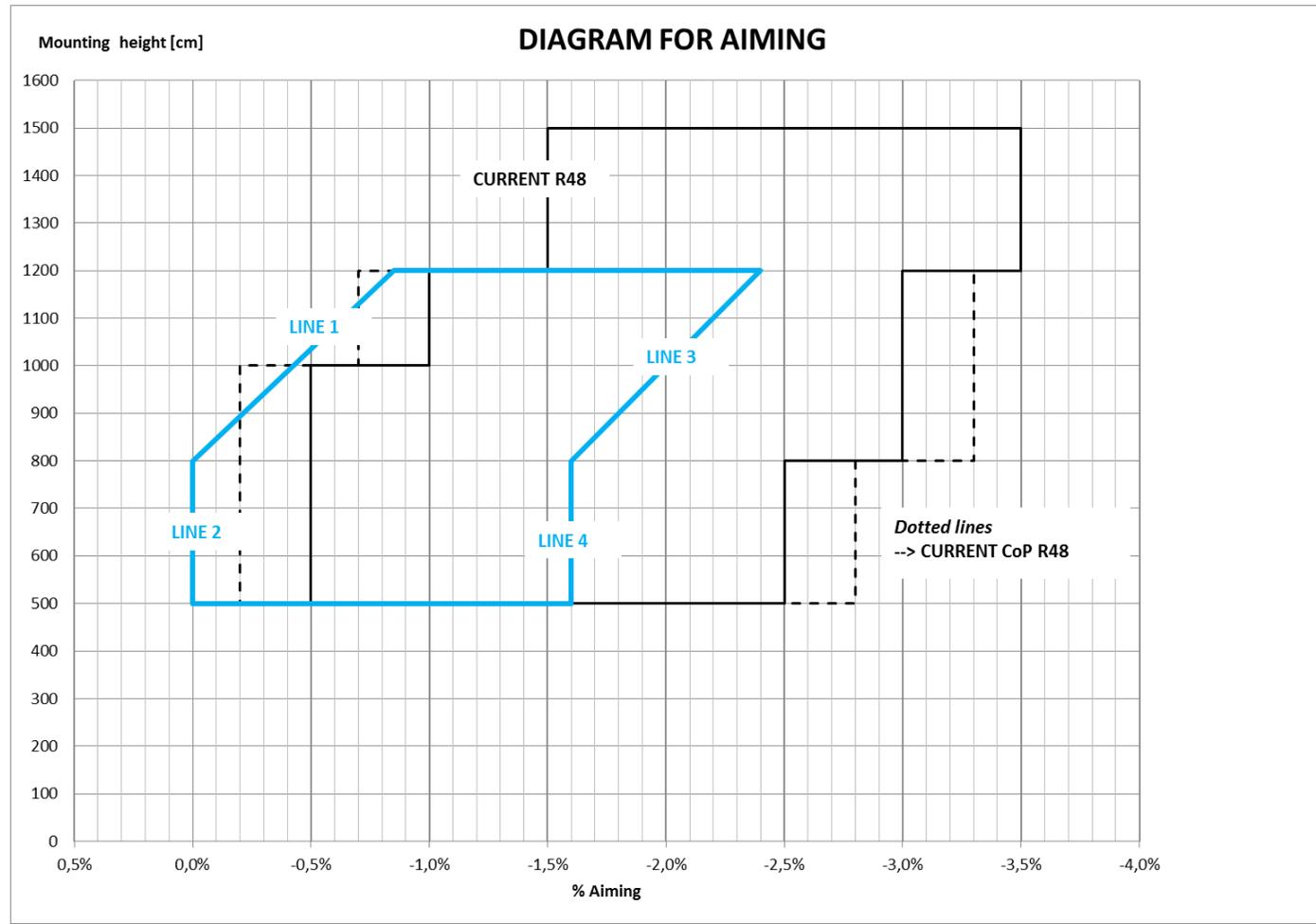


GRE IWG-VGL - Proposal and justification for Lines defining the limits (diagram) for the new aiming range:

PROPOSAL

**Absolute limits (including CoP) / comparing the new box (Blue box with Lines 1, 2, 3 and 4)
 with the old box (Black box) including the tolerances required to achieve CoP (Black dotted box).**



JUSTIFICATION

LINE 1 – [0.0;0.8] to [0.85;1.2] – based on Line 5 :

This **Line 1** results from both the comparison between Klettwitz test and **CIE Standard S021/E:2011** (issued from TC4-45 studies) and is a consensus between the members of IWG-VGL.

Comparison of Klettwitz test and **CIE Standard S021/E:2011**:

- During Klettwitz test, it was established a relationship between the pitch angle and the discomfort glare. A passing beam cut-off line above the horizon increases the discomfort glare for oncoming drivers, depending on the headlamp mounting height. (Reference: page **149** of **GRE-71-32**)
 - When the cut-off is positioned above the horizon this produces a zone of glare with values above 1 lumen and leads to weighted luminous flux values according to CIE Standard S021/E:2011. (Reference: pages **149** to **152** of **GRE-71-32**)
- The combination of the results obtained from the two elements above allows us to use **CIE Standard S021/E:2011** to produce calculations for the assessment of glare impact to oncoming drivers in real traffic situations. (Reference: page **152** of **GRE-71-32**)

Using the **CIE Standard S021/E:2011** Glare Zone method, GTB/OICA defined a graph for mounting heights between 0.5m to 1.2m. (Reference: page **152** of **GRE-71-32**)

On this GTB/OICA graph (see figure 2 below), the top left point of the **Line 5** is defined as [0.6; 1.2]. (This is the initial brown line of the diagram on page **2** of **GRE-77-27**).

However, the group decided to keep the real value taken from **CIE Standard S021/E:2011**: [0.85; 1.2] (see figure 1 below).

The **Line 1** was defined as a consequence.

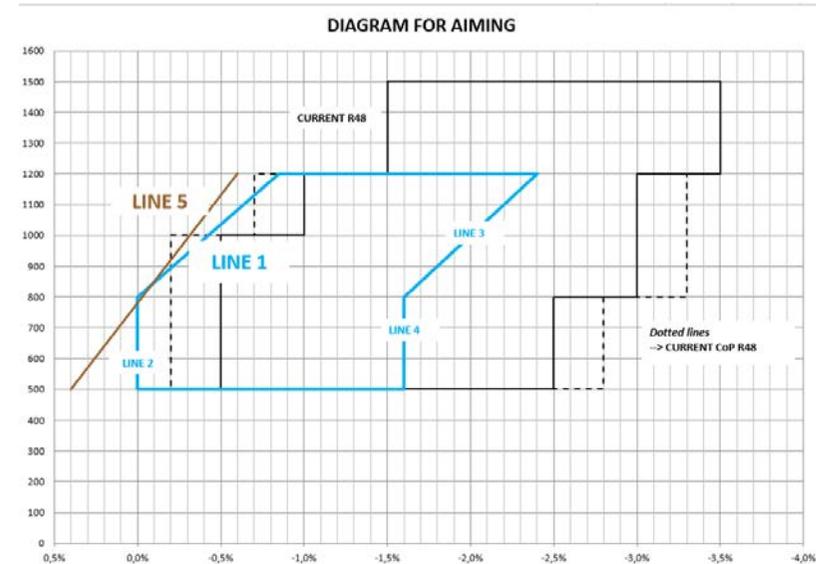
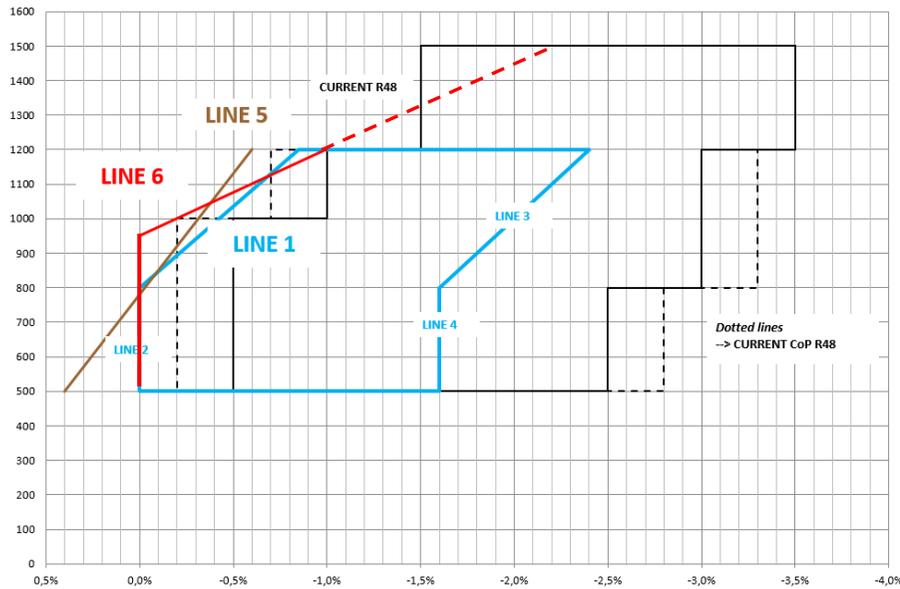


DIAGRAM FOR AIMING



VGL-08-14 Rev.1 introduced some new elements (**Line 6**) which confirmed the robustness of **Line 1**.

This **Line 6** was calculated taking into account the minimum position of the oncoming driver's eyes at 0.95m high, the height of headlamps (optical axis), and the cut-off inclination assessed at a distance

For all headlamp mounting heights where optical axis is over 0.95 it is possible to lower the inclination proportionally and still guarantee that glare remains well controlled, since, in these cases, the cut-off line will be always under 0.95m at a distance of 25m or more.

It was discovered that the **Line 6** is partially further to the left of **Line 1** and has similarities in discussed area. Therefore the group decided to keep the **Line 1**, as most part of it is on the "safe side".

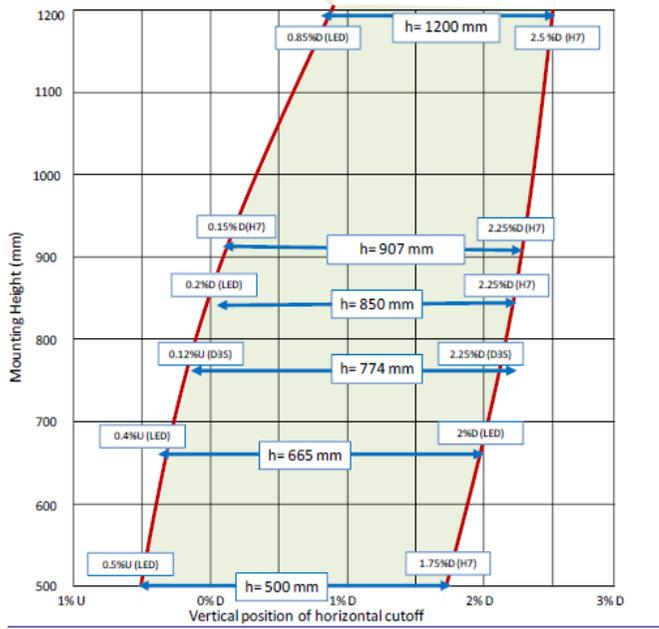


Figure 1 – GTB/OICA - Graph resulting of measurements

(Reference: page 167 of GRE-71-32)

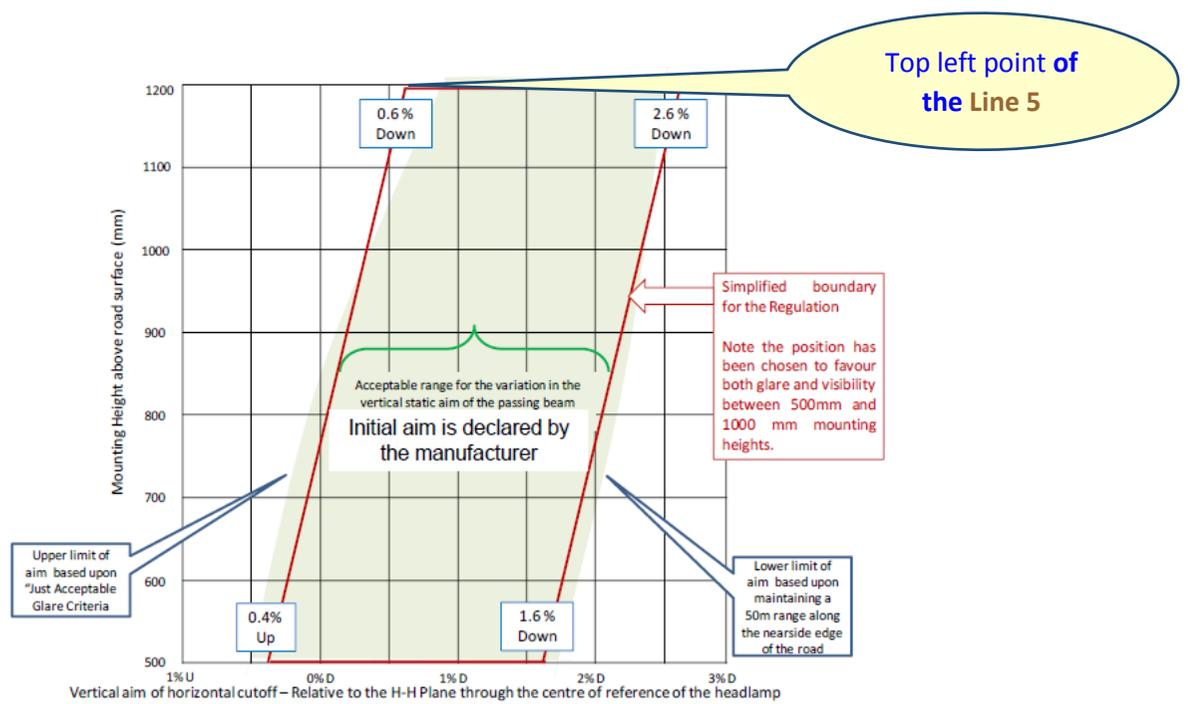


Figure 2 – GTB/OICA - Graph with straight lines

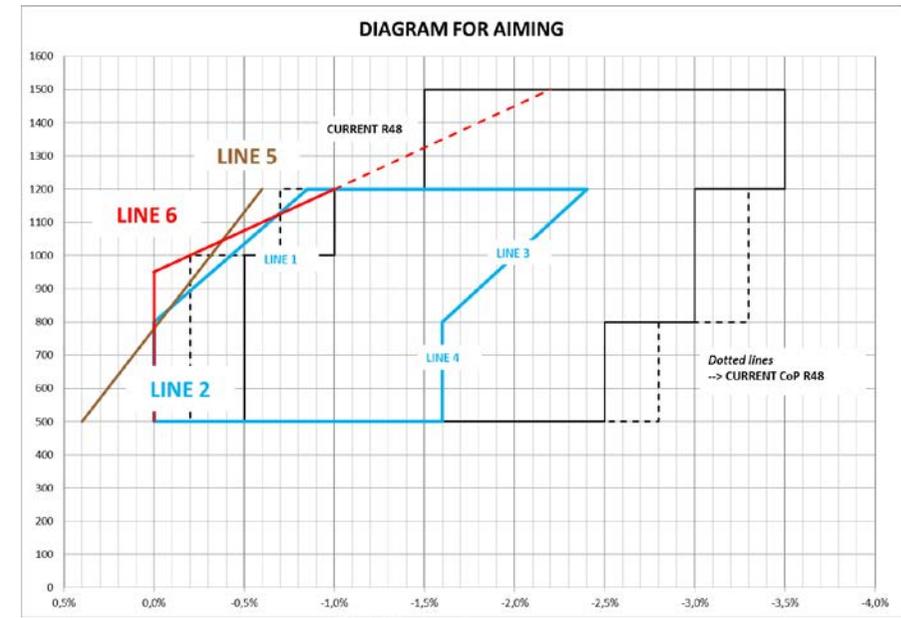
(Reference: page 168 of GRE-71-32)

Line 2 – [0.0;0.5] to [0.0;0.8]:

This **Line 2** results both the comparison between Klettwitz test and CIE Standard S021/E:2011 (issued from TC4-45 studies) and a consensus between the members of IWG-VGL not to direct the light over horizon and Line 6 assumption.

A basic straight line was drawn on the left side [0.4U; 0.5] to [0.6D; 1.2]; following the principle used to produce the **Line 5** (Reference: page 168 of GRE-71-32).

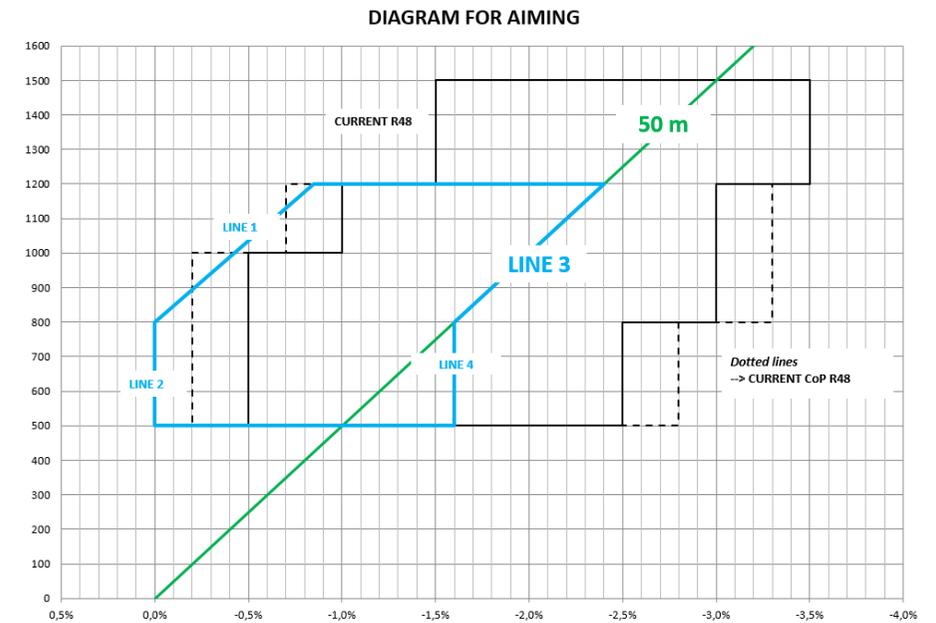
To avoid the risk of glare, the group agreed that the cut-off line must always remain below the horizon [horizontal axis] → The resultant **Line 2**: [0.0; 0.5] to [0.0; 0.8] (0.8 is a round value, resulting from **Line 2** crossing **Line 1**).



Line 3 – [1.6;0.8] to [2.4;1.2]:

The basis for **Line 3** is the green “50m” Line. The angle of **Line 3** is defined-by the requirement to achieve 50m minimum road illumination distance (with vertical illuminance of 3 lux per headlamp on road surface at its right edge), independently from mounting height, and is considered to be a minimum safety value. The theoretical origin is [0.0; 0.0]

The group agreed that **Line 3** is a significant improvement over and above the current requirements as it is performance-based and it will ensure a minimum road illumination distance of 50m.

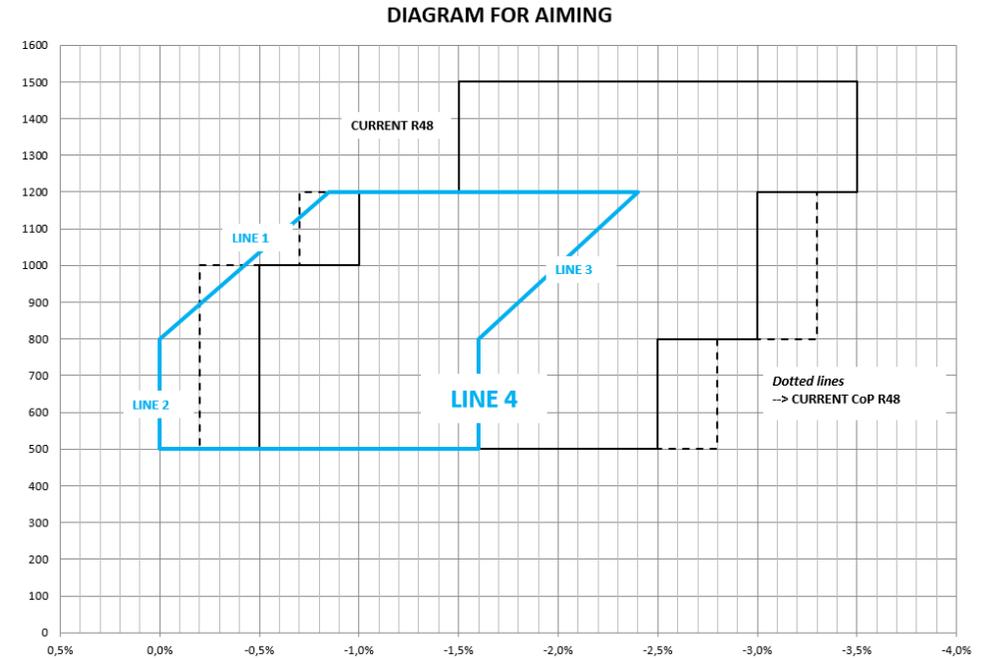


Line 4 – [1.6; 0.5] to [1.6; 0.8]:

Carmakers presented some studies about the range needed for the aiming, and requests the minimum range of 1.6%.

Therefore as a result the group decided to draw a vertical line parallel to the **Line 1** with an offset of 1.6 from [1.6; 0.5] to [1.6; 0.8].

Line 4 changes performance character of Line 3 (the same road illumination distance independently of the mounting heights) and it should be taken into account for Phase 2 of [IWG VGL / SLR] when additional data/information will be available.



Appendix I

Explanations for the value of 1 lumen, defining the Line 2:

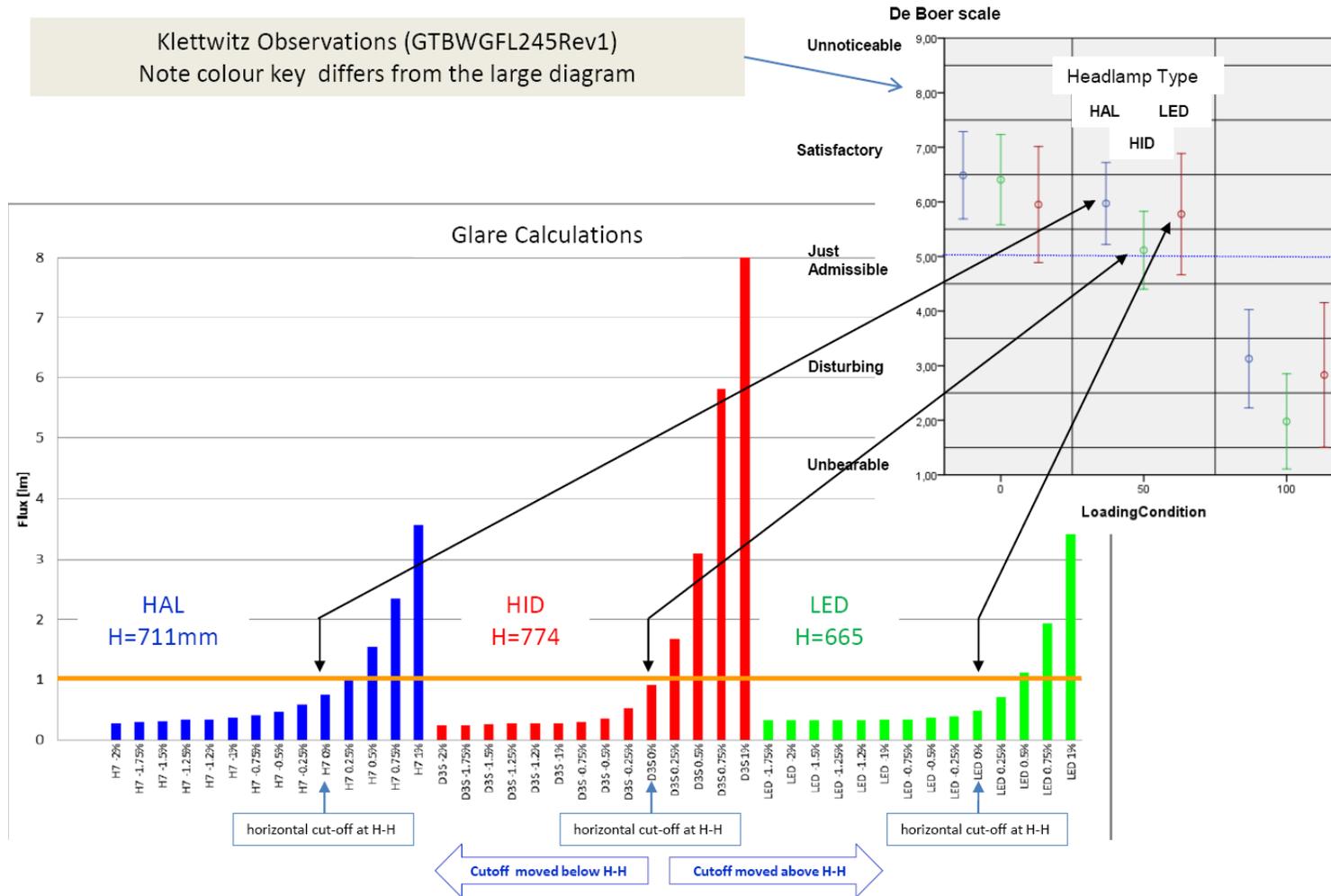


Figure 3 (Reference: page 150 of GRE-71-32)

During Klettwitz test, it was observed using the De Boer rating system that the typical score for each vehicle tested was rated at more than 5.00 or satisfactory (See small graph on top right of figure 3, middle column) and this is recognized throughout the lighting community as not creating glare.

It can be seen in this small graph (De Boer scale) that the worst case for glare is produced by HID Headlamps, the remainder of the test samples are rated as acceptable for glare, these factors have been integrated into the GTB/OICA proposal.

On the glare calculation graph of figure 3 (based on CIE Standard S021/E:2011) with 3 different headlamps types in different aiming positions, it can also be clearly seen (vertical red columns on histogram) that HID headlamps demonstrate the most unsatisfactory result from the De Boer rating system for the assessment of glare. Furthermore this graph suggests that when the cut-off remains below the 1 lumen zone, such headlamps should not produce an unsatisfactory glare rating.

→ It was considered that headlamp with a flux value less than 1 lumen in the glare zone should not cause discomfort glare to oncoming drivers.

Explanations for the performance relation between headlamp optical axis height, cut-off inclination and minimum guaranteed road illumination distance:

Starting from minimum photometric requirements for passing beam enclosed in component Regulation (No 98, 112, 123) by nominal headlamp inclination (1%) and nominal headlamp height (0.75m) it was obtained the minimum guaranteed vertical road illumination on road surface. This is the illuminance of 2 lx for single headlamp (4 lx for pair) at the distance of 75 m in point equivalent to 75R - 75 m beyond the vehicle on road/shoulder border.

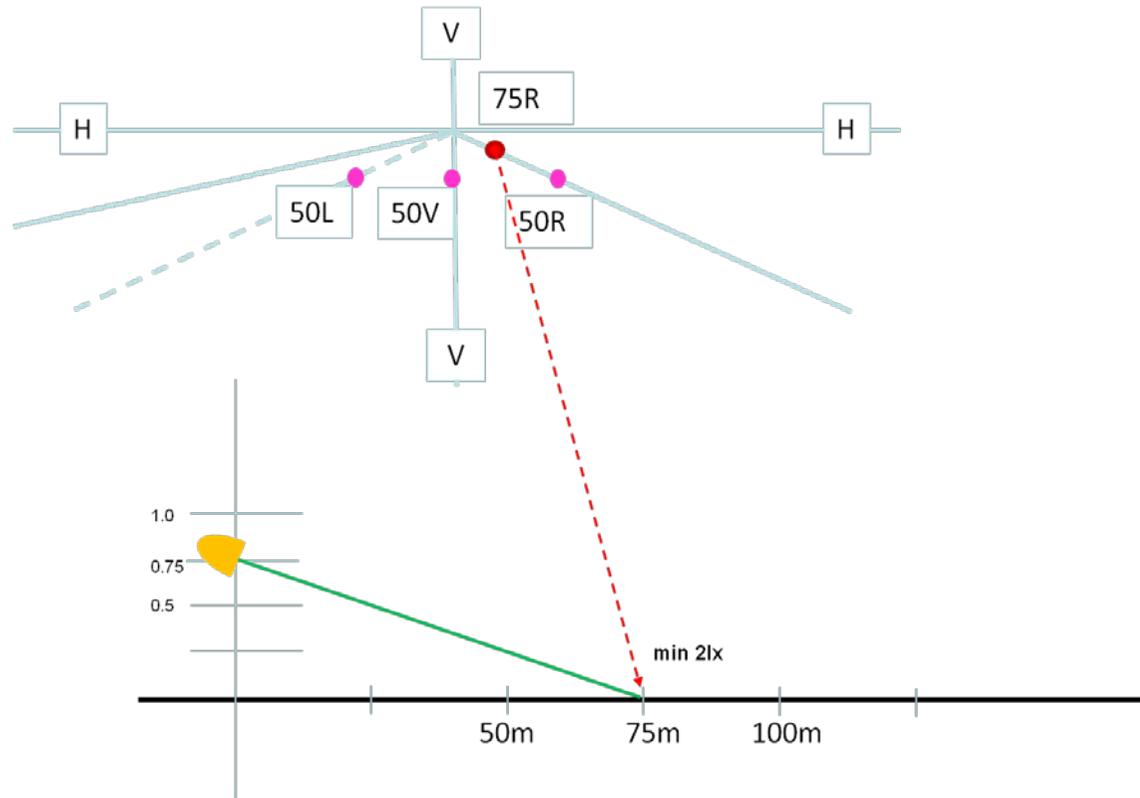


Fig. 1 Translation of headlamp Regulation (No 112, 98, 123) requirements to minimum road illumination distance.

Road is also illuminated in front of the vehicle for similar distance but with lower intensity (not directly required in Regulations). It is because of high luminous intensity just below cut-off line which cross road at the same distance as 75 R.

Because of very small angle of inclination of cut-off line this value do not change measurably for allowed mounting heights range.

To maintain the same rod illumination distance “**L**” independently on headlamp mounting height (headlamp optical axis height) the relation between mounting height “**h**” and cut-off inclination “**i**” should be such that-cut off will cross the road in the same distance independently on headlamp axis height.

Because:

$$i=h/L$$

and for $L=\text{const}$

$$h/i = \text{const}$$

This means that to meet above requirement for any distance “**L**” (not only 75 m) the dependence “**h**” from “**i**” must be linear and **cross 0,0 point** as presented on graph below:

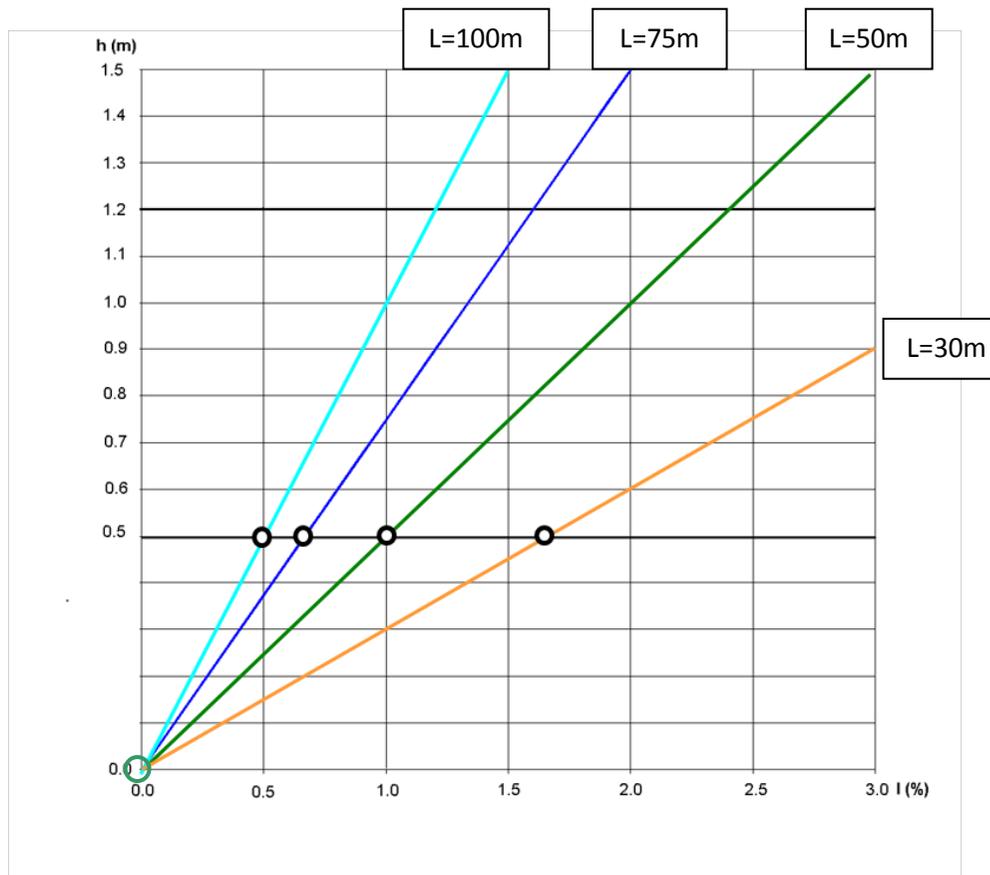


Fig. 2. Examples of different lines binding together headlamp optical axis height “h” with cut-off inclination “I” to obtain the same minimum road illumination distance.

The position of the line reflect minimum guaranteed road illumination distance “L” which increases when the line is moved to the left.

Explanations for the performance glare Line 6 :

Assumptions taken for glare Line No 6:

- The illuminance of beam pattern of passing beam under cut-off line for distances considered (less than 150 m) can be high enough to cause glare.
- No additional intensity restrictions just under cut-off are included in component Regulations No 98, 112, 123.
- Horizontal part of cut-off line cannot be positioned higher than horizon.
- Minimum eye-height of driver was taken from the **CIE Standard S021/E:2011** as 0.95 m (rounded 0.94 m)

It is requested that the cut-off should be under eye-height. Because of practical reasons it is proposed that the distance beyond 25 m from vehicle is considered. Glare occurring where distance between obstacle and vehicle is less than 25 m should have no significant influence for driver reaction. Driver should recognize obstacle earlier because from shorter distance has no chance for effective reaction by typical allowed speed (90km/h or more).

FORMULA FOR GLARE LINE No 6 CALCULATION:

$$I = \Delta h / L_{min}$$

Where:

I - cut-off inclination

Δh - headlamp optical axis height over minimum eye-height (0.95m)

L_{min} - maximum distance beyond the vehicle where glare is accepted (25 m)

CALCULATION EXAMPLE FOR HEADLAMP HEIGHT 1.2 m

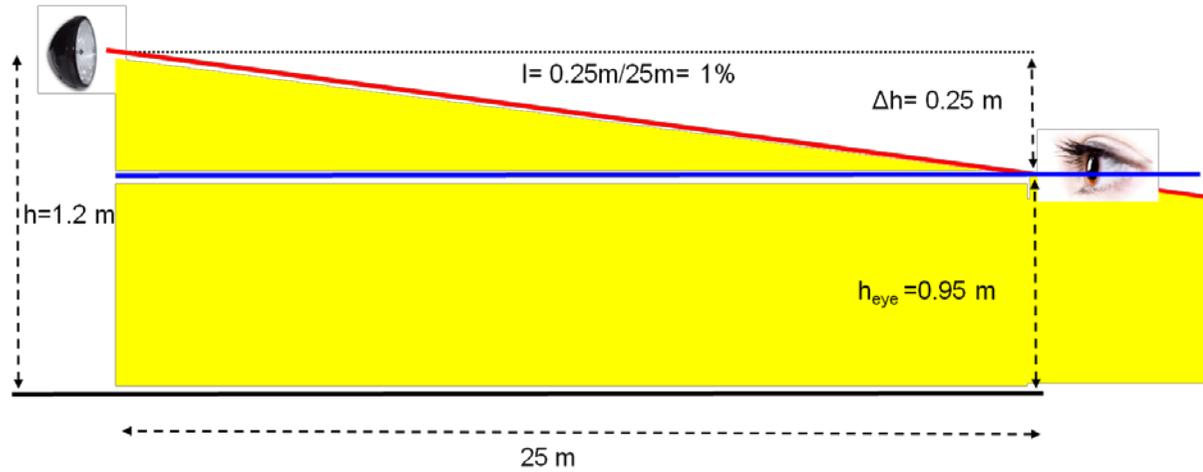


Fig.1. Examples of idea and calculations for "I" for headlamp axis positioned at height of 1.2 m .

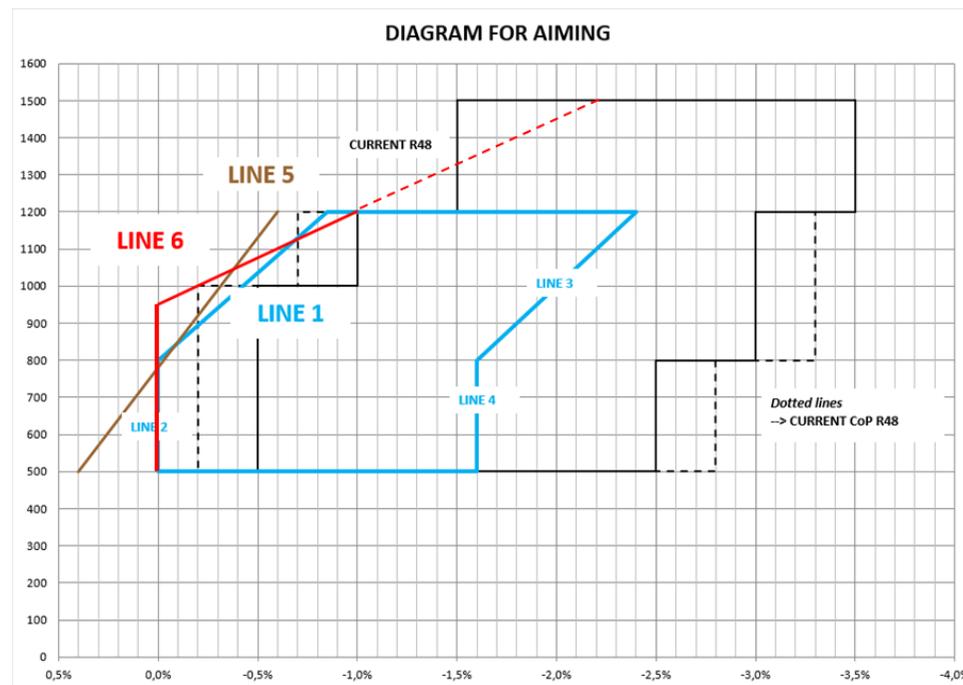


Fig. 2. Position of calculated performance "glare protection" line on h/I graph.