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.
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\(^3\) 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).

<table>
<thead>
<tr>
<th>Angle Deg</th>
<th>cosine</th>
<th>cosine^3</th>
<th>Cosine^3 Correction 100*(1-cosine^3)/cosine^3 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.00872665</td>
<td>0.99996192</td>
<td>0.99988577</td>
</tr>
<tr>
<td>1</td>
<td>0.01745329</td>
<td>0.9998477</td>
<td>0.99954316</td>
</tr>
<tr>
<td>1.5</td>
<td>0.02617994</td>
<td>0.99965732</td>
<td>0.99897233</td>
</tr>
<tr>
<td>2</td>
<td>0.03490658</td>
<td>0.99939083</td>
<td>0.99817359</td>
</tr>
<tr>
<td>2.5</td>
<td>0.04363323</td>
<td>0.99904822</td>
<td>0.99714738</td>
</tr>
<tr>
<td>3</td>
<td>0.05235988</td>
<td>0.99862953</td>
<td>0.99589424</td>
</tr>
<tr>
<td>3.5</td>
<td>0.06108652</td>
<td>0.9981348</td>
<td>0.99441483</td>
</tr>
<tr>
<td>4</td>
<td>0.06981317</td>
<td>0.99756405</td>
<td>0.99270994</td>
</tr>
<tr>
<td>4.5</td>
<td>0.07853982</td>
<td>0.99691733</td>
<td>0.99078048</td>
</tr>
<tr>
<td>5</td>
<td>0.08726646</td>
<td>0.9961947</td>
<td>0.98862748</td>
</tr>
<tr>
<td>5.5</td>
<td>0.09599311</td>
<td>0.9953962</td>
<td>0.98625208</td>
</tr>
<tr>
<td>6</td>
<td>0.10471975</td>
<td>0.9945219</td>
<td>0.98365555</td>
</tr>
<tr>
<td>6.5</td>
<td>0.1134464</td>
<td>0.99357186</td>
<td>0.98083926</td>
</tr>
<tr>
<td>7</td>
<td>0.12217305</td>
<td>0.99254615</td>
<td>0.97780472</td>
</tr>
<tr>
<td>7.5</td>
<td>0.13089969</td>
<td>0.9914486</td>
<td>0.97455335</td>
</tr>
<tr>
<td>8</td>
<td>0.13962634</td>
<td>0.99026807</td>
<td>0.97108742</td>
</tr>
<tr>
<td>8.5</td>
<td>0.14835299</td>
<td>0.98901586</td>
<td>0.96740822</td>
</tr>
<tr>
<td>9</td>
<td>0.15707963</td>
<td>0.98768834</td>
<td>0.96351789</td>
</tr>
<tr>
<td>9.5</td>
<td>0.16580628</td>
<td>0.9862856</td>
<td>0.95941848</td>
</tr>
<tr>
<td>10</td>
<td>0.17453292</td>
<td>0.98480775</td>
<td>0.95511217</td>
</tr>
<tr>
<td>10.5</td>
<td>0.18325957</td>
<td>0.98325491</td>
<td>0.95060122</td>
</tr>
<tr>
<td>11</td>
<td>0.19198622</td>
<td>0.98162718</td>
<td>0.94588803</td>
</tr>
<tr>
<td>11.5</td>
<td>0.20071286</td>
<td>0.9799247</td>
<td>0.94097508</td>
</tr>
<tr>
<td>12</td>
<td>0.20943951</td>
<td>0.9781476</td>
<td>0.93586495</td>
</tr>
</tbody>
</table>

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.