2 220	2 405
		>1,0°R to 1,7°R		2 500	3 000	3 250
	Line 4 Preceding vehicle at 50 m in the case of Left-Hand Traffic	1,7°R to 1,0°L		1 850	2 220	2 405
		>1,0°L to 1,7°L		2 500	3 000	3 250
	Line 5 Preceding vehicle at 100 m in the case of Right-Hand Traffic	0,9°L to 0,5°R	0,15°Up	5 300	6 360	6 890
		>0,5°R to 0,9°R		7 000	8 400	9 100
	Line 5 Preceding vehicle at 100 m in the case of Left-Hand Traffic	0,9°R to 0,5°L		5 300	6 360	6 890
		>0,5°L to 0,9°L		7 000	8 400	9 100
	Line 6 Preceding vehicle at 200 m in the case of Left-Hand Traffic and Right-Hand Traffic	0,45°L to 0,45° R	0,1°Up	16 000	19 200	20 800

Part B	Test Point	Position /degrees(*)		Column A	Column B	Column C
		Horizontal	Vertical	Min. Intensity (**) $\triangleq$ 0% CoP	Min. Intensity (**) $\triangleq$ 20% CoP	Min. Intensity (**) $\triangleq$ 30% CoP
				(cd)	(cd)	(cd)
	50R	1,72 R	0,86 D	5 100	4 080	3 570
	50V	V	0,86 D	5 100	4 080	3 570
	50L	3,43 L	0,86 D	2 550	2 040	1 785
	25LL	16 L	1,72 D	1 180	944	826
	25RR	11 R	1,72 D	1 180	944	826

Notes to Table 32

(*) Angular positions are indicated for right-hand traffic.

(**) The photometric requirements for each single measuring point (angular position) of this lighting function apply to half of the sum of the respective measured values from all lighting units of the system applied for this function. Each of the lines defined in part A of Table 32, in conjunction with the test points as prescribed in part B of Table 32 shall be measured individually corresponding to the signal provided by the signal generator.

In the case where the passing beam, which meets the requirements of paragraph 5.3.6.2., is continuously operated in conjunction with the adaptation of the driving beam, the photometric requirements in Part B of Table 32 shall not be applied.

5.4. Technical requirements concerning headlamps to provide a passing-beam of the Class AS, BS, CS, DS and ES (symbols "C-AS", "C-BS", "WC-CS", "WC-DS" and "WC-ES")

5.4.1. Aiming procedure

5.4.1.1. For a correct aiming the passing beam shall produce a sufficiently sharp "cut-off" to permit a satisfactory visual adjustment with its aid as indicated in paragraph 1 of Annex 6. The aiming shall be carried out using a flat vertical screen set up at a distance of 10 or 25 m forward of the headlamp and at right angles to the H-V. The screen shall be sufficiently wide to allow examination and adjustment of the "cut-off" of the passing beam over at least 3° on either side of the V-V line. The "cut-off" shall be substantially horizontal and shall be as straight as possible from at least 3° L to 3° R.

5.4.1.2. The headlamp shall be aimed according to paragraph 3. of Annex 6.

If, however, vertical adjustment cannot be performed repeatedly to the required position within the allowed tolerances, the instrumental method of Annex 6, paragraphs 4 and 5 shall be applied to test compliance with the required minimum quality of the "cut-off" line and to perform the beam vertical adjustment.

5.4.2. When so aimed, the headlamp must, if its approval is sought solely for provision of a passing beam, ⁽¹⁾ comply with the requirements set out in paragraphs 5.4.4.; if it is intended to provide both a passing beam and a driving beam, it shall comply with the requirements set out in paragraphs 5.4.4. and 5.1.

5.4.3. Where a headlamp so aimed does not meet the requirements set out in paragraphs 5.4.4. and 5.1., its alignment may be changed, except for headlamps that have no mechanism to adjust horizontal aim, on condition that the axis of the beam is not displaced laterally by more than 0,5 degree to the right or left and vertically by not more than 0,25 degree up or down. To facilitate alignment by means of the "cut-off", the headlamp may be partially occluded in order to sharpen the "cut-off". However, the "cut-off" should not extend beyond the line H-H.

⁽¹⁾ Such a special "passing beam" headlamp may incorporate a driving beam not subject to requirements.

- 5.4.4. The passing beam shall meet the requirements as shown in the applicable table below and the applicable figure as shown in Annex 4.

Notes:

For Class ES headlamps the voltage applied to the terminals of the ballast(s) is either $13,2\text{ V} \pm 0,1\text{ V}$ for 12 V systems or as otherwise specified (see Annex 12).

"D" means under the H-H line.

"U" means above the H-H line.

"R" means right of the V-V line.

"L" means left of the V-V line.

- 5.4.4.1. For Class AS headlamps (Figure A4-VIII in Annex 4):

Table 33

Passing-beam Class AS

Test point / line / zone	Angular coordinates - degrees(*)		Required luminous intensity in cd
Any point in Zone 1	0° à 15° U	5° L à 5° R	≤ 320 cd
Any point on line 25L to 25R	1,72° D	5° L à 5° R	≥ 1 100 cd
Any point on line 12.5L to 12.5R	3,43° D	5° L à 5° R	≥ 550 cd

Note to Table 33

(*) 0,25° tolerance allowed independently at each test point for photometry unless indicated otherwise.

- 5.4.4.2. For Class BS headlamps (Figure A4-IX in Annex 4):

Table 34

Passing-beam Class BS

Test/point/ line/zone	Angular coordinates - degrees(*)		Required luminous intensity in cd
Any point in Zone 1	0° à 15° U	5° L à 5° R	≤ 700 cd
Any point on line 50L to 50R except 50V	0,86° D	2,5° L à 2,5° R	≥ 1 100 cd
Point 50V	0,86° D	0	≥ 2 200 cd
Any point on line 25L to 25R	1,72° D	5° L to 5° R	≥ 2 200 cd
Any point in Zone 2	0,86° D to 1,72° D	5° L to 5° R	≥ 1 100 cd

Note to Table 34

(*) 0,25° tolerance allowed independently at each test point for photometry unless indicated otherwise.

5.4.4.3. For Class CS, DS or ES headlamp (Figure A4-X in Annex 4):

Table 35

Passing-beam Class CS, DS or ES

Test point / line / zone	Test point angular coordinates degrees(*)		Required luminous intensity in cd			
			Minimum			Maximum
			ClassCS	ClassDS	Class ES	Classes CS, DS, ES
1	0,86°D	3,5°R	2 000	2 000	2 500	13 750
2	0,86°D	0	2 450	4 900	4 900	–
3	0,86°D	3,5°L	2 000	2 000	2 500	13 750
4	0,50°U	1,50°L and 1,50°R	–	–	–	900
5	2,00°D	15°L and 15°R	550	1 100	1 100	–
6	4,00°D	20°L and 20°R	150	300	600	–
7	0	0	–	–	–	1 700
Line 1	2,00°D	9°L to 9°R	1 350	1 350	1 900	–
8(**)	4,00°U	8,0°L	$\Sigma 8 + 9 + 10 \geq 150 \text{ cd}^{(**)}$			700
9(**)	4,00°U	0				700
10(**)	4,00°U	8,0°R				700
11(**)	2,00°U	4,0°L	$\Sigma 11 + 12 + 13 \geq 300 \text{ cd}^{(**)}$			900
12(**)	2,00°U	0				900
13(**)	2,00°U	4,0°R				900
14(**)	0	8,0°L and 8,0°R	50 cd(**)	50 cd(**)	50 cd(**)	–
15(**)	0	4,0°L and 4,0°R	100 cd(**)	100 cd(**)	100 cd(**)	900
Zone 1	1°U/8°L-4°U/8°L-4°U/8°R-1°U/8°R-0/4°R-0/1°R-0,6°U/0-0/1°L-0/4°L-1°U/8°L		–	–	–	900
Zone 2	>4U to <15 U	8°L to 8°R	–	–	–	700

Notes to Table 35

(*) 0,25° tolerance allowed independently at each test point for photometry unless indicated otherwise.

(**) On request of the applicant during measurement of these points, the front position lamp approved to UN Regulation No. 50, UN Regulation No. 7 or UN Regulation No. 148; if combined, grouped, or reciprocally incorporated-shall be switched ON.

5.4.4.3.1. Four seconds after ignition of a passing-beam of Class ES which has not been operated for 30 minutes or more, at least 3 750 cd must be reached at point 2 (0,86D-V) for headlamps incorporating driving-beam and passing-beam functions or having only a passing-beam function.

The power supply shall be sufficient to secure the required rise of the high current pulse.

- 5.4.4.4. The light shall be as evenly distributed as possible within zones 1 and 2 for Class CS, DS or ES headlamps.
- 5.4.4.5. Either one or two filament light sources (Classes AS, BS, CS, DS) or one gas discharge light source (Class ES) or one or more LED light source(s) or LED module(s) (Classes AS, BS, CS, DS, ES) are permitted for the passing beam.
- 5.4.5. Additional light source(s) and/or additional lighting unit(s) used to produce bend lighting is (are) permitted for vehicles of categories L and T, provided that:
- 5.4.5.1. The following requirement regarding illumination shall be met, when the principal passing beam(s) and corresponding additional light source(s) used to produce bend lighting are activated simultaneously:
- (a) Left bank (when the motorcycle is rotated to the left about its longitudinal axis) the luminous intensity values shall not exceed 900cd in the zone extending from HH to 15 deg above HH and from VV to 10 deg left.
 - (b) Right bank (when the motorcycle is rotated to the right about its longitudinal axis) the luminous intensity values shall not exceed 900cd in the zone extending from HH to 15 deg above HH and from VV to 10 deg right.
- 5.4.5.2. This test shall be carried out with the minimum bank angle specified by the applicant simulating the condition by means of the test fixture etc.
- 5.4.5.3. For this measurement, at the request of the applicant, principal passing beam and additional light source(s) used to produce bend lighting, may be measured individually and the photometric values obtained combined to determine compliance with the specified luminous intensity values.
- 5.5. Technical requirements concerning front fog lamps of the Class F3 (symbol "F3")
- 5.5.1. Photometric adjustment and measuring conditions
- 5.5.1.1. The front fog lamp shall be aimed according to Annex 6 paragraph 3.
If, however, vertical adjustment cannot be performed repeatedly to the required position within the allowed tolerances, the instrumental method of Annex 6, paragraphs 4. and 5. shall be applied to test compliance with the required minimum quality of the "cut-off" line and to perform the beam vertical adjustment.
- 5.5.1.2. The front fog lamp shall meet the requirements as shown in Table 36 and Figure A4-XI in Annex 4.
- 5.5.2. Photometric requirements
When so adjusted, the front fog lamp shall meet the photometric requirements in Table 36 (refer also to Figure A4-XI of Annex 4):

Table 36

Type approval photometric requirements for front fog lamp

Designated lines or zones	Vertical position(*) above h + below h -	Horizontal position(*) left of v: -right of v: +	Luminous intensity (in cd)	To comply
Point 1, 2(**)	+60°	±45°	85 max	All points
Point 3, 4(**)	+40°	±30°		
Point 5, 6(**)	+30°	±60°		
Point 7, 10(**)	+20°	±40°		
Point 8, 9(**)	+20°	±15°		

Designated lines or zones	Vertical position(*) above h + below h -	Horizontal position(*) left of v: -right of v: +	Luminous intensity (in cd)	To comply
Line 1(**)	+8°	-26° to +26°	130 max	All line
Line 2(**)	+4°	-26° to +26°	150 max	All line
Line 3	+2°	-26° to +26°	245 max	All line
Line 4	+1°	-26° to +26°	360 max	All line
Line 5	0°	-10° to +10°	485 max	All line
Line 6 (***)	-2,5°	-10° to +10°	2 700 min	All line
Line 7 (***)	-6,0°	-10° to +10°	< 50 per cent of max. on line 6	All line
Line 8L and R(***)	-1,5° to -3,5°	-22° and +22°	1 100 min	One or more points
Line 9L and R(***)	-1,5° to -4,5°	-35° and +35°	450 min	One or more points
Zone D(***)	-1,5° to -3,5°	-10° to +10°	12 000 max	Whole zone

Notes to Table 36

(*) The co-ordinates are specified in degrees for an angular web with a vertical polar axis.

(**) See paragraph 5.5.2.4.

(***) See paragraph 5.5.2.2.

- 5.5.2.1. The luminous intensity shall be measured either with white light or coloured light as prescribed by the applicant for use of the fog lamp in normal service. Variations in homogeneity detrimental to satisfactory visibility in the zone above the line 5 from 10 degrees left to 10 degrees right are not permitted.
- 5.5.2.2. At the request of the applicant, two front fog lamps constituting a matched pair corresponding to paragraph 3.3.2.4.3. may be tested separately. In this case the specified requirements for lines 6, 7, 8, 9 and the Zone D in Table 36 apply to half the sum of readings of the right-hand and left-hand side front fog lamp. However each of the two front fog lamps shall meet at least 50 per cent of the minimum value required for line 6. Additionally, each of the two front fog lamps that constitute the matched pair are only required to meet the requirements of line 6 and line 7 from 5° inwards to 10° outwards.
- 5.5.2.3. Inside the field between lines 1 to 5 in Figure A4-XI of Annex 4, the beam pattern should be substantially uniform. Discontinuities in intensities detrimental to satisfactory visibility between the lines 6, 7, 8 and 9 are not permitted.
- 5.5.2.4. In the light-distribution as specified in Table 36, single narrow spots or stripes inside the area including the measuring points 1 to 10 and line 1 or inside the area of line 1 and line 2 with not more than 175 cd are allowed, if not extending beyond a conical angle of 2° aperture or a width of 1°. If multiple spots or stripes are present they shall be separated by a minimum angle of 10°.
- 5.5.2.5. If the specified luminous intensity requirements are not met, a re-aim of the cut-off position within $\pm 0,5^\circ$ vertical and/or $\pm 2^\circ$ horizontal is allowed. In the re-aimed position all photometric requirements shall be met.

5.5.3. Other photometric requirements

5.5.3.1. In the case of front fog lamps equipped with gas-discharge light sources with the ballast not integrated with the light source, the luminous intensity shall exceed 1 080 cd in the measuring point at 0° horizontal and 2° D vertical four seconds after activation of the fog lamp which has not been operated for 30 minutes or more.

5.5.3.2. To adapt to dense fog or similar conditions of reduced visibility, it is permitted to automatically vary the luminous intensities provided that:

- (a) An active electronic light source control gear is incorporated into the front fog lamp function system;
- (b) All intensities are varied proportionately.

The system, when checked for compliance according to the provisions of paragraph 4.6.6., is considered acceptable if the luminous intensities remain within 60 per cent and 100 per cent of the values specified in Table 36.

5.5.3.2.1. An indication shall be inserted in the communication form (Annex 1, item 9).

5.5.3.2.2. The Technical Service responsible for type approval tests shall verify that the system provides automatic modifications, such that good road illumination is achieved and no discomfort is caused to the driver or to other road users.

5.5.3.2.3. Photometric measurements shall be performed according to the applicant's description.

5.5.4. Tolerance requirements for conformity of production control procedure:

5.5.4.1. When testing the photometric performances of any front fog lamp chosen at random according to paragraph 5.5., no measured value of the luminous intensity may deviate unfavourably by more than 20 per cent

5.5.4.2. For the measured values in Table 36 the respective maximum deviations may be:

Table 37

Conformity of production, photometric requirements for front fog lamp

Designated lines or zones	Vertical position (*)above h +below h -	Horizontal position(*)left of v: -right of v: +	Luminous intensity candela		To comply
			Equivalent 20 per cent	Equivalent 30 per cent	
Point 1, 2(**)	+60°	±45°	115 max	130 max	All points
Point 3, 4(**)	+40°	±30°			
Point 5, 6(**)	+30°	±60°			
Point 7, 10(**)	+20°	±40°			
Point 8, 9(**)	+20°	±15°			
Line 1(**)	+8°	-26° to +26°	160 max	170 max	All line
Line 2(**)	+4°	-26° to +26°	180 max	195 max	All line
Line 3	+2°	-26° to +26°	295 max	320 max	All line
Line 4	+1°	-26° to +26°	435 max	470 max	All line
Line 5	0°	-10° to +10°	585 max	630 max	All line

Designated lines or zones	Vertical position (*)above h +below h -	Horizontal position(*)left of v: -right of v: +	Luminous intensity candela		To comply
			Equivalent 20 per cent	Equivalent 30 per cent	
Line 6(**)	-2,5°	from 5° inwards to 10° outwards	2 160 min	1 890 min	All line
Line 8 L and R(**)	-1,5° to -3,5°	-22° and +22°	880 min	770 min	One or more points
Line 9 L and R(**)	-1,5° to -4,5°	-35° and +35°	360 min	315 min	One or more points
Zone D	-1,5° to -3,5 °	-10° to +10°	14 400 max	15 600 max	Whole zone

Note to Table 37:

(*) The co-ordinates are specified in degrees for an angular web with a vertical polar axis.

(**) See paragraph 5.5.2.4.

(***) See paragraph 5.5.2.2.

5.6. Technical requirements concerning cornering lamps (symbol K)

5.6.1. Intensity of light emitted

5.6.1.1. For the left-hand device, the minimum intensity of the light at the specified measuring points shall be as follows:

- (a) 2,5D – 30L: 240 cd
- (b) 2,5D – 45L: 400 cd
- (c) 2,5D – 60L: 240 cd

The same values apply symmetrically for a right-hand device. (Shown in Annex 4 Figure A4-XII)

5.6.1.2. The intensity of the light emitted in all directions shall not exceed:

- (a) 300 cd above the 1,0U, L and R line;
- (b) 600 cd between the horizontal plane and the 1,0U, L and R Line; and
- (c) 14 000 cd below the 0,57 D, L and R line.

5.6.1.3. In the case of a single lamp containing more than one light source when all light sources are illuminated the maximum intensities shall not be exceeded.

5.6.1.4. Failure of a single lamp containing more than one light source:

5.6.1.4.1. In a single lamp containing more than one light source, a group of light sources, wired so that the failure of any one of them causes all of them to stop emitting light, shall be considered to be one light source.

5.6.1.4.2. In case of failure of any one light source in a single lamp containing more than one light source, at least one of the following provisions shall apply:

- (a) The light intensity complies with the minimum intensity required in the table of standard light distribution in space as shown in Annex 4, Figure L; or

- (b) A signal for activation of a tell-tale indicating failure, as indicated in paragraph 6.20.8. of UN Regulation No. 48, is produced, provided that the luminous intensity at 2,5°D 45°L for a left-side lamp (the L angle should be substituted for the R angle for a right-side lamp) is at least 50 per cent of the minimum intensity required. In this case a note in the communication form states that the lamp is only for use on a vehicle fitted with a tell-tale indicating failure.

5.6.2. Measurement methods

5.6.2.1. When photometric measurements are taken, stray reflections shall be avoided by appropriate masking.

5.6.2.2. In the event that the results of measurements are challenged, measurements shall be taken in such a way as to meet the following requirements:

5.6.2.2.1. The distance of measurement shall be such that the law of the inverse of the square of the distance is applicable;

5.6.2.2.2. The measuring equipment shall be such that the angle subtended by the receiver from the reference centre of the light is between 10' and 1°;

5.6.2.2.3. The intensity requirement for a particular direction of observation shall be satisfied if the required intensity is obtained in a direction deviating by not more than one quarter of a degree from the direction of observation.

5.6.2.3. Measuring points expressed in degrees of angle with the axis of reference are shown in Annex 4, Figure A4-XII.

The values shown in the table give, for the various directions of measurement, the minimum intensities in cd.

5.6.2.4. Horizontal and vertical angles for the field of geometric visibility are shown in Annex 4, Figures A4-XIII. The directions $H = 0^\circ$ and $V = 0^\circ$ correspond to the axis of reference. On the vehicle they are horizontal, parallel to the median longitudinal plane of the vehicle and oriented in the required direction of visibility. They pass through the centre of reference.

5.6.3. Photometric measurement of lamps equipped with several light sources. The photometric performance shall be checked:

5.6.3.1. In case of non-replaceable light sources, with the light sources present in the lamp, in accordance with paragraph 4.6.

5.6.3.2. In case of replaceable light sources, in addition to paragraph 4.6.

The luminous intensity values produced shall be corrected.

(a) For filament light sources the correction factor is the ratio between the reference luminous flux and the mean value of the luminous flux found at the voltage applied (13,2 V or 13,5 V);

(b) For LED light sources the correction factor is the ratio between the objective luminous flux and the mean value of the luminous flux found at the voltage applied (6,75 V, 13,5 V or 28,0 V).

The actual luminous fluxes of each light source used shall not deviate more than ± 5 per cent from the mean value. Alternatively and in case of filament light sources only, a standard filament light source may be used in turn, in each of the individual positions, operated at its reference flux, the individual measurements in each position being added together.

5.6.3.3. For any cornering lamp except those equipped with filament light source(s), the luminous intensities, measured after one minute and after 10 minutes of operation, shall comply with the minimum and maximum requirements. The luminous intensity distributions after one and after 10 minutes of operation shall be calculated from the luminous intensity distribution measured after photometric stability has occurred by applying at each test point the ratio of luminous intensities measured at 45°L 2,5°D for a left-side lamp (the L angle should be substituted for the R angle for a right-side lamp):

- (a) After one minute;
- (b) After 10 minutes; and
- (c) After photometric stability has occurred.

Photometric stability has occurred means the variation of the luminous intensity for the specified test point is less than 3 per cent within any 15 minute period.

6. TRANSITIONAL PROVISIONS

6.1. General

6.1.1. Contracting Parties applying this Regulation shall continue to accept type approvals of the lamps (functions), to any of the preceding series of amendments to this Regulation, which are not affected by the changes introduced by the latest series of amendments.

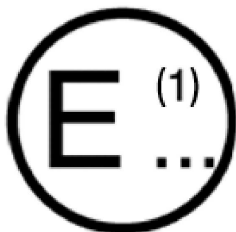
To verify this, the change index applicable to the pertinent lamp (function) shall not differ from its change index as indicated in the latest series of amendments.

6.1.2. Contracting Parties applying this Regulation shall not refuse to grant extensions to type approvals according to any preceding series of amendments to this Regulation.

ANNEX 1

Communication

(Maximum format: A4 (210 × 297 mm))



issued by: Name of administration:

.....

.....

.....

Concerning: ⁽²⁾

Approval granted

Approval extended

Approval refused

Approval withdrawn

Production definitively discontinued

of a type of device or system pursuant to UN Regulation No. 149

Class of the device: Change index:

Approval No.

Unique Identifier (UI) (If applicable):

1. Trade name or mark of the device or system:.....

2. Manufacturer's name for the type of device or system:

.....

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:

9.1. For Headlamps of Classes A and B ⁽¹⁾

⁽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.

- 9.1.1. Category as described by the relevant marking: ⁽³⁾
- 9.1.2. Number, category and kind of light source(s):
- 9.1.3. Reference luminous flux used for the principal passing-beam (lm):
- 9.1.4. Principal passing-beam operated at approximately (V):.....
- 9.1.5. Measures according to paragraph 4.12. of this Regulation:.....
- 9.1.6. Number and specific identification code(s) of LED module(s) and for each LED module a statement whether it is replaceable or not: yes/no ⁽¹⁾.....
- 9.1.7. Number and specific identification code(s) of electronic light source control gear(s)
- 9.1.8. Total objective luminous flux as described in paragraph 4.5.6. of this Regulation exceeds 2 000 lumens: yes/no/does not apply ⁽¹⁾
- 9.1.9. The adjustment of the cut-off has been determined at: 10 m/25 m/does not apply ⁽¹⁾
The determination of the minimum sharpness of the "cut-off" has been carried out at: 10 m/25 m/does not apply ⁽¹⁾
- 9.2. For headlamps of Class D
- 9.2.1. Headlamp/system submitted for approval as type: ⁽⁴⁾
- 9.2.2. The passing beam light source may/may not ⁽¹⁾ be lit simultaneously with the driving beam light source and/or another reciprocally incorporated headlamp.
- 9.2.3. The rated voltage of the device is:.....
- 9.2.4. Number, category and kind of light source(s):.....

⁽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
→ ↔ → ↔

⁽⁴⁾ Indicate the appropriate marking selected from the list below:

DC, DC/, DC/PL, DR, DCR, DC/R, DC PL, DR PL, DCR DC/R
DC, DCR, DC/R, DC/, DC PL, DCR PL, DC/R DC/PL, PL, PL,
→ → → → → → → → →
→
DC, DCR, DC/R, DC/, DC PL, DCR PL, DC/R DC/PL,
↔ ↔ ↔ ↔ ↔ ↔ ↔ ↔
→

9.2.4.1. If more than one objective luminous flux value is specified:

Objective luminous flux value used for the principal passing beam [lm]

9.2.4.2. If more than one objective luminous flux value is specified:

Objective luminous flux value used for the driving beam [lm]

9.2.5. Trade name and identification number of separate ballast(s) or part(s) of ballast(s):

9.2.6. The adjustment of the "cut-off" has been determined at 10 m/25 m. ⁽¹⁾

The determination of the minimum sharpness of the "cut-off" has been carried out at 10 m/25 m. ⁽¹⁾

9.2.7. Number and specific identification code(s) of LED module(s):

9.2.8. Distributed lighting system with one common gas-discharge light source: Yes/No ⁽¹⁾

9.2.9. Remarks (if any):

9.2.10. Measures according to paragraph 4.12. of this Regulation:

9.3. For AFS – Systems

9.3.1. Category as described by the relevant marking ⁽²⁾

9.3.2. Number, category and kind of light source(s):

9.3.2.1. Number and specific identification code(s) of LED module(s) and for each LED module a statement whether it is replaceable or not: yes/no ⁽¹⁾

.....

9.3.2.2. Number and specific identification code(s) of electronic light source control gear(s), if applicable

9.3.2.3. Total objective luminous flux as described in paragraph 4.5.2.6. of this Regulation exceeds 2 000 lumen: yes/no ⁽¹⁾

9.3.3. (a) Indications according to paragraph 5.3.5.1. of this Regulation (which lighting unit(s) provide a "cut-off" as defined in Annex 5 of this Regulation, that projects into a zone extending from 6 degrees left to 4 degrees right and upwards from a horizontal line positioned at 0,8 degree down)

(b) The adjustment of the "cut-off" has been determined at 10 m / 25 m ⁽¹⁾

(c) The determination of the minimum sharpness of the "cut-off" has been carried out at 10 m / 25 m ⁽¹⁾

9.3.4. The vehicle(s) for which the system is intended as original equipment

9.3.5. Whether approval is sought for a system which is not intended to be included as part of the approval of a vehicle type according to UN Regulation No. 48: yes/no ⁽¹⁾

9.3.5.1. If in the affirmative: information sufficient to identify the vehicle(s) for which the system is intended

⁽¹⁾ Indicate the appropriate marking as foreseen according to this Regulation for each installation unit or assembly of installation units.

9.3.6. Indications according to paragraph 5.3.5.2. of this Regulation (which class E passing beam mode(s), if any, comply with a "data set" of Table 14 of this Regulation).....

9.3.7. Whether approval is sought for a system intended to be installed on vehicles only, which provide means for a stabilization/limitation of the system's supply: yes/no ⁽¹⁾

9.3.8. The adjustment of the "cut-off" has been determined at 10 m / 25 m. ⁽¹⁾

The determination of the minimum sharpness of the "cut-off" has been carried out at 10 m / 25 m. ⁽¹⁾

9.3.9. The system is designed to provide passing beams of: ⁽⁶⁾

9.3.9.1. Class C ☒ Class V ☐ Class E ☐ Class W ☐

9.3.9.2. With the following mode(s), identified by the designation(s), if it applies¹⁴

Mode No. C 1	Mode No. V ...	Mode No. E ...	Mode No. W ...
Mode No. C ...	Mode No. V ...	Mode No. E ...	Mode No. W ...
Mode No. C ...	Mode No. V ...	Mode No. E ...	Mode No. W ...

9.3.9.3. Where the lighting units indicated below are energized ⁽⁵⁾ ⁽⁷⁾ ⁽⁸⁾ for the mode No.

(a) If no bend lighting applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

(b) If bend lighting of category 1 applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

(c) if bend lighting of category 2 applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

Note: Indications according to paragraph (a) through (c) above are needed additionally for each further mode.

9.3.9.4. The lighting units marked below are energized, when the system is in its neutral state ⁽⁵⁾ ⁽⁷⁾

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

⁽⁶⁾ Mark with an X where applicable.

⁽⁷⁾ To be extended if more modes are provided.

⁽⁸⁾ To be continued if more units are provided.

9.3.9.5. The lighting units marked below are energized, when the system is in its traffic change function ⁽⁵⁾ ⁽⁶⁾ ⁽⁷⁾

(a) If no bend lighting applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

(b) If bend lighting of category 1 applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

(c) If bend lighting of category 2 applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

9.3.10. The system is designed to provide a main beam ⁽⁵⁾ ⁽⁶⁾ ⁽⁷⁾:

9.3.10.1. Yes ☐ No ☐

9.3.10.2. With the following mode(s), identified by the designation(s), if it applies:

Main beam mode No. M 1

Main beam mode No. M ...

Main beam mode No. M ...

9.3.10.3. Where the lighting units marked below are energized, for mode No.

(a) If no bend lighting applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

(b) If bend lighting applies:

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

Note: Indications according to this paragraph (a) through (b) above are needed additionally for each further mode.

9.3.10.4. The lighting units marked below are energized, when the system is in its neutral state ⁽⁶⁾ ⁽⁸⁾

Left side	No.1 ☐	No.3 ☐	No.5 ☐	No.7 ☐	No. 9 ☐	No.11 ☐
Right side	No.2 ☐	No.4 ☐	No.6 ☐	No.8 ☐	No.10 ☐	No.12 ☐

9.3.10.5. The system is designed to provide an adaptation of the driving beam for:

Right-Hand and Left-Hand traffic: yes ☐ no ☐

Right-Hand traffic only: yes ☐ no ☐

Left-Hand traffic only: yes ☐ no ☐

9.4. For headlamps of Classes AS, BS, CS, DS and ES ⁽¹⁾

9.4.1. Category as described by the relevant marking: ⁽⁹⁾

9.4.2. Number, category and kind of light source(s), if any:

9.4.3. Number and specific identification code(s) of LED modules and for each LED module a statement whether it is replaceable or not: yes/no ⁽¹⁾.....

9.4.4. Number and specific identification code(s) of electronic light source control gear(s), if any:

9.4.5. The determination of "cut-off" sharpness yes / no ⁽¹⁾

If yes, it was carried out at 10 m/25 m ⁽¹⁾

9.4.6. Trade name and identification number of separate ballast(s) or part(s) of ballast(s):

9.4.7. The passing beam light source may/may not ⁽¹⁾ be lit simultaneously with the driving beam light source and/or another reciprocally incorporated headlamp.

9.4.8. The minimum bank angle(s) to satisfy the requirement of paragraph 5.4.5.2., if any

9.4.9. Primary Driving Beam: yes / no ⁽¹⁾

Secondary Driving Beam: yes / no ⁽¹⁾

The Secondary Driving Beam shall only be operated together with a passing beam or a primary driving beam.

9.5. For front fog lamps Class F3

9.5.1. Class as described by the relevant marking:

(F3, F3/, F3PL, F3/PL)

9.5.2. Number, category and kind of light source(s):

9.5.3 LED module: yes/no ⁽¹⁾ and for each LED module a statement whether it is replaceable or not: yes/no ⁽¹⁾

⁽⁹⁾ Indicate the appropriate marking selected from the list below:

C-AS,	C-BS,	R-BS,	CR-BS,	C/-BS,	C/R-BS,
WC-CS,	C-BS PL,	R-BS PL,	CR-BS PL,	C/-BS PL,	C/R-BS PL,
WC/-CS,	WC-DS,	WR-CS,	WR-DS,	WCR-CS,	WCR-DS,
WC-DS PL,	WC/-DS,	WC/R-CS,	WC/R-DS,	WC-CS PL,	WCR-DS PL,
WC/CS PL,	WR-CS PL,	WR-DS PL,	WCR-CS PL,	WCR-DS PL,	
WC+CS,	WC/-DS PL,	WC/R-DS PL,	WC/R-DS PL,		
WC+CS PL,	WC+DS,	WC+R-CS,	WC+R-DS,	C+BS,	C+R-BS,
WC+CS PL,	WC+DS PL,	WC+R-CS PL,	WC+R-DS PL,	C+BS PL,	C+R-BS PL,
WC-ES,	WR-ES,	WCR-ES,	WC/-ES,	WC/R-ES,	WC-ES PL,
WR-ES PL,	WCR-ES PL,	WC/-ES PL,	WC/R-ES PL,		
WC+ES,	WC+R-ES,	WC+ES PL,	WC+R-ES PL,		

- 9.5.4. LED module specific identification code:
- 9.5.5. Application of electronic light source control gear: ⁽¹⁰⁾ yes/no ⁽¹⁾
 Supply to the light source:
 Specification of the light source control gear:
 Input voltage: ⁽¹¹⁾
 In the case of an electronic light source control gear not being part of the lamp:
 Output signal specification:
- 9.5.6. Colour of light emitted: white/selective yellow ⁽¹⁾
- 9.5.7. Luminous flux of the light source (see paragraph 4.5.2.6.)
 greater than 2 000 lumens: ... yes/no ⁽¹⁾
- 9.5.8. Luminous intensity is variable: ... yes/no ⁽¹⁾
- 9.5.9. The determination of the cut-off gradient (if measured)
 was carried out at 10 m / 25 m ⁽¹⁾
- 9.6. For cornering lamps
- 9.6.1. Number, category and kind of light source(s): ⁽¹²⁾
- 9.6.2. Voltage and wattage:
- 9.6.3. Light source module: yes/no ⁽¹⁾
- 9.6.4. Light source module specific identification code:
- 9.6.5. Application of an electronic light source control gear:
 (a) Being part of the lamp yes/no ⁽¹⁾
 (b) Being not part of the lamp yes/no ⁽¹⁾
- 9.6.6. Input voltage supplied by an electronic light source control gear:
- 9.6.7. Electronic light source control gear manufacturer and identification number (when the light source control gear is part of the lamp but is not included into the lamp body):
- 9.6.8. Geometrical conditions of installation and relating variations, if any:
10. Approval mark(s) position(s):
11. Reason(s) for extension of approval (if applicable):
12. Approval granted / extended / refused / withdrawn ⁽¹⁾

⁽¹⁰⁾ The voltage specifications shall include the tolerances or voltage range as specified by the manufacturer and verified by this approval.

⁽¹¹⁾ The parameters of the input voltage including duty cycle, frequency, pulse shape and peak voltage shall be included.

⁽¹²⁾ For cornering lamps with non-replaceable light sources indicate the number and total wattage of the light sources used.

13. Place:
14. Date:
15. Signature:
16. The list of documents deposited with the Type Approval Authority, which has granted approval is annexed to this communication and may be obtained on request.

ANNEX 2

Minimum requirements for conformity of production control procedures

1. GENERAL

1.1. The conformity requirements shall be considered satisfied from a mechanical and geometric 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 lamps shall not be contested if, when testing photometric performances of any lamp chosen at random and equipped with a standard (étalon) light source and/or non-replaceable light source(s) 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.

1.2.1.1. For class A, B and D headlamps corresponding to paragraph 5.2. of this Regulation for the values B 50 L (or R) and zone III, the maximum unfavourable deviation may be respectively:

B 50 L (or R): 170 cd equivalent 20 per cent

255 cd equivalent 30 per cent

Zone III: 255 cd equivalent 20 per cent

380 cd equivalent 30 per cent

1.2.1.2. For AFS corresponding to paragraph 5.3. of this Regulation no value measured and corrected according to the prescriptions of paragraph 4.6. to this Regulation, deviates unfavourably from the value prescribed in column B of the Tables 17 to 32, if applicable.

1.2.1.3. For class BS, CS, DS and ES headlamps corresponding to paragraph 5.4. of this Regulation for values in zone I, the maximum unfavourable deviation may be respectively:

Zone I: 255 cd equivalent 20 per cent

380 cd equivalent 30 per cent

1.2.1.3.1. 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 0,5 degree, to the right or left and not by more than 0,2 degree up and down.

1.2.1.4. For front fog lamps corresponding to paragraph 5.5. of this Regulation Table 37 shall apply;

1.2.2. or, in case of class A, B or D headlamps corresponding to paragraph 5.2. of this Regulation, if

1.2.2.1. For the passing-beam, the values prescribed in this Regulation are met at one point within a circle of 0,35 degrees around points:

in case of class A or B headlamps B 50 L (or R) (with a tolerance of 85 cd), 75 R (or L), 50 V, 25 R, 25 L, and in the entire area of zone IV which is not more than 0,52 degrees above line 25 R and 25 L;

in case of class D headlamps B 50 L (or R) (with a tolerance of 85 cd), 75 R (or L), 50 V, 25 R1, 25 L2, and on segment I;

- 1.2.2.2. and if, for the driving beam, HV being situated within the isocandela $0,75 I_{\max}$ 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 5.1. 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 0,5 degree to the right or left and not by more than 0,2 degree up or down.
- 1.2.4. For AFS corresponding to paragraph 5.3. of this Regulation, if the results of the test described above do not meet the requirements, the alignment of the system may be changed in each class, provided that the axis of the beam is not displaced laterally by more than 0,5 degree to the right or left and not by more than 0,2 degree up or down, each independently and with respect to the first aiming.

These provisions do not apply to lighting units as indicated under paragraph 5.3.3.1.1. of this Regulation.

- 1.2.5. If in the case of a lamp equipped with a replaceable light source the results of the tests described above do not meet the requirements, tests shall be repeated using another standard (étalon) light source.
- 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 lamps or systems shall be tested according to the procedure described in paragraph 3.1. of Annex 7 after being subjected three consecutive times to the cycle described in paragraph 3.2.2. of Annex 7

A headlamp or system shall be considered as acceptable if Δr does not exceed 1,5 mrad upwards and does not exceed 2,5 mrad downwards.

If this value exceeds 1,5 mrad but is not more than 2,0 mrad upwards or exceeds 2,5 mrad but is not more than 3,0 mrad downwards, 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 upwards and shall not exceed 2,5 mrad downwards.

However, if this value of 1,5 mrad upwards and 2,5 mrad downwards on these two systems is not complied with, another two systems shall be subjected to the same procedure and the value of Δr for each of them shall not exceed 1,5 mrad upwards and shall not exceed 2,5 mrad downwards.

A front fog lamp shall be considered as acceptable if Δr does not exceed 3,0 mrad. If this value exceeds 3,0 mrad but is not more than 4,0 mrad, a second front fog lamp shall be subjected to the test after which the mean of the absolute values recorded on both samples shall not exceed 3,0 mrad.

- 1.4. If, however, vertical adjustment cannot be performed repeatedly to the required position within the tolerances described in paragraph 1.2.3. of Annex 5 or paragraph 3.2. of Annex 6 respectively, one sample shall be tested according to the procedure described in paragraph 2. of Annex 5 or paragraph 4. of Annex 6 respectively.
- 1.5. For cornering lamps
- 1.5.1. With respect to photometric performances, the conformity of mass-produced lamps shall not be contested if, when testing photometric performances of any lamp chosen at random and equipped with a standard light source, or when the lamps are equipped with non-replaceable light sources (filament light sources or other), and when all measurements are made at 6,75 V, 13,5 V or 28,0 V respectively:
- 1.5.1.1. No measured value deviates unfavourably by more than 20 per cent from the values prescribed in this Regulation.

- 1.5.1.2. If, in the case of a lamp equipped with a replaceable light source and if results of the test described above do not meet the requirements, tests on lamps shall be repeated using another standard light source.
- 1.5.2. The chromaticity coordinates shall be complied with when the lamp is equipped with a standard light source, or for lamps equipped with non-replaceable light sources (filament light sources or other), when the colorimetric characteristics are verified with the light source present in the lamp.
- 1.5.3 In the case of non-replaceable filament light source(s) or light source module(s) equipped with non-replaceable filament light sources, at any conformity of production check:
- 1.5.3.1 the holder of the approval mark shall demonstrate the use in normal production and show the identification of the non-replaceable filament light source(s) as indicated in the type approval documentation;
- 1.5.3.2. in the case where doubt exists in respect to compliance of the non-replaceable filament light source(s) with lifetime requirements and/or, in the case of colour coated filament light sources, with colour endurance requirements, as specified in paragraph 4.11 of IEC 60809, Edition 3, conformity shall be checked as specified in paragraph 4.11 of IEC 60809, Edition 3.
- 1.6. The chromaticity coordinates shall be complied with.
2. MINIMUM REQUIREMENTS FOR VERIFICATION OF CONFORMITY BY THE MANUFACTURER
- For each type of lamp 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 provisions 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 and colorimetric 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 measurements made by a competent authority.
- 2.2.4. In all cases the reference methods shall be those of this Regulation, particularly for the purpose of administrative verification and sampling.
- 2.3. Nature of sampling
- Samples of lamps shall be selected at random from the production of a uniform batch. A uniform batch means a set of lamps 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

2.4.1. The sampled devices shall be subjected to photometric measurements at the points provided for in the Regulation, the reading being limited:

2.4.1.1. For driving-beam headlamps according to paragraph 5.1. and / or passing-beam headlamps (asymmetrical) according to paragraph 5.2. of this Regulation apply:

2.4.1.1.1. For Classes A and B (driving and/or passing-beam headlamps of Classes A and B (asymmetrical)) to the points $I_{\max}$, 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.

2.4.1.1.2. For Class D (driving and/or passing-beam headlamps of Class D (GDL asymmetrical)) to the points $I_{\max}$, HV¹, HL, HR² in the case of the driving beam, and to points B 50 L (or R)¹, HV, 50 V, 75 R (or L) and 25 L² (or R²) in the case of the passing beam.

2.4.1.2. For driving-beam headlamps according to paragraph 5.1. and / or passing-beam headlamps (symmetrical) according to paragraph 5.4. of this Regulation apply:

2.4.1.2.1. For Class AS headlamps to the points HV, LH, RH, 12,5L and 12,5R.

2.4.1.2.2. For Class BS headlamps to the points $I_{\max}$ and HV¹ in the case of the driving beam, and to the points HV, 0,86D/3,5R, 0,86D/3,5L in the case of the passing beam.

2.4.1.2.3. For Classes CS, DS and ES headlamps to the points $I_{\max}$ and HV¹ in the case of the driving beam, and to the points HV, 0,86D/3,5R, 0,86D/3,5L in the case of the passing beam.

2.4.1.3. For AFS according to paragraph 5.3. to this Regulation, to the points $I_{\max}$, HV¹, HL and HR⁽³⁾ in the case of a driving-beam and to points B50L, HV if applicable, 50V, 75R if applicable, and 25LL in the case of the passing-beam(s).

2.4.1.4. For front fog lamps according to paragraph 5.5. of this Regulation, to the points 8 and 9, and the lines 1, 5, 6, 8 and 9 as specified in Table 37.

2.4.2. For cornering lamps according to paragraph 5.6. of this Regulation, the samples shall be subjected to photometric measurements for the minimum values at the points indicated in Figure A4-XII in Annex 4 and the required chromaticity coordinates.

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 the acceptability of his products in order to meet the requirements laid down for verification of conformity of products in paragraph 3.5.1. of this Regulation.

The criteria governing the acceptability shall be such that with a confidence level of 95% the minimum probability of passing a spot check in accordance with Annex 3 (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 on HH located at 2.5 degrees to the left and to the right of point HV respectively.

⁽³⁾ HL and HR: points on HH located at 2.6 degrees to the left and to the right of point HV respectively.

ANNEX 3

Minimum requirements for sampling by an inspector

1. GENERAL

- 1.1. The conformity requirements shall be considered satisfied from a mechanical and a geometric standpoint, in accordance with the requirements of this Regulation, if any, if the differences do not exceed inevitable manufacturing deviations.
- 1.2. With respect to photometric performance, the conformity of mass-produced lamps shall not be contested if, when testing the photometric performances of any lamp chosen at random, and equipped with a standard (étalon) light source and/or non-replaceable light source(s) and/or LED module(s), as present in the lamp:
 - (a) No measured value deviates from the values prescribed in paragraph 1.2. of Annex 2;
 - (b) If, in the case of a lamp equipped with a replaceable light source and if results of the test described above do not meet the requirements, tests on lamps shall be repeated using another standard light source.
- 1.3. Lamps with apparent defects are disregarded.
- 1.4. The chromaticity coordinates shall be complied with.

2. FIRST SAMPLING

In the first sampling four lamps are selected at random. The first sample of two is marked A, the second sample of two is marked B.

- 2.1. The conformity of mass-produced lamps shall not be contested if the deviation of any specimen of samples A and B (all four lamps) is not more than 20 per cent.

In the case, that the deviation of both lamps of sample A is not more than 0 per cent the measurement can be closed.
- 2.2. The conformity of mass-produced lamps shall be contested if the deviation of at least one specimen of samples A or B is more than 20 per cent.

The manufacturer shall be requested to bring his production in line with the requirements (alignment) and a repeated sampling according to paragraph 3. shall be carried out within two months' time after the notification. The samples A and B shall be retained by the Technical Service until the entire COP process is finished.

3. FIRST REPEATED SAMPLING

A sample of four lamps is selected at random from stock manufactured after alignment.

The first sample of two is marked C, the second sample of two is marked D.

- 3.1. The conformity of mass-produced lamps is shall not be contested if the deviation of any specimen of samples C and D (all four lamps) is not more than 20 per cent.

In the case that the deviation of both lamps of sample C is not more than 0 per cent the measurement can be closed.
- 3.2. The conformity of mass-produced lamps shall be contested if the deviation of at least:
 - 3.2.1. One specimen of samples C or D is more than 20 per cent but the deviation of all specimen of these samples is not more than 30 per cent.

The manufacturer shall be requested again to bring his production in line with the requirements (alignment).

A second repeated sampling according to paragraph 4. shall be carried out within two months' time after the notification. The samples C and D shall be retained by the Technical Service until the entire COP process is finished.

3.2.2. One specimen of samples C or D is more than 30 per cent.

In this case the approval shall be withdrawn and paragraph 5. shall be applied.

4. SECOND REPEATED SAMPLING

A sample of four lamps is selected at random from stock manufactured after alignment.

The first sample of two is marked E, the second sample of two is marked F.

4.1. The conformity of mass-produced lamps shall not be contested if the deviation of any specimen of samples E and F (all four lamps) is not more than 20 per cent.

In the case that the deviation of both lamps of sample E is not more than 0 per cent the measurement can be closed.

4.2. The conformity of mass-produced lamps shall be contested if the deviation of at least one specimen of samples E or F is more than 20 per cent.

In this case the approval shall be withdrawn and paragraph 5 shall be applied.

5. APPROVAL WITHDRAWN

Approval shall be withdrawn according to paragraph 3.6. of this Regulation.

6. CHANGE OF THE VERTICAL POSITION OF THE CUT-OFF LINE FOR PASSING BEAM

With respect to the verification of the change in vertical position of the cut-off line for passing beam under the influence of heat, the following procedure shall be applied:

One of the lamps or system of sample A shall be tested according to the procedure described in paragraph 3. of Annex 7 after being subjected three consecutive times to the cycle described in paragraph 3.2.2. of Annex 7.

The passing beam or the system shall be considered as acceptable if Δr does not exceed 1,5 mrad upwards and does not exceed 2,5 mrad downwards.

If this value exceeds 1,5 mrad but is not more than 2,0 mrad upwards or exceeds 2,5 mrad but is not more than 3,0 mrad downwards, a second system 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 upwards and shall not exceed 2,5 mrad downwards.

However, if this value of 1,5 mrad upwards and 2,5 mrad downwards on sample A is not complied with, another two systems 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 upwards and shall not exceed 2,5 mrad downwards.

In the case of front fog lamps in accordance with paragraph 5.5. to this Regulation the lamp shall be considered as acceptable if r does not exceed 3,0 mrad.

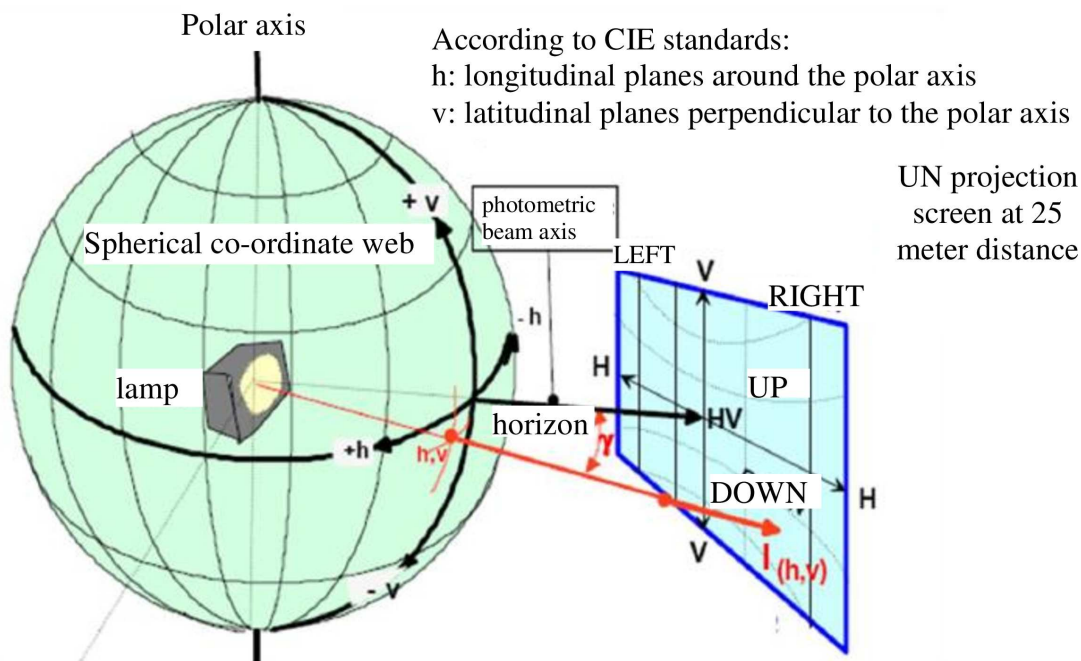
If this value exceeds 3,0 mrad but is not more than 4,0 mrad, the second front fog lamp of sample A shall be subjected to the test after which the mean of the absolute values recorded in both samples shall not exceed 3,0 mrad.

However, if this value of 3,0 mrad on sample A is not complied with, the two front fog lamps of sample B shall be subjected to the same procedure and the value of r for each of them shall not exceed 3,0 mrad.

ANNEX 4

Spherical coordinate measuring system and test point locations

Figure A4-1

Spherical coordinate measuring system

$$E_{25m} = I_{(h,v)} \times \cos \gamma / r^2$$

1. PHOTOMETRIC MEASUREMENT PROVISIONS

- 1.1. The RID or part(s) thereof shall be mounted on a goniometer with a fixed horizontal axis and moveable axis perpendicular to the fixed horizontal axis.
 - 1.1.1. The luminous intensity values shall be determined by means of a photoreceptor contained within a square of 65 mm side and, except for cornering lamps, set up to a distance of at least 25 m forward of the centre of reference of each headlamp or lighting unit perpendicular to the measurement axis from the origin of the goniometer. The point HV is the centre-point of the coordinate system with a vertical polar axis. Line h is the horizontal through HV (see Figure A4-1).
 - 1.1.2. The angular co-ordinates are specified in deg on a sphere with a vertical polar axis according to the gonio-photometer as defined in Figure A4-1.
 - 1.1.3. During photometric measurements, stray reflections should be avoided by appropriate masking.
- 1.2. Any equivalent photometric method is acceptable, if the accordingly applicable correlation is observed.
- 1.3. An aiming screen shall be used and may be located at a shorter distance than that of the photoreceptor.
- 1.4. The RID or part(s) thereof shall be so aimed before starting the measurements that the position of the "cut-off" complies with the relevant requirements for the specific function in paragraph 5 to this Regulation.

1.5. In case of AFS:

- 1.5.1. Any offset of the centre of reference of each lighting unit, with respect to the goniometer rotation axes, should be avoided. This applies especially to the vertical direction and to lighting units producing a "cut-off".
- 1.5.2. The photometric requirements for each single measuring point (angular position) of a lighting function or mode as specified in this Regulation apply to half of the sum of the respective measured values from all lighting units of the system applied for this function or mode, or, from all lighting units as indicated in the respective requirement;
 - 1.5.2.1. However in those cases where a provision is specified for one side only, the division by the factor of 2 does not apply. These cases are: paragraphs 5.3.2.5.2., 5.3.2.8.1., 5.1.3.5., 5.1.3.6., 5.3.3.4.1., 5.3.5.1. of this Regulation, and note 4 of Table 9.
- 1.5.3. The lighting units of the system shall be measured individually; however, simultaneous measurements may be performed on two or more lighting units of an installation unit, being equipped with the same light source types with respect to their power supply (either power controlled or not), if they are sized and situated such, that their illuminating surfaces are completely contained in a rectangle of not more than 300 mm in horizontal extend and not more than 150 mm vertical extend, and, if a common centre of reference is specified by the manufacturer.
- 1.5.4. The system shall prior to the subsequent test procedures be set to the neutral state.
- 1.5.5. The system or part(s) thereof shall be so aimed before starting the measurements that the position of the "cut-off" complies with the requirements indicated in the Table 10. Parts of a system measured individually and having no "cut-off" shall be installed on the goniometer under the conditions (mounting position) specified by the applicant.

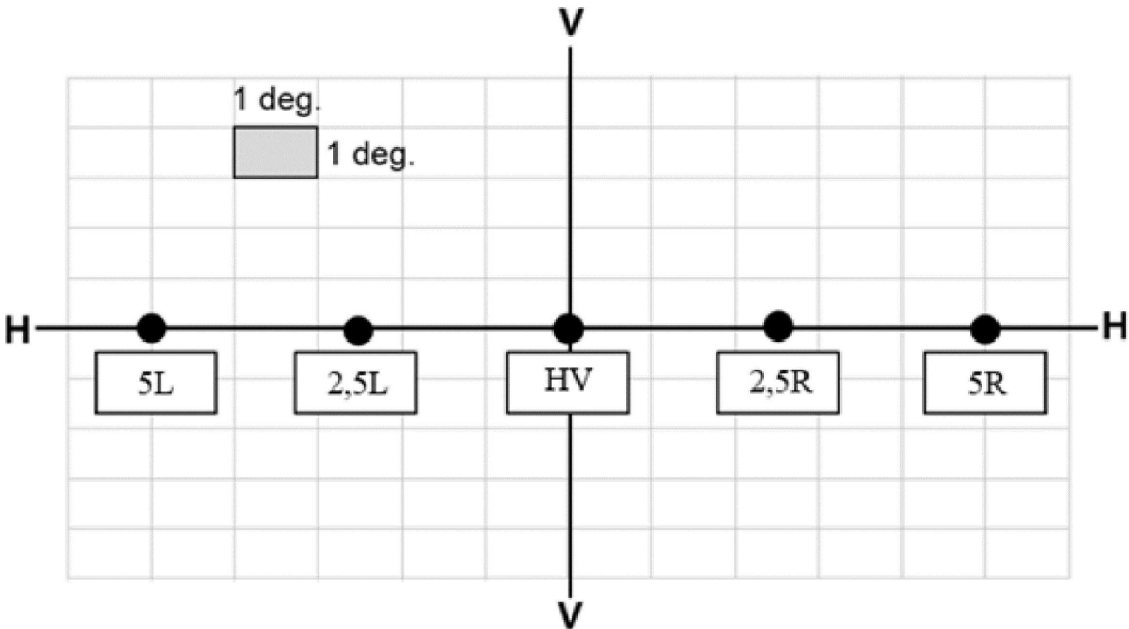
1.6. In case of Cornering lamps

- 1.6.1. When photometric measurements are taken, stray reflections shall be avoided by appropriate masking.
- 1.6.2. In the event that the results of measurements are challenged, measurements shall be taken in such a way as to meet the following requirements:
 - 1.6.2.1. The distance of measurement shall be such that the law of the inverse of the square of the distance is applicable;
 - 1.6.2.2. The measuring equipment shall be such that the angle subtended by the receiver from the reference centre of the light is between 10' and 1°;
 - 1.6.2.3. The intensity requirement for a particular direction of observation shall be satisfied if the required intensity is obtained in a direction deviating by not more than one quarter of a degree from the direction of observation.

2. TEST POINT LOCATIONS

Figure A4-II

Driving beam test points



h-h = horizontal plane, v-v = vertical plane passing through the optical axis of the headlamp

Figure A4-III

Primary driving beam - position of test points

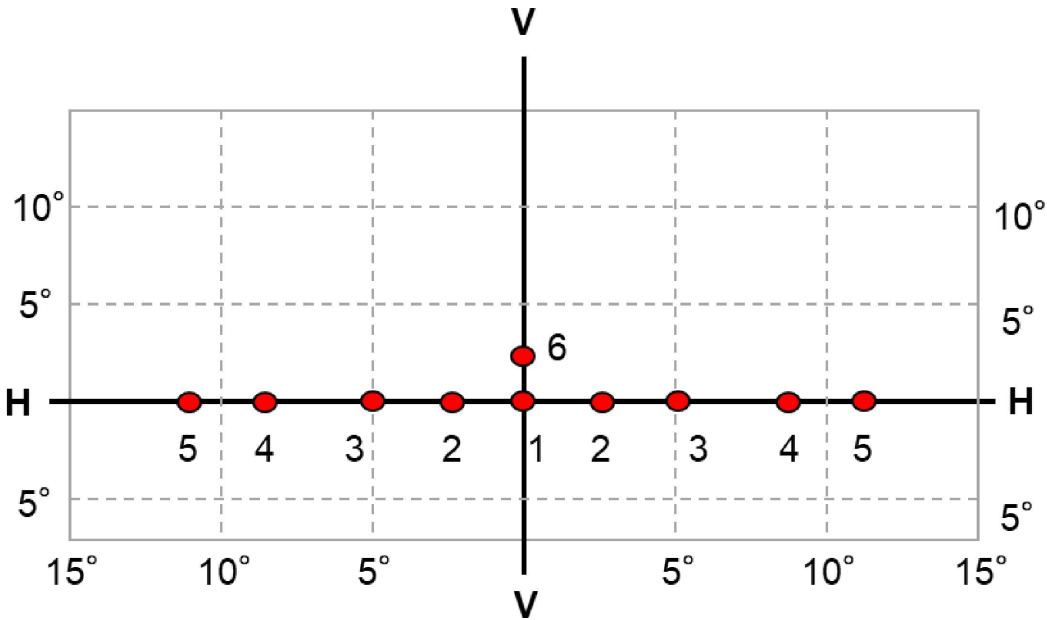


Figure A4-IV

Secondary driving beam - position of test points

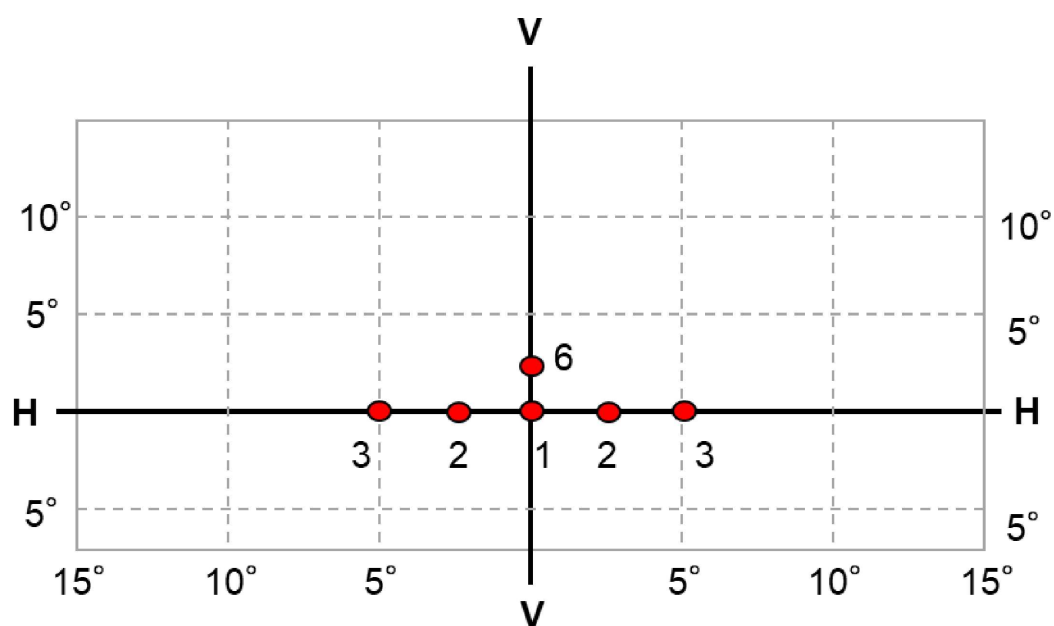
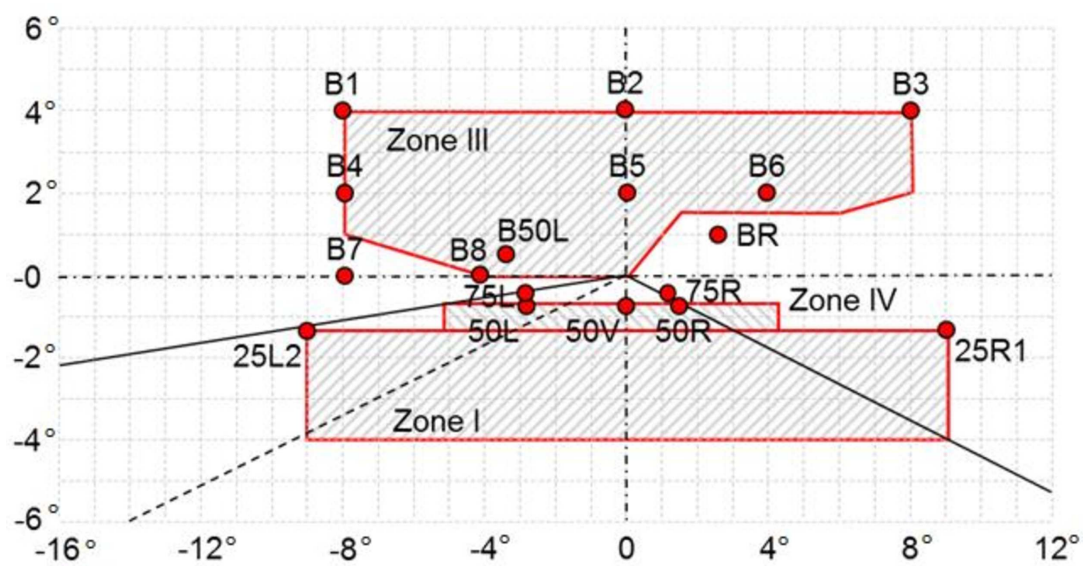


Figure A4-V

Passing-beam for right-hand traffic



The test point locations for left-hand traffic are mirrored about the VV line

Figure A4-VIII

Passing beam test points and zones for Class AS headlamp(s)

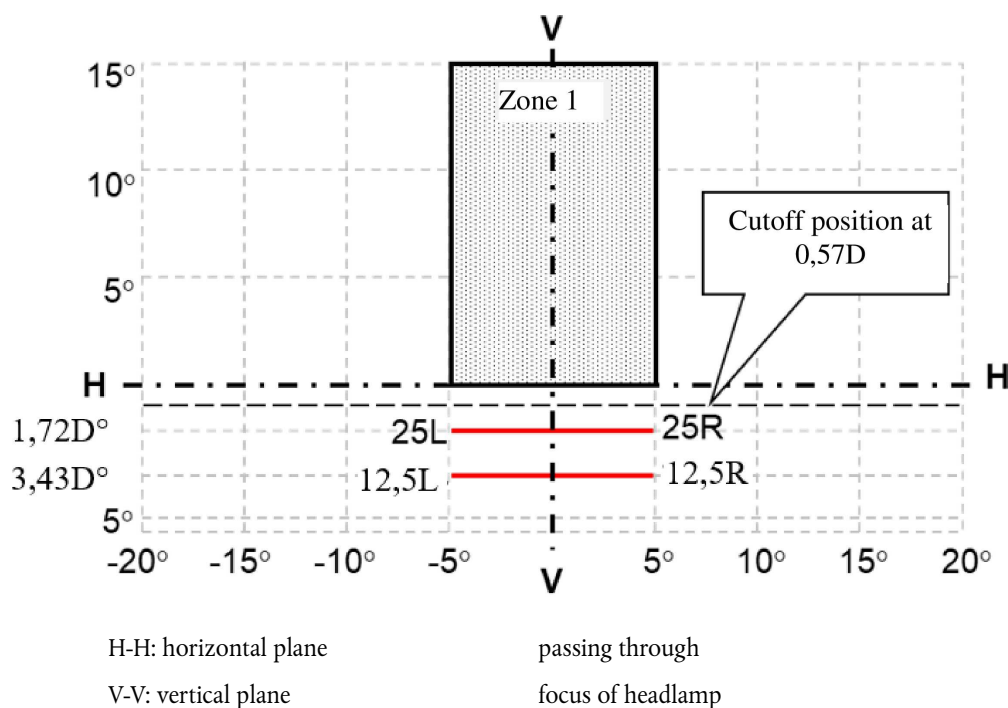


Figure A4-IX

Passing beam test points and zones for Class BS headlamp(s)

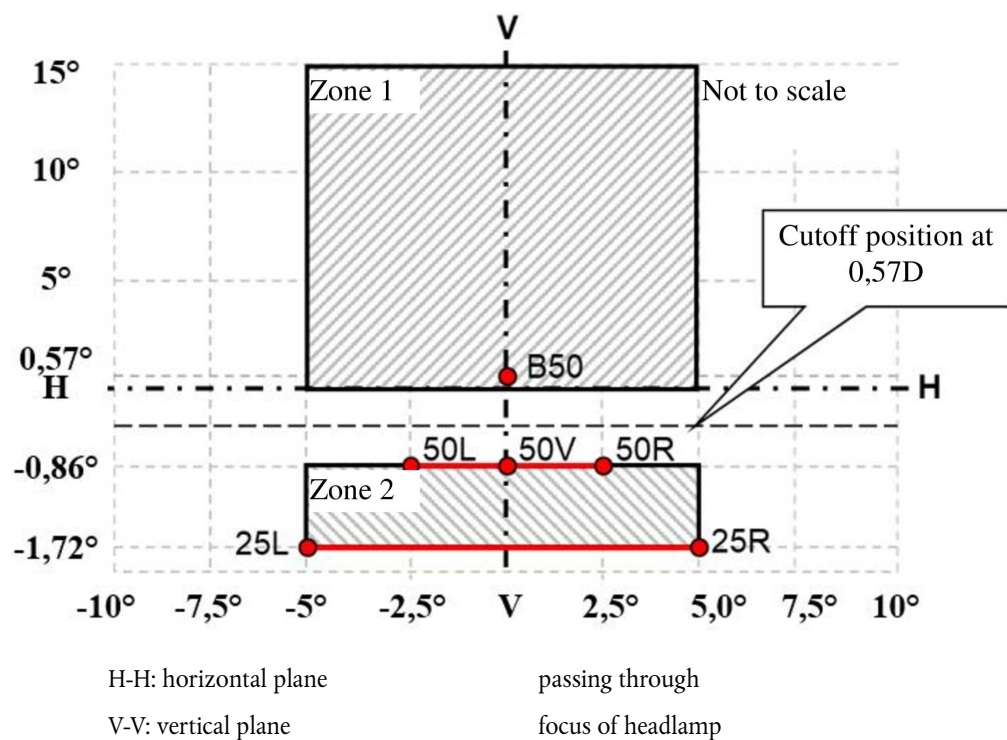


Figure A4-X

Passing beam - position of test points and zones for Classes CS, DS and ES headlamp(s)

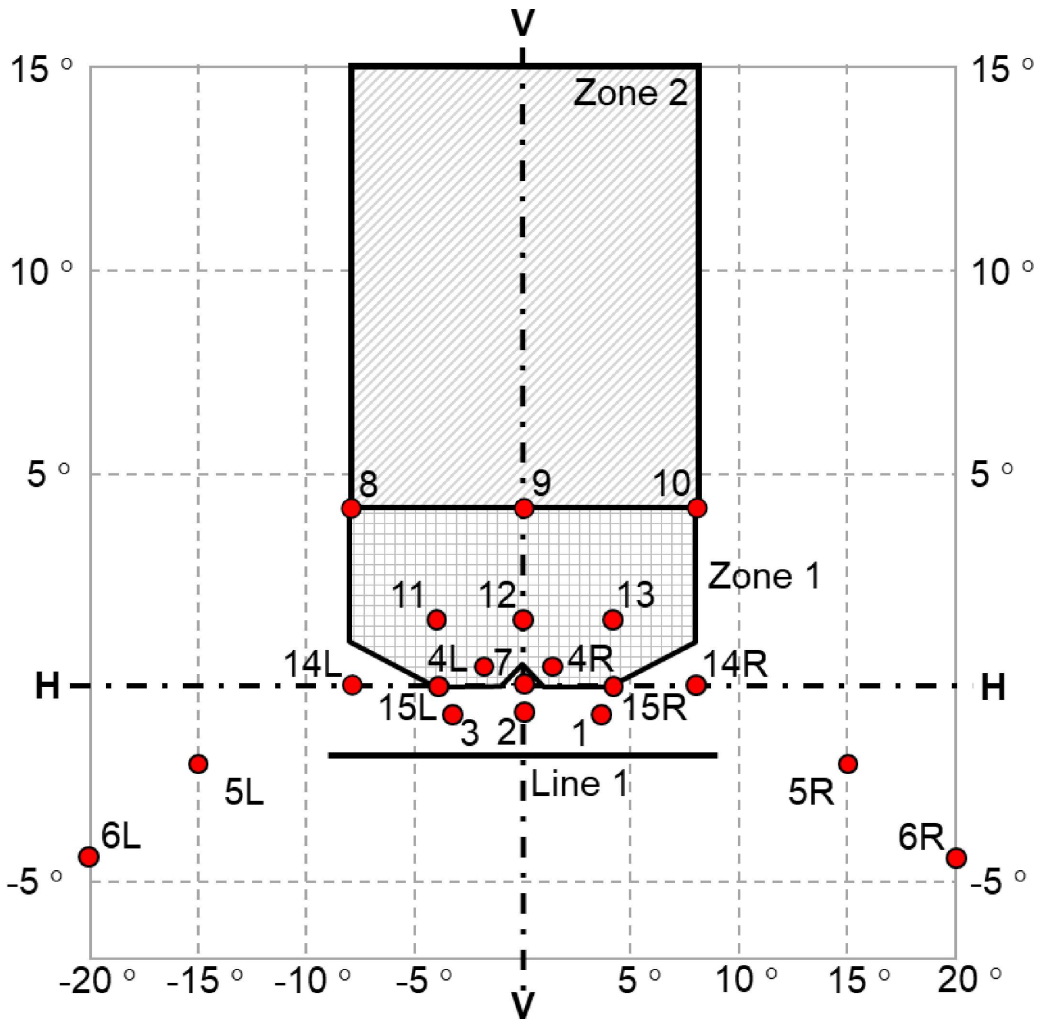


Figure A4-XI

Light distribution of the Class F3 front fog lamp

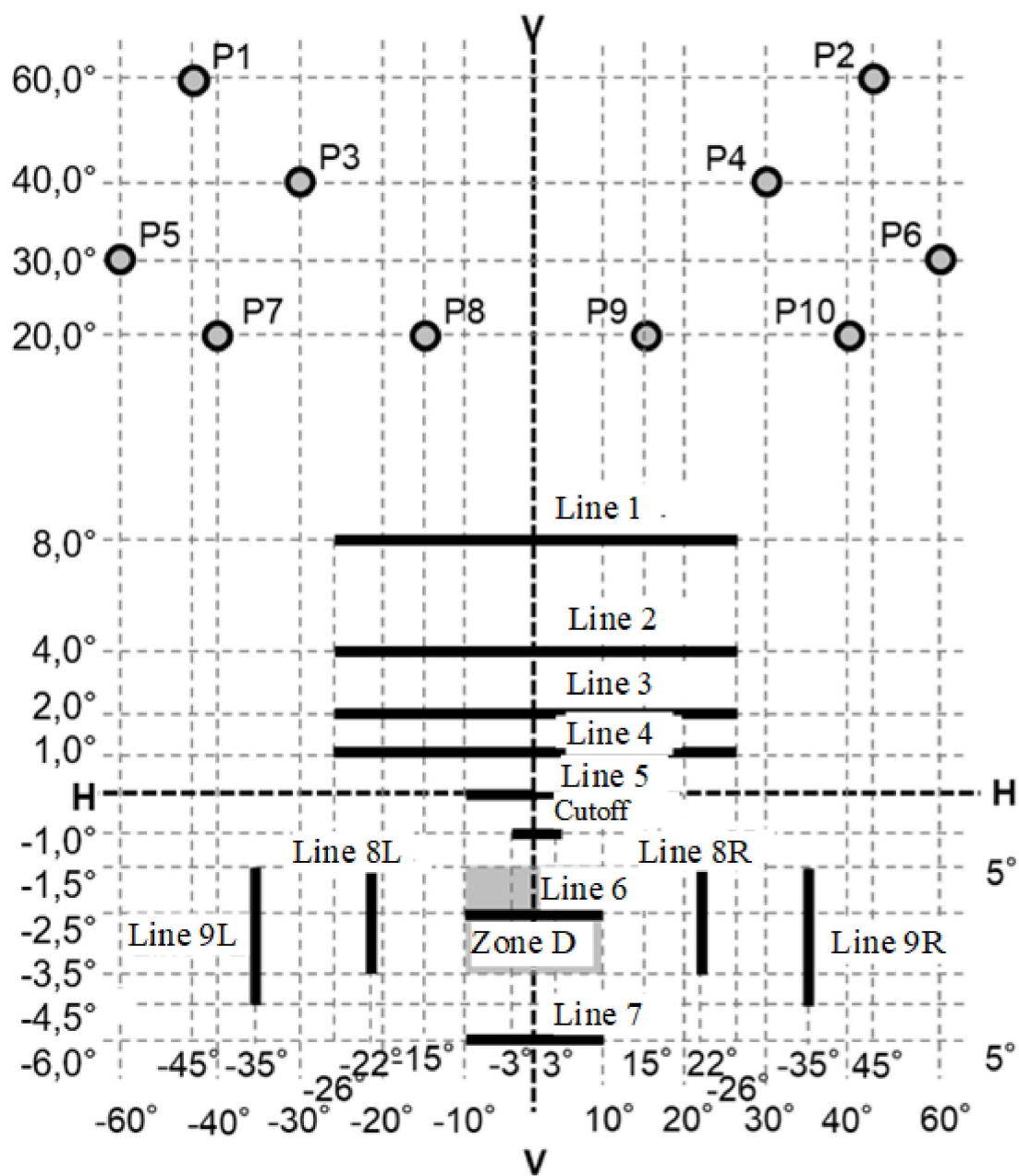


Figure A4-XII

Measuring points for cornering lamps (left side lamp)

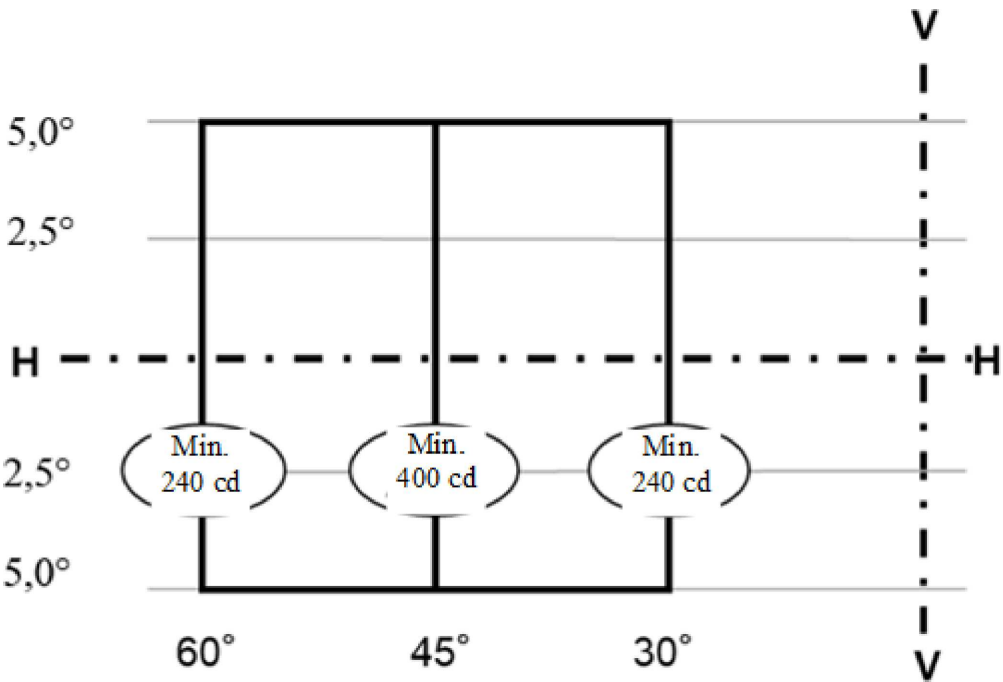
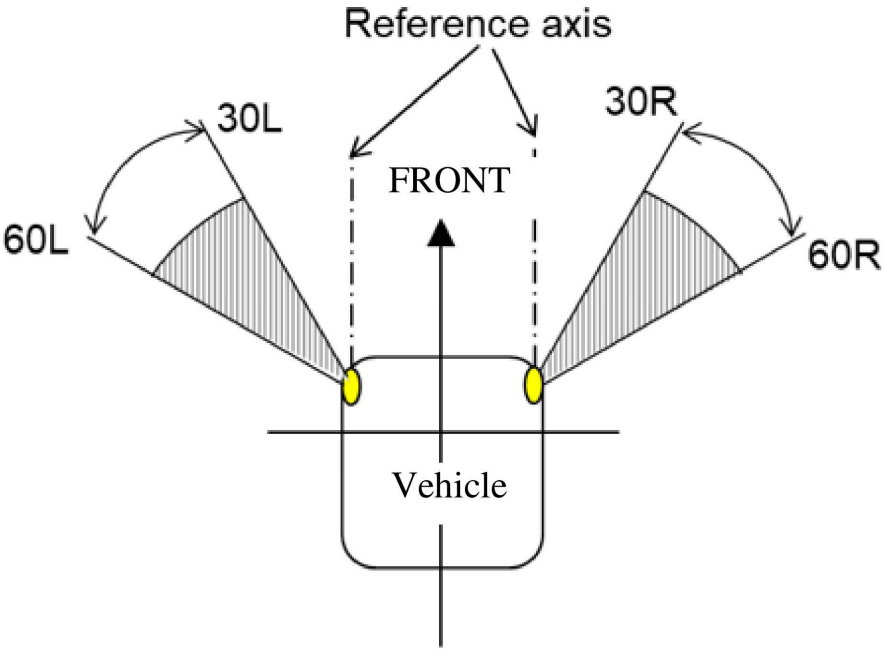


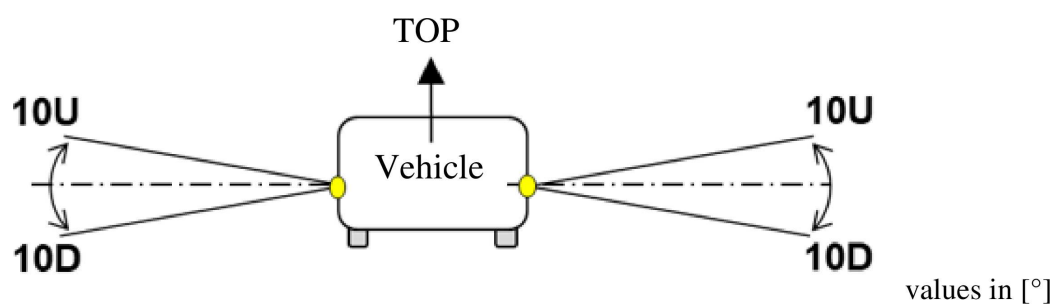
Figure A4-XIII

Horizontal geometric visibility for cornering lamps



values in [°]

Figure A4-XIV

Vertical geometric visibility for cornering lamps

ANNEX 5

Aiming procedure, instrumental verification of the "cut-off" for asymmetric passing-beams

1. VISUAL AIMING PROCEDURE

- 1.1. The luminous intensity distribution of a principal passing-beam headlamp or of at least one lighting unit for a class C passing beam of an AFS in its neutral state shall incorporate a "cut-off" (see Figure A5-I), which enables the headlamp to be adjusted correctly for the photometric measurements and for the aiming on the vehicle.

The "cut-off" shall provide:

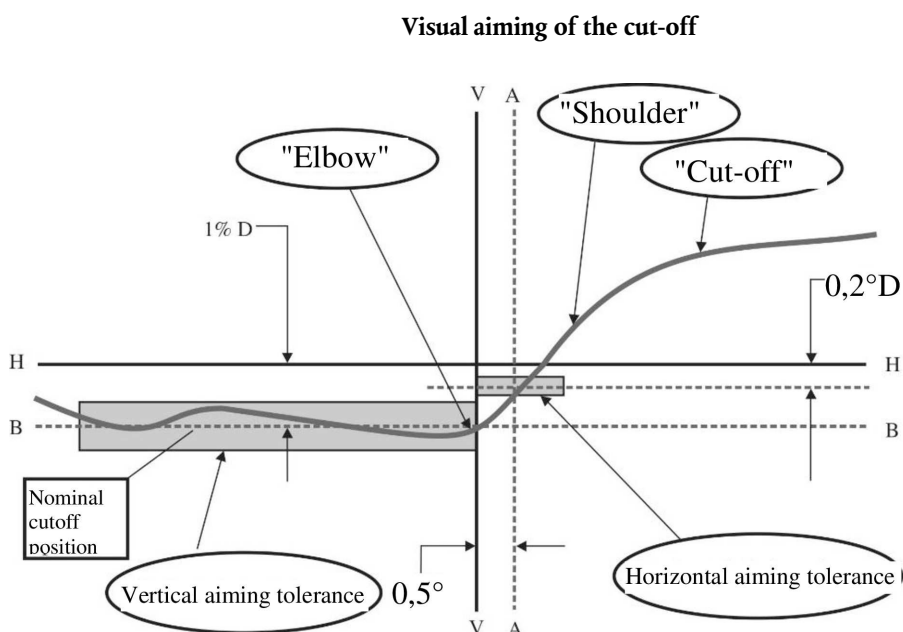
- (a) For right hand traffic beams:
- (i) A straight "horizontal part" towards the left;
 - (ii) A raised "elbow - shoulder" part towards the right.
- (b) For left hand traffic beams:
- (i) A straight "horizontal part" towards the right;
 - (ii) A raised "elbow - shoulder" part towards the left.

In each case the "elbow-shoulder" part shall have a sharp edge.

- 1.2. The headlamp or AFS shall be visually aimed by means of the "cut-off" (see Figure A5-I) as follows. The aiming shall be carried out using a flat vertical screen set up at a distance of 10 m or 25 m (as indicated in item 9 of Annex 1) forward of the headlamp or AFS and at right angles to the H-V axis as shown in Annex 4. The 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.

- 1.2.1. 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 ($0,57$ degrees) below the H-H line;

Figure A5-I



Note: The scales are different for vertical and horizontal lines.

1.2.2. 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° D its "shoulder" shall not exceed the line A to the left;
- (b) The line 0,2° D or below its "shoulder" should cross the line A; and
- (c) The kink of the "elbow" is basically located within $\pm 0,5$ degrees to the left or right of 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° D its "shoulder" shall not exceed the line A to the right;
- (b) On the line 0,2° or below its "shoulder" cross the line A; and
- (c) The kink of the "elbow" should be primarily on the V-V line;

1.2.3. Where a headlamp or AFS so aimed does not meet the requirements set out in paragraphs this Regulation 5.2. to 5.4. of this Regulation respectively, 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° to the left or 0,75° to the right, for right hand traffic; or
- (b) 0,5° to the right or 0,75° to the left, for left hand traffic; and

Vertically not more than 0,25° up or down from line B.

1.2.4. If, however, vertical adjustment cannot be performed repeatedly to the required position within the tolerances described in paragraph 1.2.3., the instrumental method of paragraph 2. 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.

1.2.5. When so aimed, a headlamp, if its approval is sought solely for provision of a passing-beam⁹, need comply only with the requirements set out in paragraphs 5.2. to 5.4. of this Regulation; if it is intended to provide both a passing-beam and a driving-beam, it shall comply with the requirements set out in paragraphs 5.1. to 5.4. of this Regulation.

2. INSTRUMENTAL VERIFICATION OF THE "CUT-OFF" LINE FOR ASYMMETRIC PASSING-BEAMS

2.1. General

In the case where paragraph 1.2.4. applies, the quality of the "cut-off" line shall be tested according to the requirements set out in paragraph 2.2. and the instrumental vertical and horizontal adjustment of the beam shall be performed according to the requirements set out in paragraph 2.3.

Before carrying out the measurement of the quality of "cut-off", and the instrumental aiming procedure, a visual pre-aim in accordance with paragraphs 1.2.1. and 1.2.2. is required.

2.2. 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° 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 to 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 at least one set of measurements complies with the requirements of paragraphs 2.2.1. to 2.2.3.

2.2.1. Not more than one "cut-off" shall be visible ⁽¹⁾

2.2.2. 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 and E = the illumination on the aiming screen.

The value of G shall not be less than 0,13 (minimum sharpness) and not greater than 0,40 (maximum sharpness).

2.2.3. 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 A5-II).

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:

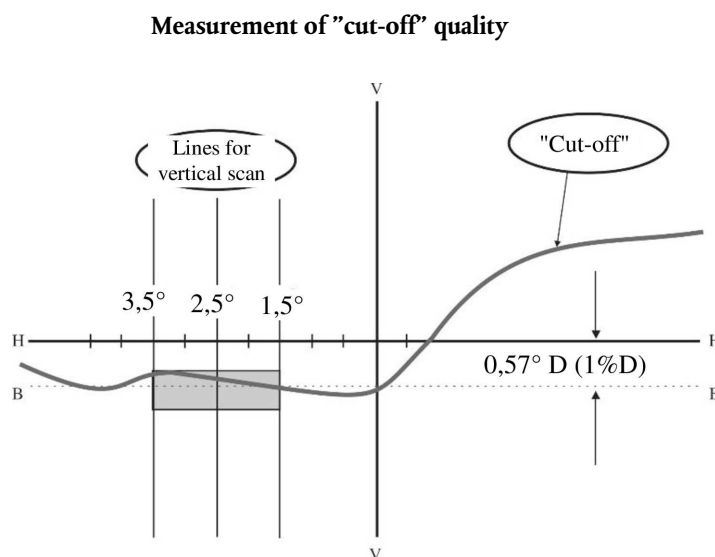
The maximum vertical distance between the inflection points determined shall not exceed $0,2^\circ$.

$$(d^2 (\log E) / d\beta^2 = 0).$$

2.3. Vertical and horizontal adjustment

If the "cut-off" complies with the quality requirements of paragraph 2.2. the beam adjustment may be performed instrumentally.

Figure A5-II



Note: The scales are different for vertical and horizontal lines.

⁽¹⁾ This paragraph should be amended when an objective test method is available.

2.3.1. Vertical adjustment

Moving upward from below the line B (see Figure A5-III), 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 $d^2 (\log E) / d\beta^2 = 0$) is determined and positioned on the line B situated one per cent below H-H.

2.3.2. Horizontal adjustment

The applicant shall specify one of the following horizontal aim methods:

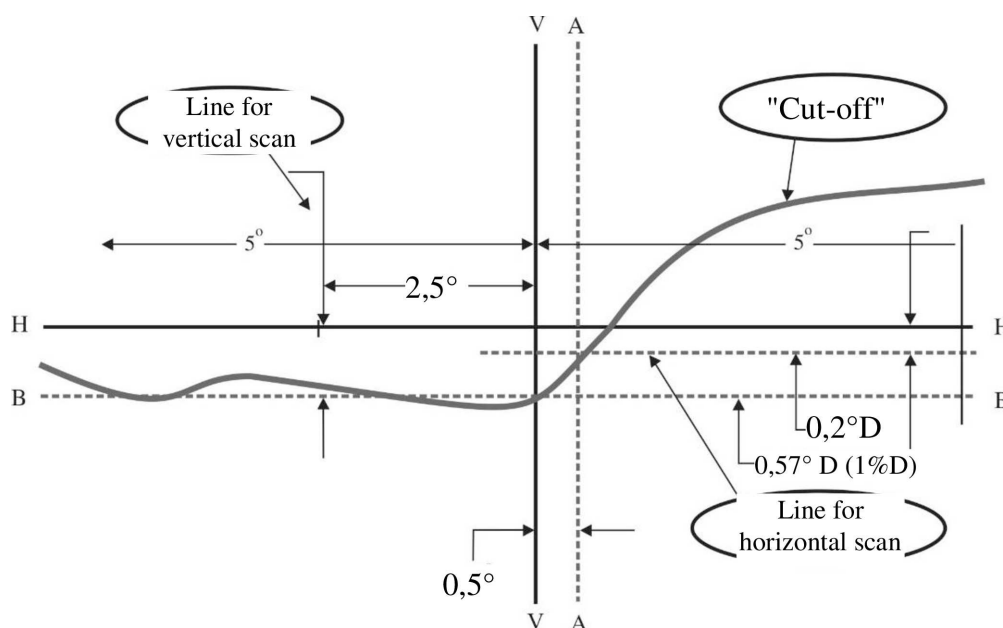
(a) The "0,2 D line" method (see Figure A5-III).

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 A5-III

Instrumental vertical and horizontal adjustment - horizontal line scan method



Note: The scales are different for vertical and horizontal lines.

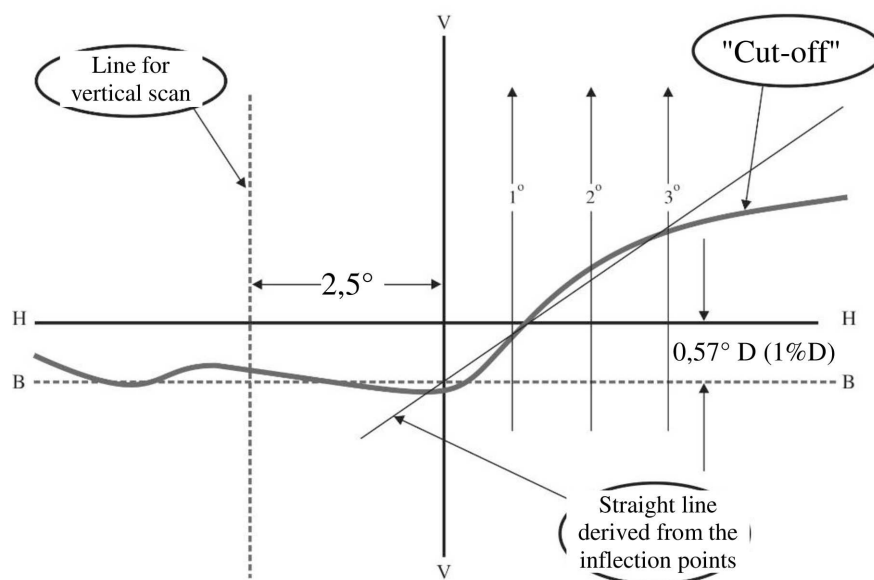
(b) The "3 line" method (see Figure A5-IV)

Three vertical lines shall be scanned from $2^\circ D$ to $2^\circ U$ at $1^\circ R$, $2^\circ R$, and $3^\circ R$ 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 A5-IV

Instrumental vertical and horizontal adjustment - Three line scan method

Note: The scales are different for vertical and horizontal lines.

ANNEX 6

Definition and sharpness of the horizontal "cut-off" line and aiming procedure by means of this "cut-off" line for symmetrical passing beam headlamps and front fog lamps

1. GENERAL

- 1.1. The luminous intensity distribution of the symmetrical passing-beam headlamps and front fog lamp shall incorporate a "cut-off" line which enables the lamp to be adjusted correctly for the photometric measurements and for the aiming on the vehicle. The characteristics of the "cut-off" line shall comply with the requirements set out in paragraphs 2. to 4.:

2. SHAPE OF THE "CUT-OFF" LINE

- 2.1. For visual adjustment of the lamp the "cut-off" line shall provide:

- 2.1.1. A horizontal line for vertical adjustment of the symmetrical passing-beam headlamp extending to either side of the V-V line (see Figure A6-I) as specified in paragraph 5.4.1.1. of this Regulation.
- 2.1.2. A horizontal line for vertical adjustment of the front fog lamp extending to 4° either side of the V-V line (see Figure A6-II).

Figure A6-I

Shape and position of the "cut-off" line of symmetrical passing-beam headlamp

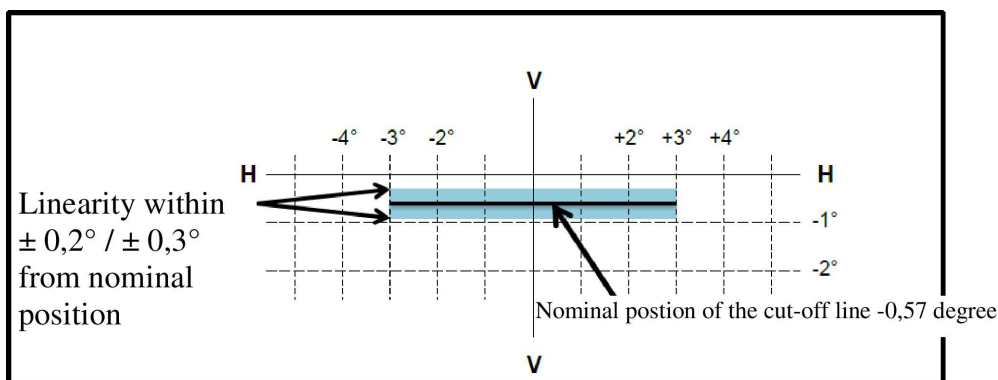
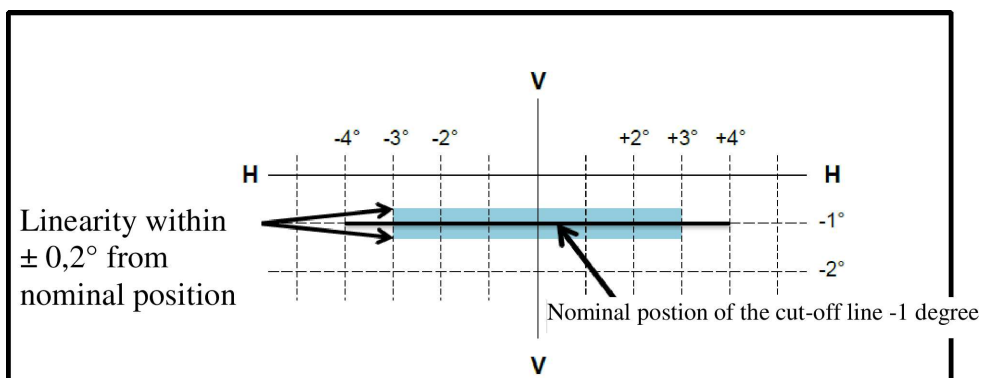


Figure A6-II

Shape and position of the "cut-off" line of the front fog lamp



3. ADJUSTMENT OF THE SYMMETRICAL PASSING-BEAM HEADLAMP AND FRONT FOG LAMP.

3.1. Horizontal adjustment: the cut-off line shall be so positioned that the projected beam pattern appears approximately symmetrical to the V-V line. When the front fog lamp is designed for use in pairs or has otherwise an asymmetric beam pattern, it shall be horizontally aligned according to the specification of the applicant, or otherwise in such a way that the cut-off line appears symmetrical to the V-V line.

3.2. Vertical adjustment: after horizontal adjustment of the lamp according to paragraph 3.1., the vertical adjustment shall be performed in such a way that the beam with its "cut-off" line is moved upwards from the lower position until the "cut-off" line is situated at nominal vertical position. For nominal vertical adjustment the "cut-off" line is positioned on the V-V line

(a) At 0,57 degree (1 per cent) below the h-h line for symmetrical headlamps of the Classes AS, BS, CS, DS and ES;

(b) At 1 degree below the h-h line for front fog lamps.

If the horizontal part is not straight but slightly curved or inclined, the "cut-off" line shall not exceed the vertical range formed by two horizontal lines which are situated from 3° left to 3° right of the V-V line at:

(a) 0,2° for Class BS headlamps and front fog lamps;

(b) 0,3° for Classes AS, CS, DS and ES headlamps;

above and below the nominal position of the "cut-off" (see Figures A6-I and A6-II respectively).

3.3. If the vertical positions of three attempts to adjust the cut-off differ by more than:

(a) 0,2° for Class BS headlamps and front fog lamps;

(b) 0,3° for Classes AS, CS, DS and ES headlamps;

the horizontal part of the "cut-off" line is assumed not to provide sufficient linearity or sharpness for performing visual adjustment. In this case the quality of "cut-off" shall be tested instrumentally for compliance with requirements as follows.

4. MEASUREMENT OF THE QUALITY OF "CUT-OFF"

4.1. Measurements shall be performed by vertically scanning through the horizontal part of the "cut-off" line in angular steps not exceeding 0,05°:

(a) At either a measurement distance of 10 m and a detector with a diameter of approximately 10 mm;

(b) Or at a measurement distance of 25 m and a detector with a diameter of approximately 30 mm.

The "cut-off" quality shall be considered acceptable if at least one measurement at 10 m or 25 m complies with the requirements of paragraphs 4.1.1. to 4.1.3.

The measuring distance at which the test was determined shall be noted down in the communication form according to Annex 1, paragraph 9.2.6.

The scanning is performed from its lower position upwards through the "cut-off" line along the vertical lines at:

(a) - 3° to -1,5° and +1,5° to +3° from the V-V line for headlamps

(b) - 2,5° and + 2,5° from the V-V line for front fog lamps.

When so measured, the quality of the "cut-off" line shall meet the following requirements:

4.1.1. Not more than one "cut-off" line shall be visible ⁽¹⁾.

4.1.2. Sharpness of "cut-off": if scanned vertically through the horizontal part of the "cut-off" line along the $\pm 2.5^\circ$ -lines, the maximum value measured for:

$$G = (\log E_\beta - \log E_{(\beta \pm 0,1^\circ)})$$

is called the sharpness factor G of the "cut-off" line. The value of G shall not be less than:

- (a) 0,13 for Class BS headlamps;
- (b) 0,08 for Classes AS, CS, DS, ES headlamps and front fog lamps.

4.1.3. Linearity: the part of the "cut-off" line which serves for vertical adjustment shall be horizontal from 3°L to 3°R of the V-V line. This requirement is deemed to be met if the vertical positions of the inflection points according to paragraph 3.2. above at 3° left and right of the V-V line do not differ by more than:

- (a) $0,2^\circ$ for Class BS headlamps and front fog lamps;
- (b) $0,3^\circ$ for Classes AS, CS, DS and ES headlamps;

from the nominal position at the V-V line.

5. INSTRUMENTAL VERTICAL ADJUSTMENT

If the "cut-off" line complies with the above quality requirements, the vertical beam adjustment can be performed instrumentally. For this purpose the inflection point where $d^2 (\log E) / dv^2 = 0$ is positioned on the V-V line in its nominal position below the h-h-line. The movement for measuring and adjusting the "cut-off" line shall be upwards from below the nominal position.

⁽¹⁾ This paragraph should be amended when an objective test method is available.

ANNEX 7

Tests for stability of photometric performance of Road Illumination Devices in operation (except cornering lamps)

1. TESTS ON COMPLETE ROAD ILLUMINATION DEVICES (RID)

Once the photometric values have been measured according to this Regulation:

(a) In the case of a headlamp with an asymmetrical passing-beam pattern:

at the point for $I_{\max}$ for driving-beam and in points 25L2, 50 R, B 50 L for passing-beam (or 25R2, 50 L, B 50 R for headlamps designed for left-hand traffic);

(b) In the case of a headlamp with a symmetrical beam pattern:

at the point for $I_{\max}$ for driving beam and in points 0,50U/1,5L and 0,50U/1,5R, 50R, 50L for Class B passing beam and in points 0,86D-3,5R, 0,86D-3,5L, 0,50U-1,5L and 0,50U-1,5R for Classes C, D and E, for passing beam;

(c) In the case of a front fog lamps:

at the point of maximum illumination in zone D ($I_{\max}$) and in the point HV;

(d) In the case of an AFS:

at the point for $I_{\max}$ for driving-beam and in points 25LL, 50V, B 50 L (or 25RR, 50V, B 50 R for AFS designed for left-hand traffic) for passing-beam;

A complete sample shall be tested for stability of photometric performance in operation.

1.1. In the case of headlamps or front fog lamps:

"Complete sample" shall be understood to mean the complete lamp itself including ballast(s) and those surrounding body parts, light sources or LED module(s) which could influence its thermal dissipation.

1.2. In the case of an AFS:

(a) "Complete sample" shall be understood to mean the complete right and left side of a system itself including electronic light source control-gear(s) and/or supply and operating device(s) and those surrounding body parts and lamps which could influence its thermal dissipation. Each installation unit of the system and lamp(s) and/or LED module, if any, of the complete system may be tested separately.

(b) "Test sample" in the following text means correspondingly either the "complete sample" or the installation unit under test.

(c) The expression "light source" shall be understood to comprise also any single filament of a filament light source, LED light source, LED modules or light emitting parts of a LED light source or LED module

1.3. 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 light source and 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.

(c) In the case of an AFS providing an adaptation of the driving-beam, the driving-beam shall be in the maximum condition if activated.

1.4. The measuring equipment shall be equivalent to that used during type approval tests. The AFS or part(s) thereof shall, prior to the subsequent tests, be set to the neutral state.

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.

2. TEST FOR STABILITY OF PHOTOMETRIC PERFORMANCE

2.1. Clean device

The device shall be operated for 12 hours as described in paragraph 2.1.1. and checked as prescribed in paragraph 2.1.2.

2.1.1. Test procedure ⁽¹⁾

2.1.1.1. The device shall be operated for a period according to the specified time, so that:

- (a) In the case where a device is designed to provide only one lighting function (driving beam or passing beam or front fog lamp) and not more than one class in case of passing beam, the corresponding light source(s) is/are lit for the time, ⁽²⁾ specified in paragraph 2.1.;
- (b) In the case where a device is designed to provide 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 device shall be subjected to the following cycle until the time specified is reached as follows:
 - 15 minutes, principal passing-beam lit
 - 5 minutes, all functions 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, activating¹ successively the passing-beam half of the time and the driving-beam(s) (simultaneously) for half the time specified in paragraph 2.1.
 - (iii) In the case of a passing beam and a driving beam provided by the same gas-discharge light source, the cycle will be:
 - 15 minutes, passing beam lit
 - 5 minutes, all driving beam contributors lit.
- (c) In case of an AFS,
 - (i) Where a test sample provides more than one function or class of passing beam according to this Regulation: if the applicant declares that each specified function or class of passing beam of the test sample has its own light source(s), being exclusively lit² at a time, the test shall be carried out in accordance with this condition, activating¹ the most power consuming mode of each specified function or class of passing beam successively for the same (equally divided) part of the time specified in paragraph 2.1.
 - (ii) In all other cases, ^{1,2} the test sample shall be subjected to the following cycle test for each, the mode(s) of class C passing beam, the class V passing beam, the class E passing beam and the class W passing beam, whatever is provided or partly provided by the test sample, for the same (equally divided) part of the time specified in paragraph 2.1.:
 - 15 minutes, first, e.g. class C passing beam mode lit with its most power-consuming mode for straight road conditions;

⁽¹⁾ For the test schedule see Annex 7, Appendix 1.

⁽²⁾ When the tested headlamp includes signaling 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 additional light sources be simultaneously lit when headlamp flashing is used, this shall not be considered as being normal use of light sources.

- 5 minutes, same passing beam mode lit as before and, additionally, all light sources (*) of the test sample, which are possible to be lit at the same time, according to the applicant's declaration;

after having reached the said (equally divided) part of the time specified in paragraph 2.1., the above test cycle shall be performed with the second, third and fourth class of passing beam, if applicable, in the above order.

(d) 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 functions 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) lit² at a time, the test shall be carried out in accordance with this condition, activating¹ successively the front fog lamp half of the time and the driving-beam(s) (simultaneously) for half the time specified in paragraph 2.1.

(e) In the case where a test sample includes other grouped lighting function(s), all the individual functions shall be lit simultaneously for the time specified in (a) or (b) above for individual lighting functions, according to the manufacturer's specifications.

(f) In the case of a 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 lit;
- 5 minutes, all functions 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)² lit at a time, the test shall be carried out in accordance with this condition, activating¹ successively the principal passing-beam half of the time and the driving-beam(s) for half the time specified in paragraph 2.1., 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 lamp² lit at a time, the test shall be carried out in accordance with this condition, activating¹ successively the principal passing-beam half of the time and the front fog lamp for half of the time specified in paragraph 2.1., 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)² lit or only the front fog lamp² lit at a time, the test shall be carried out in accordance with this condition, activating¹ 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 2.1.

(g) In the case of a passing-beam designed to provide bend lighting with the addition of light source(s) or LED module(s), it/they shall be switched on for one minute, and switched off for nine minutes during the activation of the passing-beam only (see Appendix 1 of this Annex).

If the headlamp has several additional light sources used to produce bend lighting, the test shall be carried out with the combination of light source(s) that represents the most severe operating condition.

(*) All light sources of lighting functions even if no approval is sought according to this Regulation must be taken into account, except those covered by footnote 3.

- (h) In the case that the driving beam uses several light sources and if the applicant declares that a part of the driving beam (one of these additional light sources) will be used exclusively for short time signals (flash to pass), the test shall be carried out without this part of the driving beam.

2.1.1.2. 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 or the light source in case the ballast is integrated with the light source is $13,2 \pm 0,1$ 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 light source(s) and LED module(s) shall be measured at 6,75 V, 13,2 V or 28,0 V respectively, if not otherwise specified within the pertinent Regulation. LED light source(s) and 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.
- (g) For a gas-discharge light source, the test voltage for the ballast or for the light source in case the ballast is integrated with the light source is $13,2 \pm 0,1$ volts for 12 V network system, or otherwise specified in the application for approval.

2.1.2. Test results

2.1.2.1. Visual inspection

Once the headlamp has been stabilized 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.

2.1.2.2. Photometric test

To comply with the requirements, the photometric values shall be verified in the following points:

2.1.2.2.1. In the case of a headlamp with an asymmetrical beam pattern:

- (a) Passing-beam, except for AFS system:

- 50 R - B 50 L – 25L2 for headlamps designed for right-hand traffic;
- 50 L - B 50 R – 25R2 for headlamps designed for left-hand traffic.

(b) Passing-beam, for AFS system:

Class C passing beam and each specified other passing beam class:

50V, B50L and 25LL, if applicable.

(c) Driving-beam: Point $I_{\max}$

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 3. of this Annex).

Except for point B 50 L, 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. The value measured at point B 50 L shall not exceed the photometric value measured prior to the test by more than 170 cd.

2.1.2.2.2. In the case of a head lamp with a symmetrical beam pattern:

(a) Class B headlamp:

— Passing beam: 50R - 50L - 0,50U/1,5L and 0,50U/1,5R.

— Driving beam: Point of $I_{\max}$

(b) For Classes C, D and E headlamp:

— Passing beam: 0,86D/3,5R - 0,86D/3,5L - 0,50U/1,5L and 1,5R.

(c) Driving beam: Point of $I_{\max}$

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 3. of this Annex).

Except for points 0,50U/1,5L and 0,50U/1,5R, 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. The value measured at points 0,50U/1,5L and 0,50U/1,5R shall not exceed the photometric value measured prior to the test by more than 255cd.

2.1.2.2.3. In the case of front fog lamps on line 5 at point $h = 0$ and the point of $I_{\max}$ in zone D.

Another aiming may be carried out to allow for any deformation of the front fog lamp base due to heat (the change of the position of the cut-off line is covered in paragraph 3. 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.

2.2. Dirty headlamp

After being tested as specified in paragraph 2.1., the headlamp shall be operated for one hour as described in paragraph 2.1.1. for each function or class of passing beam ^(*) after being prepared as prescribed in paragraph 2.2.1., and checked as prescribed in paragraph 2.1.2., after each test a sufficient cooling down period must be assured.

2.2.1. Preparation of the headlamp

2.2.1.1. Test mixture:

See Appendix 2 to this Annex

(*) The class W passing beam, if any, is disregarded for lighting units providing or contributing to any other passing beam class or lighting function.

2.2.1.2. 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 below:

- (a) In the case of a headlamp with an asymmetrical beam pattern:
 - (i) Point of $I_{\max}$ in passing-beam/driving-beam and in driving-beam only;
 - (ii) 50 R and 50 V for a headlamp producing only a passing-beam, designed for right-hand traffic;
 - (iii) 50 L and 50 V for a headlamp producing only a passing-beam, designed for left-hand traffic;
 - (iv) 50V for a class C passing beam of AFS system, and each specified passing beam mode.
- (b) In the case of a headlamp with a symmetrical beam pattern:
 - (i) For Class B headlamp:
 - Passing beam / driving beam and driving beam only:
Point of $I_{\max}$
 - Passing beam only: B 50 and 50 V
 - (ii) For Class C, D and E headlamp:
 - Passing beam/driving beam and driving beam only: Point of $I_{\max}$
 - Passing beam only: 0,50U/1,5L and 1,5R and 0,86D/V
- (c) In the case of a front fog lamps:
 - point of $I_{\max}$ in zone D.

3. 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 headlamp producing a passing-beam, for front fog lamps, or in the case of an AFS for a system or part(s) of emitting a class C (basic) passing-beam, or each specified passing-beam mode.

The device tested in accordance with paragraph 2., shall be subjected to the test described in paragraph 3.1., without being removed from or readjusted in relation to its test fixture.

If the AFS consists of more than one lighting unit or more than one assembly of lighting units which provide a cut-off, each of these is understood to be a test sample for the purpose of this test and must be tested separately.

If the AFS has a moving optical part, only the position closest to the average vertical angular stroke and/or the initial position according to the neutral state is chosen for this test.

The test is confined to signal input conditions corresponding to a straight road, only.

3.1. Test Procedure

3.1.1. For the purpose of this test, the voltage shall be adjusted as specified in paragraph 2.1.1.2.;

The test shall be carried out in a dry and still atmosphere at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$.

The device shall be operated 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 2.1.1.2.):

- (a) Using a mass production filament light source as submitted with the device, which has been aged for at least 1 hour;

- (b) Using mass production LED light source(s) and/or the LED module(s) as submitted with the device, which has been aged for at least 48 hours;
- (c) Using a mass production gas-discharge light source which has been aged for at least 15 hours.

3.1.2. In the case of a device with an asymmetrical beam pattern:

the position of the "cut-off" line in its horizontal part (between V-V and the vertical lines passing through point B 50 L for right-hand traffic or B 50 R for left-hand traffic) shall be verified 3 minutes (r3) and 60 minutes (r60) respectively after operation.

3.1.3. In the case of a headlamp with a symmetrical beam pattern: the position of the "cut-off" line in its horizontal part (between V-V and the vertical lines passing through point 50 L and 50 R for Class BS headlamp, 3,5 L and 3,5 R for Class CS, DS and ES headlamp) shall be verified 3 minutes (r3) and 60 minutes (r60) respectively after operation.

3.1.4. In the case of a front fog lamps: the position of the "cut-off" line between a point situated 3,0 degrees left and a point situated 3.0 degrees right of the cut-off line V-V shall be verified 3 minutes (r3) and 60 minutes (r60) 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.

3.2. Test results

3.2.1. The result, expressed in milliradians (mrad), shall be considered as acceptable when:

- (a) In case of headlamps or AFS, the absolute value $\Delta r_1 = |r_3 - r_{60}|$ recorded on the device is not more than 1,0 mrad ($\Delta r_1 \leq 1,0$ mrad) upward and not more than 2,0 mrad ($\Delta r_1 \leq 2,0$ mrad) downwards.
- (b) In case of front fog lamps, the absolute value $\Delta r_1 = |r_3 - r_{60}|$ recorded on this device is not more than 2,0 mrad ($\Delta r_1 \leq 2,0$ mrad).

3.2.2. However, if the result does not comply with the requirements in paragraph 3.2.1. and does not exceed the values in Table A7-1, a further sample mounted on a test fixture representative of the correct installation on the vehicle shall be tested as described in paragraph 3.1. after being subjected three consecutive times to the cycle as described below, in order to stabilise the position of the mechanical parts of the device:

- (a) Operation of the device for one hour (the voltage shall be adjusted as specified in paragraph 2.1.1.2.);
- (b) One hour period with the lamp switched off.

After these three cycles, the device shall be considered as acceptable if the absolute values Δr measured according to paragraph 3.2. on this further sample meet the requirements in paragraph 3.2.1.

Table A7-1

Movement values

Movement	Device	Value
Upward	Headlamp or AFS	1,5 mrad
	Front fog lamp	3,0 mrad
Downward	All	3,0 mrad

Annex 7 - 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

Additional light source(s) or LED module(s) of bend light

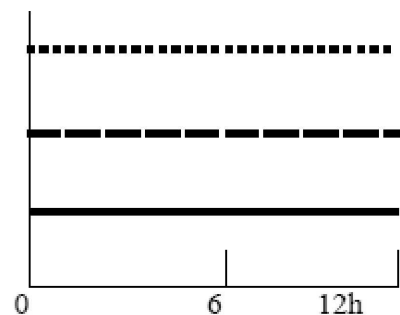
P, D or F

2. P+F or P+D or P+ D_1+D_2 or P+D+F or P+ D_1+D_2 + F

Additional light source(s) or LED module(s) of bend light

D or F or D_1+D_2 or D+F

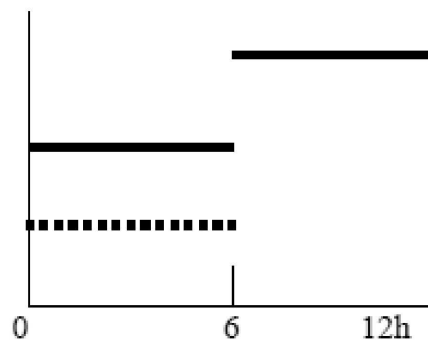
P

3. P/F or P/D or P/ D_1+D_2

Additional light source(s) or LED module(s) of bend light

D or F or D_1+D_2

P

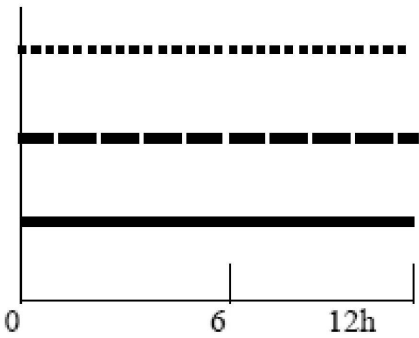


4. D+F or D₁+D₂ +F

Additional light source(s) or LED module(s) of bend light

D or D₁+D₂

F

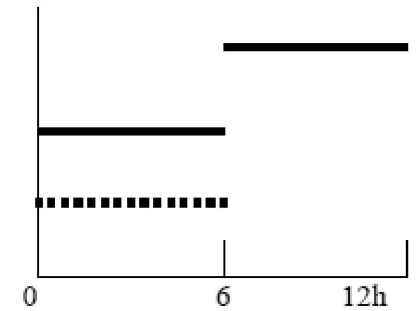


5. D/F or D₁+D₂/F

D or D₁+D₂

F

Additional light source(s) or LED module(s) of bend light



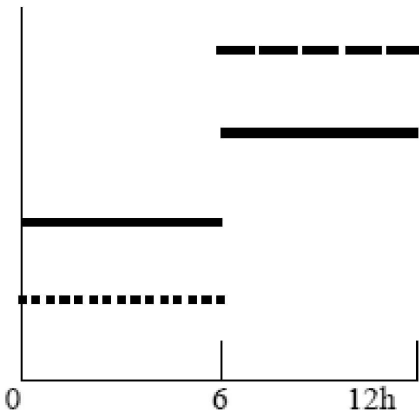
6. P/D+F or P/D₁+D₂+F

F

D or D₁+D₂

P

Additional light source(s) or LED module(s) of bend light



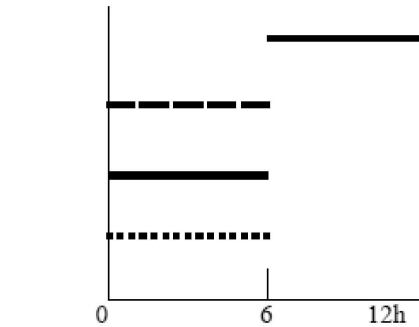
7. P+D/F or P+D₁+D₂/F

F

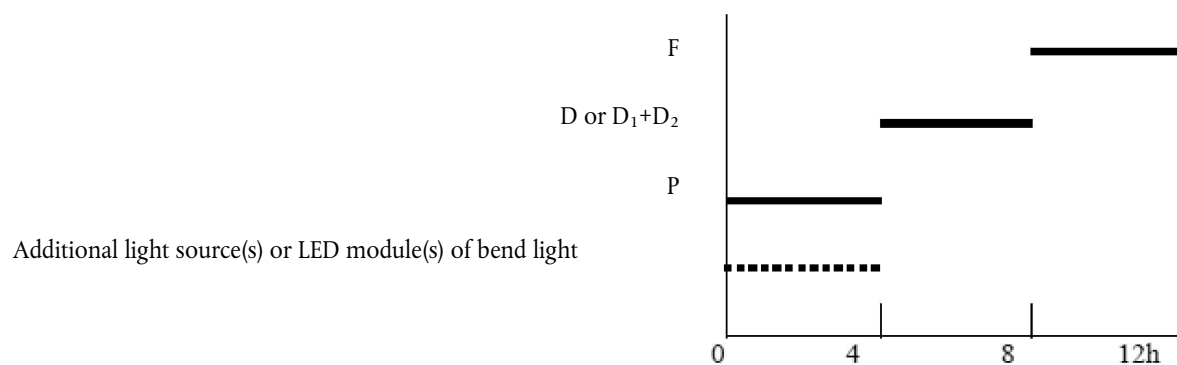
D or D₁+D₂

P

Additional light source(s) or LED module(s) of bend light



8. $P/D/F$ or $P/D_1+D_2/F$



*Annex 7 - Appendix 2***Test mixture for dirty headlamp test**

1. For devices with the outer lens made of glass:

The mixture of water and a polluting agent to be applied to the device shall be composed of:

- (a) 9 parts by weight of silica sand with a particle size of 0-100 µm;
- (b) 1 part by weight of vegetal carbon dust produced from beech wood with a particle size of 0-100 µm;
- (c) 0,2 parts by weight of NaCMC; ⁽⁶⁾ and
- (d) 5 parts by weight of sodium chloride (pure at 99 per cent);
- (e) an appropriate quantity of distilled water, with a conductivity of ≤ 1 mS/m.

The mixture shall not be more than 14 days old.

2. For devices with outer lens made of plastic material:

The mixture of water and polluting agent to be applied to the device shall be composed of:

- (a) 9 parts by weight of silica sand with a particle size of 0-100 µm;
- (b) 1 part by weight of vegetal carbon dust produced from beech wood with a particle size of 0-100 µm;
- (c) 0,2 parts by weight of NaCMC; ⁽⁶⁾ and
- (d) 5 parts by weight of sodium chloride (pure at 99 per cent);
- (e) 13 parts by weight of distilled water with a conductivity of ≤ 1 mS/m; and
- (f) 2 ± 1 drops by weight of surfactant. ⁽⁷⁾

The mixture shall not be more than 14 days old.

⁽⁶⁾ 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.

⁽⁷⁾ The tolerance on quantity is due to the necessity of obtaining a dirt that correctly spreads out on all the plastic lens.

ANNEX 8

Requirements for road illumination devices (except cornering lamps) incorporating lenses of plastic material - testing of lens or material samples

1. GENERAL ADMINISTRATIVE REQUIREMENTS

- 1.1. A test report shall be prepared on the basis of this Annex, covering the test and test results described below in paragraphs 3.1 to 3.5; this report will be added to the test report for the device covered by the approval application and to its documentation.

The road illumination device used for this test shall be noted in the test report.

- 1.2. Every application for approval shall be accompanied by:

- 1.2.1. For the test of plastic material of which the lenses are made: Fourteen lenses;

- 1.2.1.1. Ten of these lenses may be replaced by ten samples of material at least 60 x 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 x 15 mm;

- 1.2.1.2. Every such lens or sample of material shall be produced by the method to be used in mass production;

- 1.2.2. An optical assembly, if applicable, to which the lenses can be fitted in accordance with the manufacturer's instructions.

- 1.2.3. For testing the ultraviolet (UV)-resistance of light transmitting components made of plastic material against UV radiation of LED modules inside the headlamp:

One sample of each of the relevant material as being used in the road illumination device or one road illumination device 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;

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 9 are being applied or if provisions are taken, to shield the relevant device components from UV radiation, e.g. by glass filters.

2. GENERAL REQUIREMENTS

- 2.1. The samples supplied pursuant to paragraph 1.2. shall satisfy the requirements indicated in paragraphs 3.1. to 3.6.

- 2.2. The two samples of complete road illumination devices supplied pursuant to paragraph 3.1.3.4. of this Regulation and incorporating lenses of plastic material shall, with regard to the lens material, satisfy the requirements indicated in paragraph 3.7.

- 2.3. The samples (lenses of plastic material or samples of material) shall be subjected, with the optical assembly to which they are intended to be fitted (where applicable), to approval tests in the chronological order indicated in Table A8-1.

- 2.4. However, if the lamp manufacturer can prove that the product has already passed the tests prescribed in paragraphs 3.1. to 3.5., or the equivalent tests pursuant to another regulation, those tests need not be repeated; only the tests prescribed in Table A8-2 shall be mandatory.

3. SPECIFIC TEST REQUIREMENTS

3.1. Resistance to temperature changes

3.1.1. Three new samples (lenses) shall be subjected to five cycles of temperature and humidity (RH = relative humidity) change in accordance with the following programme:

- (a) 3 hours at $40\text{ °C} \pm 2\text{ °C}$ and 85-95 per cent RH;
- (b) 1 hour at $23\text{ °C} \pm 5\text{ °C}$ and 60-75 per cent RH;
- (c) 15 hours at $-30\text{ °C} \pm 2\text{ °C}$;
- (d) 1 hour at $23\text{ °C} \pm 5\text{ °C}$ and 60-75 per cent RH;
- (e) 3 hours at $80\text{ °C} \pm 2\text{ °C}$;
- (f) 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.

3.1.2. Photometric measurements

3.1.2.1. Photometric measurements shall be carried out on the samples before and after the test.

3.1.2.2. These measurements shall be made using a standard (étalon) light source and/or LED module(s), or if applicable with a standard gas-discharge light source, as present in the road illumination device, at the following points:

- (a) In the case of classes A, B and D:
 - B 50 L and 50 R for the passing-beam (B 50 R and 50 L in the case of headlamps intended for left-hand traffic);
 - $I_{\max}$ for the driving-beam.
- (b) In the case of AFS:
 - B50L and 50V for the Class C passing-beam lighting;
 - $I_{\max}$ for the driving-beam of a system
- (c) In the case of classes BS, CS, DS and ES:
 - B 50, 50L and 50R for Class BS headlamp, 0,86D/3,5R, 0,86D/3,5L, 0,50U/1,5L and 1,5R for Class CS, DS and ES headlamps for the passing beam or a passing/driving lamp;
 - $I_{\max}$ for the driving beam of a driving lamp or a passing/driving lamp;
- (d) In the case of front fog lamps:
 - intersection VV line with line 6 and
 - intersection VV line with line 4.

3.1.2.3. 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.

3.2. Resistance to atmospheric and chemical agents

3.2.1. 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 1/min.

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.

3.2.2. Resistance to chemical agents

After the test described in paragraph 3.2.1. and the measurement described in paragraph 3.2.3.1. have been carried out, the outer face of the said three samples shall be treated as described in paragraph 3.2.2.2. with the mixture defined in paragraph 3.2.2.1.

3.2.2.1. 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).

3.2.2.2. Application of the test mixture

Soak a piece of cotton cloth (as per ISO 105) until saturation with the mixture defined in paragraph 3.2.2.1. and, within 10 seconds, apply it for 10 minutes to the outer face of the sample at a pressure of 50 N/cm^2 , corresponding to an effort of 100 N applied on a test surface of $14 \times 14\text{ mm}$.

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.

3.2.2.3. 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 3.4.1. (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.

3.2.3. Results

3.2.3.1. 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 ($\Delta t_m < 0,020$).

- 3.2.3.2. 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 $\Delta d = \frac{T_5 - T_4}{T_2}$, measured on the three samples according to the procedure described in Appendix 2 to this Annex shall not exceed 0,020 ($\Delta d_m < 0,020$).

3.3. Resistance to light source radiations

If necessary the following test shall be done:

Flat samples of each light transmitting plastic component of the road illumination device are exposed to the light of the light source(s). The parameters such as angles and distances of these samples shall be the same as in the road illumination device. These samples shall have the same colour and surface treatment, if any, as the parts of the road illumination device.

After 1 500 hours of continuous operation, the colorimetric requirements of the transmitted light must be met with a new light source, and the surfaces of the samples shall be free of cracks, scratches, scalings or deformation.

The UV-resistance testing of internal materials to light source radiation is not necessary if light sources according to UN Regulation No. 37 and/or low-UV-type gas discharge light sources and/or low-UV-type LED modules are being applied or if provisions are taken, to shield the relevant system components from UV radiation, e.g. by glass filters.

3.4. Resistance to detergents and hydrocarbons

3.4.1. 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 sulphonate.

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.

3.4.2. 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.

3.4.3. 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 shall not exceed 0,010 ($\Delta t_m < 0,010$).

3.5. Resistance to mechanical deterioration

3.5.1. 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.

3.5.2. Results

After this test, the variations:

in transmission: $\Delta t = \frac{T_2 - T_3}{T_2}$,

and in diffusion: $\Delta d = \frac{T_5 - T_4}{T_2}$,

shall be measured according to the procedure described in Appendix 2 in the area specified in paragraph 1.2.1.1. The mean value of the three samples shall be such that:

$$\Delta t_m < 0,100;$$

$$\Delta d_m < 0,050.$$

3.6. Test of adherence of coatings, if any

3.6.1. Preparation of the sample

A surface of 20 mm x 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 x 2 mm. The pressure on the blade or needle shall be sufficient to cut at least the coating.

3.6.2. Description of the test

Use an adhesive tape with a force adhesion of 2 N/(cm of width) ± 20 per cent measured under the standardized conditions specified in Appendix 4. 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 3.6.1.

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 m/s $\pm$ 0,2 m/s.

3.6.3. 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.

3.7. Tests of the complete road illumination device incorporating a lens of plastic material.

3.7.1. Resistance to mechanical deterioration of the lens surface.

3.7.1.1. Tests

The lens of sample No. 1 shall be subjected to the test described in paragraph 3.5.1. above.

3.7.1.2. Results

3.7.1.2.1 In case of classes A, B and D and AFS, after the test the results of photometric measurements carried out on the headlamp in accordance with this Regulation shall not exceed:

- (a) By more than 30 per cent the maximum values prescribed at points B 50 L and HV and by 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)

or

- (b) By more than 10 per cent below the minimum values prescribed for HV in the case of a headlamp producing driving beam only.

3.7.1.2.2. In the case of Classes BS, CS, DS and ES, after the test, the results of photometric measurements carried out on the headlamp in accordance with this Regulation shall not exceed:

- (a) By more than 30 per cent the maximum values prescribed at point HV and not be more than 10 per cent below the minimum values prescribed at point 50 L and 50 R for Class BS headlamp, 0,86D/3,5R, 0,86D/3,5L for Classes CS, DS and ES headlamp

or

(b) By more than 10 per cent below the minimum values prescribed for HV in the case of a headlamp producing driving beam only.

3.7.1.2.3. In the case of fog lamps, after the test, the results of photometric measurements prescribed for lines 2 and 5 shall not exceed the maximum values prescribed by more than 30 per cent.

3.7.2. Test of adherence of coatings, if any

The lens of sample No. 2 shall be subjected to the test described in paragraph 3.6.

4. VERIFICATION OF THE CONFORMITY OF PRODUCTION

4.1. With regard to the materials used for the manufacture of lenses, the road illumination devices or installation units of a series shall be recognised as complying with this Regulation if:

4.1.1. 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 paras. 3.2.2., 3.4.1. and 3.4.2.);

4.1.2. After the test described in paragraph 3.7.1.1., the photometric values at the points of measurement considered in paragraph 3.7.1.2. are within the limits prescribed for conformity of production by this Regulation.

4.2. If the test results fail to satisfy the requirements, the tests shall be repeated on another sample of road illumination devices selected at random.

Annex 8 - Appendix 1

Chronological order of material tests

A. Tests on plastic materials (lenses or samples of material supplied pursuant to paragraph 1.2.).

Table A8-1

Chronological order of material tests

Samples	Lenses or samples of material										Lenses			
Tests	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Limited photometry											X	X	X	
Temperature change											X	X	X	
Limited photometry											X	X	X	
Transmission measurement	X	X	X	X	X	X	X	X	X					
Diffusion measurement	X	X	X				X	X	X					
Atmospheric agents	X	X	X											
Transmission measurement	X	X	X											
Chemical agents	X	X	X											
Diffusion measurements	X	X	X											
Detergents				X	X	X								
Hydrocarbons				X	X	X								
Transmission measurement				X	X	X								
Deterioration							X	X	X					
Transmission measurement							X	X	X					
Diffusion measurement							X	X	X					
Adherence														X
Resistance to light source radiations (*)										X				

(*) This test concerns front fog lamps equipped with gas-discharge light sources, headlamps and AFS.

Table A8-2

Tests on complete devices, systems or parts thereof (supplied pursuant to paragraph 3.1.3.4. of this Regulation)

Tests	Complete devices, systems or parts thereof	
	Sample No.	
	1	2
Deterioration	X	
Photometry	X	
Adherence		X

Annex 8 - Appendix 2

Method of measurement of the diffusion and transmission of light**1. EQUIPMENT** (see figure A8-I)

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 $\beta/2 = 14^\circ$.

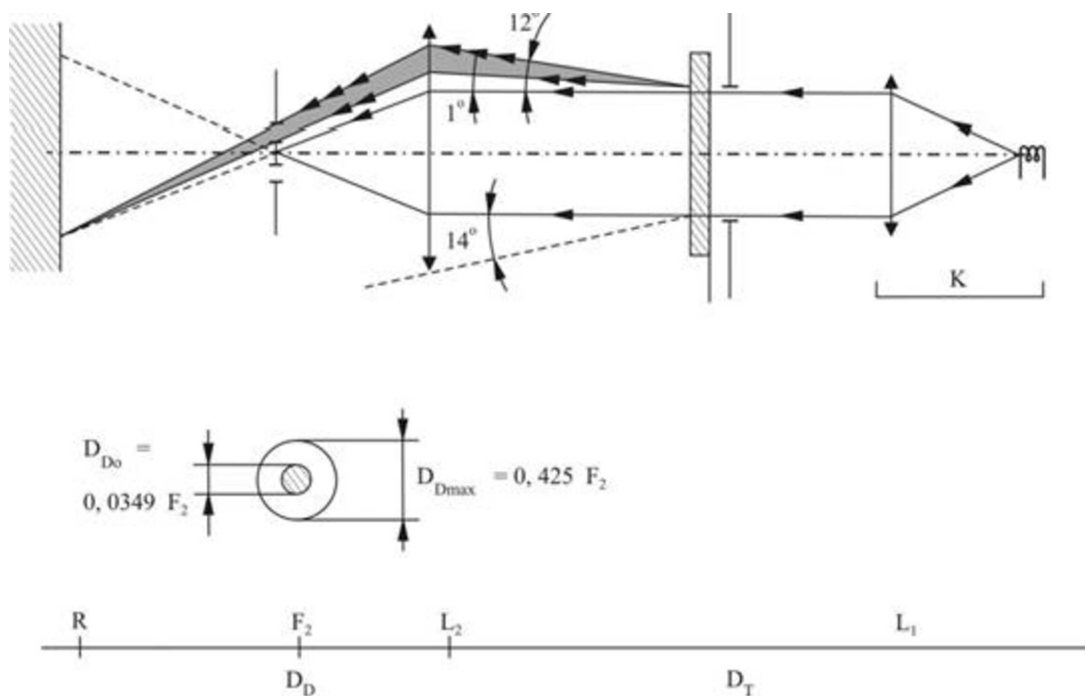
An annular diaphragm D_D , with angles $\alpha_0/2 = 1^\circ$ and $\alpha_{\max}/2 = 12^\circ$ is placed in an image focal plane of the lens L_2 .

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.

Figure A8-I

Optical set up for measurement of variations in diffusion and transmission

⁽¹⁾ For L_2 it is recommended to use a focal distance of about 80 mm.

2. MEASUREMENTS

The following readings shall be taken:

Table A8-3

Readings

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

*Annex 8 - 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 $-0/+0,5$ 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:

- (a) 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;
- (b) 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:

$$\Delta d = \frac{T_5 - T_4}{T_2} = 0,0250 \pm 0,0025$$

Several reference samples may be used to check that the whole surface to be tested has deteriorated homogeneously.

*Annex 8 - 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 °C ± 5 °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 para. 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 mm/s ± 30 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 9

Requirements for LED modules and Road Illumination Devices (except cornering lamps) including LED modules and/or LED light sources

1. GENERAL REQUIREMENTS FOR LED MODULES

- 1.1. Each LED module sample submitted shall conform to the relevant requirements 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 requirements of the headlamp or AFS system 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 OF LED MODULES

- 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.
- 3.1.2. The kind of light sources on a LED module shall be light-emitting diodes (LED) as defined in paragraph 2.7.1. of UN Regulation 48 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 paragraph 4.6.4. of this Regulation. If not specified differently in this Annex LED modules shall be tested inside the device as submitted by the manufacturer.

3.2.2. LED light source operating conditions

All samples shall be tested under the conditions as specified in paragraph 4.6.3. of this Regulation.

3.2.3. Ambient temperature

For the measurement of electrical and photometric characteristics, the device 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 provisions as described in paragraph 4.16. of this Regulation.

The minimum red content of the light of a LED module or a device incorporating LED module(s) tested (at 50 V for headlamps and AFS) 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.).

This value shall be calculated using intervals of one nanometre. The UV-radiation shall be weighted according to the values as indicated Table A9-1:

Table A9-1

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.

	S(λ)			S(λ)			S(λ)
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	0,000053
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						

4.3. Temperature stability for device including LED light source(s) and/or LED module(s)

4.3.1. Luminous intensity

- 4.3.1.1. A photometric measurement of the device 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:	25R in case of headlamps of classes A, B and D 50V in case of headlamps of classes AS, BS, CS, DS, ES 25RR in case of AFS
Driving-beam:	H – V
Front fog lamps:	horizontal 0° vertical 2,5°D

- 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 minutes 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 luminous intensity 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., 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 3.1.3. 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. One module 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 or AFS application.

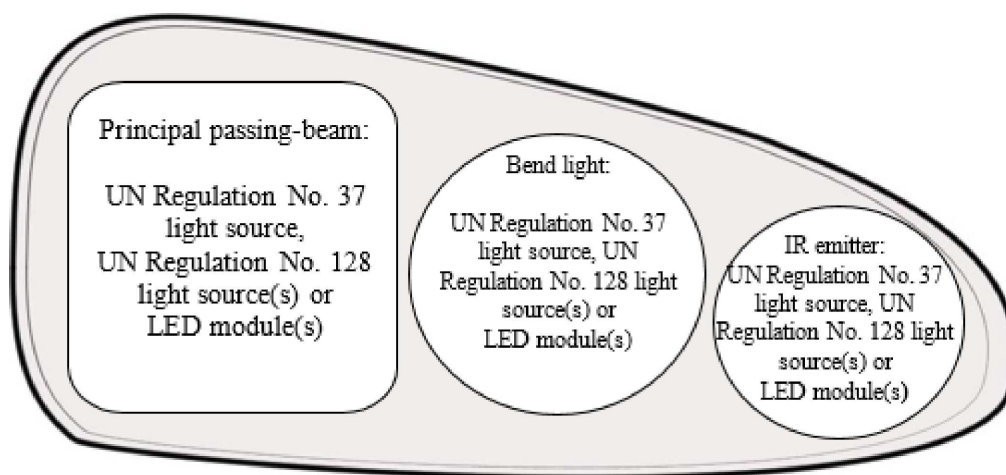
Before the test each LED module shall be aged at least for seventy-two hours under the same conditions as in the corresponding headlamp application.

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.

ANNEX 10

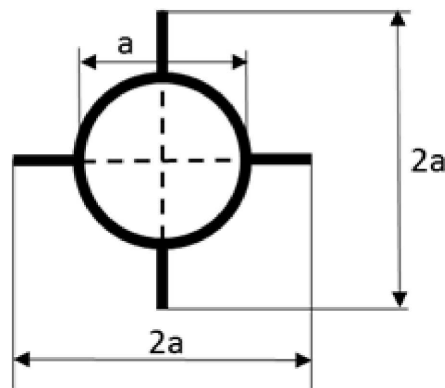
A general illustration for principal passing-beam and beam contributors and correlated light source options*Figure A10-I***General illustration**

ANNEX 11

Centre of reference

In the case it is required:

Figure A11-I

Centre of reference

$a = 2 \text{ mm min.}$

This optional mark of the centre of reference shall be positioned on the lens at its intersection with the reference axis of the passing beam and also on the lenses of the driving beams when they are neither grouped nor combined nor reciprocally incorporated with a passing beam and on the lens of a front fog lamp.

Figure A11-I represents the mark of the centre of reference as projected on a plane substantially tangent to the lens about the centre of the circle. The lines constituting this mark may either be solid or dotted.

—

ANNEX 12

Voltage markings

Figure A12-I
Voltage marking A

nn V

This marking must be placed on the main body of each headlamp containing only gas discharge light sources and ballast, and on each external part of the ballast.

The ballast(s) is(are) designed for a network system of nn Volts.

Figure A12-II
Voltage marking B

nn ~~24~~ V

This marking must be placed on the main body of each headlamp containing at least one gas discharge light source and ballast.

The ballast(s) is(are) designed for a network system of nn Volts.

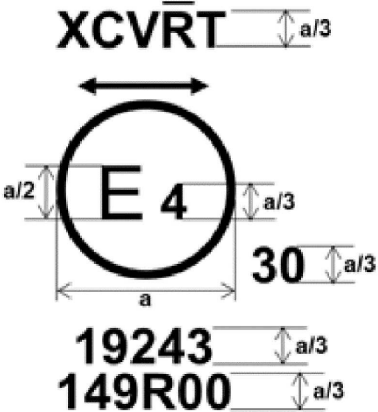
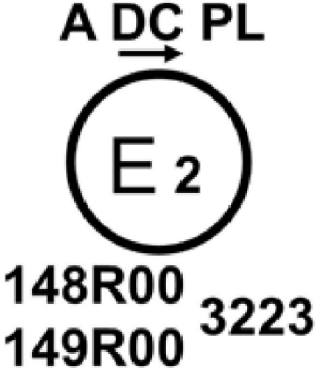
None of the filament light sources which the headlamp contains is designed for a 24 Volts network system.

ANNEX 13

Arrangement of approval marks

The following approval mark arrangements are given merely as examples and any other arrangement made in accordance with paragraph 3.3. of this Regulation is acceptable.

1. Approval mark of a single road illumination device

Figure A13-I Marking example 1  a = see para. 3.3.1.2.1. of this Regulation	The device bearing the approval mark shown on the left is an installation unit of an AFS approved in the Netherlands (E4) under approval number 19243 pursuant to this Regulation. The number after 149R indicates that approval was granted in accordance with the requirements of this Regulation in its original form (00). The functions identification symbols show that the approval was granted in respect of the driving-beam (R) and the Class C and Class V passing-beam. The double pointed arrow shows that the passing beam is suitable for both traffic systems by means of an appropriate adjustment of the setting of the optical element or the light source on the vehicle. Class C passing-beam, Class V passing-beam and driving-beam comply to bending lighting provisions, as indicated by the letter "T". The score above the letter "R" indicates that the driving-beam function is provided by more than one installation unit on that side of the system. Number 30 indicates that the maximum luminous intensity of the driving-beam is between 123 625 and 145 125 candelas.
Figure A13-II Marking example 2 	The lamp bearing the approval mark shown on the left is a gas-discharge passing beam headlamp (DC) for left-hand traffic only (arrow) using a plastic lens (PL) approved in France (E2) pursuant to this Regulation 149R as set in the original series of amendments (00) combined with a front position lamp (A) as set in the original series of amendments (00) of the Regulation on Light Signalling Devices 148R. Both lamps (functions) are approved under approval number 3223.

2. Approval mark of grouped, combined or reciprocally incorporated lamps

Note: The vertical and horizontal lines schematize the shape of the light-signalling lamp. These lines are not part of the approval mark.

Figure A13-III

Marking example 3

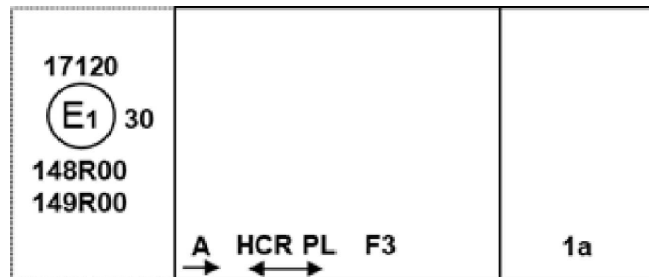
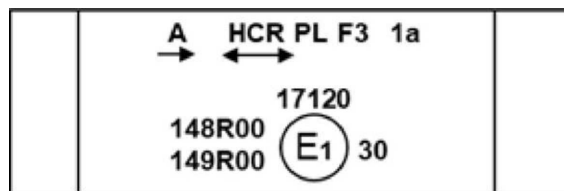


Figure A13-IV

Marking example 4-a



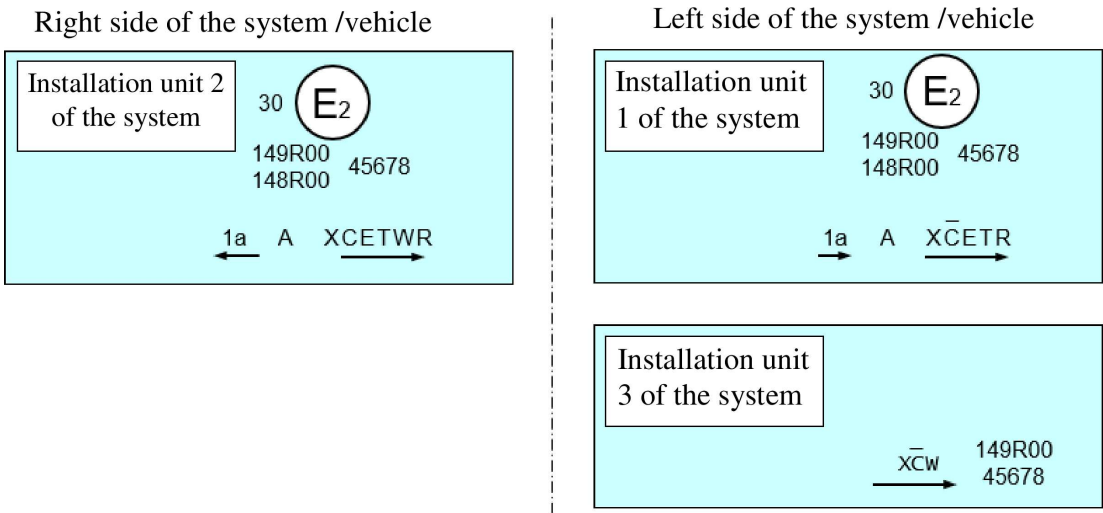
Note: The examples in Figures A13-III and A13-IV correspond to a lighting device bearing an approval mark comprising:

- A front position lamp approved in accordance with the 00 series of amendments to UN Regulation No. 148. The horizontal arrow indicates the side on which the required photometric specifications are met up to an angle of 80° H;
- A headlamp, Class B, with a passing-beam designed for right-hand traffic only and a driving-beam with a maximum intensity comprised between 123,625 and 145,125 candelas (as indicated by the number 30), approved in accordance with the requirements of this Regulation, as amended by the 00 series of amendments and incorporating a lens of plastic material;
- A front fog lamp approved in accordance with the 00 series of amendments of this Regulation and incorporating a lens of plastic material;
- A front direction indicator lamp of category 1a approved in accordance with the 00 series of amendments to UN Regulation No. 148.

Figure A13-V

Marking example 4-b

This example corresponds to an adaptive front-lighting system composed of two installation units for the left side of the vehicle and one installation unit for the right side.



The system bearing the above approval marks meets the requirements of this Regulation (original version of the Regulation) in respect of both a passing-beam for left-hand traffic and a driving-beam with a maximum intensity comprised between 123 625 and 145 125 candelas (as indicated by the number 30) grouped with a front direction indicator lamp of category 1a and a front position lamp approved in accordance with the 00 series of amendments of UN Regulation No. 148.

The installation unit 1 of the system (left side) is designed to contribute to the Class C passing-beam and the Class E passing-beam. The score above the letter "C" indicates that on that side more than one installation unit contributes to the Class C passing-beam. The letter "T" to the right following the listed symbols indicates that each, the Class C passing-beam and the Class E passing-beam are providing a bending mode.

The installation unit 3 of the system (left side) is designed to provide the second part of the Class C passing-beam of that side (as indicated by the score above the letter "C") and a Class W passing-beam. For this additional lighting unit, a circle surrounding the letter "E" followed by the distinguishing number of the country is not necessary.

The installation unit 2 of the system (right side) is designed to contribute to the Class C passing-beam, a Class E passing-beam, both with bending mode and a Class W passing-beam.

Note: In the above example, the different installation units of the system shall bear the same approval number.

3. Identification code of light source modules

Figure A13-VI

Light source module marking

MD E3 17325

The light source module bearing the identification code shown in Figure A13-VI has been approved together with a lamp approved in Italy (E3) under approval number 17325.

*Figure A13-VII***Lighting unit marking**

ALU E43 1234

The additional lighting unit bearing the identification code shown in Figure A13-VII has been approved together with a headlamp initially approved in Japan (E43) under approval number 1234

Description forms

Maximum format: A4 (210 × 297 mm)

Adaptive front-lighting system description form No. 1

AFS control signals relevant to the lighting functions, and modes of functions provided by the system

AFS Control Signal	Function/mode(s) of, being influenced by the signal ⁽¹⁾					Technical characteristics ⁽²⁾ (use separate sheet, if needed)
	Passing-beam				Driving-beam	
	Class C	Class V	Class C	Class C		
None / default	☒				☐	
V-Signal	☐	☐	☐	☐	☐	
E-Signal	☐	☐	☐	☐	☐	
W-Signal	☐	☐	☐	☐	☐	
T-Signal	☐	☐	☐	☐	☐	
Other Signals ⁽³⁾	☐	☐	☐	☐	☐	

⁽¹⁾ Mark in the respective box(es) with an cross (X) the combination(s) which apply.⁽²⁾ To be indicated in terms of:

- (a) Physical nature (electrical current/ voltage, optical, mechanical, hydraulic, pneumatic, ...).
- (b) Information type (continuous/analogous, binary, digitally coded,...).
- (c) Time dependent properties (time constant, resolution, ..).
- (d) Signal status when the respective conditions according to paragraph 6.22.7.4. of UN Regulation No. 48 are fulfilled.
- (e) Signal status in case of failure (with reference to the system input).

⁽³⁾ According to the applicants description; use separate sheet, if needed.

Adaptive front-lighting system description form No. 2

Cut-off status, adjustment devices and adjustment procedures relevant to the lighting units

Lighting unit No. ⁽¹⁾	Cut-off status ⁽²⁾		Adjustment device				Characteristics & additional provisions(if any) ⁽³⁾
	The lighting unit provides or contributes to one or more passing-beam cut-off(s),		vertical		horizontal		
	as defined in Annex 5 to this Regulation ⁽³⁾	and provisions of paragraph 5.3.5.1. of this Regulation apply ⁽³⁾	Individual ("master") ⁽³⁾ · ⁽⁶⁾	linked to "master" unit No. ⁽⁴⁾	Individual ("master") ⁽³⁾ · ⁽⁶⁾	linked to "master" unit No. ⁽⁴⁾	
1	yes / no	yes / no	yes / no		yes / no		
2	yes / no	yes / no	yes / no		yes / no		
3	yes / no	yes / no	yes / no		yes / no		
4	yes / no	yes / no	yes / no		yes / no		
5	yes / no	yes / no	yes / no		yes / no		
6	yes / no	yes / no	yes / no		yes / no		
7	yes / no	yes / no	yes / no		yes / no		

⁽¹⁾ Designation of each individual lighting unit of the system as indicated in Annex 1 to this Regulation and as shown in the drawing according to paragraph 3.1.2. of this Regulation; use separate sheet(s) if needed.

⁽²⁾ Relevant to provisions of paragraph 6.22.6.1.2. of UN Regulation No. 48.

⁽³⁾ Strike out what does not apply.

⁽⁴⁾ Indicate corresponding lighting unit(s) number(s), if applicable.

⁽⁵⁾ Information such as e.g.: the order of adjustment of lighting units or assemblies of lighting units, any additional provisions for the adjustment process.

⁽⁶⁾ The adjustment of a "master" lighting unit may also adjust (an) other lighting unit(s).

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>

UN Regulation No 150 – Uniform provisions concerning the approval of retro-reflective devices and markings for power-driven vehicles and their trailers [2021/1721]

Incorporating all valid text up to:

Supplement 3 to the original version of the Regulation — Date of entry into force: 30 September 2021

This document is meant purely as documentation tool. The authentic and legally binding texts are:

- ECE/TRANS/WP.29/2018/159/Rev.1
- ECE/TRANS/WP.29/2019/83
- ECE/TRANS/WP.29/2020/34 and
- ECE/TRANS/WP.29/2021/47

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INTRODUCTION

This Regulation combines the provisions of individual UN Regulations Nos. 3, 27, 69, 70 and 104 into a single UN Regulation, and is the outcome of the World Forum for Harmonization of Vehicle Regulations (WP.29) decision to simplify the lighting and light-signalling Regulations based on the initial proposal by the European Union and Japan.

The objective of this Regulation is to increase the clarity, to consolidate and streamline the complexity of requirements in UN Regulations Nos. 3, 27, 69, 70 and 104 and to prepare for the future transition to performance based requirements, by reducing the number of UN Regulations through an editorial exercise without changing any of the detailed technical requirements already in force up to the date of entry into force of this Regulation.

Although this Regulation departs from the traditional approach of having a separate Regulation for each retro-reflective device, by combining all retro-reflectors retro-reflective marking plates, retro-reflective markings and advance warning triangles into a single Regulation, this simplified UN Regulation contains all provisions and operates according to the existing structure of series of amendments, their transitional provisions and supplements. The transitional provisions associated with a new series of amendments to this Regulation will be identified for each device as applicable, this also includes a list of devices and their applicable change indexes relating to the series of amendments.

It is expected that all Contracting Parties to the 1958 Agreement will adopt this Regulation and will provide detailed explanation in case they are not in a position to adopt particular retro-reflective devices. These decisions will be registered in ECE/TRANS/WP.29/343 that records the status of the annexed UN Regulations and of the amendments.

Regarding the requirements for approval markings, this Regulation includes the requirements for the use of the "Unique Identifier" and is conditional upon access to a secure internet database established by UNECE (in accordance with Schedule 5 of the 1958 Agreement) where all type approval documentation is held. When the "Unique Identifier" is used there is no requirement for retro-reflective devices to carry the conventional type approval markings (E-mark). If it is technically not possible to use the "Unique Identifier" (e.g. if the access to the UN internet database cannot be secured or the UN secure internet database is not operative) the use of conventional type approval markings is required until the use of the "Unique Identifier" is enabled.

1. SCOPE

This Regulation applies to retro-reflective devices as:

Retro-reflectors of the Classes IA, IB, IIIA, IIIB and IVA

Retro-reflective Markings of the Classes C, D, E and F

Retro-reflective Marking Plates for Heavy and Long Vehicles of the Classes 1, 2, 3, 4 and 5

Retro-reflective Marking Plates for Slow Moving Vehicles of the Classes 1 and 2

Advance Warning Triangles of Type 1 and 2

2. DEFINITIONS

For the purpose of this Regulation:

2.1. All the definitions given in the latest series of amendments to UN Regulation No. 48 in force at the time of application for type approval shall apply, unless otherwise specified in this Regulation or in the pertinent installation UN Regulations Nos. 53, 74 and 86.

2.1.1. "*Retro-reflective devices of different types*" means retro-reflective devices, as retro-reflectors or retro-reflective materials or marking plates or advance warning triangles of different types, which differ in such essential respects as:

(a) The trade name or mark:

(i) Retro-reflective devices bearing the same trade name or mark but produced by different manufacturers are considered as being of different types;

(ii) Retro-reflective devices produced by the same manufacturer differing only by the trade name or mark are considered as being of the same type;

(b) The characteristics of the retro-reflective material;

(c) The characteristics of the fluorescent material, if applicable;

(d) The parts affecting the properties of the retro-reflective materials and/or plates;

(e) The distinctive geometrical and mechanical features of the design (only for plates/devices corresponding to the Annex 5).

For materials and/or plates corresponding to the Annex 5, differences in the shape and dimensions of the marking shall not constitute a different type.

2.1.2. In the case of a type of "*retro-reflective device*" or reflective marking material differing only by the trade name or mark from a type that has already been approved it shall be sufficient to submit:

(a) A declaration by the "*retro-reflective device*" or reflective marking material manufacturer that the type submitted is identical with (except in the trade name or mark) and has been produced by the same manufacturer as the type already approved, the latter being identified by its approval number;

(b) Two samples bearing the new trade name or mark or equivalent documentation.

2.2. A type of "*retro-reflective device*" or retro-reflective material is defined by the models and descriptive literature submitted with the application for approval. Retro-reflective devices can be considered as belonging to the same type if they have one or more "retro-reflecting optical units" which are identical with those of the standard model, or if not identical are symmetrical and suitable for mounting one on the left and one on the right side of the vehicle, and if their other parts differ from those of the standard model only in ways not affecting the properties to which this Regulation applies. A change of colour of the retro-reflective materials of the Classes "D" and "E" does not constitute a change of type.

2.3. Definitions CIE-Goniometer System

2.3.1. Geometric definitions (see Figure A4-II)

2.3.1.1. "*Illumination axis (symbol I)*" means a line segment from the centre of reference to the light source.

2.3.1.2. "*Observation axis (symbol O)*" means a line segment from the centre of reference to the photometer head;

2.3.1.3. "*Observation angle (symbol α)*" means the angle between the illumination axis and the observation axis. The observation angle is always positive and, in the case of retro-reflection, is restricted to small angles;

2.3.1.4. "*Observation on half-plane*" means the half-plane which originates on the illumination axis and which contains the observation axis;

2.3.1.5. "*Reference axis (symbol R)*" means a designated line segment originating on the centre of reference which is used to describe the angular position of the retro-reflective device;

2.3.1.6. "*Entrance angle (symbol β)*" means the angle from the illumination axis to the reference axis. The entrance angle is usually not larger than 90° but, for completeness, its full range is defined as $0^\circ < \beta < 180^\circ$. In order to specify the orientation in full, this angle is characterised by two components, β_1 and β_2 ;

2.3.1.7. "*Rotation angle (symbol ε)*" means the angle indicating the orientation of the retro-reflecting material by an appropriate symbol with respect to rotation about the reference axis. If retro-reflective materials or devices have a marking (e.g. TOP), this marking governs the starting position. The angle of rotation ε lies in the range $-180^\circ < \varepsilon < +180^\circ$.

2.3.1.8. "*First axis (symbol 1)*" means an axis through the centre of reference and perpendicular to the observation half-plane;

2.3.1.9. "*First component of the entrance angle (symbol β_1)*" means the angle from the illumination axis to the plane containing the reference axis and the first axis;
range: $-180^\circ < \beta_1 < 180^\circ$;

2.3.1.10. "*Second component of the entrance angle (symbol β_2)*" means the angle from the plane containing the observation half-plane to the reference axis;
range $-90^\circ < \beta_2 < 90^\circ$;

2.3.1.11. "*Second axis (symbol 2)*" means an axis through the centre of reference and perpendicular to both the first axis and the reference axis. The positive direction of the second axis lies in the observation half-plane when $-90^\circ < \beta_1 < 90^\circ$ as shown in Figure A4-II.

2.3.2. Definition of photometric terms

2.3.2.1. "*Coefficient of retro-reflection (symbol R')*" means the quotient of the coefficient of luminous intensity R of a plane retro-reflecting surface and its area A

$$\left(R' = \frac{R}{A} \right) \quad \text{The coefficient of retro-reflection } R' \text{ is expressed in candelas per m}^2 \text{ per lx (cd} \cdot \text{m}^{-2} \cdot \text{lx}^{-1})$$

$$\left(R' = \frac{I}{E_{\perp} \cdot A} \right) \quad (\text{Luminance} / \text{Illumination});$$

- 2.3.2.2. "Angular diameter of the retro-reflector sample (symbol η_1)" means the angle subtended by the greatest dimension of the retro-reflective sample, either at the centre of the source of illumination or at the centre of the receiver ($\beta_1 = \beta_2 = 0^\circ$);
- 2.3.2.3. "Angular diameter of the receiver (symbol η_2)" means the angle subtended by the greatest dimension of the receiver as seen from the centre of reference ($\beta_1 = \beta_2 = 0^\circ$);
- 2.3.2.4. "Luminance factor (symbol β)" means the ratio of the luminance of the body to the luminance of a perfect diffuser under identical conditions of illumination and observation;
- 2.3.2.5. "Colour of the reflected light of the device" - the definitions of the colour of the reflected light are given in paragraph 2.11. of UN Regulation No. 48.
3. ADMINISTRATIVE PROVISIONS
- 3.1. Application for approval
- 3.1.1. The application for type approval shall be submitted by the holder of the trade name or mark or by his duly accredited representative. It shall be accompanied by:
- 3.1.1.1. In case of retroreflectors:
- (a) At the choice of the applicant, the application for type approval will specify that the device may be installed on a vehicle with different inclinations of the reference axis in respect to the vehicle reference planes and to the ground or, in the case of Classes IA, IB and IVA retro-reflectors, rotate around its reference axis; these different conditions of installation shall be indicated in the communication form;
 - (b) Drawings, in triplicate, in sufficient detail to permit identification of the type, showing geometrically the position(s) in which the retro-reflecting device may be fitted to the vehicle, and in case of class IB or IIIB-retro-reflectors details of installation. The drawings must show the position intended for the approval number and class indicator in relation to the circle of the approval mark;
 - (c) A brief description giving the technical specifications of the materials of which the retro-reflecting optical unit is made;
 - (d) Samples of the retro-reflecting device of a colour specified by the manufacturer and, if necessary, the means of fixation; the number of samples to be submitted is specified in paragraphs 5.1. and 5.2.;
 - (e) If necessary, two samples in other colour(s) for simultaneous or subsequent extension of the approval to devices in other colour(s);
 - (f) In the case of devices of Class IVA: samples of the retro-reflecting device and, if necessary, the means of fixation; the number of samples to be submitted is specified in paragraph 5.3.
- 3.1.1.2. In case of advance warning triangles:
- (a) Dimensional drawings in triplicate in sufficient detail to permit identification of the type;
 - (b) A brief description giving the technical specifications of the materials constituting the advance warning triangle and instructions for use;
 - (c) A copy of the instructions on its assembly for use;
 - (d) Samples of the retro-reflective and of the fluorescent areas; the number of samples to be submitted is specified in paragraph 5.9.
- 3.1.1.3. In case of marking plates:
- (a) Drawings, in triplicate, sufficiently detailed to permit identification of the type. The drawings shall show geometrically the position in which the marking plate is to be fitted to the rear end of the vehicle. They shall also show the position intended for the approval number and the identification symbol in relation to the circle of the approval mark;

- (b) A brief description giving the technical specifications of the materials of which the retro-reflective areas are made;
 - (c) A brief description giving the technical specifications of the materials of which the fluorescent areas are made;
 - (d) Samples of the retro-reflective and of the fluorescent areas; the number of samples to be submitted is specified in paragraphs 5.7. and 5.8.
- 3.1.1.3.1. The Type Approval Authority shall verify the existence of satisfactory arrangements for ensuring effective control of the conformity of production before type approval is granted.
- 3.1.1.4. In case of retro-reflective marking material:
- (a) Drawings, in triplicate, sufficiently detailed to permit identification of the type. The drawings shall show geometrically the orientation in which the marking materials are to be fitted to a vehicle. They shall also show the position intended for the approval number and the identification symbol in relation to the circle of the approval mark;
 - (b) A brief description giving the technical specifications of the retro-reflective marking materials;
 - (c) Samples of the retro-reflective marking materials, as specified in paragraphs 5.4. and 5.5.;
 - (d) In the case of a type of reflective marking material differing only by the trade name or mark from a type that has already been approved it shall be sufficient to submit:
 - (i) A declaration by the reflective marking material manufacturer that the type submitted is identical with (except in the trade name or mark) and has been produced by the same manufacturer as the type already approved, the latter being identified by its approval code;
 - (ii) Two samples bearing the new trade name or mark or equivalent documentation.
- 3.2. Approval
- 3.2.1. A separate approval is required for each retro-reflective device listed in paragraph 1.
- 3.2.2. Notice of approval or of extension or refusal or withdrawal of approval of a type of a device pursuant to this Regulation shall be communicated to the Contracting Parties to the 1958 Agreement which apply this Regulation, by means of a form conforming to the model in Annex 1;
- 3.2.3. An approval number shall be assigned to each type approved and shall be marked on the device following the requirements of paragraph 3.3. The same Contracting Party shall not assign the same number to another type of device of the same function, except in the case of an extension of the approval to a device differing only in colour.
- 3.2.4. If the approval granted in respect of a retro-reflecting device is extended to other such devices differing only in colour, the two samples in any other colour submitted in conformity with paragraph 3.1.1.1. (d) of this Regulation shall be required to meet only the colorimetric and photometric specifications, the other tests no longer being required. This paragraph is not applicable to devices of Class IVA.

3.2.5. The symbols identifying the retro-reflective devices to be referenced in the Annex 1 shall be as follows:

Table 1

List of retro-reflective devices and their symbols

Retro-reflective devices	Symbol	Additional symbol	Minimum "a" for Figure A24-I (values in mm)	Paragraph
Retro-reflector for motor vehicles (independent)	IA		4	5.1.
Retro-reflector for motor vehicles (combined with other signal lamps which are not watertight)	IB		4	5.1.
Retro-reflector for trailers (independent)	IIIA		4	5.2.
Retro-reflector for trailers (combined with other signal lamps which are not watertight)	IIIB		4	5.2.
Wide-angle retro reflector	IVA		4	5.3.
Conspicuity marking (material for contour/strip marking)	C	104R	12	5.4.
Conspicuity marking (material for distinctive markings/graphics intended for a limited area)	D	104R	12	5.5
Conspicuity marking (material for distinctive markings/graphics intended for an extended area)	E	104R	12	5.5.
Conspicuity marking (materials for distinctive markings or graphics as base or background in printing process for fully coloured logos and markings of class "E" in use which fulfil the requirements of class "D" materials)	D/E	104R	12	5.5.
Retro-reflective materials for extremities marking of class F	F	104R	12	5.6.
Retro-reflective marking for long or heavy vehicles (retro-reflective and fluorescent materials) Marking plate of class 1 or class 2	RF		5	5.7.
Retro-reflective marking for long or heavy vehicles (retro-reflective only materials) - Marking plate of class 3, class 4 or class 5	RR		5	5.7. for class 3 or 4 5.6. for class 5
Marking for slow moving vehicles (retro-reflective and fluorescent materials) - Marking plate of class 1	RF		5	5.8.
Marking for slow moving vehicles (retro-reflective only materials) - Marking plate of class 2	RR		5	5.8.
Advance Warning Triangle	-	27R	8	5.9.

- 3.2.6. The applicable change indexes for each device relating to the series of amendments shall be as follows (see also paragraph 6.1.1.):

Table 2

Series of amendments and change index

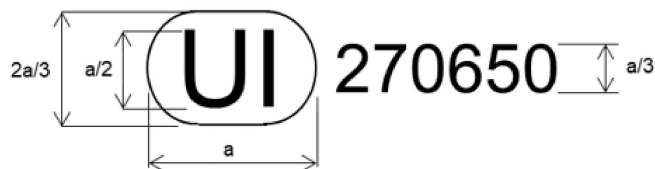
Series of amendments to the Regulation	00		
Device	Change Index for the specific device		
Retro-reflector for motor vehicles (independent)	0		
Retro-reflector for motor vehicles (combined with other signal lamps which are not watertight)	0		
Retro-reflector for trailers (independent)	0		
Retro-reflector for trailers (combined with other signal lamps which are not watertight)	0		
Wide-angle retro reflector	0		
Conspicuity marking (material for contour/strip marking)	0		
Conspicuity marking (material for distinctive markings/graphics intended for a limited area)	0		
Conspicuity marking (material for distinctive markings/graphics intended for an extended area)	0		
Conspicuity marking (materials for distinctive markings or graphics as base or background in printing process for fully coloured logos and markings of class "E" in use which fulfil the requirements of class "D" materials)	0		
Retro-reflective materials for extremities marking of class F	0		
Retro-reflective marking for long or heavy vehicles (retro-reflective and fluorescent materials) Marking plate of class 1 or class 2	0		
Retro-reflective marking for long or heavy vehicles (retro-reflective only materials) Marking plate of class 3, class 4 or class 5	0		
Marking for slow moving vehicles (retro-reflective and fluorescent materials) Marking plate of class 1	0		
Marking for slow moving vehicles (retro-reflective only materials) Marking plate of class 2	0		
Advance Warning Triangle	0		

- 3.3. Approval mark

- 3.3.1. General provisions

- 3.3.1.1. Every device belonging to an approved type shall comprise a space of sufficient size for the Unique Identifier (UI) as referred to in the 1958 Agreement and other markings as defined in paragraph 3.3.4.2. to 3.3.4.6. or, if technically not possible, the approval marking with the additional symbols and other markings as defined in paragraph 3.3.2.

- 3.3.1.2. Examples of the arrangement of the markings are shown in Annex 24.
- 3.3.2. The approval marking shall consist of:
- 3.3.2.1. A circle surrounding the letter "E" followed by the distinguishing number of the country which has granted approval.
- 3.3.2.2. The approval number prescribed in paragraph 3.2.3.
- 3.3.2.3. The symbols identifying the retro-reflective device prescribed in paragraph 3.2.4.
- 3.3.2.4. The number of this Regulation followed by the letter 'R' and the two digits indicating the series of amendments in force at the time of issue of the approval.
- 3.3.2.5. The approval number shall be placed close to the circle prescribed in paragraph 3.3.2.1.
- 3.3.2.6. On devices with reduced light distribution, in conformity with paragraph 5.1.4.5., 5.2.3.2. or 5.3.4.2. to this Regulation, a vertical arrow starting from a horizontal segment and directed downwards.
- 3.3.3. The Unique Identifier mark shall follow the format in the example shown below:

*Figure I***Unique identifier** $a \geq 8 \text{ mm}$

The above Unique Identifier marked on the retro-reflective device shows that the type concerned has been approved and that the relevant information on that type approval can be accessed on the UN secure internet database by using 270650 as the Unique Identifier.

- 3.3.4. Marking requirements
- Retro-reflective devices for approval
- 3.3.4.1. Comprise a space sufficient size for the approval marking or the Unique Identifier.
- 3.3.4.1.1. In any case the approval marking or the Unique Identifier shall be visible when the retro-reflective device is fitted on the vehicle or when a movable part such as the hood or boot lid or a door is opened.
- 3.3.4.1.2. The approval marking shall be placed on an inner or outer part (transparent or not) of the retro-reflective device which cannot be separated from the transparent part of the retro-reflective device.
- 3.3.4.2. Bear the trade name or mark of the applicant; this marking shall be clearly legible and indelible.

- 3.3.4.2.1. In case of a retro-reflective device of Class IA, IIIA, IB, IIIB or IVA, the word "TOP" inscribed horizontally on the highest part of the illuminating surface, if such an indication is necessary to determine without ambiguity the angle or angles of rotation prescribed by the manufacturer.
- 3.3.4.2.2. In case of Class C, D, E or F, an orientation mark "TOP" which must be inscribed on any marking material whose retro-reflective system is not omni-rotational at least:
- (a) On strips in a 0,5 m distance,
 - (b) On areas within 100 x 100 mm².
- 3.3.4.2.3. In case of Class 1, 2, 3, 4 or 5, on the plates whose retro-reflective system is not omni-rotational, the word "TOP" is inscribed horizontally on the part of the plates which is intended to be the highest part of the plate when mounted on the vehicle.
- 3.3.4.3. The symbols identifying the retro-reflective device, marking materials or plates and the additional symbols prescribed in Table 1.
- 3.3.4.4. The approval mark shall be clearly legible and indelible.
- 3.3.4.4.1. In case of Class C, D, E or F, the approval mark shall be visible and clearly legible on the outside of the marking material and shall be indelible and positioned at least once:
- (a) At 0,5 m intervals on strips,
 - (b) On areas within 100 x 100 mm²
- 3.3.4.5. The approval number and the 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 the same direction.
- 3.3.4.6. The space for the approval mark shall be shown in the drawings mentioned in paragraph 3.1.1.
- 3.3.4.7. When two or more lamps are part of the same unit of grouped, combined or reciprocally incorporated lamps (including a retro-reflector), approval is granted only if each of these lamps satisfies the requirements of this Regulation or of another Regulation. Lamps not satisfying any one of those Regulations shall not be part of such a unit of grouped, combined or reciprocally incorporated lamps.
- 3.3.4.8. Where grouped, combined or reciprocally incorporated lamps comply with the requirements of several Regulations, a single international approval mark may be applied, consisting of a circle surrounding the letter "E" followed by the distinguishing number of the country which has granted the approval, an approval number and, if necessary, the required arrow. This approval mark may be placed anywhere on the grouped, combined or reciprocally incorporated lamps provided that:
- 3.3.4.8.1. It is visible after their installation;
- 3.3.4.8.2. 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.
- 3.3.4.9. 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, shall be marked:
- 3.3.4.9.1. Either on the appropriate light-emitting surface,

- 3.3.4.9.2. Or in a group, in such a way that each lamp of the grouped, combined or reciprocally incorporated lamps may be clearly identified (see the possible examples shown in Annex 24).
- 3.3.4.10. 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 a Regulation under which approval has been granted.
- 3.3.4.11. The space for the approval mark shall be shown in the drawings mentioned in paragraph 3.1.2.3.;
- 3.4. Modifications of a type of retro-reflective device for motor vehicles and their trailers and extension of approval
 - 3.4.1. Every modification of the type of retro-reflective device shall be notified to the Type Approval Authority which approved the type. The Authority may then either:
 - 3.4.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect, and that in any case the retro-reflective of device still meets the requirements; or
 - 3.4.1.2. Require a further report from the technical service responsible for conducting the tests.
 - 3.4.2. Confirmation or refusal of approval, specifying the alterations, shall be communicated by the procedure specified in paragraph 3.2.2. to the Contracting Parties to the 1958 Agreement applying this Regulation.
 - 3.4.3. The Type Approval Authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Contracting Parties to the 1958 Agreement applying the UN Regulation under which the approval has been granted by means of a communication form conforming to the model in Annex 1.
- 3.5. Conformity of production

The conformity of production procedures shall comply with those set out in the 1958 Agreement, Schedule 1 (E/ECE/TRANS/505/Rev.3), with the following requirements:

 - 3.5.1. Retro-reflectors approved under this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraphs 4 and 5.
 - 3.5.1.1. The minimum requirements for conformity of production control procedures set forth in Annex 2 shall be complied with.
 - 3.5.1.2. The minimum requirements for sampling by an inspector set forth in Annex 3 shall be complied with.
 - 3.5.2. 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.
 - 3.5.3. Advance warning triangles approved under this Regulation shall be so manufactured as to conform to the type approved under this Regulation.

The compliance with the requirements set forth in paragraphs 4. and 5. shall be verified as follows:

 - 3.5.3.1. In addition, the stability in time of the optical properties and colour of retro-reflecting optical units of advance warning triangles conforming to an approved type and in use shall be verified. In the event of a systematic deficiency of the retro-reflecting optical units of advance warning triangles in use and conforming to an approved type, approval may be withdrawn. A "systematic deficiency" shall be deemed to exist where an approved type of advance warning triangle fails to meet the requirements of paragraph 5.

- 3.5.4. Any retro-reflective marking material approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraphs 4. and 5.
- 3.5.4.1. The conformity of production shall not be contested if the mean value of the photometric measurements of five specimens taken at random deviates unfavourably by not more than 20 per cent from the prescribed values given in paragraphs 4. and 5.
- 3.5.4.2. The conformity of production shall not be contested, if the mean value of the colorimetric properties of five specimens taken at random meet the specifications of paragraphs 4. and 5. to be judged by visual inspection.
- 3.5.4.3. 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.
- 3.5.5. Any retro-reflective marking plates approved to this Regulation shall be so manufactured as to conform to the type approved by meeting the requirements set forth in paragraphs 4. and 5. (as to resistance to external agents, only paragraph 5.7.6.1. is applied).
- 3.5.5.1. The minimum requirements for conformity of production control procedures set forth in Annex 2 to this Regulation shall be complied with.
- 3.5.5.2. The minimum requirements for sampling by an inspector set forth in Annex 3 to this Regulation shall be complied with.
- 3.5.5.3. 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.
- 3.6. Penalties for non-conformity of production
- 3.6.1. The approval granted may be withdrawn if the requirements in this Regulation are not met.
- 3.6.2. If a Contracting Party to the 1958 Agreement which applies this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation by means of a communication form conforming to the model in Annex 1.
- 3.7. Production definitively discontinued
- If the holder of the approval completely ceases to manufacture a retro-reflective 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 Contracting Parties to the Agreement applying this Regulation by means of a communication form conforming to the model in Annex 1.
- 3.8. Name and address of the Technical Services responsible for conducting approval tests; and of Type Approval Authorities
- The Contracting Parties to the Agreement applying this Regulation shall communicate to the United Nations secretariat the names and addresses of the Technical Services responsible for conducting approval tests and of the Type Approval Authorities which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, or the definitive discontinuation of production issued in other countries, are to be sent.

4. GENERAL REQUIREMENTS

The requirements contained in sections 5. "General specifications" and 6. "Individual specifications" and in the Annexes referenced in the said sections of UN Regulations Nos. 48, 53, 74 or 86, and their series of amendments in force at the time of application for the retro-reflecting device type approval shall apply to this Regulation.

The requirements pertinent to each retro-reflecting device and to the category/ies of vehicle on which the retro-reflecting device is intended to be installed shall be applied, where its verification at the moment of retro-reflecting device type approval is feasible.

4.1. For the purpose of this Regulation, retro-reflectors or retro-reflective materials or marking plates or advance warning triangles for general descriptions herein after referred to as "retro-reflective devices".

4.1.1. Retro-reflective devices shall be so constructed that they function satisfactorily and will continue to do so in normal use. In addition, they must not have any defect in design or manufacture that is detrimental to their efficient operation or to their maintenance in good condition.

4.1.2. The components of retro-reflective devices or parts thereof shall not be capable of being easily dismantled.

4.1.3. The means of attachment of the marking materials shall be durable and stable.

4.1.4. The outer surface of retro-reflective devices shall be easy to clean. The surface shall therefore not be rough and any protuberances they may exhibit shall not prevent easy cleaning.

4.1.5. There shall be no access to the inner surface of the retro-reflectors when in normal use.

4.1.6. In case of retro-reflectors

4.1.6.1. Retro-reflective devices may consist of a combined retro-reflecting optical unit and filter, which must be so designed that they cannot be separated under normal conditions of use.

4.1.6.2. The colouring of retro-reflecting optical units and filters by means of paint or varnish is not permitted.

4.2. Colorimetric test conditions

4.2.1. Test procedure for night time colours:

4.2.1.1. These specifications shall apply only to white, red or amber retro-reflective devices.

4.2.1.2. For testing the colour of the retro-reflective device, this device shall be illuminated by the CIE Standard Illuminant A, with an angle of divergence of $1/3$ degrees and an illumination angle of $V = H = 0$ degree, or, if this produces a colourless surface reflection, an angle $V = \pm 5$ degrees, $H = 0$ degree, the trichromatic coordinates of the reflected luminous flux must be within the limits according to the specifications for the individual retroreflecting device in paragraph 4.

4.2.1.3. White retro-reflective devices must not produce a selective reflection, that is to say, the trichromatic coordinates "x" and "y" of Standard Illuminant "A" used to illuminate the retro-reflective device must not undergo a change of more than 0.01 after reflection by the retro-reflective device.

4.2.2. Test procedure for day time colours:

- 4.2.2.1. For testing the day time colour of the materials, the material shall be illuminated by the CIE Standard Illuminant D 65 at an angle of 45° to the normal and viewed (measured) along the normal (45/0 geometry), with a spectrophotometer in accordance with the provisions of CIE document No. 15 (1971).

The colour of the material in new condition shall be within the limits according to the specifications for the individual retro-reflective device in paragraph 5.9.5.2.2.

4.2.3. Test procedure for fluorescent colours:

4.2.3.1. Colour of the fluorescent material without retro-reflection:

- 4.2.3.1.1. For testing the colour of the fluorescent material, the material shall be illuminated by the CIE Standard Illuminant D65 (ISO 11664-2:2007(E)/CIE S 014-2/E:2006) and measured with a spectrophotometer in accordance with the provisions of Publication CIE 15:2004, Recommendations on Colorimetry - Second Edition, either illuminated polychromatically or with a monochromator providing stepwise the CIE Standard Illuminant D 65 (ISO 11664-2:2007(E)/CIE S 014-2/E:2006) at an angle 45° to the normal and viewed along the normal (geometry 45/0). In the latter case, the stepwise resolution $\Delta\lambda$ shall be not larger than 10 nm. Alternatively, similar "illuminants" are allowed, if verified that the colorimetric measuring procedure is of the same sufficient accuracy, meaning that the quality of the simulation of D65 shall be assessed by the method described in ISO 23603:2005(E)/CIE S 012/E:2004. The spectral distribution of the illuminant shall be in category BC (CIELAB) or better.

The illumination shall be carried out at an angle 45° to the normal and viewed along the normal (geometry 45/0).

4.2.3.2. Colour of the fluorescent material with retro-reflection:

- 4.2.3.2.1. For testing the colour of the fluorescent material, the material shall be illuminated by the CIE Standard Illuminant D65 (ISO 11664-2:2007(E)/CIE S 014-2/E:2006) and measured with a spectrophotometer in accordance with the provisions of publication CIE 15:2004, Recommendations on Colorimetry - second edition, either illuminated polychromatically or with a monochromator providing stepwise the CIE Standard Illuminant D 65 (ISO 11664-2:2007(E)/CIE S 014-2/E:2006). In the latter case, the stepwise resolution $\Delta\lambda$ shall be not larger than 10 nm. Alternatively, similar "illuminants" are allowed, if verified that the colorimetric measuring procedure is of the same sufficient accuracy, meaning that the quality of the simulation of D65 shall be assessed by the method described in ISO 23603:2005(E)/CIE S 012/E:2004. The spectral distribution of the illuminant shall be in category BC (CIELAB) or better. The illumination shall be carried out circumferential at an angle 45° to the normal and viewed along the normal (annular geometry 45/0) (circumferential/normal geometry), as described in Annex 23.

4.3. Determination of the luminance factor:

4.3.1. For the determination of the luminance factor, the sample shall be tested

- (a) For retro-reflective devices without fluorescence (day time colours) and fluorescent material without retro-reflection with the same method as described in paragraph 4.2.3.1.;
- (b) For fluorescent material with retro-reflection with the same method as described in paragraph 4.2.3.2.

- 4.3.1.1. By putting the luminance L of the sample into relation to the luminance L_o of a perfect diffuser whose luminance factor β_o is known under identical conditions of illumination and observation; the luminance factor β of the sample then results from the formula:

$$\beta = \frac{L}{L_o} \cdot \beta_o$$

- 4.3.1.2. When the colour of the fluorescent material has been colorimetrically determined in compliance with paragraph 4.2.3., from the ratio of the tristimulus value Y the sample and the tristimulus value of the perfect diffuser Y_0 in this case it is:

$$\beta = \frac{Y}{Y_0}$$

5. SPECIFIC TECHNICAL REQUIREMENTS

5.1. Technical requirements concerning retro-reflectors of the Classes IA and IB (Symbols "IA" and "IB")

5.1.1. Every retro-reflector of the Classes IA and IB, when tested according to paragraph 5.1.7., shall meet:

- (a) The dimensions and shape requirements set forth in Annex 5; and
- (b) The photometric and colorimetric requirements as specified in paragraphs 5.1.4. to 5.1.5.; and
- (c) The physical and mechanical requirements set forth in paragraph 5.1.7., depending on the nature of the materials and construction of the retro-reflective devices.

5.1.2. The applicant shall submit ten samples for approval which shall be tested in the chronological order as indicated in paragraph 5.1.7.

5.1.3. Test procedure

5.1.3.1. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5), the ten samples shall be subjected to the heat resistance test described in Annex 6 and at least one hour after this test examined as to their colorimetric characteristics in paragraph 5.1.5. and CIL in paragraph 5.1.4., for an angle of divergence of 20' and an illumination angle $V = H = 0^\circ$ or if necessary, in the position defined in Annex 4, paragraphs 1.1. and 1.2.

The two retro-reflective devices giving the minimum and maximum values shall then be fully tested as shown in paragraph 5.1.4.

These two samples shall be kept by the laboratories for any further checks which may be found necessary.

The other eight samples shall be divided into four groups of two:

- | | |
|---------------|---|
| First group: | The two samples shall be subjected successively to the water penetration test (Annex 7) and then, if this test is satisfactory, to the tests for resistance to fuels and lubricants (Annex 9 and Annex 10). |
| Second group: | The two samples shall, if necessary, be subjected to the corrosion test in Annex 11, and then to the abrasive-strength test of the rear face of the retro-reflective device Annex 12. |
| Third group: | The two samples shall be subjected to the test for stability in time of the optical properties of retro-reflective device Annex 14. |
| Fourth group: | The two samples shall be subjected to the colour-fastness test (Annex 21). |

5.1.3.2. After undergoing the tests referred to in the paragraph 5.1.3.1., the retro-reflective devices in each group must have:

5.1.3.2.1. A colour which satisfies the conditions laid down in paragraph 5.1.5.

5.1.3.2.2. A CIL which satisfies the conditions laid down in paragraph 5.1.4. The verification shall be performed only for an angle of divergence of 20' and an illumination angle of $V = H = 0^\circ$ or, if necessary, in all positions specified in Annex 4, paragraphs 1.1. and 1.2.

- 5.1.4. Minimum values for the CIL values of retro-reflection
- 5.1.4.1. When applying for approval, the applicant shall specify one or more or a range of axis of reference, corresponding to the illumination angle $V = H = 0^\circ$ in the table of coefficients of luminous intensity (CIL).
- 5.1.4.2. In the case where more than one or a range of different axis of reference are specified by the manufacturer, the photometric measurements shall be repeated making reference each time to a different axis of reference or to the extreme axis of reference of the range specified by the manufacturer.
- 5.1.4.3. For photometric measurements, only the illuminating surface defined by the planes contiguous to the outermost parts of the optical system of the retro-reflective device as indicated by the manufacturer and contained within a circle of 200 mm diameter for Class IA or IB shall be considered, and the illuminating surface itself shall be limited to 100 cm² though the surfaces of the retro-reflecting optical units need not necessarily attain this area. The manufacturer shall specify the perimeter of the area to be used.
- 5.1.4.4. Class IA and Class IB
- 5.1.4.4.1. When measured as described in paragraph 3. of Annex 4, the CIL values for red retro-reflective devices must be equal to or greater than those in Table 3, expressed in millicandelas per lux, for the angles of divergence and illumination shown.

Table 3

Requirements for CIL values (Classes IA and IB) [mcd.lx⁻¹]

Class	Angle of divergence ^a	Illumination angles (in degrees)			
		Vertical V	0°	±10°	±5°
		Horizontal H	0°	0°	±20°
IA, IB	20'		300	200	100
	1°30'		5	2,8	2,5

CIL values lower than those shown in the last two columns of Table 3 are not permissible within the solid angle having the centre of reference as its apex and bounded by the planes intersecting along the following lines:

$$(V = \pm 10^\circ, H = 0^\circ)$$

$$(V = \pm 5^\circ, H = \pm 20^\circ).$$

- 5.1.4.4.2. CIL values for amber retro-reflective devices in Class IA or IB must be at least equal to those in Table 3 multiplied by the coefficient 2,5.
- 5.1.4.4.3. CIL values for white retro-reflective devices in Class IA or IB must be at least equal to those in Table 3 multiplied by the coefficient 4.
- 5.1.4.5. However, in the case where a retro-reflective device of Class IA or Class IB, is intended to be installed with its H plane at a mounting height less than 750 mm above the ground, the CIL values are verified only up to an angle of 5° downwards.
- 5.1.5. Colour of the reflected light of the device:
- 5.1.5.1. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1.
- 5.1.5.2. The trichromatic coordinates of the reflected luminous flux must be within the limits for the night-time colours red, amber or white as specified in UN Regulation No. 48.

5.1.6. Special specification (tests) / resistance to external agents

Depending on the nature of the materials of which the retro-reflective devices and, in particular, their optical units, are made, the Type Approval Authorities may authorize laboratories to omit certain unnecessary tests, subject to the express reservation that such omission must be mentioned under "Remarks" on the form notifying approval.

This is only applicable to tests described in Annexes 11, 12, 14 and 21.

5.1.7. Chronological order of tests

Table 4

Chronological order of tests (Classes IA and IB)

Number of Annex	Tests	Samples									
		a	b	c	d	e	f	g	h	i	j
-	General specifications: visual inspection	x	x	x	x	x	x	x	x	x	x
5	Shapes and dimensions: visual inspection	x	x	x	x	x	x	x	x	x	x
6	Heat: 48 h at 65° ± 2°C	x	x	x	x	x	x	x	x	x	x
	Visual inspection for distortion	x	x	x	x	x	x	x	x	x	x
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt	x	x x	x	x	x	x	x	x	x	x
4	Photometry: limited to 20' and V = H = 0°	x	x	x	x	x	x	x	x	x	x
4	Complete photometry			x	x						
7	Water: 10 min. in normal position 10 min. in inverted position visual inspection							x x x	x x x		
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt							x x	x x		
4	Photometry: limited to 20' and V = H = 0°							x	x		
9	Motor fuels: 5 min. visual inspection							x x	x x		
10	Oils: 5 min. visual inspection							x x	x x		
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt							x	x		
4	Photometry: limited to 20' and V = H = 0°							x	x		
8	Corrosion: 24 hours 2 hours interval 24 hours visual inspection					x x x x	x x x x				

Number of Annex	Tests	Samples									
		a	b	c	d	e	f	g	h	i	j
12	Rear face: 1 min. visual inspection					x x	x x				
	Colorimetry: visual inspection Trichromatic coordinates in case of doubt					x x	x x				
	Photometry: limited to 20' and V = H = 0°					x	x				
14	Stability in time										
23	Colorimetry: Visual inspection or trichromatic coordinates										
4	Photometry: limited to 20' and V = H = 0°										
13	Colour-fastness										
23	Colorimetry: Visual inspection or trichromatic coordinates										
4	Photometry: limited to 20' and V = H = 0°										
	Deposit of samples with authority			x	x						

5.2. Technical requirements concerning retro-reflectors of the Classes IIIA and IIIB (Symbols "IIIA" and "IIIB")

5.2.1. Every retro-reflector of the Classes IIIA and IIIB, when tested according to paragraph 5.2.6., shall meet:

- (a) The dimensions and shape requirements set forth in Annex 5; and
- (b) The photometric and colorimetric requirements as specified in paragraphs 5.2.3. to 5.2.4.; and
- (c) The physical and mechanical requirements set forth in paragraph 5.2.6., depending on the nature of the materials and construction of the retro-reflective devices

5.2.2. The applicant shall submit ten samples for approval which shall be tested in the chronological order as indicated in paragraph 5.2.6.

5.2.2.1. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5), the ten samples shall be subjected to the heat resistance test described in Annex 6 and at least one hour after this test examined as to their colorimetric characteristics in paragraph 5.2.4. and CIL in paragraph 5.2.3., for an angle of divergence of 20' and an illumination angle V = H = 0° or if necessary, in the position defined in Annex 4, paragraphs 1.1. and 1.2.

The two retro-reflective devices giving the minimum and maximum values shall then be fully tested as shown in paragraph 5.2.4.

These two samples shall be kept by the laboratories for any further checks which may be found necessary.

The other eight samples shall be divided into four groups of two:

First group: The two samples shall be subjected successively to the water penetration test (Annex 7) and then, if this test is satisfactory, to the tests for resistance to fuels and lubricants (Annex 9 and Annex 10).

Second group: The two samples shall, if necessary, be subjected to the corrosion test in Annex 11, and then to the abrasive-strength test of the rear face of the retro-reflective device Annex 12.

Third group: The two samples shall be subjected to the test for stability in time of the optical properties of retro-reflective device Annex 14.

Fourth group: The two samples shall be subjected to the colour-fastness test (Annex 21).

5.2.2.2. After undergoing the tests referred to in the paragraph 5.2.2.1., the retro-reflective devices in each group must have:

5.2.2.2.1. a colour which satisfies the conditions laid down in paragraph 5.2.4.;

5.2.2.2.2. A CIL which satisfies the conditions laid down in paragraph 5.2.3. The verification shall be performed only for an angle of divergence of 20' and an illumination angle of $V = H = 0^\circ$ or, if necessary, in all positions specified in Annex 4, paragraphs 1.1. and 1.2.

5.2.3. Minimum values for the CIL values of retro-reflection:

5.2.3.1. When measured as described in Annex 4, the CIL values for red retro-reflective devices must be equal to or greater than those in Table 5, expressed in millicandelas per lux, for the angles of divergence and illumination shown.

Table 5

Requirements for CIL values (Classes IIIA and IIIB) [mcd.lx^{-1}]

Class	Angle of divergence α	Illumination angles (in degrees)			
		Vertical V	0°	$\pm 10^\circ$	$\pm 5^\circ$
		Horizontal H	0°	0°	$\pm 20^\circ$
IIIA, IIIB	20'		450	200	150
	1°30'		12	8	8

CIL values lower than those shown in the last two columns of Table 5 are not permissible within the solid angle having the centre of reference as its apex and bounded by the planes intersecting along the following lines:

$(V = \pm 10^\circ, H = 0^\circ)$

$(V = \pm 5^\circ, H = \pm 20^\circ)$.

5.2.3.2. However, in the case where a retro-reflective device of Class IIIA or Class IIIB is intended to be installed with its H plane at a mounting height less than 750 mm above the ground, the CIL values are verified only up to an angle of 5° downwards.

5.2.4. Colour of the reflected light of the device:

5.2.4.1. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1..

5.2.4.2. The trichromatic coordinates of the reflected luminous flux must be within the limits for the night-time colour red as specified in UN Regulation No. 48.

5.2.5. Special specification (tests) / resistance to external agents

Depending on the nature of the materials of which the retro-reflective devices and, in particular, their optical units, are made, the Type Approval Authorities may authorize laboratories to omit certain unnecessary tests, subject to the express reservation that such omission must be mentioned under "Remarks" on the form notifying approval.

This is only applicable to tests described in Annexes 11, 12, 14 and 21.

5.2.6. Chronological order of tests

Table 6

Chronological order of tests (Classes IIIA and IIIB)

Number of Annex	Tests	Samples									
		a	b	c	d	e	f	g	h	i	j
-	General specifications: visual inspection	x	x	x	x	x	x	x	x	x	x
5	Shapes and dimensions: visual inspection	x	x	x	x	x	x	x	x	x	x
6	Heat: 48 h at 65° ± 2°C Visual inspection for distortion	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt	x	x x	x	x	x	x	x	x	x	x
	Photometry: limited to 20' and V = H = 0°	x	x	x	x	x	x	x	x	x	x
4	Complete photometry			x	x						
7	Water: 10 min. in normal position 10 min. in inverted position visual inspection							x x x	x x x		
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt							x x	x x		
4	Photometry: limited to 20' and V = H = 0°							x	x		
9	Motor fuels: 5 min. visual inspection							x x	x x		
10	Oils: 5 min. visual inspection							x x	x x		
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt							x	x		
4	Photometry: limited to 20' and V = H = 0°							x	x		
8	Corrosion: 24 hours 2 hours interval 24 hours visual inspection					x x x x	x x x x				
12	Rear face: 1 min. visual inspection					x x	x x				

Number of Annex	Tests	Samples									
		a	b	c	d	e	f	g	h	i	j
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt					x	x				
4	Photometry: limited to 20' and $V = H = 0^\circ$					x	x				
14	Stability in time										
23	Colorimetry: Visual inspection or trichromatic coordinates										
4	Photometry: limited to 20' and $V = H = 0^\circ$										
13	Colour-fastness										
23	Colorimetry: Visual inspection or trichromatic coordinates										
4	Photometry: limited to 20' and $V = H = 0^\circ$										
	Deposit of samples with authority			x	x						

5.3. Technical requirements concerning retro-reflectors of the Class IVA (Symbols "IVA")

5.3.1. Every retro-reflector of the Class IVA, when tested according to paragraph 5.3.7., shall meet:

- (a) The dimensions and shape requirements set forth in Annex 5; and
- (b) The photometric and colorimetric requirements as specified in paragraphs 5.3.4. to 5.3.5.; and
- (c) The physical and mechanical requirements set forth in paragraph 5.3.7., depending on the nature of the materials and construction of the retro-reflective devices.

5.3.2. The applicant shall submit ten samples for approval which shall be tested in the chronological order as indicated in paragraph 5.3.7.

5.3.3. Test procedure

5.3.3.1. After verification of the specifications in paragraph 4. and the specifications of shape and dimensions in Annex 5, the ten samples shall be subjected to the heat resistance test in Annex 6 and one hour minimum after this test examined as to their colorimetric characteristics in paragraph 5.3.5. and CIL in paragraph 5.3.4. for an angle of divergence of 20' and an illumination angle $V = H = 0^\circ$ or, if necessary, in the positions defined in Annex 4, paragraphs 1.1. and 1.2. The two retro-reflective devices giving the minimum and maximum values shall then be fully tested as shown in paragraph 5.3.4. These two samples shall be kept by the laboratories for any further checks which may be found necessary.

5.3.3.2. Four samples out of the remaining eight samples shall be selected at random and divided into two groups of two in each group.

First group:

The two samples shall be subjected successively to the water-penetration resistance test in Annex 7 and then, if this test is satisfactory, to the tests for resistance to fuels and lubricating oils in Annex 9 and Annex 10.

Second group:

The two samples shall, if relevant, be subjected to the corrosion test (Annex 11), and then to the abrasive-strength test of the rear face of the retro-reflective device in Annex 12, these two samples shall also be subjected to the impact test in Annex 18.

5.3.3.3. After undergoing the tests referred to in the above paragraph, the retro-reflective devices in each group must have:

5.3.3.3.1. A colour which satisfies the conditions laid down in paragraph 5.3.5. This shall be verified by a qualitative method and, in case of doubt, confirmed by a quantitative method;

5.3.3.3.2. A CIL which satisfies the conditions laid down in paragraph 5.3.4.

Verification shall be performed only for an angle of divergence of 20' and an illumination angle of $V = H = 0^\circ$ or, if necessary, in the positions specified in Annex 4, paragraphs 1.1. and 1.2.

5.3.3.4. The four remaining samples can be utilized, if necessary, for any other purpose.

5.3.4. Minimum values for the CIL values of retro-reflection

5.3.4.1. When measured as described in paragraph 3. of Annex 4, for devices of Class IVA the CIL values must be equal to or greater than those in Table 7, expressed in millicandelas per lux, for the angles of divergence and illumination shown.

Table 7

Requirements for CIL values (Class IVA) [mcd.lx^{-1}]

Colour	Angle of divergence α	Illumination angles (in degrees)						
		Vertical V	0	± 10	0	0	0	0
		Horizontal H	0	0	± 20	± 30	± 40	± 50
White	20'		1 800	1 200	610	540	470	400
	1°30'		34	24	15	15	15	15
Amber	20'		1 125	750	380	335	290	250
	1°30'		21	15	10	10	10	10
Red	20'		450	300	150	135	115	100
	1°30'		9	6	4	4	4	4

5.3.4.2. However, in the case where a retro-reflective device of Class IVA is intended to be installed with its H plane at a mounting height less than 750 mm above the ground, the CIL values are verified only up to an angle of 5° downwards.

5.3.5. Colour of the reflected light of the device

5.3.5.1. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1.

5.3.5.2. The trichromatic coordinates of the reflected luminous flux must be within the limits for the night-time colours red, amber or white as specified in UN Regulation No. 48.

5.3.6. Special specification (tests) / resistance to external agents

Depending on the nature of the materials of which the retro-reflective devices and, in particular, their optical units, are made, the Type Approval Authorities may authorize laboratories to omit certain unnecessary tests, subject to the express reservation that such omission must be mentioned under "Remarks" on the form notifying approval.

This is only applicable to tests described in Annexes 11, 12, 14 and 21.

5.3.7. Chronological order of tests for Class IVA

Table 8

Chronological order of tests (Class IVA)

Number of Annex	Tests	Samples									
		a	b	c	d	e	f	g	h	i	j
-	General specifications: visual inspection	x	x	x	x	x	x	x	x	x	x
5	Shape and dimensions: visual inspection	x	x	x	x	x	x	x	x	x	x
6	Heat: 48 h at 65 °C ± 2°C Visual inspection for distortion	x x	x x	x x	x x	x x	x x	x x	x x	x x	x x
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt	x	x x	x	x	x	x	x	x	x	x
4	Photometry: limited to 20' and V = H = 0°	x	x	x	x	x	x	x	x	x	x
4	Complete photometry	x	x								
7	Water: 10 min. in normal position 10 min. in inverted position visual inspection			x x x	x x x						
9	Motor fuels: 5 min. visual inspection			x x	x x						
10	Oils: 5 min. visual inspection			x x	x x						
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt			x x	x x						
4	Photometry: limited to 20' and V = H = 0°			x	x						
8	Corrosion: 24 hours 2 hours' interval 24 hours visual inspection					x x x x	x x x x				
12	Rear face: 1 min. visual inspection					x x	x x				

Number of Annex	Tests	Samples									
		a	b	c	d	e	f	g	h	i	j
18	Impact visual inspection					x x	x x				
23	Colorimetry: visual inspection Trichromatic coordinates in case of doubt					x x	x x				
4	Photometry: limited to 20' and V = H = 0°					x	x				
	Deposit of samples with Authority	x	x								

5.4. Technical requirements concerning retro-reflective markings of class C (symbol "C")

5.4.1. Every retro-reflective marking of the Class C, when tested according to paragraph 5.4.3., shall meet:

- (a) The dimensions and shape requirements set forth in Annex 5; and
- (b) The photometric and colorimetric requirements as specified in paragraphs 5.4.4. to 5.4.5.; and
- (c) The physical and mechanical requirements set forth in paragraph 5.4.6.

5.4.2. The applicant shall submit for approval:

5.4.2.1. Five test samples representing strips of retro-reflective marking materials have to be submitted to the test laboratory. In the case of strips, at least a length of 3 meters shall be provided

5.4.2.2. The test samples shall be representative of current production, manufactured in accordance with the recommendation of the manufacturer(s) of the retro-reflective marking materials. ⁽¹⁾

5.4.2.3. The samples shall be tested in the chronological order indicated in paragraph 5.4.7.

5.4.3. Test procedure

5.4.3.1. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5), the samples shall be subjected to the heat resistance test described in Annex 6, prior to the tests described in the paragraphs 5.4.4. and 5.4.5.

5.4.3.2. The photometric and colorimetric measurements may be made on five samples. The mean values should be taken.

5.4.3.3. For other tests, samples which have not undergone any testing should be used.

5.4.4. Minimum values for the coefficient of retro-reflection

Photometric specifications for retro-reflective markings of Class C:

5.4.4.1. When measured as described in Annex 4, the coefficient of retro-reflection R' in candelas per m² per lux (cd/m²/lux) of the retro-reflective areas in new condition shall be at least as indicated in Table 9 for white, yellow and red materials.

⁽¹⁾ Test samples of retro-reflective marking materials shall be applied to edged and degreased aluminium panels of 2 mm thickness and shall be conditioned for 24 hours at 23°C ± 2°C at 50% ± 5% relative humidity prior to testing.

Table 9

Minimum values for the Coefficient of Retro-reflection R' [cd•m⁻²•lx⁻¹]

Observation angle α [°]	Entrance Angle β [°]					
$\alpha=0,33(20')$	$\beta 1$	0	0	0	0	0
	$\beta 2$	5	20	30	40	60
Colour						
Yellow		300	–	130	75	10
White		450	–	200	95	16
Red		120	60	30	10	–

5.4.5. Colour of the reflected light of the device

5.4.5.1. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1.

5.4.5.2. The trichromatic coordinates of the reflected luminous flux must be within the limits for the night-time colours red, amber or white as specified in UN Regulation No. 48.

5.4.6. Special specification (tests) / resistance to external agents

5.4.6.1. Resistance to weathering

A specimen shall be subjected to a test as specified in Annex 13.

5.4.6.2. Resistance to corrosion

A specimen of the sample unit shall be subjected to a test as specified in Annex 11.

5.4.6.3. Resistance to fuels

A specimen of the sample unit shall be subjected to a test as specified in Annex 9.

5.4.6.4. Resistance to heat

A specimen of the sample unit shall be subjected to a test as specified in Annex 6.

5.4.6.5. Resistance to cleaning

A specimen of the sample unit shall be subjected to a test as specified in Annex 15.

5.4.6.6. Stability of photometric properties

A specimen of the sample unit shall be subjected to a test as specified in Annex 14.

5.4.6.7. Resistance to penetration of water

A specimen of the sample unit shall be subjected to a test as specified in Annex 7.

5.4.6.8. Bonding strength (in the case of adhesive materials)

A specimen of the sample unit shall be subjected to a test as specified in Annex 16.

5.4.6.9. Flexing

For samples that are to be adhered to a flexible substrate, i.e. tarpaulin, the following shall apply:

A specimen of the sample unit shall be subjected to a test as specified in Annex 17.

5.4.7. Chronological order of tests for Classes C

5.4.7.1. Five test samples representing either strips or planes of retro-reflective marking materials have to be submitted to the test laboratory. In the case of strips, at least a length of 3 meters shall be provided; in the case of planes, at least a surface of 500 mm x 500 mm shall be provided.

5.4.7.2. The test samples shall be representative of current production, manufactured in accordance with the recommendation of the manufacturer(s) of the retro-reflective marking materials. ⁽²⁾

5.4.7.3. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5), the samples shall be subjected to the heat resistance test described in Annex 8, prior to the tests described in Annexes 6 and 7.

5.4.7.4. The photometric and colorimetric measurements may be made on five samples. The mean values should be taken.

5.4.7.5. For other tests, samples which have not undergone any testing should be used.

5.5. technical requirements concerning retro-reflective markings of the Classes D and E (Symbols "D" and "E")

5.5.1. Every retro-reflective marking of the Classes D and E shall meet the photometric requirements as specified in paragraphs 5.5.3. to 5.5.5.

5.5.2. The applicant shall submit for approval:

5.5.2.1. Five test samples representing planes of retro-reflective marking materials have to be submitted to the test laboratory. In the case of planes, at least a surface of 500 mm x 500 mm shall be provided.

5.5.2.2. The test samples shall be representative of current production, manufactured in accordance with the recommendation of the manufacturer(s) of the retro-reflective marking materials. ⁽³⁾

5.5.3. Test procedure

Every retro-reflective marking of the Class D and E shall meet the requirements of the checks and tests described in paragraph 5.5.5.

5.5.4. Maximum values for the coefficient of retro-reflection

⁽²⁾ Test samples of retro-reflective marking materials shall be applied to edged and degreased aluminium panels of 2 mm thickness and shall be conditioned for 24 hours at 23°C ± 2°C at 50% ± 5% relative humidity prior to testing.

⁽³⁾ Test samples of retro-reflective marking materials shall be applied to edged and degreased aluminium panels of 2 mm thickness and shall be conditioned for 24 hours at 23°C ± 2°C at 50% ± 5% relative humidity prior to testing.

Table 10

Photometric specifications for distinctive markings or graphics of class D and class E: Maximum values for the Coefficient of Retro-reflection R' [cd•m⁻²•lx⁻¹]

Observation angle α [°]		Entrance Angle β (°)				
$\alpha = 0,33^\circ (20')$		β_1	0	0	0	0
		β_2	5	30	40	60
Any colour	class D		150	65	37	5
	class E		50	22	12	1

Note: If the sample is provided with an orientation mark, the specified values must only be observed for this orientation. Test samples without an orientation mark must be observed for values at 0° and 90° orientations as well.

5.5.5. Colour of the reflected light of the device

5.5.5.1. Retro-reflective distinctive markings and/or graphics (classes D and E) may be of any colour.

5.5.6. Special specification (tests) / resistance to external agents

5.5.6.1. Advertising, consisting of retro-reflective logos, distinctive markings or letters/characters has to be decent.

It may consist of marking materials of class "D" if the total retro-reflective area is less than 2 m²; if the total retro-reflective area is at least 2 m² class "E" shall be used. ^(*)

5.5.6.2. White retro-reflective marking materials intended as base or background in printing processes for fully coloured logos and markings of class "E" in use, without unprinted blank areas, may fulfil the requirements in Annex 7 for class "D" materials and must be marked as class "D/E".

5.5.6.3. Depending on the nature of retro-reflective marking material, the Type Approval Authorities may authorize laboratories to omit certain unnecessary tests, provided that such omission is mentioned under "Remarks" on the form notifying approval.

5.6. Technical requirements concerning retro-reflective markings of the Class F and retro-reflective marking plates of the Class 5

5.6.1. Every retro-reflective marking of the Class F shall meet the requirements of the checks and tests for:

- (a) Dimensions and shape set forth in Annex 5; and
- (b) The photometric and colorimetric requirements as specified in paragraph 5.6.4. to 5.6.5.; and
- (c) The physical and mechanical requirements set forth in paragraph 5.5.6.

5.6.2. The applicant shall submit for approval:

^(*) Nothing in this Regulation shall preclude the national authorities to prohibit the use of retro-reflective advertising, logos, distinctive markings, letters/characters as defined in paragraph 2.1.2.

5.6.2.1. Five test samples representing either strips or planes of retro-reflective marking materials to the test laboratory. In the case of strips, at least a length of 3 meters shall be provided; in the case of planes, at least a surface of 500 mm x 500 mm shall be provided.

5.6.2.2. The test samples shall be representative of current production, manufactured in accordance with the recommendation of the manufacturer(s) of the retro-reflective marking materials. ⁽⁵⁾

The samples shall be tested in the chronological order indicated in paragraph 5.6.4.

5.6.3. Test procedure

Every retro-reflective marking of the Class F and Class 5 shall meet the requirements of the checks and tests described in paragraphs 5.6.4. and 5.6.5.

5.6.4. Minimum values for the Coefficient of Retro-reflection

Photometric specifications for retro-reflective markings of Class F:

Table 11

Minimum values for the Coefficient of Retro-reflection R' [cd•m⁻²•lx⁻¹]

Observation angle α [°]	Entrance Angle β [°]					
$\alpha=0.33(20^\circ)$	$\beta 1$	0	0	0	0	0
	$\beta 2$	5	20	30	40	60
Colour						
White		450	–	200	95	16
Red		120	60	30	10	–

Photometric specifications for retro-reflective markings of Class 5:

Table 11-2

Minimum values for the Coefficient of Retro-reflection R' [cd•m⁻²•lx⁻¹]

Observation angle α [°]	Entrance Angle β [°]				
$\alpha=0.33(20^\circ)$	$\beta 1$	0	0	0	0
	$\beta 2$	5	30	40	60
Colour					
White		450	200	95	16
Red		120	30	10	2

5.6.5. Colour of the reflected light of the device

5.6.5.1. The testing of the day-time colour for retro-reflective device shall be carried out according to the method described in paragraph 4.2.2.

⁽⁵⁾ Test samples of retro-reflective marking materials shall be applied to edged and degreased aluminium panels of 2 mm thickness and shall be conditioned for 24 hours at 23°C ± 2°C at 50% ± 5% relative humidity prior to testing.

- 5.6.5.2. The trichromatic coordinates of the reflected luminous flux must be within the limits for the red and white colour as specified in UN Regulation No. 48.
- 5.6.5.3. Luminance factor determined in accordance to paragraph 4.2.2.:
for red colour shall be $\geq 0,03$,
for white colour, it shall be $\geq 0,25$.
- 5.6.6. Special specification (tests) / resistance to external agents
- 5.6.6.1. Resistance to weathering
A specimen shall be subjected to a test as specified in Annex 13
- 5.6.6.2. Resistance to corrosion
A specimen of the sample unit shall be subjected to a test as specified in Annex 11.
- 5.6.6.3. Resistance to fuels
A specimen of the sample unit shall be subjected to a test as specified in Annex 9.
- 5.6.6.4. Resistance to heat
A specimen of the sample unit shall be subjected to a test as specified in Annex 6.
- 5.6.6.5. Resistance to cleaning
A specimen of the sample unit shall be subjected to a test as specified in Annex 15.
- 5.6.6.6. Stability of photometric properties
A specimen of the sample unit shall be subjected to a test as specified in Annex 14.
- 5.6.6.7. Resistance to penetration of water
A specimen of the sample unit shall be subjected to a test as specified in Annex 7.
- 5.6.6.8. Bonding strength (in the case of adhesive materials)
A specimen of the sample unit shall be subjected to a test as specified in Annex 16.
- 5.6.6.9. Flexing
For samples that are to be adhered to a flexible substrate, i.e. tarpaulin, the following shall apply:
A specimen of the sample unit shall be subjected to a test as specified in Annex 17.
- 5.6.7. In the case of Plates:
A specimen of a complete plate shall be subjected to a test of rigidity of plates as specified in Annex 19.
- 5.7. Technical requirements concerning retro-reflective markings plates of the Classes 1, 2, 3 and 4
- 5.7.1. Retro-reflective devices of this paragraph must satisfy the conditions as to
(a) Dimensions and shape set forth in Annexes 5, and
(b) The photometric and colorimetric as specified in paragraphs 5.7.4. to 5.7.5. and
(c) The physical and mechanical requirements set forth in paragraph 5.7.6.
- 5.7.2. The applicant shall submit for approval:

5.7.2.1. Two large chevron rear marking plates for trucks and tractors and two large rear marking plates for trailers and semi-trailers (or their equivalent in smaller plates) shall be supplied to the testing laboratory for the various tests to be conducted.

5.7.2.2. The test samples shall be representative of current production, fabricated in accordance with the recommendations of the manufacturer of the retro-reflective or retro-reflective/fluorescent materials or devices.

The samples shall be tested in the chronological order indicated in paragraph 5.7.3.

5.7.3. Test procedure

Every retro-reflective marking Plate of the classes 1, 2, 3 and 4: shall meet the requirements of the checks and tests described in Annex 5.

5.7.3.1. After verification of the general specifications (paragraph 3.) and the specifications of shape and dimensions (Annex 5) the samples shall be subjected to the heat resistance test described in Annex 9 to this Regulation, prior to the tests described in Annexes 6, 7 and 8.

5.7.3.2. The photometric and colorimetric measurements may be made on the same sample.

5.7.3.3. For the other tests, samples which have not undergone any testing should be used.

5.7.4. Maximum values for the coefficient of retro-reflection

Photometric specifications for retro-reflective markings plates of the classes 1, 2, 3 and 4:

Devices of class 1 and class 2 shall fulfil the values in Table 12 for yellow only,

Devices of class 3 and class 4 those in Table 12 for yellow and red.

Table 12

Minimum values for the Coefficient of Retro-reflection R' [$\text{cd} \cdot \text{m}^{-2} \cdot \text{lx}^{-1}$]

Observation angle α [°]	Entrance angle β [°]				
20'	β_1	0°	0°	0°	0°
	β_2	5°	30°	40°	60°
Coefficient R' [$\text{cd} \cdot \text{m}^{-2} \cdot \text{lx}^{-1}$]	Colour: Yellow	300	180	75	10
	Colour: Red	10	7	4	-

5.7.4.1. The subtended angle at the sample shall not be larger than 80'.

5.7.5. Colour of the reflected light of the device

5.7.5.1. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1.

5.7.5.1.1. The trichromatic coordinates of the reflected luminous flux must be within the limits for the red and yellow colour as specified in UN Regulation No. 48.

5.7.5.2. The testing of the colour for retro-reflective device (day-time colour) shall be carried out according to the method described in paragraph 4.2.2.

5.7.5.2.1. The trichromatic coordinates of the reflected luminous flux must be within the limits for the red and yellow colour as specified in UN Regulation No. 48.

- 5.7.5.2.2. Luminance factor β determined in accordance to paragraph 4.2.3.:
(a) For red colour shall be $\geq 0,03$.
(b) For yellow colour, it shall be $\geq 0,16$.
- 5.7.5.3. The testing of the colour for the fluorescent material shall be carried out according to the method described in paragraph 4.2.3.
- 5.7.5.3.1. The trichromatic coordinates of the reflected luminous flux must be within the limits for the colour as specified in UN Regulation No. 48
- 5.7.5.3.2. Luminance factor β determined in accordance to paragraph 4.2.3.: for red colour shall be $\geq 0,3$.
- 5.7.5.4. Rear marking plates for heavy vehicles and trailers shall be composed of yellow retro-reflective and red retro-reflective or yellow retro-reflective and red fluorescent materials or devices.
- 5.7.6. Special specification (tests) / resistance to external agents
- 5.7.6.1. Resistance to weathering
A specimen shall be subjected to a test as specified in Annex 13.
- 5.7.6.2. Resistance to corrosion
A specimen of the sample unit shall be subjected to a test as specified in Annex 11.
- 5.7.6.3. Resistance to fuels
A specimen of the sample unit shall be subjected to a test as specified in Annex 9.
- 5.7.6.4. Resistance to heat
A specimen of the sample unit shall be subjected to a test as specified in Annex 6.
- 5.7.6.5. Resistance to cleaning
A specimen of the sample unit shall be subjected to a test as specified in Annex 15.
- 5.7.6.6. Stability of photometric properties
A specimen of the sample unit shall be subjected to a test as specified in Annex 14.
- 5.7.6.7. Resistance to penetration of water
A specimen of the sample unit shall be subjected to a test as specified in Annex 7.
- 5.7.6.8. Bonding strength (in the case of adhesive materials)
A specimen of the sample unit shall be subjected to a test as specified in Annex 16.
- 5.7.6.9. Flexing
- 5.7.6.9.1. For samples that are to be adhered to a flexible substrate, i.e. tarpaulin, the following shall apply:
A specimen of the sample unit shall be subjected to a test as specified in Annex 17.
- 5.7.6.9.2. In the case of Plates:
A specimen of a complete plate shall be subjected to a test of rigidity of plates as specified in Annex 19.
- 5.7.7. Chronological order of tests for Classes 1, 2, 3 and 4

- 5.7.7.1. Two large chevron rear marking plates for trucks and tractors and two large rear marking plates for trailers and semi-trailers (or their equivalent in smaller plates) shall be supplied to the testing laboratory for the various tests to be conducted.
- 5.7.7.2. The test samples shall be representative of current production, fabricated in accordance with the recommendations of the manufacturer of the retro-reflective or retro-reflective/fluorescent materials or devices.
- 5.7.7.3. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5) the samples shall be subjected to the heat resistance test described in Annex 6, prior to the tests described in paragraphs 4.2. and 5.7.4. and in Annex 8.
- 5.7.7.4. The photometric and colorimetric measurements may be made on the same sample.
- 5.7.7.5. For the other tests, samples which have not undergone any testing should be used.
- 5.8. Technical requirements concerning retro-reflective marking plates for slow moving vehicles of the Class SMV
- 5.8.1. Retro-reflective devices of this paragraph must satisfy the conditions as to
 - (a) Dimensions and shape set forth in Annex 5; and
 - (b) The photometric and colorimetric as specified in paragraphs 5.8.4. to 5.8.5.; and
 - (c) The physical and mechanical requirements set forth in Annexes 9, 11 to 13.
- 5.8.2. The applicant shall submit for approval:
 - 5.8.2.1. Five SMV rear marking plates shall be supplied to the testing laboratory for the various tests to be conducted.
 - 5.8.2.2. The test samples shall be representative of current production, fabricated in accordance with the recommendations of the manufacturer(s) of the retro-reflective and fluorescent (class 1) or retro-reflective only (class 2).

The samples shall be tested in the chronological order indicated in paragraph 5.8.7.
- 5.8.3. Test procedure
 - 5.8.3.1. Every Retro-reflective Marking Plate for slow moving vehicles of the Class SMV shall meet the requirements of the checks and tests described in Annex 5.
 - 5.8.3.2. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5) four samples shall be subjected to the heat resistance test described in Annex 6 to this Regulation, prior to the tests described in paragraphs 4.2. and 5.7.4. and in Annex 8. The fifth sample shall be kept for reference purposes during the test procedures.
 - 5.8.3.3. The photometric and colorimetric measurements may be made on the same sample.
 - 5.8.3.4. For the other tests, samples which have not undergone any testing should be used.
- 5.8.4. Maximum values for the coefficient of retro-reflection
Photometric specifications for retro-reflective markings plates for slow moving vehicles of the Class SMV
 - 5.8.4.1. When measured as described in paragraph 3., the coefficient of retro-reflection R' in candelas per m^2 per lux ($cd/m^2/lux$) of the entire red retro-reflective area in new condition shall be at least as indicated in Table 13.

Table 13

Minimum values for the Coefficient of Retro-reflection R' [$\text{cd} \cdot \text{m}^{-2} \cdot \text{lx}^{-1}$]

Observation angle α	Entrance angle β				
20'	β_1	0°	0°	0°	0°
	β_2	5°	20°	30°	40°
Coefficient R' [$\text{cd} \cdot \text{m}^{-2} \cdot \text{lx}^{-1}$]	R' of the outer border (class 1, 2)	120	60	30	10
	R' of the enclosed triangle (class 2)	10	7	4	-

- 5.8.4.2. The subtended angle at the sample shall not be larger than 80'.
- 5.8.5. Colour of the reflected light of the device
- 5.8.5.1. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1.
- 5.8.5.1.1. The trichromatic coordinates of the reflected luminous flux must be within the limits for the colour as specified in UN Regulation No. 48.
- 5.8.5.2. The testing of the colour for retro-reflective device (day-time colour) shall be carried out according to the method described in paragraph 4.2.2.
- 5.8.5.2.1. The trichromatic coordinates of the reflected luminous flux must be within the limits for the colour red as specified in UN Regulation No. 48.
- 5.8.5.2.2. Luminance factor β determined in accordance to paragraph 4.2.2. shall be $\geq 0,03$.
- 5.8.6. Colorimetric Specifications
- 5.8.6.1. SMV rear marking plates for slow-moving vehicles and their trailers shall be composed either of red retro-reflective and red fluorescent materials or devices (class 1) or red retro-reflective only materials or devices (class 2).
- 5.8.7. Special specifications (tests) / resistance to external agents
- 5.8.7.1. Resistance to weathering
A specimen shall be subjected to a test as specified in Annex 13.
- 5.8.7.2. Resistance to corrosion
A specimen of the sample unit shall be subjected to a test as specified in Annex 11.
- 5.8.7.3. Resistance to fuels
A specimen of the sample unit shall be subjected to a test as specified in Annex 9.
- 5.8.7.4. Resistance to heat
A specimen of the sample unit shall be subjected to a test as specified in Annex 6.
- 5.8.7.5. Resistance to cleaning
A specimen of the sample unit shall be subjected to a test as specified in Annex 15.

- 5.8.7.6. Stability of photometric properties
A specimen of the sample unit shall be subjected to a test as specified in Annex 14.
- 5.8.7.7. Resistance to penetration of water
A specimen of the sample unit shall be subjected to a test as specified in Annex 7.
- 5.8.7.8. Bonding strength (in the case of adhesive materials)
A specimen of the sample unit shall be subjected to a test as specified in Annex 16.
- 5.8.7.9. Flexing
- 5.8.7.9.1. For samples that are to be adhered to a flexible substrate, i.e. tarpaulin, the following shall apply:
A specimen of the sample unit shall be subjected to a test as specified in Annex 17.
- 5.8.7.9.2. In the case of Plates:
A specimen of a complete plate shall be subjected to a test of rigidity of plates as specified in Annex 19.
- 5.8.8. Chronological order
- 5.8.8.1. Five SMV rear marking plates shall be supplied to the testing laboratory for the various tests to be conducted.
- 5.8.8.2. The test samples shall be representative of current production, fabricated in accordance with the recommendations of the manufacturer(s) of the retro-reflective and fluorescent (class 1) or retro-reflective only (class 2).
- 5.8.8.3. After verification of the general specifications (paragraph 4.) and the specifications of shape and dimensions (Annex 5) four samples shall be subjected to the heat resistance test described in Annex 6, prior to the tests described in paragraphs 4.2. and 5.7.4. and in Annex 8. The fifth sample shall be kept for reference purposes during the test procedures.
- 5.8.8.4. The photometric and colorimetric measurements may be made on the same sample.
- 5.8.8.5. For the other tests, samples which have not undergone any testing should be used.
- 5.9. Technical requirements concerning advance warning triangles of type 1 and 2
- 5.9.1. Retro-reflective devices of this paragraph must satisfy the conditions as to
- (a) Dimensions and shape set forth in Annex 5; and
 - (b) The photometric and colorimetric as specified in paragraphs 5.9.4. to 5.9.5.; and
 - (c) The physical and mechanical requirements set forth in Annexes 7, 9, 12, 13, 20.
- 5.9.2. The applicant shall submit for approval:
- 5.9.2.1. Four samples of the advance warning triangle and at least two protective covers if the advance warning triangles are to be supplied with protective covers;
- 5.9.2.2. Two samples of the fluorescent or fluorescent retro-reflecting material in which a 100 x 100 mm square can be inscribed and which are fully representative of the material applied under the same conditions to the same base material as used for the advance warning triangle;
- 5.9.2.3. In the case of a type of advance-warning triangle differing only by the trade name or mark from a type that has already been approved it shall be sufficient to submit:

- 5.9.2.3.1. A declaration by the advance-warning triangle manufacturer that the type submitted is identical (except in the trade name or mark) with and has been produced by the same manufacturer as, the type already approved, the latter being identified by its approval number;
- 5.9.2.3.2. Two samples bearing the new trade name or mark or equivalent documentation.
The samples shall be tested in the chronological order indicated in paragraph 5.9.6.
- 5.9.3. Test procedure
Every advance warning triangle and its protective cover, if any, shall meet the requirements of the checks and tests described in Annex 5.
- 5.9.4. Minimum values for the coefficient of retro-reflection
Photometric specifications for advance warning triangles of Type 1 and 2
- 5.9.4.1. When measured as described in paragraph 5.9.4.1.1. and Annex 4, paragraphs 2., 3. and 4., the CIL values of the entire red retro-reflective area in new condition shall be at least as indicated in Table 14.
- 5.9.4.1.1. For this measurement it is assumed that the direction of illumination $H = V = \Theta$ for the advance warning triangle in its position of use is parallel to the base plane and vertical to the lower side of the triangle, which in turn is parallel to the said base plane.
- 5.9.4.2. Retro-reflective devices and fluorescent retro-reflecting material.

Table 14

Minimum values for the CIL [mcd.lx^{-1}]

	Illumination angles β			
	0°	$\pm 20^\circ$	0°	0°
Vertical V (β_1)	0°	$\pm 20^\circ$	0°	0°
Horizontal H (β_2)	0° or $\pm 5^\circ$	0°	$\pm 30^\circ$	$\pm 40^\circ$
Angles of divergence $20'$	8 000	4 000	1 700	600
Angles of divergence $1^\circ 30'$	600	200	100	50

- 5.9.4.2.1. The CIL measured on random slices of 50 mm length of the retro-reflective device shall lie between extremes having a ratio not in excess of 3. These slices are taken between the perpendiculars to the side of the triangle and passing through the corresponding apexes of the central aperture. This requirement applies to an angle of divergence of $20'$ and to illumination angles of $V = 0^\circ$, $H = 0^\circ$ or $\pm 5^\circ$ and $V = \pm 20^\circ$, $H = 0^\circ$.
- 5.9.4.2.2. Diversity of luminance at angles of illumination of $V = 0^\circ$, $H = \pm 30^\circ$, and $V = 0^\circ$, $H = \pm 40^\circ$ shall be tolerated on condition that the triangular shape remains clearly discernible, for an angle of divergence of $20'$ and an illumination of approximately 1 lux.
- 5.9.4.2.3. The measurements referred to above shall be performed by the method described in Annex 4, paragraph 3.
- 5.9.5. Colorimetric specification
- 5.9.5.1. Retro-reflective devices
- 5.9.5.1.1. Retro-reflective devices shall be made of material coloured red in the mass.

- 5.9.5.1.2. The testing of the colour for retro-reflective device (night-time colour) shall be carried out according to the method described in paragraph 4.2.1. and the trichromatic co-ordinates of the red reflected luminous flux shall be within the following limits:

Table 15

Colour coordinates for retro-reflective device (night-time colour)

Point	1	2	3	4
x	0,712	0,735	0,589	0,625
y	0,258	0,265	0,376	0,375

- 5.9.5.2. Fluorescent materials

- 5.9.5.2.1. The fluorescent materials shall either be coloured in the mass or take the form of separate coatings applied to the surface of the triangle.

- 5.9.5.2.2. The testing of the colour of the fluorescent materials (daytime colour) of advance warning triangle of type 1 or type 2 shall be carried out according to the method described in paragraph 4.2.3. and the colour of the material in new condition shall be within an area of which the corner points are determined by the following coordinates as specified in Table 16:

Table 16

Colour coordinates of the fluorescent materials (daytime colour)

Point	1	2	3	4
x	0,570	0,506	0,595	0,690
y	0,430	0,404	0,315	0,310

- 5.9.5.2.3. The testing of the luminance factor of the fluorescent materials shall be carried out according to the method described in paragraph 4.3.

The luminance factor including the luminance by reflection and fluorescence shall be:

- (a) For advance warning triangle of type 1, not less than 30 per cent; and
- (b) For advance warning triangle of type 2, not less than 25 per cent.

- 5.9.5.3. The largest measured trichromatic coordinate y value according to paragraph 4.2.1. (night-time colour) shall be smaller or equal to the largest measured trichromatic coordinate y value according to paragraph 4.2.2. (day-time colour).

- 5.9.6. Special specification (tests) / resistance to external agents

- 5.9.6.1. Resistance to weathering

A specimen shall be subjected to a test as specified in Annex 13.

- 5.9.6.2. Resistance to fuels

A specimen of the sample unit shall be subjected to a test as specified in Annex 9.

- 5.9.6.3. Resistance to heat

A specimen of the sample unit shall be subjected to a test as specified in Annex 20.

5.9.6.4. Resistance to penetration of water

A specimen of the sample unit shall be subjected to a test as specified in Annex 7.

5.9.6.5. Wind test

A specimen of a complete plate shall be subjected to a test of rigidity of plates as specified in Annex 20.

5.9.6.6. Test of clearance to ground

A specimen of the sample unit shall be subjected to a test as specified in Annex 20.

5.9.7. Chronological order

5.9.7.1. General

5.9.7.1.1. The applicant shall submit samples, as mentioned in paragraphs 3.1, for approval.

5.9.7.1.2. After verification of the general specifications (paragraph 4) and the specifications of shape and dimensions (Annex 5, Figure A5-VIII or Figure A5-IX), all samples shall be subjected to the heat resistance test (Annex 6) and examined after at least one hour of rest.

5.9.7.1.3. The CIL value of the four samples of the advance warning triangles submitted is measured at an observation angle of 20' and at an illumination angle with the components $V = 0^\circ$, $H = \pm 5^\circ$; this test is carried out in accordance with the method described in paragraph 4.

5.9.7.1.4. The two samples with the smallest and the largest CIL value in the tests according to paragraph 5.9.7.1.3. shall be subsequently subjected to the following tests:

5.9.7.1.4.1. Measurement of the values of the CIL in respect of the observation and illumination angles referred to in paragraph 5.9.4. according to the method described in paragraph 4.

5.9.7.1.4.2. Testing of the colour of the retro-reflected light according to paragraph 4.2. on the sample with the highest CIL concerned shall be examined.

5.9.7.1.4.3. Test of clearance to ground according to Annex 20, paragraph 1.

5.9.7.1.4.4. Mechanical solidity test according to Annex 20, paragraph 2.

5.9.7.1.5. One sample other than those referred to in paragraph 5.9.7.1.4. shall be subjected to the following tests:

5.9.7.1.5.1. Testing of resistance to penetration of water into the retro-reflective device according to Annex 7 or if relevant, of the mirror-backed reverse side of the retro-reflective device, according to Annex 7.

5.9.7.1.6. The second sample, other than those referred to in paragraph 5.9.7.1.4., shall be subjected to the following tests:

5.9.7.1.6.1. Water test according to Annex 7.

5.9.7.1.6.2. Testing of resistance to fuels according to Annex 9.

5.9.7.1.6.3. Test of stability against wind according to Annex 20.

5.9.7.1.7. After the tests specified in paragraph 5.9.7.1.4., the two samples submitted according to paragraph 3.1 shall be subjected to the following tests:

5.9.7.1.7.1. Colour test according to paragraph 4.2.;

5.9.7.1.7.2. Test of the luminance factor according to paragraph 4.3.;

5.9.7.1.7.3. Test of resistance to weathering according to Annex 13.

6. TRANSITIONAL PROVISIONS

6.1 General

6.1.1. Contracting Parties applying this Regulation shall continue to accept type approvals of the devices, to any of the preceding series of amendments to this Regulation, which are not affected by the changes introduced by the latest series of amendments.

To verify this, the change index applicable to the pertinent device shall not differ from its change index as indicated in the latest series of amendments.

6.1.2. Contracting Parties applying this Regulation shall not refuse to grant extensions to type approvals according to any preceding series of amendments to this Regulation.

ANNEX 1

Communication

(Maximum format: A4 (210 x 297 mm))



issued by: Name of administration:

.....

.....

.....

concerning: ⁽²⁾

Approval

Approval extended

Approval refused

Approval withdrawn

Production definitively discontinued

of a type of retro-reflective device

of a type of advance warning triangle

of a type of SMV rear marking plate

of a type of rear marking plate,

of retro-reflective markings of heavy and long vehicles and their trailers pursuant to UN Regulation No. 150

Class of the device: Change index:

Approval No:

Unique Identifier (UI) (If applicable):

1. Trade name or mark of the retro-reflective device or marking material:

.....

2. Manufacturer's name:

2.1. for the retro-reflecting type of device:

2.2. for the advance warning triangle

2.3. for the SMV rear marking plate type:

2.3.1. SMV rear marking plate class:

2.4. for the rear marking plate type:

2.4.1. Rear marking plate class:

2.5. Class of the marking material:

3. Name and address of the manufacturer:

⁽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.

4. If applicable, name and address of manufacturer's representative:
.....
5. Date on which the marking material was submitted for approval tests:
6. Technical service responsible for carrying out the approval test:
7. Date of test report issued by the technical service:
8. Number of test report issued by the technical service:
9. Remarks:
10. Approval granted/refused/extended/withdrawn ²
11. Reason(s) for the extension (if applicable):
.....
12. Place:
13. Date:
14. Signature:
Name:
15. Annexed is a list of documents making up the approval file, deposited with the Type Approval Authority which granted approval; a copy can be obtained on request.

ANNEX 2

Minimum requirements for conformity of production control procedures

1. GENERAL

- 1.1. The conformity requirements shall be considered satisfied from a mechanical and geometric standpoint, if the differences do not exceed inevitable manufacturing deviations within the requirements of this Regulation.
- 1.2. With respect to photometric performances, the conformity of mass-produced retro-reflective devices shall not be contested if, when testing photometric performances of any retro-reflective device chosen at random no measured value deviates unfavourably by more than 20 per cent from the minimum values prescribed in this Regulation.
- 1.3. The chromaticity coordinates shall be complied with.

2. MINIMUM REQUIREMENTS FOR VERIFICATION OF CONFORMITY BY THE MANUFACTURER

For each type of retro-reflective device 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 provisions 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 and colorimetric characteristics and the resistance to penetration of water.

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 Type Approval Authority. 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 measurements made by a Type Approval Authority.

- 2.2.4. In all cases the reference methods shall be those of this Regulation, particularly for the purpose of administrative verification and sampling.

2.3. Nature of sampling

Samples of retro-reflective devices shall be selected at random from the production of a uniform batch. A uniform batch means a set of retro-reflective devices 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 retro-reflective device shall be subjected to photometric measurements at the points and the chromaticity coordinates provided for in the Regulation.

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 Type Approval Authority, criteria governing the acceptability of his products in order to meet the specifications laid down for the verification of conformity of products in paragraph 3.5.1. of this Regulation. The criteria governing the 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 3 (first sampling) would be 0,95.

ANNEX 3

Minimum requirements for sampling by an inspector

1. GENERAL

- 1.1. The conformity requirements shall be considered satisfied from a mechanical and a geometric standpoint, in accordance with the requirements of this Regulation, if any, if the differences do not exceed inevitable manufacturing deviations.
- 1.2. With respect to photometric performance, the conformity of mass-produced retro-reflective devices shall not be contested if, when testing photometric performances of any retro-reflective device chosen at random:
 - 1.2.1. No measured value deviates unfavourably by more than 20 per cent from the minimum values prescribed in this Regulation.
 - 1.2.2. Retro-reflective devices with apparent defects are disregarded.
- 1.3. The chromaticity coordinates shall be complied with.

2. FIRST SAMPLING

In the first sampling four retro-reflective devices are selected at random. The first sample of two is marked A, the second sample of two is marked B.

- 2.1. The conformity of mass-produced retro-reflective devices shall not be contested if the deviation of any specimen of samples A and B (all four retro-reflective devices) is not more than 20 per cent.

In the case, that the deviation of both retro-reflective devices of sample A is not more than 0 per cent, the measurement can be closed.
- 2.2. The conformity of mass-produced retro-reflective devices shall be contested if the deviation of at least one specimen of samples A or B is more than 20 per cent.

The manufacturer shall be requested to bring his production in line with the requirements (alignment) and a repeated sampling according to paragraph 3. below shall be carried out within two months' time after the notification. The samples A and B shall be retained by the Technical Service until the entire CoP process is finished.

3. FIRST REPEATED SAMPLING

A sample of four retro-reflective devices is selected at random from stock manufactured after alignment.

The first sample of two is marked C, the second sample of two is marked D.

- 3.1. The conformity of mass-produced retro-reflective devices shall not be contested if the deviation of any specimen of samples C and D (all four retro-reflective devices) is not more than 20 per cent.

In the case, that the deviation of both retro-reflective devices of sample C is not more than 0 per cent, the measurement can be closed.
- 3.2. The conformity of mass-produced retro-reflective devices shall be contested if the deviation of at least:
 - 3.2.1. One specimen of samples C or D is more than 20 per cent but the deviation of all specimen of these samples is not more than 30 per cent.

The manufacturer shall be requested again to bring his production in line with the requirements (alignment).

A second repeated sampling according to paragraph 4. shall be carried out within two months' time after the notification. The samples C and D shall be retained by the Technical Service until the entire CoP process is finished.

3.2.2. One specimen of samples C and D is more than 30 per cent:

In this case the approval shall be withdrawn and paragraph 5. shall be applied.

4. SECOND REPEATED SAMPLING

A sample of four retro-reflective devices is selected at random from stock manufactured after alignment.

The first sample of two is marked E, the second sample of two is marked F.

4.1. The conformity of mass-produced retro-reflective devices shall not be contested if the deviation of any specimen of samples E and F (all four retro-reflective devices) is not more than 20 per cent. In the case, that the deviation of both retro-reflective devices of sample E is not more than 0 per cent the measurement can be closed.

4.2. The conformity of mass-produced retro-reflective devices shall be contested if the deviation of at least one specimen of samples E or F is more than 20 per cent.

In this case the approval shall be withdrawn and paragraph 5. shall be applied.

5. APPROVAL WITHDRAWN

Approval shall be withdrawn according to paragraph 3.6. of this Regulation.

6. RESISTANCE TO WATER PENETRATION

6.1. One of the retro-reflectors of sample A after the sampling procedure in paragraph 2. shall be tested according to the procedure described in paragraph 1. of Annex 7 or, in the case of the Advance Warning Triangle, the sample A shall be tested according to the procedure described in paragraph 2. of Annex 7.

The retro-reflectors shall be considered as acceptable if the test has been passed. However, if the test on sample A is not complied with, the two retro-reflective devices of sample B shall be subjected to the same procedure and both shall pass the test.

6.2. Specimens of one of the rear marking plates of sample A after the sampling procedure in paragraph 2., shall be tested according to the procedures described in Annexes 6, 7, 9, 11, 13, 15, 16 and 18 to this Regulation.

The rear marking plate shall be considered acceptable if the tests were passed.

However, if the tests on specimens of sample A did not pass the tests, the two rear marking plates of sample B shall be subjected to the same procedure and both shall pass the test.

ANNEX 4

Photometric measurements of retro-reflective devices and marking materials

1. TEST PROCEDURES

- 1.1. When the CIL of a retro-reflective device is measured for an angle β of $V = H = 0^\circ$, it shall be ascertained whether any mirror effect is produced by slightly turning the device. If there is any such effect, a reading shall be taken with an angle β of $V = \pm 5^\circ$, $H = 0^\circ$. The position adopted shall be that corresponding to the minimum CIL for one of these positions.
- 1.2. With an illumination angle β of $V = H = 0^\circ$, or the angle specified in paragraph 5. of this Regulation, and an angle of divergence of $20'$, retro-reflective devices which are not marked "TOP" shall be rotated about their axes of reference to the position of minimum CIL, which must conform to the value specified in paragraph 5. of this Regulation. When the CIL is measured for the other angles of illumination and divergence, the retro-reflective device shall be placed in the position corresponding to this value of ε . If the specified values are not attained, the device may be rotated about its axis of reference $\pm 5^\circ$ from that position.
- 1.3. With an illumination angle β of $V = H = 0^\circ$, or the angle specified in paragraph 4. of this Regulation, and an angle of divergence of $20'$, retro-reflective devices marked "TOP" shall be rotated about their axes $\pm 5^\circ$. The CIL must not fall below the prescribed value in any position assumed by the device during this rotation.
- 1.4. If for the direction $V = H = 0^\circ$, and for $\varepsilon = 0^\circ$ the CIL exceeds the specified value by 50 per cent or more, all measurements for all angles of illumination and divergence shall be made for $\varepsilon = 0^\circ$.

2. DEFINITIONS

The definitions are explained by Figures A4-I to A4-V.

3. DIMENSIONAL AND PHYSICAL SPECIFICATIONS FOR THE PHOTOMETRY OF RETRO-REFLECTIVE DEVICES

- 3.1. The CIE-angular system as shown in Figure A4-I shall be used.

An adequate support (goniometer) is demonstrated in Figure A4-II.

- 3.2. For testing the retro-reflection the retro-reflective devices shall be illuminated with a CIE Standard Illuminant A (ISO 11664-2:2007(E)/CIE S 014-2/E:2006) and measured as described in Annex 4.

- 3.3. The measuring geometry is described in Figure A4-I and the following limits are set up:

Angular diameter of the source -	$\delta \leq 10'$
Angular diameter of the measuring device -	$\gamma \leq 10'$
Angular diameter of the illuminated area -	$\eta \leq 80'$

- 3.4. During photometric measurements, stray reflections should be avoided by appropriate masking.

- 3.5. The measuring distance shall be chosen in such an order that at least the limits for the angles α , β and γ given in Figure A4-IV are respected, but not lower than 10 m or its optical equivalent.

The retro-reflection values shall be determined by means of a measuring geometry as described above with the retro-reflecting device set up to a distance of at least 10m forward of the centre of reference of each retro-reflecting device perpendicular to the measurement axis from the origin of the gonio(photo)meter system.

3.6. The illuminance at the retro-reflective device

The illuminance over the useful area of the retro-reflective device, measured perpendicular to the incident light shall be sufficiently uniform. A check on this condition requires a measuring element, the sensitive area of which is not greater than one-tenth of the area to be examined. The variation in the value of the illuminance shall then comply with the condition:

$$\frac{\text{maximum value}}{\text{minimum value}} \leq 1,05$$

3.7. The colour temperature and the spectral distribution of the source

The source used for illuminating the retro-reflective device shall as faithfully as possible represent the CIE Illuminant A, both as regards colour temperature and spectral power distribution.

3.8. The photometer head (measuring element)

3.8.1. The photometer head shall be corrected to the spectral luminous efficiency for the CIE standard photometric observer in photopic vision.

3.8.2. The device shall not show a perceptible change in local sensitivity within the area of its aperture; otherwise suitable provisions shall be added, e.g. the application of a diffusing window at a certain distance in front of the sensitive surface.

3.8.3. Experience has shown that non-linearity of photometer heads may be a problem with the very small light quantities which are the rule in the photometry of retro-reflective devices. A check at comparable illuminance levels on the photometer head is recommended.

3.9. The influence of a regular reflection

The amount and distribution of the regular reflection from the surface of the retro-reflector depends on the flatness and the gloss of the surface. In general, regular reflection is best avoided when the reference axis is placed so that the regular reflection is directed on the opposite side of the source from the photometer head (for example with $\beta_1 = -5^\circ$).

4. MEASUREMENT PRECAUTIONS IN THE PHOTOMETRY OF RETRO-REFLECTION

4.1. Residual and stray light

4.1.1. Since very low light levels are to be measured special precautions are needed to minimize errors due to stray light. The background to the sample and the framework of the sample holder should be matt black and the field of view of the photometer head and the spread of light from both the sample and the source should each be restricted as much as possible.

4.1.2. Reflections from the floor and walls which occur over the relatively long test distances used shall be screened from both the sample and the photometer head by baffles. The importance of looking from the photometer head to check for sources of stray light cannot be over emphasized.

4.1.3. A valuable aid to reducing the amount of stray light in the laboratory is to use a slide projector type of optical system for the light source. With this, an iris diaphragm or suitable sized apertures may be used in the optical system to restrict the illuminated area at the sample to the minimum size needed to provide uniform illuminance over the sample.

4.1.4. Residual stray light should always be allowed for by measuring it when the sample is covered by an opaque matt black surface, zigzag folded black paper of the same size and shape or a specular black surface suitably oriented with a light trap. This value should be subtracted from that measured on the retro-reflective device

4.2. Stability of the apparatus

4.2.1. The light source and photometer head should remain stable throughout the period of the test. Since the sensitivity and the adaptation to the $V(\lambda)$ function of most photometer heads change with temperature, the laboratory ambient temperature should not vary significantly during this period. Sufficient time should always be allowed for the apparatus to stabilize before commencing measurements.

4.2.2. The power supply to the light source should be adequately stabilized so that the luminous intensity of the lamp can be maintained throughout the test to within the required accuracy for the work.

4.2.3. A useful check on the overall stability of the reflex photometer during a series of tests is to make periodic measurements of CIL values of a stable reference standard.

4.2.4. Another technique is to incorporate in the apparatus an auxiliary detector to check or monitor the output of the light source. Although the output from the auxiliary detector can be checked for any change in reading, a useful refinement is to use the output to alter electronically the sensitivity of the main reflex photometer head and compensate automatically for changes in the light output of the source.

4.3. Description of Goniometer

A goniometer as defined in paragraph 2.3. of this Regulation, which can be used in making retro-reflection measurements in the CIE geometry is illustrated in Figure A4-II. In this illustration, the photometer head (O) is arbitrarily shown to be vertically above the source (I). The first axis is shown to be fixed and horizontal and is situated perpendicular to the observation half-plane. Any arrangement of the components which is equivalent to the one shown can be used.

Figure A4-I

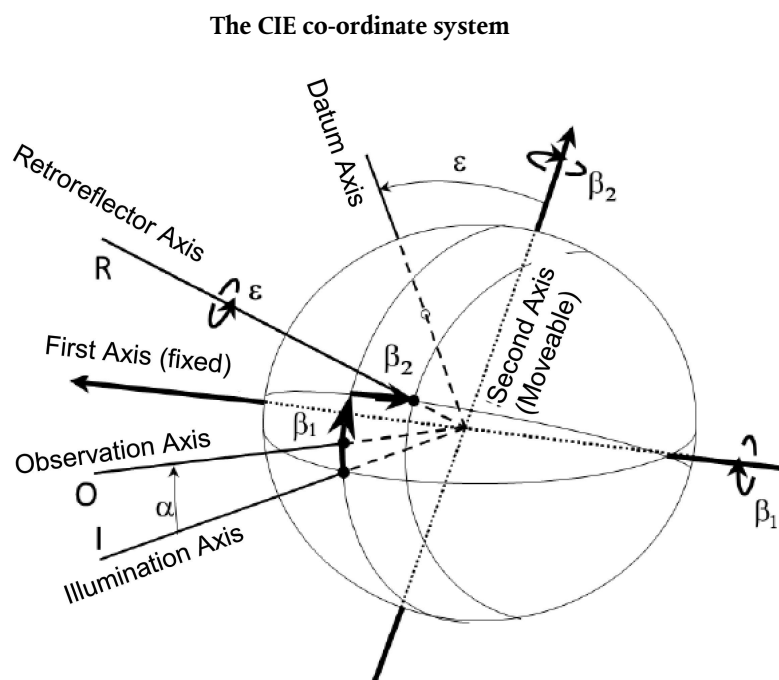
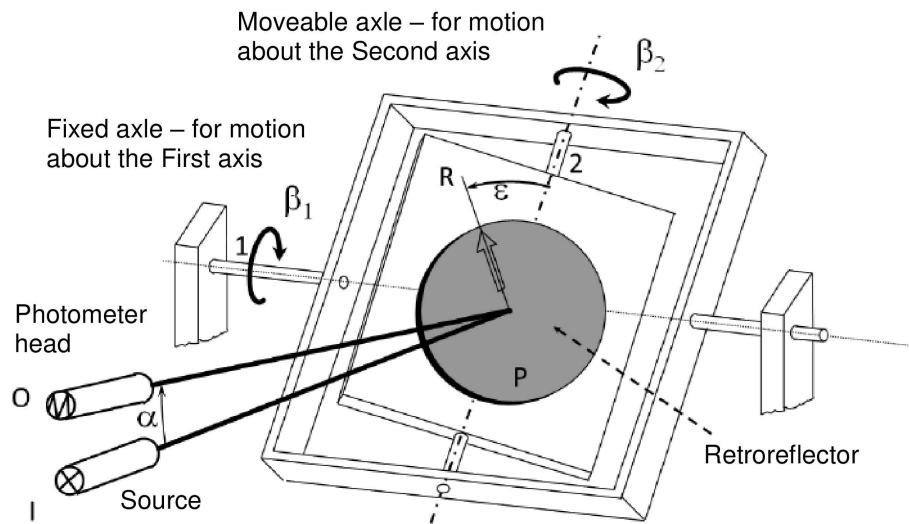


Figure A4-I shows the CIE angular system for specifying and measuring retro-reflective device and marking materials. The first axis is perpendicular to the plane containing the observation axis and the illumination axis. The second axis is perpendicular both to the first axis and to the reference axis.

Figure A4-II

Goniometer mechanism embodying the CIE angular system



1: First Axis	I: Illumination Axis	α: Observation angle
2: Second Axis	O: Observation Axis	β ₁ , β ₂ : Entrance angles
	R: Reference Axis	ε: Rotation angle
	P: Retro-reflective material	

Figure A4-II represents a Goniometer mechanism embodying the CIE angular system for specifying and measuring retro-reflective device and marking materials. All axes, angles, and directions of rotation are shown positive.

Notes:

- (a) The principle fixed axis is the illumination axis;
- (b) The first axis is fixed perpendicular to the plane containing the observation and illumination axis;
- (c) The reference axis is fixed in the retro-reflective device and moveable with β₁ and β₂.

Figure A4-III

Distribution of retro-reflected light at retro-reflector

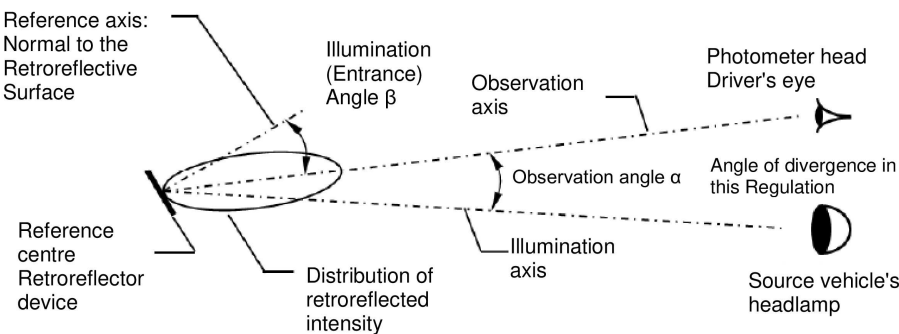
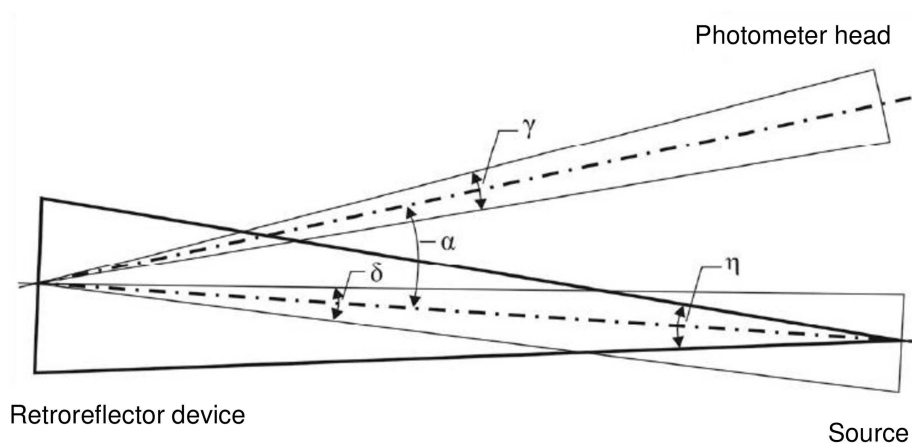


Figure A4-IV

Measuring geometry for the measurement of a retro-reflective device

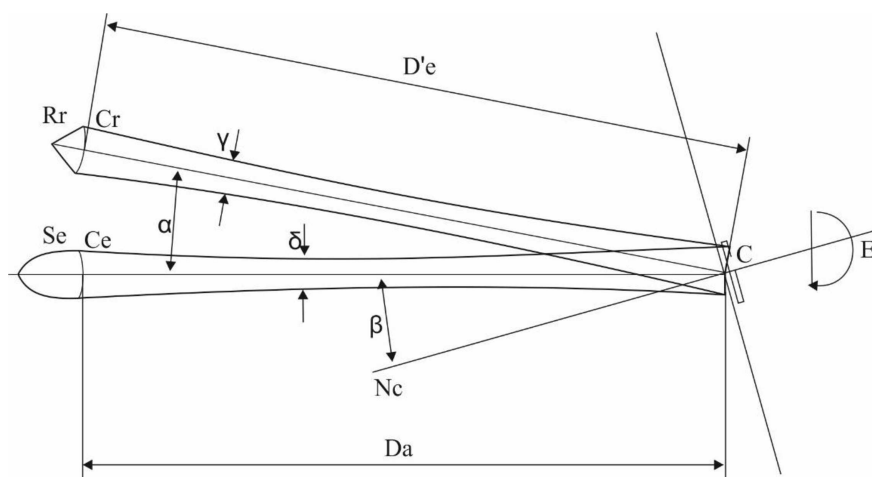
For the purpose of this Regulation, the following limits are set up:

$$\delta \leq 10'$$

$$\gamma \leq 10'$$

$$\eta \leq 80'$$

Figure A4-V

Arrangement of the test equipment for retro-reflective devices of Classes IA, IB, IIIA, IIIB, IVA

Elevation

Symbols and units

A = Area of the illuminating surface of the retro-reflective device (cm²)

C = Centre of reference

NC = Axis of reference

Rr = Receiver, observer or measuring device

Cr = Centre of receiver

Ør = Diameter of receiver Rr if circular (cm)

Se = Source of illumination

Cs = Centre of source of illumination

$\varnothing_s$ = Diameter of source of illumination (cm)

D_e = Distance from centre C_s to centre C (m)

$D'e$ = Distance from centre C_r to centre C (m)

Note: In general, D_e and $D'e$ are very nearly the same and under normal conditions of observation it may be assumed that $D_e = D'e$.

D = Observation distance from and from beyond which the illuminating surface appears to be continuous

α = Angle of divergence

β = Illumination angle. With respect to the line C_sC which is always considered to be horizontal, this angle is prefixed by the signs – (left), + (right), + (up) or – (down), according to the position of the source S_e in relation to the axis NC , as seen when looking towards the retro-reflective device. For any direction defined by two angles, vertical and horizontal, the vertical angle is always given first.

Γ = Angular diameter of the measuring device R_r as seen from point C

δ = Angular diameter of the source S_e as seen from point C

ε = Angle of rotation. This angle is positive when the rotation is clockwise as seen when looking towards the illuminating surface. If the retro-reflective device is marked "TOP", the position thus indicated is taken as the origin.

E = Illumination of the retro-reflective device (lux)

CIL = Coefficient of luminous intensity (millicandelas/lux)

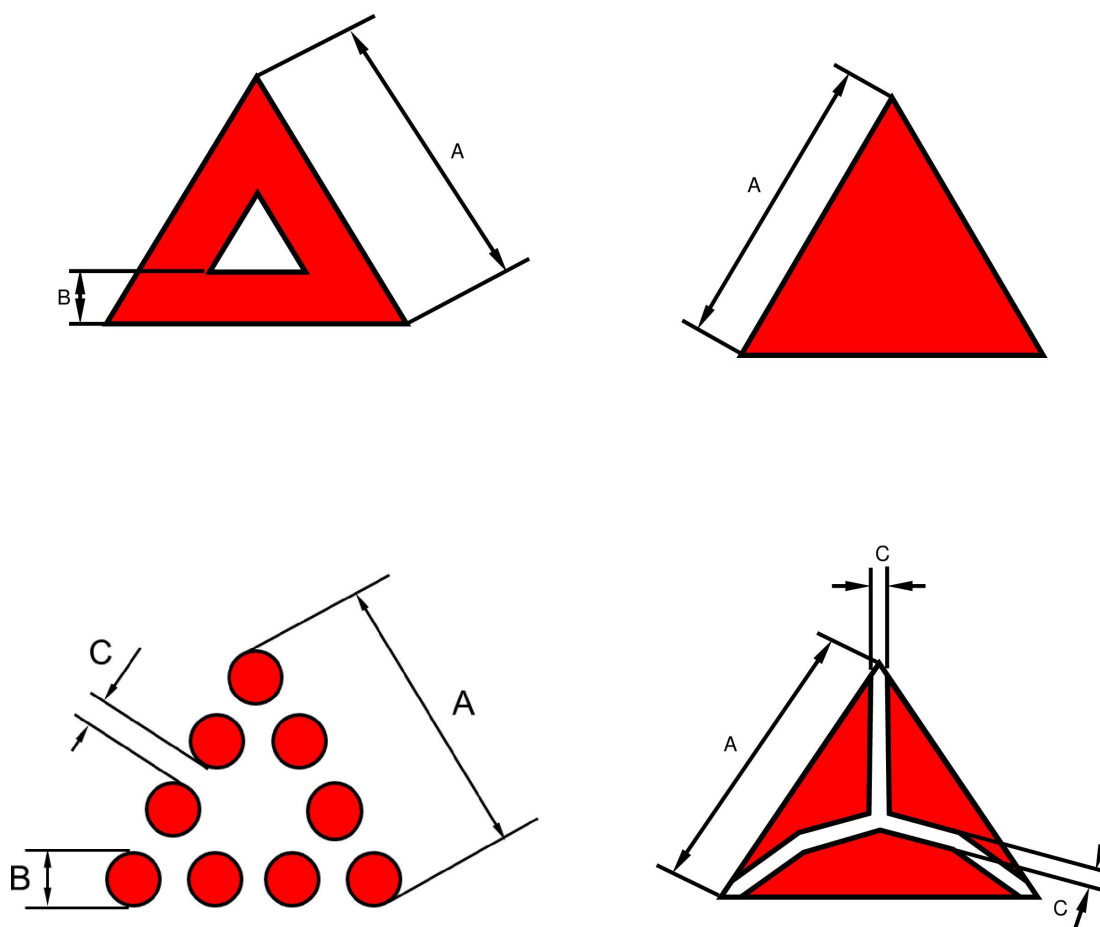
Angles are expressed in degrees and minutes.

ANNEX 5

Specifications of shape and dimensions

1. SHAPE AND DIMENSIONS OF RETRO-REFLECTIVE DEVICES IN CLASS IA OR IB
 - 1.1. The shape of the illuminating surfaces shall not be easily confused with a triangle at normal observation distances.
 - 1.2. The preceding paragraph 1.1. notwithstanding, a shape resembling the letters or digits of simple form O, I, U or 8 is permissible.
2. SHAPE AND DIMENSIONS OF RETRO-REFLECTIVE DEVICES IN CLASSES IIIA AND IIIB (SEE APPENDIX TO THIS ANNEX)
 - 2.1. The illuminating surfaces of retro-reflective devices in Classes IIIA and IIIB must have the shape of an equilateral triangle. If the word "TOP" is inscribed in one corner, the apex of that corner must be directed upwards.
 - 2.2. The illuminating surface may or may not have at its centre a triangular, non-retro-reflecting area, with sides parallel to those of the outer triangle.
 - 2.3. The illuminating surface may or may not be continuous. In any case, the shortest distance between two adjacent retro-reflecting optical units must not exceed 15 mm.
 - 2.4. The illuminating surface of a retro-reflective device shall be considered to be continuous if the edges of the illuminating surfaces of adjacent separate optical units are parallel and if the said optical units are evenly distributed over the whole solid surface of the triangle.
 - 2.5. If the illuminated surface is not continuous, the number of separate retro-reflecting optical units including the corner units shall not be less than four on each side of the triangle.
 - 2.5.1. The separate retro-reflecting optical units shall not be replaceable unless they consist of approved retro-reflective devices in Class IA.
 - 2.6. The outside edges of the illuminating surfaces of triangular retro-reflective devices in Classes IIIA and IIIB shall be between 150 and 200 mm long. In the case of devices of hollow-triangle type, the width of the sides, measured at right angles to the latter, shall be equal to at least 20 per cent of the effective length between the extremities of the illuminating surface.
3. SHAPE AND DIMENSIONS OF RETRO-REFLECTIVE DEVICES IN CLASS IVA
 - 3.1. The shape of the light emitting surfaces shall not be easily confused with a triangle at normal observation distances. However, a shape resembling the letters and digits of simple form, O, I, U and 8 is permissible.
 - 3.2. The light emitting surface of the retro-reflective device must be at least 25 cm².
 - 3.3. Compliance with the above specifications shall be verified by visual inspection.

Figure A5-I

Retro-reflectors for trailers – Classes IIIA and IIIB

$$150 \text{ mm} \leq A \leq 200 \text{ mm}$$

$$B \geq \frac{A}{5}$$

$$C \leq 15 \text{ mm}$$

Note: These sketches are for illustration purposes only.

4. SHAPE AND DIMENSIONS OF RETRO-REFLECTIVE SIDE AND REAR MARKING WITH STRIPS

4.1. General

The markings shall be made of strips of retro-reflective material.

4.2. Dimensions

4.2.1. The width of a side and/or rear marking material shall be 50 mm +10/-0 mm.

4.2.2. The minimum length of an element of a retro-reflective marking material shall be such that at least one approval mark is visible.

5. SIDE, REAR AND/OR FRONT MARKING WITH STRIPS (CLASS F) RETRO-REFLECTIVE MARKINGS PLATES OF THE CLASS 5

5.1. General

The markings shall be made of strips of retro-reflective material.

5.2. Dimensions

5.2.1. Class F and Class 5 retro-reflective materials shall consist of red and white diagonal stripes downwards at $45^\circ \pm 1^\circ$ as shown in Figures A5-II, A5-III and A5-IV respectively. The basic standard area is a square of $141 \text{ mm} \pm 1 \text{ mm}$ in length subdivided diagonally into a white half and red half, which represents one standard area as shown in Figure A5-II.

5.2.2. The minimum length of an element of a retro-reflective marking material shall incorporate a minimum of 9 standard areas as described in paragraph 5.2.1. on large vehicles with available mounting space, but may be reduced to a minimum of 4 standard areas on vehicles with limited mounting space.

Figure A5-II

Retro-reflective material marking of Class F (Standard Element)

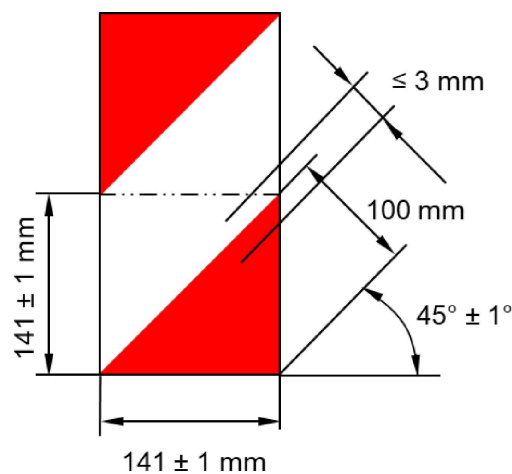


Figure A5-III

Retro-reflective material marking of Class F

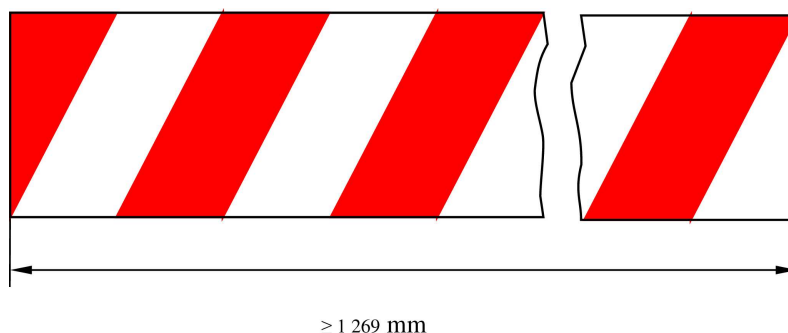
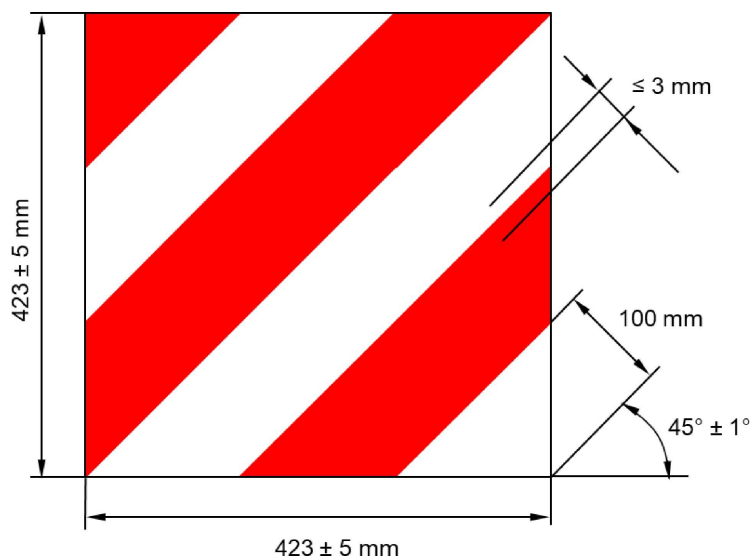


Figure A5-IV

Retro-reflective material marking of Class 5**6. SHAPE AND DIMENSIONS OF RETRO-REFLECTIVE/FLUORESCENT REAR MARKING PLATE(S)****6.1. Shape**

The plates shall be rectangular in shape for mounting at the rear of vehicles.

6.2. Pattern

For mounting on trailers and semi-trailers, the plates shall have a yellow retro-reflective background with a red fluorescent or retro-reflective border;

For mounting on non-articulated vehicles (tractors or trucks), the plates shall be of the chevron type with alternate, oblique stripes of yellow retro-reflective and red fluorescent or retro-reflective materials or devices.

6.3. Dimensions

The minimum total summarized length of a set of rear marking plates consisting only of one, two or four marking plates with retro-reflective and fluorescent materials shall be 1 130 mm, the maximum total length shall be 2 300 mm.

6.3.1. The width of a rear marking plate shall be:

For trucks and tractors: 140 ± 10 mm.

For trailers and semi-trailers: 200^{+30}_{-5} mm.

6.3.2. The length of each rear marking plate in a set consisting of two plates for trucks and tractors, as illustrated in Figures A5-V and A5-VI, may be reduced, to a minimum of 130 mm, provided that the width is increased such that the area of each marking is at least 735 cm², does not exceed 1 725 cm² and the marking plates are rectangular.**6.3.3. The width of the red fluorescent border of the rear marking plates for trailers and semi-trailers shall be $40 \text{ mm} \pm 1 \text{ mm}$.****6.3.4. The slope of the oblique stripes of the chevron band shall be $45^\circ \pm 5^\circ$. The width of the stripes shall be $100 \text{ mm} \pm 2,5 \text{ mm}$.**

Prescribed shapes, patterns and dimensional features are illustrated in Figure A5-V.

6.3.5. Rear marking plates supplied in sets shall form matching pairs.

Figure A5-V

Rear Marking Plates (Class 1 and Class 3)

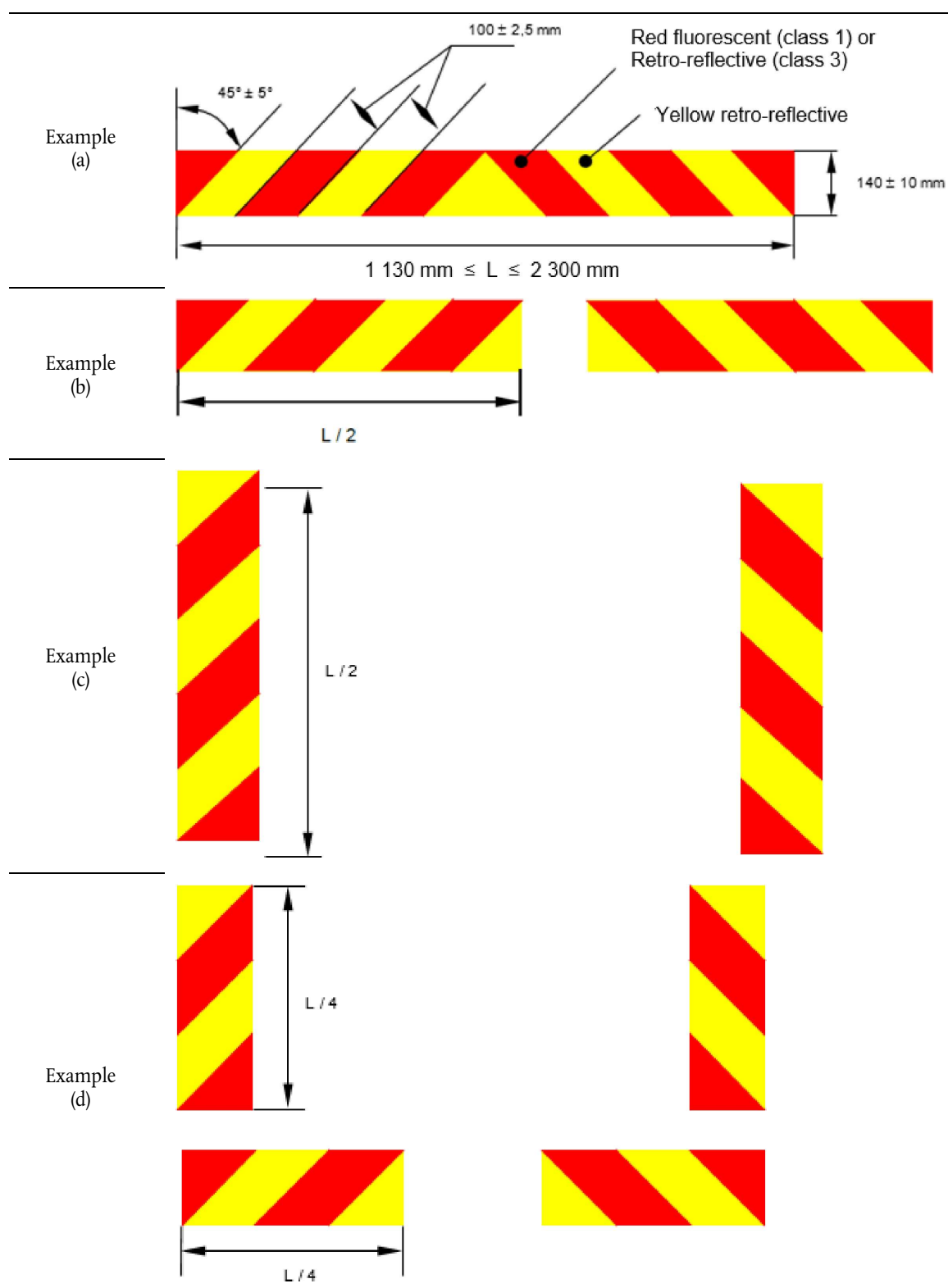
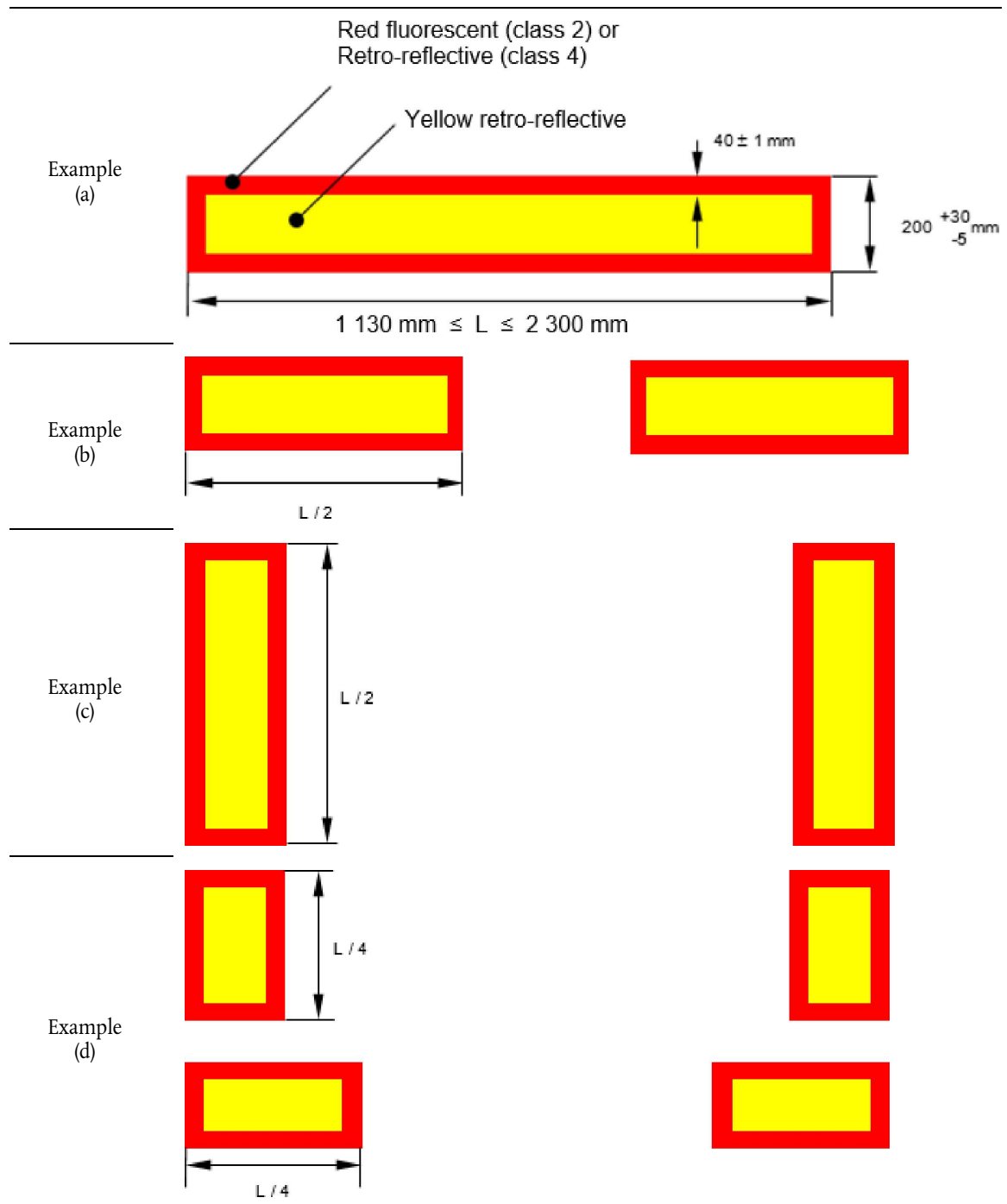


Figure A5-VI

Rear marking Plates (Class 2 and Class 4)

7. SHAPE AND DIMENSIONS OF RETRO-REFLECTIVE/FLUORESCENT (CLASS 1) OR RETRO-REFLECTIVE ONLY (CLASS 2) SMV REAR MARKING PLATES

7.1. Shape

The plates shall be in the shape of an equilateral triangle with truncated corners, for mounting with one apex upwards at the rear of slow-moving vehicles.

7.2. Pattern

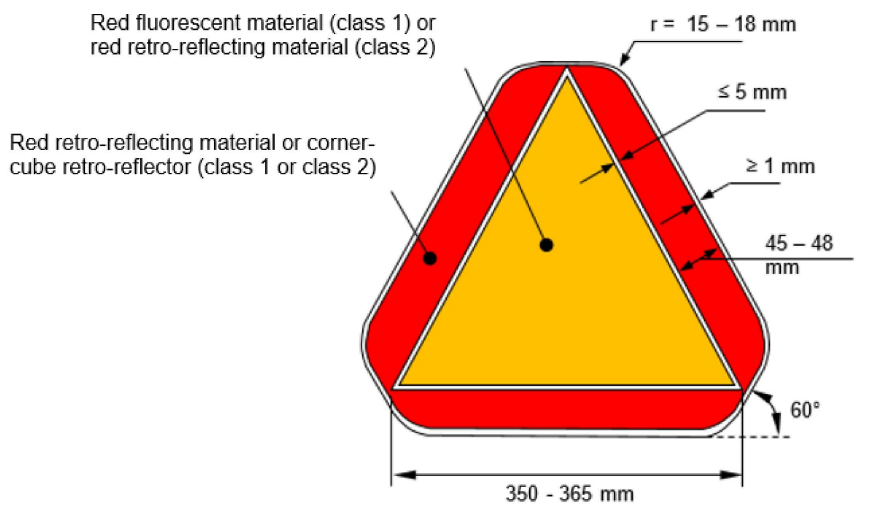
The SMV rear marking plates shall have a red fluorescent centre and red retro-reflective borders made of either retro-reflective sheeting or coating or of plastic corner-cube reflectors (class 1). The SMV rear marking plates of class 2 shall have a retro-reflective centre.

7.3. Dimensions

The length of the base of the enclosed fluorescent triangle (class 1) or retro-reflective triangle (class 2) shall be: minimum 350 mm and maximum 365 mm. The minimum width of the light-emitting surface of the red retro-reflective border shall be 45 mm, the maximum width 48 mm. These features are illustrated in the example of Figure A5-VI.

Figure A5-VII

Example of a slow-moving vehicle plate



8. SHAPE AND DIMENSIONS OF THE ADVANCE WARNING TRIANGLE (FIGURE A5-VIII OR A5-IX)

8.1. Shape and dimensions of the triangle

8.1.1. The theoretical sides of the triangle shall be 500 ± 50 mm long.

8.1.2. In the case of an advance warning triangle of type 1, the retro-reflecting units shall be arranged along the edge within a strip of an unvarying width which shall be between 25 mm and 50 mm. In the case of an advance warning triangle of type 2 with fluorescent retro-reflecting material, the unvarying width shall be between 50 mm and 85 mm.

8.1.3. Between the outer edge of the triangle and the retro-reflecting strip there may be an edging not more than 5 mm wide and not necessarily red-coloured.

8.1.4. The retro-reflecting strip may be continuous or not. In the latter case the free area of the supporting material shall be red (see also paragraph 5.9.4.2.1. of this Regulation).

8.1.5. In the case of an advance warning triangle of type 1, the fluorescent surface shall be continuous to the retro-reflecting units. It shall be arranged symmetrically along the three sides of the triangle. When in use, its surface area shall be not less than 315 cm². However, an edging, continuous or not, not more than 5 mm wide, which need not necessarily be red-coloured, may be placed between the retro-reflecting surface and the fluorescent surface.

8.1.6. The side of the open centre of the triangle shall have a minimum length of 70 mm (Figure A5-VIII).

8.2. Shape and dimensions of the support

8.2.1. The distance between the supporting surface and the lower side of the advance warning triangle shall not exceed 300 mm

8.3. The fluorescent retro-reflecting material shall be coloured in the mass, either in the retro-reflective elements or as solid surface layer.

Figure A5-VIII

Shape and dimensions of the advance warning triangle of type 1 and of the support

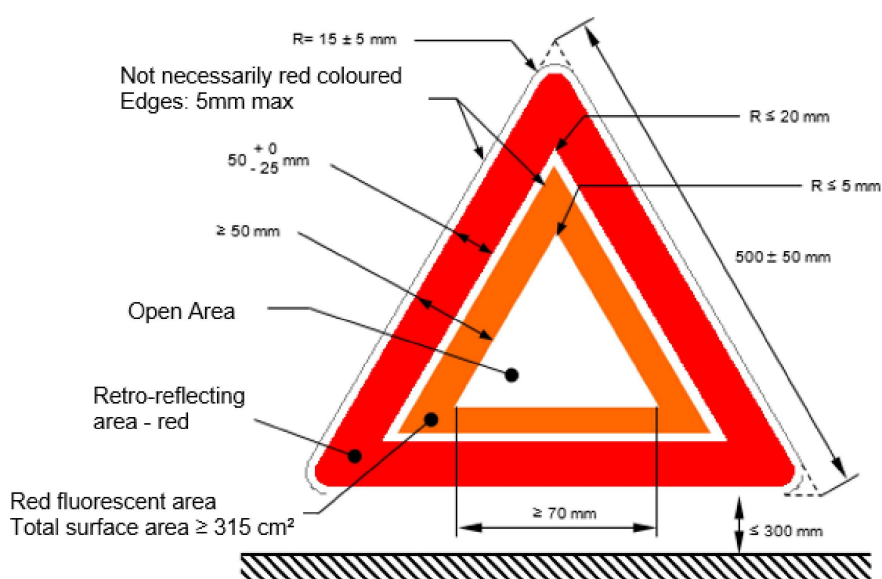


Figure A5-IX

Shape and dimensions of the advance warning triangle of type 2 and of the support

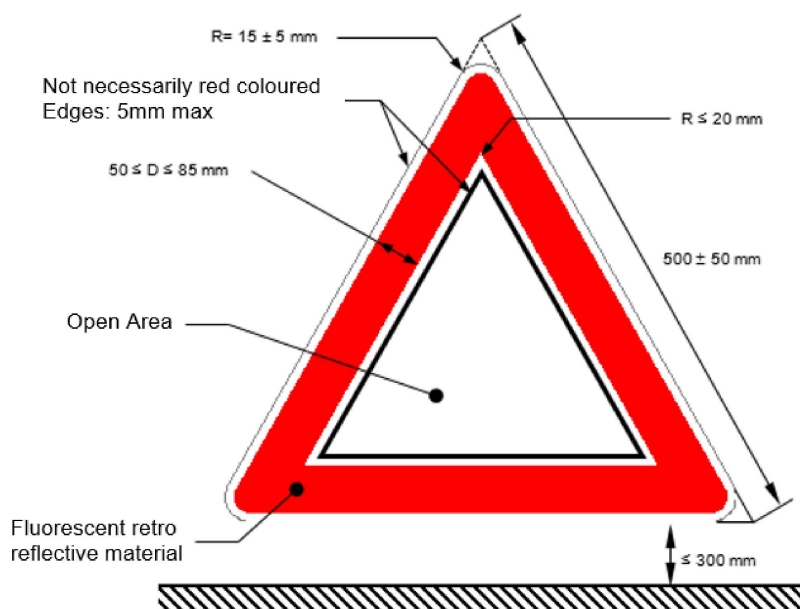
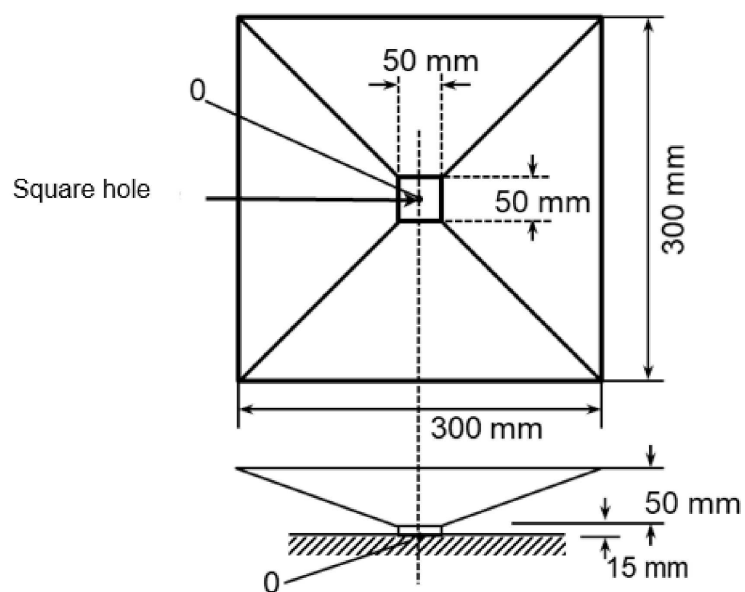


Figure A5-X

Test device for clearance to ground

ANNEX 6

Resistance to heat

1. Test procedure in the case of moulded plastics reflectors of retro-reflecting devices as Classes IA, IB, IIIA, IIIB, IVA, SMV, Marking plates of Classes 1, 2, 3, 4, 5, and Advance warning triangle of type 1:

The retro-reflective device shall be kept for 48 consecutive hours in a dry atmosphere at a temperature of $65\text{ °C} \pm 2\text{ °C}$ after which the sample shall be allowed to cool for 1 hour at $23\text{ °C} \pm 2\text{ °C}$.

2. Test procedure in the case of use of flexible materials for Classes C, F, 1, 2, 3, 4, 5 and Advance warning triangle of type 2:

A section of a sample unit not less than 300 mm long shall be kept for 12 hours in a dry atmosphere at a temperature of $65\text{ °C} \pm 2\text{ °C}$, after which the sample shall be allowed to cool for 1 hour at $23\text{ °C} \pm 2\text{ °C}$. It shall then be kept for 12 hours at a temperature of $-20\text{ °C} \pm 2\text{ °C}$.

The sample shall be examined after a recovery time of 4 hours under normal laboratory conditions.

3. After this test, no cracking or appreciable distortion of the retro-reflective device and, in particular, of its optical component must be visible.

ANNEX 7

Resistance to water penetration for retro-reflective devices, and advance warning triangles and marking plates**1. TEST FOR RETRO REFLECTORS AND RETRO-REFLECTIVE MARKINGS**

- 1.1. Retro-reflective devices whether part of a lamp or not, or a sample unit of retro-reflective marking, shall be stripped of all removable parts and immersed for 10 minutes in water at a temperature of $50\text{ °C} \pm 5\text{ °C}$, the highest point of the upper part of the illuminating surface being 20 mm below the surface of the water. This test shall be repeated after turning the retro-reflective device through 180° , so that the illuminating surface is at the bottom and the rear face is covered by about 20 mm of water. These sample units shall then be immediately immersed in the same conditions in water at a temperature of $25\text{ °C} \pm 5\text{ °C}$.
- 1.2. No water shall penetrate to the reflecting surface of the retro-reflecting optical unit. If visual inspection clearly reveals the presence of water, the device shall not be considered to have passed the test.
- 1.3. If visual inspection does not reveal the presence of water or in case of doubt:
 - 1.3.1. In the case of retro-reflectors, the CIL shall be measured by the method described in paragraphs 5.1.3.2.2. or 5.3.3.3.2., the retro-reflective device being first lightly shaken to remove excess water from the outside.
 - 1.3.2. In the case of a sample unit of retro-reflective marking the coefficient of retro-reflection R' shall be measured in conformity with Annex 7, the sample unit being first lightly shaken to remove excess water from the outside.

2. TEST FOR ADVANCE WARNING TRIANGLES

- 2.1. Test of resistance of the retro-reflective device or fluorescent retro-reflecting material
 - 2.1.1. The triangle - collapsible triangles are to be assembled as for use - shall be immersed for 10 minutes in water having a temperature of $50\text{ °C} \pm 5\text{ °C}$, with the highest point of the upper part of the illuminating surface being about 20 mm below the water surface. Immediately afterwards, this retro-reflective device shall be immersed under the same conditions in water having a temperature of $25\text{ °C} \pm 5\text{ °C}$.
 - 2.1.2. After this test, no water shall have penetrated to the reflecting surface of the retro-reflective device. If a visual inspection clearly reveals the presence of water, the device has not passed the test. Water or water vapour penetration into the edges of fluorescent retro-reflecting materials shall not be deemed to indicate failure.
 - 2.1.3. If the visual inspection does not reveal the presence of water, or in case of doubt the value of the CIL shall again be measured under the same conditions as specified in paragraph 1.2. of Annex 7, after the retro-reflective device has been gently shaken to remove excess water from the outside. The CIL shall not have diminished by more than 40 per cent of the values recorded before the test.

2.2. Water test

The triangle - collapsible advance warning triangles are to be assembled as for use - shall be immersed flat for two hours on the bottom of a tank containing water at $25\text{ °C} \pm 5\text{ °C}$, with the active face of the triangle showing upwards and being 5 cm under the surface of the water. The triangle shall then be removed and dried. No part of the device may exhibit clear signs of deterioration which might impair the effectiveness of the triangle.

3. TEST FOR MARKING PLATES

3.1. Resistance to water

A section of a sample unit not less than 300 mm long shall be immersed in distilled water at a temperature of $23 \pm 5^{\circ}\text{C}$ for a period of 18 hours; it shall then be left to dry for 24 hours under normal laboratory conditions.

After completion of the test, the section shall be examined. No part inside 10 mm from the cut edge shall show evidence of deterioration which would reduce the effectiveness of the plate.

ANNEX 8

Alternative test procedures of resistance to water penetration for retro-reflective devices of the Classes IB and IIIB

1. As an alternative, at the request of the manufacturer, the following tests (moisture and dust test) shall be applied.

2. Moisture test

The test evaluates the ability of the sample device to resist moisture penetration from a water spray and determines the drainage capability of those devices with drain holes or other exposed openings in the device.

- 2.1. Water spray test equipment

A water spray cabinet with the following characteristics shall be used:

- 2.1.1. Cabinet

The cabinet shall be equipped with a nozzle(s) which provides a solid cone water spray of sufficient angle to completely cover the sample device. The centreline of the nozzle(s) shall be directed downward at an angle of $45^\circ \pm 5^\circ$ to the vertical axis of a rotating test platform.

- 2.1.2. Rotating test platform

The rotating test platform shall have a minimum diameter of 140 mm and rotate about a vertical axis in the centre of the cabinet.

- 2.1.3. Precipitation rate

The precipitation rate of the water spray at the device shall be 2,5 (+1,6/-0) mm/min as measured with a vertical cylindrical collector centred on the vertical axis of the rotating test platform. The height of the collector shall be 100 mm and the inside diameter shall be a minimum of 140 mm.

- 2.2. Water spray test procedure

A sample device mounted on a test fixture, with initial CIL measured and recorded shall be subjected to a water spray as follows:

- 2.2.1. Device openings

All drain holes and other openings shall remain open. Drain wicks, when used, shall be tested in the device.

- 2.2.2. Rotational speed

The device shall be rotated about its vertical axis at a rate of $4,0 \pm 0,5 \text{ min}^{-1}$.

- 2.2.3. If the retro-reflector is reciprocally incorporated or grouped with signalling or lighting functions, these functions shall be operated at design voltage according to a cycle of 5 min ON (in flashing mode, where appropriate), 55 min OFF.

- 2.2.4. Test duration

The water spray test shall last 12 hours (12 cycles of 5/55 min).

- 2.2.5. Drain period

The rotation and the water spray shall be turned OFF and the device allowed to drain for 1 hour with the cabinet door closed.

2.2.6. Sample evaluation

Upon completion of the drain period. The interior of the device shall be observed for moisture accumulation. No standing pool of water shall be allowed to be formed, or which can be formed by tapping or tilting the device. The CIL shall be measured according to the method specified in Annex 4 after having dried the exterior of the device with a dry cotton cloth.

2.3. Dust exposure test

This test evaluates the ability of the sample device to resist dust penetration which could significantly affect the photometric output of the retro-reflector.

2.3.1. Dust exposure test equipment

The following equipment shall be used to test for dust exposure:

2.3.2. Dust exposure test chamber

The interior of the test chamber shall be cubical in shape in size 0,9 to 1,5 m per side. The bottom may be "hopper shaped" to aid in collecting the dust. The internal chamber volume, not including a "hopper shaped" bottom shall be 2 m³ maximum and shall be charged with 3 to 5 kg of the test dust. The chamber shall have the capability of agitating the test dust by means of compressed air or blower fans in such a way that the dust is diffused throughout the chamber.

2.3.3. The dust

The test dust used shall be fine powdered cement in accordance with standard ASTM C 150-84. (*)

2.3.4. Dust exposure test procedure

A sample device, mounted on a test fixture, with the initial CIL measured and recorded, shall be exposed to dust as follows:

2.3.5. Device openings

All drain holes and other openings shall remain open. Drain wicks, when used, shall be tested in the device.

2.3.6. Dust exposure

The mounted device shall be placed in the dust chamber no closer than 150 mm from a wall. Devices with a length exceeding 600 mm shall be horizontally centred in the test chamber. The test dust shall be agitated as completely as possible by compressed air or blower(s) at intervals of 15 min for a period of 2 to 15 s for the duration of 5 hours. The dust shall be allowed to settle between the agitation periods.

2.3.7. Measured sample evaluation

Upon completion of the dust exposure test, the exterior of the device shall be cleaned and dried with a dry cotton cloth and the CIL measured according to the method specified in paragraph 5.1.3.2.2.

(*) American Society for Testing and Materials

ANNEX 9

Resistance to fuels

1. A test mixture of 70 vol. per cent of n-heptane and 30 vol. per cent of toluol shall be applied for either:
 - 1.1. A retro-reflective device;
 - (a) The outer surface of the retro-reflective device and, in particular, of the illuminating surface, shall be lightly wiped with a cotton cloth soaked in the test mixture.
 - (b) After about five minutes, the surface shall be inspected visually. It must not show any apparent surface changes, except that slight surface cracks will not be objected to.
 - or;
 - 1.2. A sample unit of retro-reflective marking;
 - (a) A section of a sample unit not less than 300 mm long shall be immersed in the test mixture for one minute.
 - (b) After removal, the surface shall be wiped dry with a soft cloth and shall not show any visible change which would reduce its effective performance.
 2. Test for advance warning triangles:
 - 2.1. The triangle and its protective cover shall be immersed separately in a tank containing a mixture of 70 per cent n-heptane and 30 per cent toluene.
 - (a) After 60 seconds they shall be removed from the tank and drained of excess liquid.
 - (b) The triangle shall then be placed in its cover and the unit shall be laid flat in a still atmosphere.
 - (c) When completely dried, the triangle shall not adhere to its protective cover, and there shall be no visually noticeable change on its surface and shall not present apparent detrimental modifications; however, slight surface cracks may be tolerated.
-

ANNEX 10

Resistance to lubricating oils

1. Test procedure in the case of moulded plastics reflectors as Classes IA, IB, IIIA, IIIB, IVA and advance warning triangle of type 1
 - 1.1. The outer surface of the retro-reflective device and, in particular, the illuminating surface, shall be lightly wiped with a cotton cloth soaked in a detergent lubricating oil. After about 5 minutes, the surface shall be cleaned. The CIL shall then be measured (paragraphs 5.1.3.2.2. or 5.3.3.3.2.).
-

ANNEX 11

Resistance to corrosion (ISO Standard 3768)

1. Retro-reflective devices must be so designed that they retain the prescribed photometric and colorimetric characteristics despite the humidity and corrosive influences to which they are normally exposed. The resistance of the front surface to tarnishing and of the protection of the rear face to deterioration shall be checked, particularly when an essential metal component seems liable to be attacked.
 2. The retro-reflective device, or the lamp if the device is combined with a light, shall be stripped of all removable parts and subjected to the action of a saline mist for a period of 50 hours, comprising two periods of exposure of 24 hours each, separated by an interval of two hours during which the sample is allowed to dry.
 3. The saline mist shall be produced by atomizing, at a temperature of $35\text{ °C} \pm 2\text{ °C}$, a saline solution obtained:
 - 3.1. In the case of moulded plastics reflectors as Classes IA, IB, IIIA, IIIB, IVA and advance warning triangle of type 1
by dissolving 20 ± 2 parts by weight of sodium chloride in 80 parts of distilled water containing not more than 0,02 per cent of impurities.
 - 3.1.1. Immediately after completion of the test, the sample must not show signs of excessive corrosion liable to impair the efficiency of the device.
 - 3.2. In the case of a sample unit of retro-reflective marking,
By dissolving 5 parts by weight of sodium chloride in 95 parts of distilled water containing not more than 0,02 per cent of impurities.
 - 3.2.1. Immediately after completion of the test, the sample shall show no sign of corrosion liable to impair the efficiency of the marking.
 4. The coefficient of retro-reflection R' of the retro-reflective areas, when measured after a recovery period of 48 hours as specified in Annex 7, at an entrance angle of $\beta_2 = 5^\circ$ and an observation angle of $\alpha = 20'$, shall be not less than the value in Table 9 or more than the value in Table 10 respectively. Before measuring, the surface shall be cleaned to remove salt deposits from the saline mist.
-

ANNEX 12

Resistance of the accessible rear face of mirror-backed retro-reflective devices

1. Resistance of the accessible rear face of mirror-backed retro-reflective devices, in the case of moulded plastics reflectors as Classes IA, IB, IIIA, IIIB, IVA and Advance warning triangle of type 1.
 2. The reverse side of the retro-reflective device shall be brushed with a hard nylon brush.
 3. After having brushed in the case of moulded plastics reflectors as Classes IA, IB, IIIA, IIIB and IVA the rear face of the retro-reflective device, a cotton cloth soaked in the mixture, defined in Annex 9 shall be applied to the said rear face for one minute. The cotton cloth is then removed and the retro-reflective device left to dry.
 4. After having brushed, in the case of moulded plastics reflectors of Advance warning triangle of type 1, the reverse side of the retro-reflective device shall then be covered or thoroughly wetted for one minute with a mixture defined in Annex 9. The fuel shall then be removed and the device allowed to dry.
 5. As soon as evaporation is completed, the reverse side shall be brushed with the same brush as before.
 6. The CIL shall then be measured (paragraphs 5.1.3.2.2 or 5.3.3.3.2) after the whole surface of the mirror-backed rear face has been covered with Indian ink.
 7. In the case of the retro-reflector of an Advance warning triangle of type 1, the CIL shall not have diminished by more than 40 per cent of the values recorded before the test. This test is not applicable for fluorescent retro-reflecting material.
-

ANNEX 13

Resistance to weathering

1. Resistance to weathering in the case of sample units of retro-reflective marking devices
 - 1.1. Procedure - For each test, two specimens of a sample unit are taken. One specimen shall be stored in a dark and dry container for subsequent use as "reference unexposed specimen".
 - 1.2. The second specimen shall be subjected to a source of illumination with a temperature and irradiation test described in Annex 22, if required in the relevant paragraph 5. of this Regulation:
 - (a) The retro-reflector or retro-reflective material shall be exposed until blue standard No. 7 has faded to No. 4 on the grey scale.
 - (b) The fluorescent material or fluorescent / retro-reflective material shall be exposed until blue standard No. 5 has faded to No. 4 on the grey scale.
 - 1.3. After the test, the specimen shall be washed in a dilute neutral detergent solution, dried and examined for conformity with the requirements specified in paragraphs 1.4. and 1.5.
 - 1.4. Visual appearance

No area of the exposed specimen shall show any evidence of cracking, scaling, splitting, blistering, delamination, distortion, chalking, staining or corrosion.

The sample shall not exhibit any visible damage such as cracks, scaling or peeling of the fluorescent or of the fluorescent retro-reflecting material.
 - 1.5. Colour fastness

The colours of the exposed specimen shall still meet the requirements specified in the paragraph 5. of this Regulation. for the corresponding retro-reflective device.
 - 1.6. Effect on the coefficient of retro-reflection of the retro-reflective material:
 - 1.6.1. For this check, measurements shall be made only at an observation angle of $\alpha = 20^\circ$ and an entrance angle of $\beta_2 = 5^\circ$ by the method given in Annex 7.
 - 1.6.2. The coefficient of retro-reflection of the exposed specimen when dry shall be not less than 80 per cent of the value in paragraph 5. of this Regulation.
2. Resistance to weathering in the case of advance warning triangles
 - 2.1. Test of the weather-resistance of the luminance factor and of the colour of the fluorescent (advance warning triangle of type 1) and fluorescent retro-reflecting (advance warning triangle of type 2) materials.
 - 2.2. One of the samples of the fluorescent material submitted according to paragraph 3.1. of this Regulation shall be subjected to a temperature and irradiation test as described in Annex 22 until the contrast No. 4 of the grey scale has been reached for the reference sample No. 5 or the light exposure equivalents for blue wool light fastness references sample No. 5 to fade to the grey scale 4 for exposure by a Xenon-arc lamp has been reached.
 - 2.3. For a retro-reflective device with the fluorescent material, after this test, the colour co-ordinates and the luminance factor (see paragraph 3.) shall comply with the specification in the paragraph 5. of this Regulation.

The luminance factor shall comply with paragraph 5. of this Regulation and shall not have increased by more than 5 per cent compared with the value ascertained according to paragraph 5. of this Regulation.

- 2.4. If the fluorescent material is an adhesive film which had already successfully passed the above-mentioned tests in a previous approval test, the test need not be repeated; a corresponding note shall be entered under item 12 ("Remarks") in the communication concerning approval (Annex 1).
3. Resistance to weathering in the case of retro-reflective marking plates
- 3.1. Procedure - For each test, two specimens of a sample unit (see paragraph 2.4.17.4. of UN Regulation No. 48) are taken. One specimen shall be stored in a dark and dry container for subsequent use as "reference unexposed specimen".
- The second specimen shall be subjected to a source of illumination in accordance with ISO Standard 105 - B02 - 1978, Section 4.3.1; the retro-reflective material shall be exposed until blue standard No. 7 has faded to No. 4 on the grey scale and the fluorescent material until blue standard No. 5 has faded to No. 4 on the grey scale. After the test, the specimen shall be washed in a dilute neutral detergent solution, dried and examined for conformity with the requirements specified in paragraphs 3.2. to 3.4.
- 3.2. Visual appearance - No area of the exposed specimen shall show any evidence of cracking, scaling, pitting, blistering, delamination, distortion, chalking, staining or corrosion.
- There shall be no shrinkage in excess of 0.5 per cent in any linear direction and no evidence of adhesion failure such as edge lifting from the substrate.
- 3.3. Colour fastness - The colours of the exposed specimen shall still meet the requirements specified in paragraph 5.7.5.
- 3.4. Effect on the coefficient of retro-reflection of the retro-reflective material:
- 3.4.1. For this check, measurement shall be made only at an observation angle of 20° and an entrance angle of 5 degrees by the method given in paragraph 5.7.4.
- 3.4.2. The coefficient of retro-reflection of the exposed specimen when dry shall be not less than 80 per cent of the value in paragraph 5.7.4, Table 12.
- 3.4.3. The specimen shall then be subjected to simulated rainfall as described in paragraph 7.7. of EN 13422(2004) (Vertical road signs. Portable deformable warning devices and delineators. Portable road traffic signs. Cones and cylinders) and its coefficient of retroreflection under this condition shall be not less than 90 per cent of the value obtained when measured in dry condition, as explained in paragraph 3.4.2.
- It is possible to use nozzles other than those described in paragraph 7.7. of EN 13422(2004) provided that the same performance (e.g. water distribution on the surface of the test sample) of the simulated rainfall is achieved.
-

ANNEX 14

Stability of photometric properties

1. The approval granting authority has the right to test the optical properties stability of a retro-reflecting material in use (when used for marking or as distinctive markings/graphics).
 2. The Type Approval Authorities of Contracting Parties, in which the approval was granted, may undertake the same tests. If "systematic failures in use" occur for a type of retro-reflective material, the tested material samples shall be transferred for appraisal to the authority which granted approval.
 3. If other criteria are missing, the notation "systematic failures in use" for a type of retro-reflective material is to be established according to paragraph 4.1.
 4. The authority which granted approval shall have the right to check the stability in time of the optical properties of a type of rear marking plate in service.
 5. The Type Approval Authorities of countries other than the country in which approval was granted may carry out similar checks in their territory. If a type of rear marking plate in use exhibits a systematic defect, the said authorities shall transmit to the authority which granted approval, with a request for its opinion, any components removed for examination.
 6. In the absence of other criteria, the concept of "systematic defect" of a type of rear marking plate in use shall be interpreted in conformity with the intention of paragraph 4.1.
-

ANNEX 15

Resistance to cleaning in the case of a sample unit of retro-reflective marking devices

1. MANUAL CLEANING

A test sample smeared with a mixture of detergent lubricating oil and graphite shall be easily cleaned without damage to the retro-reflective surface when wiped with a mild aliphatic solvent such as n-heptane, followed by washing with a neutral detergent.

2. POWER WASHING

When subjected to a continuous spraying action for 60 seconds on the test component in its normal mounting conditions, a test sample shall show no damage to the retro-reflective surface or delamination from the substrate or separation from the sample mounting surface under the following set-up parameters:

- (a) Water/wash solution pressure $8 \pm 0,2$ MPa;
 - (b) Water/wash solution temperature $60^{\circ} - 5^{\circ}\text{C}$;
 - (c) Water/wash solution flow rate 7 ± 1 l/min;
 - (d) The tip of the cleaning wand to be positioned at distance of 600 ± 20 mm away from the retro-reflective surface;
 - (e) Cleaning wand to be held at no greater angle than 45 degrees from perpendicular to the retro-reflective surface;
 - (f) 40-degree nozzle creating wide fan pattern.
-

ANNEX 16

Bonding strength

1. Bonding strength (in the case of adhesive materials) for retro-reflecting markings
 - 1.1. The adhesion of retro-reflective materials shall be determined after 24 hours curing time by utilising a 90-degree peel on a tensile strength testing machine.
 - 1.2. The retro-reflective materials shall not be easily removable without damaging the material.
 - 1.3. The retro-reflective materials shall need a force of at least 10 N per 25 mm width at a constant speed of 300 mm per minute to be removed from their substrate.
 2. Bonding strength (in the case of adhesive materials) for retro-reflective material for rear marking plates
 - 2.1. The adhesion of retro-reflective materials shall be determined after 24 hours curing time by utilizing a 90-degree peel on a tensile strength testing machine.
 - 2.2. The adhesion of laminated or coated retro-reflective and fluorescent materials shall be determined.
 - 2.3. The coated materials, of whatever kind, shall not be removable without tools or without damaging the material.
 - 2.4. The laminated materials (adhesive films) shall need a force of at least 10 N per 25 mm width, at a speed of 300 mm per minute, to be removed from the substrate.
-

ANNEX 17

Flexing - Retro-reflecting Markings

1. For samples that are to be adhered to a flexible substrate, i.e. tarpaulin, the following shall apply:
2. A specimen of the sample unit that measures 50 mm by 300 mm shall be bent once lengthwise, around a 3,2 mm mandrel with adhesive contacting the mandrel for a period of 1 second.
3. The test temperature shall be $23\text{ °C} \pm 2\text{ °C}$.

Note: For ease of testing, spread talcum powder on the adhesive to prevent sticking to the mandrel.

4. After this test, the specimen shall not have cracking of the surface and shall not show any visible change that would reduce its effective performance.
-

ANNEX 18

Resistance to impact

1. REAR MARKING PLATES (EXCEPT FOR PLASTICS CORNER-CUBE REFLECTORS)

When a 25 mm diameter solid steel ball is dropped from a height of 2 m onto the retro-reflective and fluorescent surfaces of a supported plate, at an ambient temperature of $23 \pm 2^{\circ}\text{C}$, the material shall show no cracking or separation from the substrate at a distance of more than 5 mm from the impacted area.

2. RETRO-REFLECTIVE DEVICES OF THE CLASS IVA

The retro-reflective device shall be mounted in a manner similar to the way in which it is mounted on the vehicle, but with the lens faced horizontal and directed upwards.

Drop a 13 mm diameter polished solid steel ball, once, vertically onto the central part of the lens from a height of 0,76 m. The ball may be guided but not restricted in free fall.

When a retro-reflective device is tested at room temperature with this method, the lens shall not crack.

ANNEX 19

Rigidity of plates

1. CLASSES 1, 2, 3, 4 AND 5
 - 1.1. The rear marking plate shall be placed on two supports in such a way that the supports are parallel to the shorter edge of the plate and the distance from either support to the adjacent edge of the plate shall not exceed $L/10$, where L is the greater overall dimension of the plate. The plate shall then be loaded with bags of shot or of dry sand to a uniformly distributed pressure of $1,5 \text{ kN/m}^2$. The deflection of the plate shall be measured at a point midway between the supports.
 - 1.2. When tested as described in paragraph 1. above, the maximum deflection of the plate under the test load shall not exceed one twentieth of the distance between the supports in paragraph 1. and the residual deflection after removal of the load shall not exceed one fifth of the measured deflection under load.
 2. CLASS SMV
 - 2.1. The triangular plate shall be strongly held on one of its long sides, with the clamps of the holding device not encroaching over more than 20 mm. A force of 10N perpendicular to the plane shall be applied to the opposite apex.
 - 2.2. The apex shall then not move in the direction of the force by more than 40 mm.
 - 2.3. After removal of the force, the plate shall visibly return to its initial position. The residual deflection shall not be more than 5 mm.
-

ANNEX 20

Further test procedures for Advance Warning Triangles of Type 1 and 2**1. TEST OF CLEARANCE TO GROUND**

1.1. The advance warning triangle shall be required to pass the following tests:

1.1.1. For this test, the apparatus shown in Figure A5-X, which has the form of an inverted hollow pyramid, shall be placed on a horizontal base plane.

1.1.2. The individual supports to the ground shall be placed one after another in the square hole □□ of the test apparatus. During the test of each support, it shall be required to find a position of the test apparatus in relation to the advance warning triangle and its supporting device, which is favourable for the triangle and which ensures that:

1.1.2.1. All supports are resting simultaneously on the base plane,

1.1.2.2. Outside the area covered by the test apparatus, the distance between the base plane and parts of the triangle as well as of the supporting device is at least 50 mm (with the exception of the supports proper).

2. MECHANICAL SOLIDITY TEST

2.1. When the advance warning triangle has been set up as required by the manufacturer and its bases are firmly held, a force of 2 N shall be applied to the apex of the triangle parallel to the supporting surface and normal to the lower side of the triangle.

2.2. The apex of the triangle shall not move more than 5 cm in the direction in which the force is exerted.

2.3. After the test, the position of the device shall not be significantly different from its original position.

3. TEST OF HEAT AND LOW-TEMPERATURE RESISTANCE

3.1. The advance warning triangle, in its protective cover, if provided, shall be kept for 12 consecutive hours in a dry atmosphere at a temperature of $60\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

3.2. After the test, no cracking or noticeable distortion of the device shall be visible; this applies in particular to the retro-reflective device. The cover shall be readily openable and shall not adhere to the triangle.

3.3. After the heat-resistance test and subsequent storage for 12 consecutive hours at a temperature of $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, the advance warning triangle, in its protective cover, is to be kept for another 12 hours in a dry atmosphere at a temperature of $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$.

3.4. Immediately after removal from the cold room, no fractures or any visible distortion shall be noticeable on the device and especially on its optical parts. The protective cover, if provided, shall be properly openable, and it shall neither tear nor adhere to the advance warning triangle.

4. DETERMINATION OF THE ROUGHNESS OF THE ROAD SURFACE "SANDY BEACH" METHOD**4.1. Purpose of the method**

4.1.1. The purpose of this method is to describe and to determine to a certain extent the geometric roughness of that part of the road surface on which the advance warning triangle is placed during the test of stability in wind, as required according to Annex 5, paragraph 10.

4.2. Principle of the method

- 4.2.1. A known volume V of sand is spread evenly on the surface of the carriageway in the form of a circle. The ratio of the volume used to the area S covered is defined as "mean sand depth" HS and is expressed in mm:

$$HS = \frac{V}{S}$$

- 4.2.2. The test is carried out by means of round-grain, dry sand and having a grain size between 0,160 mm and 0,315 mm. The volume amounts to 25 ml $\pm$ 0,15 ml. The sand is spread out over the surface where the test is carried out by means of a flat, circular disc with a diameter of 65 mm, one side of which is covered with a sheet of rubber having a thickness of 1,5 mm to 2,5 mm and the other being provided with an appropriate handle. If the diameter of the circular area covered with sand is D mm, the mean sand depth will be calculated in accordance with the formula:

$$HS = \frac{4}{\pi} \cdot \frac{25}{D^2} \cdot 10^3 \text{ mm}$$

4.3. Performance of the test

- 4.3.1. The surface on which the test is to be carried out shall be dry and at first be brushed with a soft brush to remove any dirt or loose gravel.
- 4.3.2. The sand which has been firmly filled into an appropriate receptacle is then poured out on the surface to be tested in a single heap. The sand is then carefully spread out on the surface by means of repeated circular movements of the rubber faced disc so as to form the largest possible round area covered with sand. The sand will then fill all depressions and hollows.
- 4.3.3. Two diameters, at right angles to one another, of the "beach" thus formed are usually measured. The mean value is rounded off to the nearest 5 mm, with the depth of the sand HS being calculated according to the formula given in paragraph 4.2.2.
- 4.3.4. Six tests of this kind are carried out on the supporting surface, with the parts to be tested being distributed over the surface to be tested as evenly as possible. The overall mean of the results obtained is given as the mean sand depth HS of the road surface where the advance warning triangle has been placed.

5. TEST OF STABILITY AGAINST WIND

- 5.1. The advance warning triangle shall be set up in a wind tunnel, on a base measuring about 1,50 m by 1,20 m with a surface formed of abrasive material of the type P36 corresponding to the FEPA ** specification 43-1-2006. This surface shall be characterised by its geometric roughness, $HS = 0,5 \text{ mm} \pm 0,05 \text{ mm}$, which shall be defined and determined by the so-called "sandy beach" method according to Annex 4 of this Regulation.

To avoid a laminar boundary layer of the incident flow over the surface of the base, this base shall have a splitter plate and shall be set up in such a way, that the flow is completely around the plate.

- 5.2. For the air flow the following conditions shall apply:

- (a) The air stream shall reach a dynamic pressure of 180 Pa; and shall have a flow field which shall be homogeneous and free of turbulence;
- (b) The dimension of the flow field shall be such, that horizontally to each corner and vertical to the top of the advance warning triangle a clearance of at least 150 mm to the border line of this flow field shall exist;

** FEPA: Federation of European Producers of Abrasives, 20 Avenue Reille, 75014 Paris, France.

- (c) The air stream (flow field) shall be parallel to the supporting surface, in a direction which seems to be most unfavourable for the stability;
- (d) In the case of a closed wind tunnel, the area of the advance warning triangle shall be not larger than 5 per cent of the area cross-section of the closed wind tunnel.

- 5.3. When set up in this manner, the advance warning triangle shall be subjected for 3 minutes to this open-air stream.
 - 5.4. The advance warning triangle shall neither overturn nor shift. Slight shifting of the points of contact with the road surface by not more than 5 cm, however, shall be allowed.
 - 5.5. The retro-reflecting triangular part of the device shall not rotate through more than 10° round a horizontal axis or a vertical axis from its initial position. The rotation around the horizontal axis or the vertical axis shall be determined by the aid of a virtual plane at the initial position of the retro-reflecting triangular part of the device, which is orthogonal to the base and orthogonal to the air stream.
-

ANNEX 21

Colour-fastness ⁽¹⁾ of retro-reflective devices of the Classes IA, IB, IIIA, IIIB and IVA

1. The Type Approval Authority which granted approval shall have the right to check the colour-fastness of a type of retro-reflective device in service.
2. The Type Approval Authorities of countries other than the country in which approval was granted may carry out similar checks in their territory. If a type of retro-reflector in use exhibits a systematic defect, the said authorities shall transmit any components removed for examination to the Type Approval Authority which granted approval, with a request for its opinion.
3. In the absence of other criteria, the concept "systematic defect" of a type of retro-reflector in use shall be interpreted in conformity with the intention of paragraph 3.6.1. of this Regulation.

⁽¹⁾ Despite the importance of tests to check the colour-fastness of retro-reflective devices, it is in the present state of the art not yet possible to assess colour-fastness by laboratory tests of limited duration.

ANNEX 22

Colour fastness to artificial light - Xenon-arc lamp test for advance warning triangles

1. SCOPE

This annex specifies a method intended for determining the resistance of the colour of test samples of all kinds and in all forms to the action of an artificial light source representative of natural daylight (D65).

2. PRINCIPLE

A specimen of the test samples to be tested is exposed to artificial light under prescribed conditions, along with a blue wool reference as specified.

3. REFERENCE MATERIALS

The colour fastness ratings mentioned in this annex are obtained by comparison with specified blue wool references, subject to exposure for the purpose of verifying the maximum radiation allowed as the maximum contrast prescribed in this UN Regulation.

- 3.1. Blue wool references developed and produced in Europe are identified by the numerical designation 1 to 8. These references are blue wool cloths dyed with the dyes listed in Table A22-1. For the test procedure of this Regulation described by this annex only the blue wool references 5 and 7 will be applied as described in Table A22-1.

Table A22-1

Dyes for blue wool references 5 and 7

Reference	Dye (Colour Index designation) ⁽¹⁾
5	CI Acid Blue 47
7	CI Solubilised Vat Blue 5

⁽¹⁾ The Colour Index (third edition) is published by The Society of Dyers and Colourists, P.O. Box 244, Perkin House, 82 Grattan Road, Bradford BD1 2JB, UK, and by The American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709-2215, USA.

4. GREY SCALE

The grey scale for determining changes in colour of test samples in colour fastness tests. A precise colorimetric specification of the scale is given in Appendix 1 to this annex.

- 4.1. The use of the scale is described in paragraph 2. of Appendix 1 to this annex.

5. XENON-ARC LAMP APPARATUS

The apparatus shall be either an air-cooled or water-cooled Xenon-arc lamp capable of exposing samples in accordance with EN ISO 4892-2.

- 5.1. The exposure conditions shall comply with the requirements in the Table A22-2.

Table A22-2

Artificial weathering test parameters

Exposure parameters	Air-cooled lamp	Water-cooled lamp
Light/dark/water spray cycle	Continuous light without water spray	Continuous light without water spray

Black standard temperature during light only periods	(47 ± 3) °C using a black standard thermometer	(47 ± 3) °C using a black standard thermometer
Relative humidity	Approximately 40 %	Approximately 40 %
Filters	Window glass filters requirements see paragraph 5.2.	Window glass filters requirements see paragraph 5.2.
Irradiance (W/m ²) controlled at:		
Over 300nm to 400nm range	42±2	42±2
Over 300nm to 800nm range	550	630

Note 1: Water used for the specimen spray should contain no more than 1 ppm silica. Higher levels of silica can produce spotting on samples and variability in results. Water of the required purity can be obtained by distillation or by a combination of deionization and reverse osmosis.

Note 2: While irradiance levels should be set at the above levels, variations in filter ages and transmissivity, and in calibration variations, will generally mean that irradiance error will be in the order of ± 10 per cent.

5.2. Light source

The light source shall consist of a xenon arc lamp of correlated colour temperature 5 500 K to 6 500 K, the size of which will depend on the type of apparatus used. The xenon-arc lamp shall use filters that provide a reasonable simulation of solar radiation filtered by typical window glass. Table 3 gives the relative spectral irradiance requirements for the filtered xenon-arc. It is the responsibility of the supplier of the exposure device to provide necessary certification that the filters that they supply for use in the exposure tests described in this standard meets the requirements of Table A22-3.

Table A22-3

Relative spectral irradiance requirements for window glass filters a, b, c, d, e used for the Xenon-arc devices used in this standard.

Spectral Bandpass Wavelength λ in nm	Minimum % ^c	CIE No.85, Table 4 plus window glass % ^{d, e}	Maximum % ^c
$\lambda < 300$			0.29
$300 \leq \lambda \leq 320$	0,1	≤ 1	2,8
$320 < \lambda \leq 360$	23,8	33,1	35,5
$360 < \lambda \leq 400$	62,4	66,0	76,2

^a Data in Table A22-3 is the irradiance in the given bandpass expressed as a percentage of the total irradiance from 290 nm to 400 nm. To determine whether a specific filter or set of filters for a xenon-arc meets the requirements of Table A22-3, the spectral irradiance from 250 nm to 400 nm must be measured. The total irradiance in each wavelength bandpass is then summed and divided by the total irradiance from 290 nm to 400 nm.

^b The minimum and maximum data in Table A22-3 are based on more than 30 spectral irradiance measurements for water and air-cooled xenon-arcs with window glass filters of various lots and ages. Spectral irradiance data is for filters and xenon-burners within the ageing recommendations of the device manufacturer. As more spectral irradiance data become available, minor changes in the limits are possible. The minimum and maximum data are at least the three sigma limits from the mean for all measurements.

- ^c The minimum and maximum columns will not necessarily sum to 100 per cent because they represent the minimum and maximum for the data used. For any individual spectral irradiance, the calculated percentage for the bandpasses in Table A22-3 will sum to 100 per cent. For any individual xenon-arc lamp with window glass filters, the calculated percentage in each bandpass must fall within the minimum and maximum limits of Table A22-2. Test results can be expected to differ between exposures using xenon-arc devices in which the spectral irradiance differ by as much as that allowed by the tolerances. Contact the manufacturer of the xenon-arc devices for specific spectral irradiance data for the xenon-arc and filters used.
- ^d The data from Table 4 in CIE No. 85 plus window glass was determined by multiplying the CIE No. 85, Table 4 data by the spectral transmittance of 3 mm thick window glass (see ISO 11341). These data are target values for xenon-arc with window glass filters.
- ^e For the CIE 85 Table 4 plus window glass, the UV irradiance from 300 nm to 400 nm is typically about 9 per cent and the visible irradiance (400 nm to 800 nm) is typically about 91 per cent when expressed as a percentage of the total irradiance from 300 nm to 800 nm. The percentages of UV and visible irradiances on samples exposed in xenon arc devices may vary due to the number and reflectance properties of specimens being exposed.

5.3. Light exposure equivalents for blue wool light fastness references for exposure by a Xenon-arc lamp

Table A22-4

Blue wool reference

Blue wool reference		420 nm	300 nm–400 nm
No.		kJ/m^2	kJ/m^2
5	L6	340	13 824
7	L8	1 360	55 296

For colour change of step 4 on the grey scale

6. PROCEDURE (BLUE WOOL REFERENCES)

- 6.1. Place the test samples mounted on the holders in the apparatus and expose them continuously to weathering following the method described below.
 - 6.2. At the same time expose the blue wool references mounted on card-board, cover one-third of each.
 - 6.3. Only one side of the test samples shall be exposed to weathering and light.
 - 6.4. While the specimens are drying, the air in the test chamber shall not be moistened.
- Note:* The actual conditions of the weathering test depend on the kind of test apparatus used.
- 6.5. Before mounting the tested specimens for assessment, dry them in air at a temperature not exceeding 60°C.
 - 6.6. Trim and mount the exposed blue wool reference so that they measure at least 15 mm x 30 mm, one on each side of a portion of the original which has been trimmed to the same size and shape as the specimens.
 - 6.7. Unexposed samples of original fabric identical to those being tested are required as references for comparison with the specimens during weathering.

ANNEX 22 - Appendix 1

Definition of the Grey Scale

This section describes the grey scale for determining changes in colour of test samples in colour fastness tests, and its use. A precise colorimetric specification of the scale is given as a permanent record against which newly prepared working standards and standards that may have changed can be compared.

1. The essential, or 5-step, scale consists of five pairs of non-glossy grey colour chips (or swatches of grey cloth), which illustrate the perceived colour differences corresponding to fastness ratings 5, 4, 3, 2 and 1. This essential scale may be augmented by the provision of similar chips or swatches illustrating the perceived colour differences corresponding to the half-step fastness ratings 4-5, 3-4, 2-3 and 1-2, such scales being termed 9-step scales. The first member of each pair is neutral grey in colour and the second member of the pair illustrating fastness rating 5 is identical with the first member. The second members of the remaining pairs are increasingly lighter in colour so that each pair illustrates increasing contrasts or perceived colour differences which are defined colorimetrically. The full colorimetric specification is given below:
 - 1.1. The chips or swatches shall be neutral grey in colour and shall be measured with a spectrophotometer with the specular component included. The colorimetric data shall be calculated using CIE standard colorimetric system for Illuminant D65;
 - 1.2. The Y tristimulus value of the first member of each pair shall be 12 ± 1 ;
 - 1.3. The second member of each pair shall be such that the colour difference between it and the adjacent first member is as follows.

Table A22-5

CIE-Lab difference in relation to the Fastness grade

Fastness grade	CIE-Lab difference	Tolerance
5	0	0,2
(4-5)	0,8	$\pm 0,2$
4	1,7	$\pm 0,3$
(3-4)	2,5	$\pm 0,35$
3	3,4	$\pm 0,4$
(2-3)	4,8	$\pm 0,5$
2	6,8	$\pm 0,6$
(1-2)	9,6	$\pm 0,7$
1	13,6	$\pm 1,0$

Note 1: Bracketed values apply only to the 9-step scale.

Note 2: Use of the scale:

Place a piece of the original blue reference and the exposed specimen of it side by side in the same plane and oriented in the same direction. Place the grey scale nearby in the same plane. The surrounding field should be neutral grey colour approximately midway between that illustrating grade 1 and that illustrating grade 2 of the grey scale for assessing change in colour (this is approximately Munsell N5). Illuminate the surfaces with north sky light in the Northern hemisphere, south sky light in the Southern hemisphere, or an equivalent source with an illumination of 600 lx or more. The light should be incident upon the surfaces at approximately 45°, and the direction of viewing approximately perpendicular to the plane of the surfaces. Compare the visual difference between original and exposed blue standard with the differences represented by the grey scale.

If the 5-step scale is used, the fastness rating of the specimen is that number of the grey scale which has a perceived colour difference equal in magnitude to the perceived colour difference between the original and the treated specimens; if the latter is judged to be nearer the imaginary contrast lying midway between two adjacent pairs than it is to either, the specimen is given an intermediate assessment, for example 4-5 or 2-3. A rating of 5 is given only when there is no perceived difference between the tested specimen and the original material.

If the 9-step scale is used, the fastness rating of the specimen is that number of the grey scale which has a perceived colour difference nearest in magnitude to the perceived colour difference between the original and the tested specimens. A rating of 5 is given only when there is no perceived difference between the tested specimen and the original material.

ANNEX 23

Description of the measurement geometry for measurement of the colour and the luminance factor of fluorescent retro-reflective materials

Micro-prismatic materials show the phenomenon of "flares" or "sparkles" (Note 1), which might influence the measured results unless special precautions are taken. A reference method, using the wider apertures of the CIE 45°a:0° (or 0°:45°a) geometry is introduced in paragraph 12. of Annex 5.

Ideally, the measurements shall be made using the CIE 45°a:0° (or 0°:45°a), called the forty-five annular / normal geometry (or the normal/ forty-five annular geometry) defined in CIE 15. The measurement area shall be minimum 4,0 cm².

For this geometry CIE 15 recommends that:

- (a) The sampling aperture be irradiated uniformly from all directions between two circular cones with their axes normal to the sampling aperture and apices at the centre of the sampling aperture, the smaller of the cones having a half angle of 40° and the larger of 50°.
- (b) The receiver uniformly collects and evaluates all radiation reflected within a cone with its axis on the normal to the sampling aperture, apex at the centre of the sampling aperture, and a half angle of 5°.

The annular geometry can be approximated by the use of a number of light sources in a ring or a number of fibre bundles illuminated by a single source and terminated in a ring to obtain the CIE 45°c:0° (circumferential / normal geometry) (Note 2, Note 3).

An alternative manner of approximation is to use a single light source, but rotate the sample during measurement with a rotational speed that ensures that a number of revolutions takes place during the exposure time interval for a measurement so that all wavelengths are given equal weight (Note 2, Note 3).

In addition, the apertures of the light source and the receiver shall have sufficient dimensions in proportion to distances to ensure a reasonable compliance with the above-mentioned recommendations.

Note 1: "Flares" or "sparkles" are caused by characteristic paths of rays that enter and leave the sheeting surface at different angles. A characteristic path will dominate by raising the luminance factor value significantly and possibly distorting the chromaticity co-ordinates if it is included within narrow beams of illumination and measurement. However, the average contribution to the daylight reflection is normally small.

Note 2: In practice the recommendations can be approximated only. The important issue is that the annular principle is applied and that illumination and collection occur in directions forming fairly large solid angles, as this will reduce the influence of the above-mentioned "sparkles" of micro-prismatic materials and of other variations with the precise geometry shown by some of these materials.

Note 3: In spite of such precautions, the practical difficulties of establishing the annular geometry in accordance with the recommendations introduce uncertainty of measurement.

ANNEX 24

Examples of approval marks

Figure A 24-I

Marking examples for single devices

Note: The above approval number must be placed close to, but in any position in relation to, the circle surrounding the letter "E". The digits constituting the approval number must face the same way as the "E". The group of symbols indicating the class must be diametrically opposite the approval number. The Type Approval Authorities shall avoid using approval numbers IA, IB, IIIA, IIIB and IVA which might be confused with the class symbols IA, IB, IIIA, IIIB and IVA.

These sketches show various possible arrangements and are given as examples only.

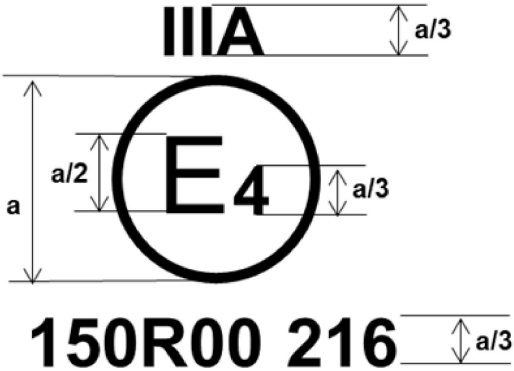
	Model A: This approval mark affixed to a retro-reflective device shows that the type of device concerned has been approved in the Netherlands (E 4) under approval number 150R00-216. The approval number shows that approval was granted in accordance with the requirements of this Regulation as modified by the original series of amendments. For a = see Table 1
	Model B: Same device as Model A, different arrangement.
	Model C: Same device as Model A, different arrangement.

Figure A24-II

Simplified marking examples for grouped, combined or reciprocally incorporated devices

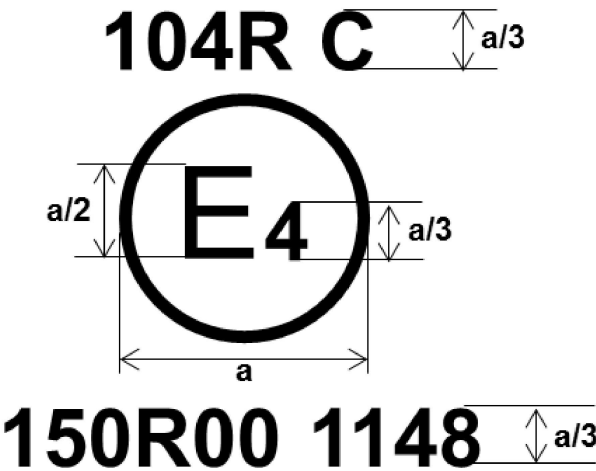
Note: The two examples of approval marks, models D and E, represent three possible variants of the marking of a lighting device when two or more lamps are part of the same unit of grouped, combined or reciprocally incorporated lamps.

	3333 E4 148R00 150R00	IA	2b	R2	Model D:
		F2	AR	S2	

IA 2b R2 F2 AR S2 3333 E4 148R00 150R00				Model E:

Figure A24-III

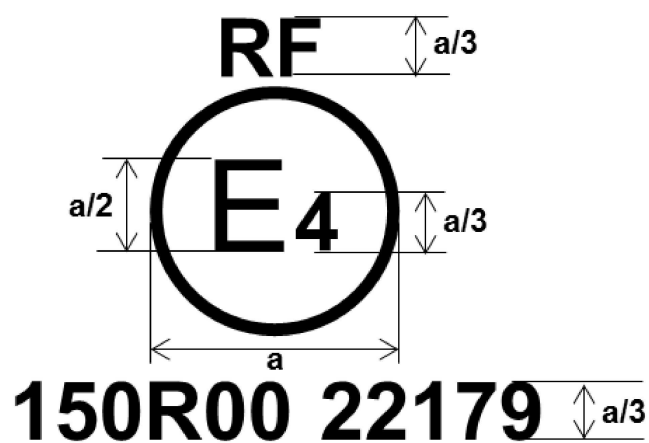
Arrangement example of the approval mark for retro-reflective marking material



For a = see Table 1

Figure A24-IV

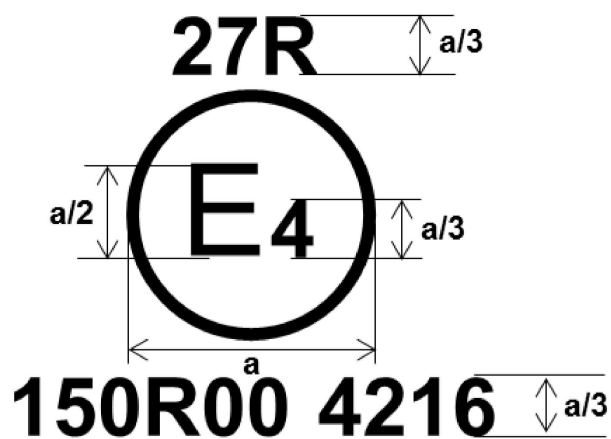
Arrangement example of the approval mark for rear marking plates and SMV



For a = see Table 1

Figure A24-V

Arrangement example of the approval mark for advance warning triangle



For a = see Table 1

ANNEX 25

Guidelines for installation of rear marking plates on slow-moving vehicles (by construction) and their trailers

1. It is recommended to the Governments to require on slow-moving vehicles which, by construction, cannot travel faster than 30 km/h, "Rear marking plates for slow-moving vehicles and their trailers" conforming to this Regulation and the specific requirements relating to its scope in accordance with the guidelines given in this annex.

2. Scope

The main purpose of these guidelines is to establish requirements for installation, arrangement, position and geometric visibility of rear marking plates on slow-moving vehicles and their trailers which, by construction, cannot travel faster than 30 km/h. It increases the visibility and permits an easy identification of these vehicles.

3. Number

At least one.

4. Arrangement

The rear marking plate(s) shall be type approved and meet the requirements of this Regulation.

The apex of a rear marking plate shall be directed upwards.

Every part of a rear marking plate shall lie within 5° of a transverse vertical plane at right angles to the longitudinal axis of the vehicle and shall face to the rear.

5. Position

In width: If there is only one rear marking plate, it must be on the opposite side of the median longitudinal plane of the vehicle to the direction of traffic prescribed in the country of registration.

In height: Above the ground, not less than 250 mm (lower edge), not more than 1 500 mm (upper edge).

In length: At the rear of the vehicle.

6. Geometric visibility

Horizontal angle: 30° inwards and outwards, covering by indispensable constructional parts of the vehicle up to 10 per cent of the rear marking plate surface is permitted;

Vertical angle: 15° above and below the horizontal;

Orientation: rearwards.

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