

Transmitted by the expert from GTB

Informal Document No. GRE-62-01  
(62nd GRE, 6 - 9 October 2009,  
agenda item 5(d))

SUPPORTING INFORMATION  
REGARDING ECE/TRANS/WP.29/GRE/2009/20, ECE/TRANS/WP.29/GRE/2009/45,  
ECE/TRANS/WP.29/GRE/2009/46, ECE/TRANS/WP.29/GRE/2009/47,  
ECE/TRANS/WP.29/GRE/2009/48.

**ADOPTION OF TEST VOLTAGE OF 13.2V AND ASSOCIATED CHANGES**

**REGULATIONS Nos. 19, 48, 98, 112 AND 123**

These collective amendments relate to a complete updating of the forward lighting regulations with regard to test voltage, the adoption of the spherical coordinate angular measuring system and the passing beam cut off definition. The objective is to update the regulations by aligning the performance measured at type approval more closely with that achieved on the vehicle and to adopt modern photometric measurement practices. Additionally, the opportunity has been taken to align the requirements of Regulations Nos. 98, 112 and 123 in terms of the cut off shape definition and associated photometric requirements.

As these changes are extensive the following explanation is intended to complement the justification included with the individual proposals.

**1. Conversion Factors used**

The current photometric requirements in the regulations are all based upon a rated luminous flux of the applicable light sources at a voltage of approximately 12 volts. Having decided to update the photometric requirements to a basis of 13.2 volts a number of factors need to be taken into consideration, such as:

- a) The basis of the photometric requirements and the associated safety considerations of the existing provisions in the regulations shall not be affected. The motivation for this change is to align the requirements to current vehicle operating conditions and to allow facilitate the adoption of new light source technologies such as Gas Discharge and LED's.
- b) In order to change the basis of type approval to 13.2 volts, it is necessary to consider the characteristics of the light sources involved in order to determine a suitable multiplying factor to be applied. As was shown in the GTB proposal ECE/TRANS/WP.29/GRE/2006/36, each filament light source has particular characteristics and the exponent used in the equation to determine the multiplying factor is not constant. The value of the conversion factor ranges from 1.32 to 1.43 and the recommendation of the experts of the GTB Light Sources Working Group was to adopt a factor of 1.35, being the median value of all applicable filament light sources.

- c) In the case of Regulations Nos. 19, 112 and 123 it is necessary to develop suitable provisions for incandescent, Gas Discharge and LED light sources. Based upon the practice established when Regulation No. 98 (Gas Discharge Headlamps) was introduced, a factor of 1.43 (1.0/0.7) has been used to take account of Gas Discharge and LED's in Regulations Nos. 19 and 123. With the change to type approval at 13.2 volts this factor of 1.43 will no longer be required but it does leave implications for the photometric values to be adopted.
- d) Taking the factors explained in b) and c) above it has been concluded that, in order to ensure all existing type approved devices can be type approved to the revised requirements based upon 13.2 volts, it will be necessary to apply the multiplying factor of 1.35 to the minimum requirements and 1.43 to the maximum requirements. This effectively ensures that in the case of headlamps, the minimum requirements of regulations 112 and 123 are maintained whilst the maximum requirements established by Regulation 98 are not exceeded. The overall result is a widening of the range between minimum and maximum values of 10 per cent in the worst case but is considered that this slight disadvantage is overcompensated by the benefits of alignment of the regulations to the new technologies offering significant advances in road safety.
- e) The following table shows the conversions of the photometric values that have been incorporated into these collective amendments to Regulations Nos. 19, 48, 98, 112 and 123.

Value in Lux at 12v	Value in cd	MINIMUM VALUES		MAXIMUM Values	
		Value in cd at 13.2 v	ROUNDED value in cd at 13.2 v	Value in cd at 13.2 v	ROUNDED value in cd at 13.2 v
			Nearest 5 to 1000cd, Nearest 50 to 5000 Nearest 100 above 5000		Nearest 5 to 1000cd, Nearest 50 to 5000 Nearest 100 above 5000
0.1	62.5	84	85	88	90
0.2	125	169	170	176	175
0.3	187.5	253	255	264	265
0.35	218.75	295	295	308	310
0.4	250	338	340	353	350
0.5	312.5	422	425	441	440
0.6	375	506	510	529	530
0.7	437.5	591	595	617	625*
0.9	562.5	759	760	793	790
1.0	625	844	845	881	880
1.4	875	1181	1180	1234	1230
1.5	937.5	1266	1250	1322	1300
2.0	1250	1688	1700	1763	1750

2.7	1687.5	2278	2300	2379	2400
3.0	1875	2531	2500	2644	2650
4.0	2500	3375	3400	3525	3550
4.2	2625	3544	3550	3701	3700
5.0	3125	4219	4200	4406	4400
6.0	3750	5063	5100	5288	5300
8.0	5000	6750	6800	7050	7100
10.0	6250	8438	8400	8813	8800
12.0	7500	10125	10100	10575	10600
14.0	8750	11813	11800	12338	12300
15.0	9375	12656	12700	13219	13200
16.0	10000	13500	13500	14100	14100
18.0	11250	15188	15200	15863	15900
20.0	12500	16875	16900	17625	17600
24.0	15000	20250	20300	21150	21200
30.0	18750	25313	25300	26438	26400
32.0	20000	27000	27000	28200	28200
35.0	21875	29531	29500	30844	30800
42.0	26250	35438	35400	37013	37000
48.0	30000	40500	40500	42300	42300
50.0	31250	42188	42200	44063	44100
60.0	37500	50625	50600	52875	52900
70.0	43750	59063	59100	61688	61700
80.0	50000	67500	67500	70500	70500
90.0	56250	75938	75900	79313	79300
100.0	62500	84375	84400	88125	88100
240.0	150000	202500	202500	211500	211500

\* The value of 625 has been adopted as this is already established as one of the critical glare values in Regulation 98.

## 2. Adoption of Spherical Coordinate System

In order to align the regulations to modern photometric laboratory practices, the specification of illuminance requirements on a flat screen located at 25 m from the device has been replaced by the specification of luminous intensity in conjunction with the spherical coordinate system. The characteristics of the spherical coordinate system, using a goniometer, are detailed in the annexes of the individual regulations.

Strictly, when transferring illuminance requirements on the flat screen to luminous intensities and spherical coordinates, it is necessary to incorporate a cosine<sup>3</sup> factor but with advice from the GTB Photometry Working Group it has been decided that this can be ignored for the small angles involved.

Calculation shows that the differences are small and are within the rounding of the values shown in the table above (See below).

Angle Deg		cosine	cosine^3	Cosine <sup>3</sup> Correction 100*((1-cosine^3)/cosine^3) %
0,5	0,00872665	0,99996192	0,99988577	0,01
1	0,01745329	0,9998477	0,99954316	0,05
1,5	0,02617994	0,99965732	0,99897233	0,10
2	0,03490658	0,99939083	0,99817359	0,18
2,5	0,04363323	0,99904822	0,99714738	0,29
3	0,05235988	0,99862953	0,99589424	0,41
3,5	0,06108652	0,9981348	0,99441483	0,56
4	0,06981317	0,99756405	0,99270994	0,73
4,5	0,07853982	0,99691733	0,99078048	0,93
5	0,08726646	0,9961947	0,98862748	1,15
5,5	0,09599311	0,9953962	0,98625208	1,39
6	0,10471975	0,9945219	0,98365555	1,66
6,5	0,1134464	0,99357186	0,98083926	1,95
7	0,12217305	0,99254615	0,97780472	2,27
7,5	0,13089969	0,99144486	0,97455353	2,61
8	0,13962634	0,99026807	0,97108742	2,98
8,5	0,14835299	0,98901586	0,96740822	3,37
9	0,15707963	0,98768834	0,96351789	3,79
9,5	0,16580628	0,9862856	0,95941848	4,23
10	0,17453292	0,98480775	0,95511217	4,70
10,5	0,18325957	0,98325491	0,95060122	5,20
11	0,19198622	0,98162718	0,94588803	5,72
11,5	0,20071286	0,9799247	0,94097508	6,27
12	0,20943951	0,9781476	0,93586495	6,85

### 3. Traffic sign illumination

The minimum requirements relating to the illumination of traffic signs currently in Regulations Nos. 98 and 112 have been retained without change. These values were based upon the requirement to provide a minimum illuminance of the traffic signs and this requirement is independent of the operating voltage. Although the values could have been increased by the factors mentioned above, it has been concluded that this is not desirable because of the conflict with the maximum values imposed in the glare zone.

### 4. Definition of the Passing Beam Cut-off.

The recent introduction of a definition of the passing beam cut-off and associated quality requirements into Regulations 98 and 112 has resulted in the need to also align the photometric requirements that determine the cut-off shape in the two regulations. Additionally, it is necessary to also introduce the cut-off definition and quality requirements into Regulation No. 123.

Following a study of the differing requirements in Regulations Nos. 98, 112 and 123 it was concluded that a harmonised approach based upon the latest state of the art and supporting research represented by Regulation No. 123 should be adopted.

## **5. Conclusion**

The result of these amendments is a complete updating of the forward lighting regulations that will encourage significant improvements in forward vision for the driver without compromising controls upon glare to other road users.