

Performance Based Regulations in the Context with Visual Performance

A General Review

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Abstract—It is the wish of the European Commission together with Japan to redraft the ECE – Regulations in a performance based concept/1/. For the Regulations on lighting and light signaling means that “New approach for lighting Regulations” in the first line a reduction of the number of 41 lighting Regulations to an set of around six to eleven documents handling the requirements for lighting and light signaling devices and their installation. The key word is “performance based”, which try to say : “No construction rules!”.

The Author try to identify the basic rules of a performance based description of lighting and light signalling regarding the needs of visual performance. The fundamental findings will be discussed in conjunction with the existing Regulations to review the differences, challenges and needs for the “New approach for lighting Regulations”.

. (*Abstract*)

Visual performance, lighting, light signalling, performance based concept, ECE - Regulations (key words)

In principal it is relatively easy to describe a performance based lighting function for vehicles.

In the case of road illumination e.g. by head lamp one need a light distribution which ensure a sufficient visible range, that means an adequate illumination of the road scene in front of the vehicle under avoidance of any disturbance (glare) of other road users. The demands to see under traffic conditions signals, obstacles, direction information, pedestrians, other road users or simply the road as such requires the definition of light distributions and measuring grids on the base of drivers demands as a fundamental criteria of a performance based description of a Regulation as it was carried out for the most part in the ECE – Regulation 123 /6/ for AFS Systems.

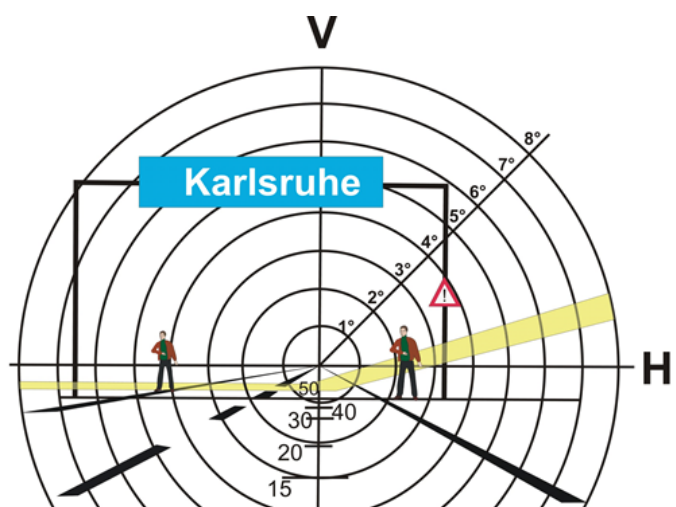


Figure 1: Road Scene in front of the vehicle /2/

With respect to signalling functions it requires, simply said, an effectual brightness inside the necessary light distribution to allow a relative high probability to detect the signal and on the same time the information, which is combined with this signal and to enable so the driver to be in the position to stop the vehicle at an early stage.

For a clear and safe transmittance of such an information it is required to generate an clear and safe signally aspect. Such a signalling aspect is normally composed by:

- the shape
- the arrangement
- the colour
- the intensity
- the contrast and
- the temporal sequence

To ensure, that the vehicle could be stopped at an sufficient early stage, it demands a visibility of the signal in a distance with a high probability, therewith under normal conditions the stopping process could be managed without any problems.

In this context it means a quality or better a performance of this signal to ensure this task. To make certain this performance the signal must be visible for a large group of road users of different ages and different surrounding conditions. Therefore one must know not only the sensitivity of the eye, one must know the threshold illuminance for a typical traffic situation or rather surrounding traffic conditions at day and night, that means in minimum a 95 % detection probability of the road user population.

Such a threshold illuminance is specified for road traffic circumstances e.g. in DIN 5037 part 2 from 1963 /3/ or could be calculated by the Blackwell data /4/. These values must be used carefully because they are corresponding to recognition probability of 50%

Never the less it is required to evaluate the adaptation level (surrounding luminance) and multiply by a factor of approximately 10 to adapt this value to typically road scene conditions.

For evaluation of the stopping distance one must be clear on, that such a stopping process incorporates a number of steps in a course of action as to cover the distances for the time of the first view, for the recognition, for reaction and last but not least for breaking.

Back to the signalling aspects and starting with the aspect element "contrast".

The typical example for the application of contrast in the ECE – Regulation is, in the Regulation No. 7 /7/, the required ratio between stop lamp and rear position lamp, which is a relevant factor for the secure perception of such important signal.

But also at other functions the contract is relevant e.g. for the detection of direction indicator lamps and headlamps or much more, but partly ignored, for the case of direction indicator lamps and day time running lamps (DRL). In this case the luminous intensity of the DRL with the corresponding luminance could be much higher than the luminance above the cut-off of the headlamps in view from the oncoming driver.

Furthermore in the case of a rear fog lamp and a stop lamp a general distance of 100 mm was found as a criteria to differentiate both signals, but this general distance does not really care for the intensity ratio between both lamps, that means in the case of a stop lamp with a relative low luminance the distance of 100mm to the rear fog lamp in to small, which could results in a recognition process of the stop signal with an dangerous delay.

Some of these examples showing the missing interrelation ship of the ECE lighting Regulations between functions with regard to intensity and arrangement. Each ECE Regulation stays on its own.

A negative example for the aspects contrast, arrangement and colour is combination of tail- ,stop- and direction indicator lamp as usual in North America. This undermines the differentiation of the information and causes a delay in recognition of the stop signal up to 0.4sec as found by Mortimer in the 1970ties. This might be slightly compensated by the introduction of the high mounted stop lamp, but do not hide the fact that this solution do not improve the performance of signal detection.

The signalling aspects “arrangement” and “shape” of lamps deems to make the identification of a vehicle and even the kind of vehicle as car, bike, trucks and trailer possible. In the latter case is the introduction of rear contour marking a big improvement for the conspicuity of trucks and trailer, which is really performance orientated and helpful for road safety.

In the Vienna Convention is, amongst other things, the signalling aspect “colour” defined in correlation from which side one see a vehicle.

The fact, that human beings have learned during the evolution to develop a high sensitivity with regard to things in motion as a fundamental aspect for survival, might be the reason the hither perception of flashing signals compared to a steady staying light of the more or less same intensity. Therefore this fact covers the signalling aspect “temporal sequence”.

An other approach is necessary with regard of the illumination of the road, which means the function head lamp. The driver demands are a good visibility range, the visibility to the side to allow good road guidance and the avoidance of glare to other road users. The compromise between range and glare has limits, which was demonstrated e.g. by the investigation of Geoff Draper in the SAE Lighting Committee. The results showing in several cases of a standard head lamp light distributions a missing range on the left side on the road to see in time a pedestrian. This demonstrates also the challenge for the driver to adapt the driving speed correctly to the real possibilities to see obstacles or pedestrians in time.

A very good base for performance based assessment of head lamp light distributions under the conditions “as installed” was developed by the CIE TC 4-45 and results in the first glance for classic static head lamps in the Publication No. 188 of 2010 /5/. Nevertheless a real performance based description of head lighting requires at least an amount of adaptively.

To improve the ECE - Lighting Regulations more performance base the visual performance of the driver and the drivers need are the guiding parameters. With regard to the existing Lighting Regulations a relative big amount of performance oriented descriptions are verifiable. There are some sins as construction requirements, which coming from the more construction guided descriptions in the beginning of the development of ECE – Regulations, where the possible technical solution was the starting point. Now concepts for improvements in road safety are the guiding criteria, but nevertheless some intentional construction requirements are in because to intentional ban some technologies or for fear of the possibilities of automatic controlling systems. The fear of automatic systems might be given by missing possibilities to check their performance to get more confidence of that. The question will be whether tools as “functional safety” could be helpful and are they really helpful in an approval process?

Summary:

In total to improve the Regulations under the aspect of performance based requirements we have to improve adaptive solutions. This is the only way to have a lighting and light signalling system which correlates really to the visual performance of all road users.

The inconsiderate criticism of the European Commission on the missing performance based orientation could be also a starting point for an initiative to bring the ECE – Regulations more in the direction to be more manageable for the users as manufacturers, technical services and authorities as well for the deciders as the governmental and non-governmental representatives in the UN-ECE-System.

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This paper is intended as a written contribution only!