

Distr.
GENERAL

TRANS/WP.29/GRE/2002/19
13 February 2002

ENGLISH ONLY

ECONOMIC COMMISSION FOR EUROPE

INLAND TRANSPORT COMMITTEE

World Forum for Harmonization of Vehicle Regulations (WP.29)

Working Party on Lighting and Light-Signalling (GRE)
(Forty-eighth session, 9-12 April 2002,
agenda item 4.2.)

EXPLANATORY NOTES TO THE PROPOSAL FOR A NEW DRAFT REGULATION:

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF
ADAPTIVE FRONTLIGHTING SYSTEMS (AFS)
FOR MOTOR VEHICLES

Transmitted by the Expert from the Working Party "Brussels 1952" (GTB)

Note: The text reproduced below was prepared by the expert from GTB, and it provides explanatory notes to the proposal for a new draft Regulation, as contained in document TRANS/WP.29/GRE/2002/18. The proposal is a result of the cooperation of GTB and AFS experts and is transmitted to GRE for consideration, following the agreement reached at the forty-fourth session of GRE (TRANS/WP.29/GRE/44, paras. 67 and 68).

Note: This document is distributed to the Experts on Lighting and Light-Signalling only.

GE.02-20608

1. INTRODUCTION

At the forty-third session of GRE the expert from GTB presented the Adaptive Front-lighting Systems (AFS) project (TRANS/WP.29/GRE/43, paras. 104-106).

At the forty-fourth session of GRE a demonstration was given in the premises of the Palais des Nations of a number of configurations of AFS installed on ten passenger cars (TRANS/WP.29/GRE/44, paras. 67 and 68). At that time it was noted that:

- the introduction of AFS would require action regarding the existing and new ECE Regulations;
- work was in progress to prepare draft amendments to Regulation No.48 and a new draft Regulation;
- the proposals would first be transmitted for consideration to GTB and later to GRE.

In the meantime the proposals have been discussed in a series of special GTB sessions with AFS experts; they were approved by GTB at its ninety-second session.

The proposal for a new draft Regulation is set out in document TRANS/WP.29/GRE/2002/18. The present document contains the background information and explanatory notes, and document TRANS/WP.29/GRE/2002/20 contains the proposal for draft amendments to Regulation No. 48, necessary for the introduction of adaptive front-lighting systems into the ECE type approval system.

2. BACKGROUND AND TECHNICAL DEVELOPMENT

In the beginning of the 1990s motor vehicle lighting experts recognized that further progress of vehicle front lighting was possible by using recent technical innovation design in two different areas:

- New materials, advanced electronics, sensor and actuator technologies as well as new light sources and computer-aided tools allow for the design of new sophisticated optical units for headlamps which can provide light distributions for special ranges of applications and variable beams for motor vehicle front lighting;
- Vehicles are equipped with many on-board sources of continuous technical information which can provide the inputs for the control of variable front lighting systems, allowing them to adapt automatically to ambient and road conditions.

In 1993 a number of motor vehicle, component and light source manufacturers initiated a research project to develop front lighting systems which can emit automatically differentiated beams being adapted to particular ambient and road conditions, providing both:

- enhanced driver's vision, and
- improved visual comfort and safety for other road users.

This project was incorporated into the framework of European Community research programmes as EUREKA 1403 and today involves 9 vehicle manufacturers, 9 lighting device manufacturers and 3 light source manufacturers. The EUREKA 1403 Working Programme defined three project phases:

1) Feasibility study

This included tests which explored the possibilities for special front lighting as a function of outside conditions, such as vehicle speed, road type and geometry, weather and ambient light for motorways, bending roads, wet roads and roads in built-up areas. Driver's demands and preferences for lighting improvements were investigated by studies in three European countries.

2) Verification by field tests and studies

This phase was dedicated to the development of photometric specifications and their verification in field tests and resulted in further improvements for the specification of headlamp systems and control parameters. Scientific research studies were launched to answer questions related to particular items, such as appearance, time-dependent effects and visibility and glare.

3) Presentation, information and drafting

For demonstration purposes, several passenger cars equipped with adaptive head-lighting systems of different configuration were used. Three such demonstrations have been arranged in order to inform government and administration experts on the state of AFS development and to provide them with an opportunity for personal driving experience:

- In May 1999 on the Balocco proving ground where the vehicles could be driven on various test tracks under different ambient and road conditions;
- In September 1999 in Darmstadt during the PAL Symposium;
- In April 2000 during the forty-fourth session of GRE on the premises of the Palais des Nations at Geneva.

Subsequent work was concentrated on the preparation of documents, covering the regulatory aspect and it took place in a special AFS Task Group on Regulations (TG-R). The text of the draft Regulation on AFS was prepared in this group and then discussed in three special GTB sessions with AFS experts. The final document resulting from this discussion has been approved at the ninety-second GTB session.

3. PRINCIPAL FEATURES OF THE DRAFT REGULATION

The text of draft Regulation No.112 (formerly draft Regulation No. "00" TRANS/WP.29/773) served as a basis for the AFS draft Regulation; elements from Regulations Nos. 87, 98 and 99 have been included. The main features of the draft, as related to these existing provisions, are discussed in more detail below.

In view of the structure of ECE Regulations on lighting and light-signalling, requirements regarding the installation of AFS and its interaction with the vehicle have been incorporated into a separate proposal for amendments to Regulation No. 48. Cross-references have been included where necessary.

The principal characteristics of AFS as described in the draft Regulation can be summarized as follows.

- The AFS is a front lighting device.
- The AFS consists of three main elements: the "lighting units" on the right and left side of the vehicle, the "system control", and the "supply and operating devices", if any. One or more lighting units are contained in an "installation unit".
- The AFS can emit more than one "mode" of a passing beam and/or a driving beam, each of them being designed for a certain range of vehicle and ambient conditions; this includes "bending modes".

As concerns the passing beam, four classes are identified by particular photometric provisions and can be emitted alternatively:

- the mandatory class C (basic) passing beam which can be generally used, with its different (optional) modes including bending mode(s),
- the class V (town/low speed) passing beam with its different (optional) modes including bending mode(s),
- the class E (motorway) passing beam with its different (optional) modes including bending mode(s),
- the class W (wet road) passing beam, with its different (optional) modes including bending mode(s).

In addition the following front lighting functions may be provided by the system: a driving beam, with its different (optional) modes including bending mode(s), and a daytime running light.

- Activation of any lighting mode(s) must be fully automatic, the control being effected by signals from the vehicle which are generated by vehicle-based parameters. The respective criteria have -in the draft amendments to Regulation No. 48- been stated in general terms in order to allow for use of advanced means of information as well as for signals which are simply to be provided such as vehicle speed, steering angle or windshield wiper action.
- Within strictly defined limits -being part of the draft amendment to Regulation No. 48, the number, dimensions, shape, and produced light intensities of the lighting units may be asymmetric with respect to the longitudinal median plane of the vehicle.
- In order to cover those cases where a failure may result in excess glare for oncoming traffic or insufficient road illumination for the driver, suitable safety provisions have been inserted; wherever possible, these cases are identified by photometric (design) specifications as threshold values for fail-safe and/or warning requirements. Corresponding provisions have also been included in the draft amendments to Regulation No. 48.
- In the AFS type approval procedure certain lighting units are identified for which levelling and cleaning requirements according to the draft amendments to Regulation No. 48 apply.

4. REMARKS TO INDIVIDUAL ITEMS / SECTIONS

DEFINITIONS: Definitions for the elements and functional states of the AFS have been introduced; those given in paragraphs 1.15. - 1.18. have been inserted in order to provide clear instructions for the practice of type approval.

As in other Regulations on individual lighting and light-signalling devices, there is a general reference to the definitions given in Regulation No. 48 which also include the definition of the AFS itself. For the purpose of the present Regulation, the "adaptive front-lighting system (AFS)" is designated as "system".

APPROVAL: The "concise technical description" of the system has been considerably extended including a number of new forms for the indication of all AFS functions and modes including their automatic control information and adjustment devices and procedures (Annexes 1 and 11).

Approval markings have been defined allowing for identification of the functionality of the system to a certain degree. They shall be located on each installation unit of the system according to the examples in Annex 2.

PHOTOMETRIC REQUIREMENTS: In order to allow for the desired spectrum of light pattern elements needed for the composition of the situation adapted front lighting and since the total number of lighting units on each side of a vehicle's front is naturally limited, some individual specialization of the lighting units was considered to be necessary: lighting units on the right and left side of the vehicle may be designed to perform to a certain degree different lighting tasks and, for special situations, they may be activated independently.

For total road illumination it is not decisive whether the light is provided symmetrically from the right and left side. For the visual impression registered by oncoming traffic the distinct intensity distribution of a passing beam below its cut-off is not considered to be a key contributor.

Photometric requirements are therefore specified for the complete system. However, for oncoming traffic the recognition as a 4-wheeled vehicle must be guaranteed. To this end minimum photometric values are in addition required for the respective angular elements (points or segments) above the cut-off of the passing beam light distribution, on each side.

PROVISIONS CONCERNING PASSING BEAM: The class C (basic/general use) passing beam specification combines requirements of Regulations No. 112 and 98 with some items as discussed for the "harmonized" passing beam proposal (TRANS/WP.29/GRE/1999/18). The photometric data are listed in Annex 3.

Visual aiming (and later adjustment on the vehicle) with the aid of the cut-off is regulated and described in detail in Annex 9. For any other mode(s) the light distribution is determined by construction, or, in case of a separate installation unit e.g., by additional procedures to be indicated in detail according to the requirements.

Measurements are then carried out in the neutral state and in any other mode specified, e.g. bending mode(s), speed dependent modes, or any others.

Class E (expressway/motorway) passing beam: this set of requirements allows for a light distribution being slightly elevated and with an increased maximum illumination allowing for larger visual range; the specifications in BR and BRR guarantee that rear-view mirror glare is avoided. The conditions of motorways as defined in the 1968 (Vienna) Convention -especially the larger lateral distance between separated traffic directions- justify the slightly enhanced glare limitations which are necessary to achieve the above improvements.

Class V (city/town/low speed) passing beam: this set of requirements allows for a light distribution with reduced illumination and requires a reduced asymmetric sector. Economic and comfortable lighting for typical in-town use of vehicles at limited speed is thus possible without compromising vision.

Class W (wet road) passing beam: these requirements allow for a light distribution which can supply more light for improved vision distance. Strictly limited illumination directly in front of the vehicle avoids the typical glare caused by wet road surface reflections. The driver's vision improvement exceeds by far the effect of the reduced foreground illumination which can still be strong enough. As a result this beam can offer clear benefits to both, the driver and oncoming traffic. Separate sets of requirements are provided for two grades of this beam, one allowing for modes optimized to lightly wet roads and the second one for modes covering the situation of the very wet roads.

Bending modes: The lighting for all classes of passing beams may - totally or in part- be laterally moved or increased. Two categories are distinguished. A category 1 bending mode includes a horizontal movement of the cut-off. In this case the maximum lateral movement as a function of curve radius is limited in the respective paragraph of the draft amendments to Regulation No. 48 (compare TRANS/WP.29/GRE/2001/15/Rev.1). As regards category 2 bending mode, the cut-off is not moved; the requirements are somewhat less stringent in this case concerning the fail-safe conditions and respective limitations. For both categories the restrictions regarding the lateral location of the maximum in the beam are largely eliminated and a minimum photometric requirement at 20° up to 45° relative to the vehicle's axis applies.

DRIVING BEAM PROVISIONS: The photometric requirements from existing regulations were combined with the less restrictive provisions regarding number and symmetry of light-emitting surfaces as introduced for passing beams. Variable light distribution is permitted for the whole beam e.g. wide/ narrow/ bending, as a function of vehicle speed or road configuration.

DAYTIME RUNNING LIGHT PROVISIONS: The luminous intensity maximum values from Regulation No. 87 and from the provisions concerning passing beam were combined. This allows for use of AFS passing beam parts for daytime running light purposes if the other relevant requirements corresponding to Regulation No. 87, such as geometry and minimum values, are observed.

OTHER PROVISIONS: The requirements of present headlamp Regulations regarding adjustable reflectors have been applied to adjustable lighting units. All special measurement provisions have been consolidated in Annex 10.

ITEMS OF PARAGRAPHS 7. to 13.: Provisions regarding colour, gauging of discomfort, and further administrative items correspond to those in the other headlamp Regulations.

COMMUNICATION (Annex 1): Specific items have been added to this annex: information on light source modules containing light sources not approved according to Regulation No. 39 or 99, and, information on fail safe provisions and conformity to the relevant (photometric) requirements by means of the system itself.

This annex was furthermore extended by a form for the respective information according to the additional possibilities allowed for in the regulation draft: the modes and classes of passing beam(s) and the lighting functions provided.

EXAMPLES OF ARRANGEMENTS OF APPROVAL MARKS (Annex 2): In addition to conventional items of marking, the indications regarding the front lighting functions, their modes and classes of passing beam are shown in several examples.

PASSING BEAM PHOTOMETRIC REQUIREMENTS (Annex 3): The detailed requirements are set out in Tables 1-4. Figure 1 is based on a road width of 7 m and 11 m respectively; the angular range of the graph is in no case to be understood as a limitation.

TESTS FOR STABILITY OF PHOTOMETRIC PERFORMANCE (Annex 4): Provisions have been inserted from existing headlamp Regulations and have been adapted to AFS terminology. Configurations such as different, exclusively operated passing beam classes, provided from the lighting units contained in one installation unit, have been taken into account.

CONFORMITY OF PRODUCTION (Annex 5): This was corrected for terminology. In principle instead of a headlamp the complete AFS system has to be regarded.

LENSES OF PLASTIC MATERIAL (Annex 6): Apart from corrections for terminology, the requirements regarding resistance to light source radiation were inserted from Regulation No. 98 in a more general form.

SAMPLING BY AN INSPECTOR (Annex 7): This was corrected for terminology.

REQUIREMENTS FOR SYSTEMS INCORPORATING LIGHT SOURCE MODULES WITH LIGHT SOURCES NOT BEING APPROVED ACCORDING TO REGULATION No. 37 OR 99 (Annex 8):

Light source modules have been introduced using the definitions of TRANS/WP.29/GRE/2001/30. Part A refers to light source modules with gas-discharge light sources; requirements from Regulation No. 99 have been taken for the technical specifications. Colour and luminous flux requirements are covered by the requirements for the lighting device. Part B refers to light source modules with other light sources.

PASSING BEAM CUT-OFF AND AIMING (Annex 9): These provisions reproduce essentially the proposal presently being discussed for final approval in GTB; some simplifications and adaptations have been introduced.

PHOTOMETRIC MEASUREMENTS (Annex 10): For the indication of the spatial positions of photometric requirements an angular grid was chosen; it allows good description also in case of laterally very extended or variable beams. The respective information is always available in common goniometers. The use of a goniometer or respective means is prescribed.

As pointed out above, the photometric requirements apply, with a few exemptions, for the whole head-lighting system. The respective measurement procedure is based on numerical addition of the measured values of all lighting units.

The photometric requirements are specified in principle on the basis of tests with reference luminous flux (which normally corresponds to operation at approximately 12V, e.g.); however, where a lighting unit incorporates a non-replaceable light source and/or a power controlled supply and operating device the tests have to be carried out with full specified vehicle voltage (e.g. 13.5 V) and the results of the photometric measurement are then converted to the specified (i.e. 12 V) level by multiplying them with the factor of 0.7.

The preference for the indication of photometric requirements was luminous intensity. However, in order to provide easily comparable information, the requirements concerning main and passing beam have -in the first place- been indicated as radial illuminance at 25 metres.

The re-aiming procedure in case of vertically adjustable optics has been applied accordingly for lighting units providing a category 1 bending mode of a passing beam. The kink of the cut-off of the beam serves as re-aiming indicator (compare TRANS/WP.29/GRE/2001/15/Rev.1.).

DESCRIPTION FORMS (Annex 11): As part of the type approval documentation two forms have been developed for the system description as the supplementary specification of the lighting function(s) and their modes, provided by the AFS. In the first form the vehicle's signals designed to control the head-lighting system's automatic operation have to be listed and described with respect to its purpose and technical nature. The second form serves for the indication of the cut-off type(s), the adjustment devices and how to use them.
