SLOVENSKI STANDARD
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Cestna razsvetljava - 2. del: Zahtevane lastnosti

Road lighting - Part 2: Performance requirements

Straßenbeleuchtung - Teil 2: Gütemerkmale

Éclairage public - Partie 2: Exigences de performance

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Road lighting - Part 2: Performance requirements

Eclairage public - Partie 2: Exigences de performance

Straßenbeleuchtung - Teil 2: Gütemerkmale

This European Standard was approved by CEN on 6 June 2015.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 13201-2:2015) has been prepared by Technical Committee CEN/TC 169 “Light and lighting”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2016 and conflicting national standards shall be withdrawn at the latest by June 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13201-2:2003.

In comparison with EN 13201-2:2003, the following significant changes have been made:

— restructuring of the document;

— addition of an introduction including background information;

— updating of terms and definitions;

— combination of several classes;

— replacement of the abbreviation TI with the symbol f_{TI};

— change of several class designations;

— change of the designations of the luminous intensity classes;

— addition of a new informative Annex C on evaluation of disability glare for C and P classes.

This document EN 13201-2 has been worked out by the Joint Working Group of CEN/TC 169 “Light and lighting” with CEN/TC 226 - “Road Equipment”, the secretariat of which is held by AFNOR.

EN 13201, *Road lighting* is a series of documents that consists of the following parts:

— *Part 1: Guidelines on selection of lighting classes* [Technical Report];

— *Part 2: Performance requirements* [present document];

— *Part 3: Calculation of performance;*

— *Part 4: Methods of measuring lighting performance;*

— *Part 5: Energy performance indicators.*

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

A lighting class is defined by a set of photometric requirements aiming at the visual needs of certain road users in certain types of road areas and environment. The needs can vary at different periods during the night and also in different seasons of the year, thus the recommendations may vary during these periods.

The purpose of introducing lighting classes is to make it easier to develop and use road lighting products and services in CEN member countries. The lighting classes have been defined with consideration of road lighting standards in these countries and the lighting classes defined in CIE 115:2010 (2nd Edition) aiming at harmonization of requirements where possible. However, specific circumstances concerned with the road layout, use and national approaches based on traditional, climatic or other conditions could require different values of the uniformities. Not all the classes describe in this standard should be applied in a given country.

The M classes are intended for drivers of motorized vehicles for use on traffic routes, and in some countries also residential roads, allowing medium to high driving speeds.

The main lighting criteria of these classes are based on the road surface luminance of the carriageway and include the average luminance, the overall uniformity and the longitudinal uniformity for the dry road surface condition. Additional criteria relate to disability glare quantified by the Threshold Increment TI and the lighting of the surrounding areas quantified by the Edge Illuminance Ratio EIR. An additional criterion, used in some countries, is the overall uniformity of luminance in a wet condition.

The C classes are also intended for drivers of motorized vehicles, but for use on conflict areas such as shopping streets, road intersections of some complexity, roundabouts and queuing areas, where the conventions for road surface luminance calculations do not apply or are impracticable. The lighting criteria are based on the horizontal illuminance and are expressed by the average and the overall uniformity. These classes have applications also for pedestrians and pedal cyclists.

The P classes or the HS classes are intended for pedestrians and pedal cyclists on footways, cycleways, emergency lanes and other road areas lying separately or along the carriageway of a traffic route, and for residential roads, pedestrian streets, parking places, schoolyards, etc.

The lighting criteria of the P classes are based on the horizontal illuminance on the road area and are expressed by the average and the minimum illuminance.

The lighting criteria of the HS classes are based on the hemispherical illuminance of the road area and are expressed by the average hemispherical illuminance and the overall uniformity of this illuminance.

The SC classes are intended as an additional class in situations where public lighting is necessary for the identification of persons and objects and in road areas with a higher than normal crime risk.

The EV classes are intended as an additional class in situations where vertical surfaces need to be seen in such road areas as toll stations, interchange areas, etc.

The requirements of the lighting classes reflect the category of road user in question or the type of road area. Thus the M classes are based on the road surface luminance, while the C, P and HS classes are based on the illuminance of the road area. The SC classes are based on semi-cylindrical illuminance, while the EV classes are based on the vertical plane illuminance.

Each series of lighting classes presents decreasing requirements in their order and form steps of lighting level.

The specified lighting levels are maintained levels which are defined as the design levels reduced by a maintenance factor to allow for depreciation (refer to 3.10). The required maintenance factor, or a maintenance regime that allows deduction of the maintenance factor, should be included in tender specifications.

It should be taken into account that the light output of some light sources is sensitive to temperature. As photometric data are generally published considering a reference temperature of 25 °C, a correction factor should be considered for these light sources, if ambient temperatures are different.

Environmental aspects of road lighting are considered in Clause 7 in terms of day time appearance, night time appearance and light emitted in directions, where it is neither necessary nor desirable. The purpose is to highlight criteria that can be included in tender specifications or similar, where relevant.

Installed luminous intensity classes for the restriction of disability glare and control of obtrusive light G*1, G*2, G*3, G*4, G*5 and G*6 are introduced in the informative Annex A. The use of G* classes is mentioned in Clause 5 for conflict areas and in Clause 7 on appearance and environmental aspects.

Installed glare index classes for the restriction of discomfort glare D0, D1, D2, D3, D4, D5 and D6 are introduced in the informative Annex A as well. These classes are intended mainly for road areas lighted for the benefit of pedestrians and pedal cyclists.

Additional items considered in the Annex A are the use of installed luminous intensity classes and obtrusive lighting.

Local lighting of pedestrian crossings is considered in the informative Annex B. The intention of local lighting is to attract the attention of drivers of motorized vehicles to the presence of the pedestrian crossing and to illuminate pedestrians in or at the crossing area.

For the C and P classes, disability glare conditions considering the TI are described in the informative Annex C.

All photometric quantities are based on photopic photometry.

From an energy efficiency and environmental perspective a lighting installation should have a lighting level that matches the minimum required value of the relevant lighting class, and should meet all other relevant requirements, for instance uniformity, lighting of surrounding areas or additional classes (SC or EV). In that sense, the lighting levels specified in the tables are target values for minimum maintained levels.

Maximum lighting levels may be provided in tender specifications or national regulations.

When designing new road lighting installations, all the lighting requirements specified in Clauses 4, 5 and 6 are relevant, and also requirements on environmental aspects as considered in Clause 7, should be complied with.

When modifying the optical components or the geometry of existing lighting installations (for instance by changing the luminaires), it should be attempted to comply with all requirements. However, this may be highly impractical or expensive in some cases, while deviations from one or more of the requirements may lead to more practicable and less expensive solutions. In such cases, decisions should only be taken after careful consideration of all the aspects.

1 Scope

This part of this European Standard defines *performance requirements which are specified as* lighting classes for road lighting aiming at the visual needs of road users, and it considers environmental aspects of road lighting.

NOTE Installed luminous intensity classes for the restriction of disability glare and control of obtrusive light and installed glare index classes for the restriction of discomfort glare are defined in the informative Annex A. Lighting of pedestrian crossings is discussed in the informative Annex B. Disability glare evaluation for conflict areas (C classes) and pedestrian and pedal cyclists (P classes) is discussed in the informative Annex C.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13201-3, *Road lighting — Part 3: Calculation of performance*

EN 13201-4, *Road lighting — Part 4: Methods of measuring lighting performance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
average road surface luminance (of a carriageway of a road)
$\bar{L}$

luminance of the road surface averaged over the carriageway

Note 1 to entry: Unit is candelas per square metre ($cd \cdot m^2$).

3.2
longitudinal uniformity (of road surface luminance of a carriageway)
U_l
lowest of the ratios determined for each driving lane of the carriageway as the ratio of the lowest to the highest road surface luminance found in a line in the centre along the driving lane

3.3
threshold increment TI (of an object at the road surface)
f_{TI}
percentage increase of contrast of an object that is needed to make it stay at threshold visibility in presence of disability glare generated by luminaires of a road lighting installation.

Note 1 to entry: TI is a measure of the effect of disability glare, described as an equivalent veiling luminance caused by scattering of light in the human eye. TI values are calculated in accordance with EN 13201-3 by means of an equation for the equivalent veiling luminance which represents a young person. When setting requirements for the limitation of the TI, or when evaluating calculated TI values, it should be taken into account that the scattering in the eye tends to increase with the age of the person. The increase is individual and may be low for some, by a factor of two for others and can be high for persons suffering from untreated cataract conditions.

3.4
edge illuminance ratio EIR (of illumination of a strip adjacent to the carriageway of a road)
R_{EI}
average horizontal illuminance on a strip just outside the edge of a carriageway in proportion to the average horizontal illuminance on a strip inside the edge, where the strips have the width of one driving lane of the carriageway

Note 1 to entry: Separate values apply for each of the two sides of a carriageway, and for each of the two sides of both carriageways of a dual carriageway. When a minimum requirement is made for the EIR of a lighting installation, each of the separate values shall meet the requirement.

3.5
average illuminance (on a road area)
$\bar{E}$
horizontal illuminance averaged over a road area

Note 1 to entry: Unit is lux (lx).

3.6
minimum illuminance (on a road area)
E_{min}
lowest illuminance on a road area

Note 1 to entry: Unit is lux (lx).

3.7
hemispherical illuminance (at a point on a road area)
E_{hs}
luminous flux on a small hemisphere with a horizontal base divided by the surface area of the hemisphere

Note 1 to entry: Unit is lux (lx).

3.8
average hemispherical illuminance (on a road area)
$\bar{E}_{hs}$
hemispherical illuminance averaged over a road area

Note 1 to entry: Unit is lux (lx).

3.9
overall uniformity (of road surface luminance, illuminance on a road area or hemispherical illuminance)
U_o
ratio of the lowest to the average value

3.10
maintained level (of average road surface luminance, average or minimum illuminance on road area, average hemispherical illuminance, minimum semi-cylindrical illuminance or minimum vertical plane illuminance)
design level reduced by a maintenance factor to allow for depreciation

3.11
semi-cylindrical illuminance (at a point)
E_{sc}
total luminous flux falling on the curved surface of a very small semi cylinder divided by the curved surface area of the semi cylinder

Note 1 to entry: The axis of the semi cylinder is to be vertical and the direction of the normal to the flat face inside the semi cylinder is to be the direction of orientation of the semi cylinder.

Note 2 to entry: Unit is lux (lx).

3.12
minimum semi-cylindrical illuminance (on a plane above a road area)
$E_{sc,min}$
lowest semi-cylindrical illuminance on a plane at a specified height above a road area

Note 1 to entry: Unit is lux (lx).

3.13
vertical plane illuminance (at a point)
E_v
illuminance at a point on a vertical plane

Note 1 to entry: Unit is lux (lx).

3.14
minimum vertical plane illuminance (on a plane above a road area)
$E_{v,min}$
lowest vertical plane illuminance on a plane at a specified height above the road area

Note 1 to entry: Unit is lux (lx).

4 Requirements for motorized traffic

The M classes in Table 1 are intended for drivers of motorized vehicles on traffic routes of medium to high driving speeds.

NOTE 1 Guidance on the application of these classes is given in CEN/TR 13201-1.

The average road surface luminance ($\bar{L}$), the overall uniformity of the luminance (U_o), the longitudinal uniformity of the luminance (U_l), the threshold increment (f_{TI}) and the edge illuminance ratio (R_{EI}) are to be calculated and measured in accordance with EN 13201-3 and EN 13201-4.

Table 1 — M lighting classes

Class	Luminance of the road surface of the carriageway for the dry and wet road surface condition				Disability glare	Lighting of surroundings
	Dry conditions			Wet	Dry conditions	Dry conditions
	$\overline{L}$ [minimum maintained] cd·m^2	U_o [minimum]	U_l [a] [minimum]	U_{ow} [b] [minimum]	f_{TI} [c] [maximum] %	R_{EI} [d] [minimum]
M1	2,00	0,40	0,70	0,15	10	0,35
M2	1,50	0,40	0,70	0,15	10	0,35
M3	1,00	0,40	0,60	0,15	15	0,30
M4	0,75	0,40	0,60	0,15	15	0,30
M5	0,50	0,35	0,40	0,15	15	0,30
M6	0,30	0,35	0,40	0,15	20	0,30

[a] Longitudinal uniformity (Ul) provides a measure of the conspicuity of the repeated pattern of bright and dark patches on the road surface and as such is only relevant to visual conditions on long uninterrupted sections of road and should therefore only be applied in such circumstances. The values stated in the column are the minimum recommended for the specific lighting class, however, they may be amended where specific circumstances appertaining to the road layout or use are determined by analysis or where specific national requirements appertain.

[b] This is the only criterion for wet road conditions. It may be applied in addition to criteria for the dry condition in accordance with specific national requirements. The values stated in the column may be amended where specific national requirements appertain.

[c] The values stated in the column f_{TI} are the maximum recommended for the specific lighting class, however, they may be amended where specific national requirements appertain.

[d] This criterion shall be applied only where there are no traffic areas with their own lighting requirements adjacent to the carriageway. The values shown are tentative and may be amended where specific national or individual scheme requirements are specified. Such values may be higher or lower than the values shown, however care should be taken to ensure adequate illumination of the areas is provided.

NOTE 2 The road surface luminance is the result of the illumination of the road surface, the reflection properties of the road surface and the geometrical conditions of observation. Conventions are given in EN 13201-3 and EN 13201-4, aiming at driving along stretches of road with viewing distances of between 60 m and 160 m.

NOTE 3 The average luminance ($\overline{L}$) reflects the general luminance level at which the driver performs. At the low level of lighting used for road lighting, performance improves with luminance in terms of increasing contrast sensitivity, increasing visual acuity and amelioration of glare.

NOTE 4 The overall uniformity (U_o) measures in a general way the variation of luminances and indicates how well the road surface serves as a background for road markings, objects and other road users.

NOTE 5 The longitudinal uniformity (U_l) provides a measure of the conspicuity of the repeated pattern of bright and dark patches on the road. It relates to visual conditions on long uninterrupted sections of road.

NOTE 6 The threshold increment (f_{TI}) indicates that although road lighting improves visual conditions it also causes disability glare to a degree depending on the type of luminaires, lamps and geometric situation. The calculated f_{TI} values represent a young driver. The underlying cause of glare is scattering in the human eye which tends to increase with the age of the person. The increase is individual and may be low for some, by a factor of two for others and can be high for persons suffering from untreated cataract conditions.