SLOVENSKI STANDARD

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Svetloba in razsvetljava – Razsvetljava športnih objektov

Light and Lighting - Sports lighting

Licht und Beleuchtung - Sportstättenbeleuchtung

Lumiere et éclairage - Eclairage des installations sportives

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Light and Lighting - Sports lighting

Lumière et éclairage - Eclairage des installations sportives

Licht und Beleuchtung - Sportstättenbeleuchtung

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard 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of an identical text or by endorsement, at the latest by February 2000, and conflicting national standards shall be withdrawn at the latest by February 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European standard deals with sports lighting to ensure good visual conditions for players, athletes, referees, spectators and CTV transmission.

The objective is to specify recommendations and requirements for good quality sports lighting by

- optimizing the perception of visual information used during sports events;
- maintaining the level of visual performance;
- providing acceptable visual comfort.

1 Scope

This standard specifies lighting for those indoor and outdoor sports events most practised in Europe. It gives lighting values for the design and control of sports lighting installations in terms of illuminances, uniformity, glare restriction and colour properties of the light sources. All requirements are meant to be as minimum requirements. It also gives methods by which these values are measured. For the limitation of glare, it also points out restrictions on the location of the luminaires for specific applications.

For emergency lighting this standard refers to the requirements of EN 1838.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited in the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1838		Lighting applications – Emergency lighting
prEN 12464	1996	Lighting applications – Lighting of work places
prEN 12665	1996	Lighting applications – Basic terms and criteria for specifying lighting requirements

3 Definitions

For the purposes of this standard the definitions of prEN 12665 and the following definitions apply:

3.1 Principal area (PA)

The actual playing area needed for the performance of a certain sport. Usually this means the actual marked out "field" area for that sport (for instance football), but in some cases this area comprises an extra playing area around the marked area (e. g. tennis, volleyball, table tennis).

NOTE: In all tables in annex A examples of area sizes are given which are most commonly used for that sport. The particular area dimensions should be checked at the time when designing a lighting installation.

3.2 Total area (TA)

Generally this area comprises the principal area (PA) plus an additional safety area outside the principal area.

3.3 Reference area

Area defined per sports on which the main lighting requirements apply including the marking lines and any extra area centred around the marked area.

NOTE: The dimensions of this area are generally based on PA, for the relevant sport and level of competition. For most sports this reference area is limited by a rectangle in the horizontal plane of the ground. An example of reference area is given in figure 1 where l and w stand respectively for the length and the width of the rectangular reference area. Where a total area (TA) is specified, it will also be necessary to fulfil the requirements as defined in 5.1 a).

3.4 Grid points for measurement and calculation

Arrangement of calculation and measurement points and their number in each dimension of the reference area.

When the reference area is rectangular, l_p and w_p (see figure 1) define the dimensions of the rectangle limited by the four corner points which are common for calculation and measurement.

When the reference area covers a symmetrical track, l will be l_p, which is the quarter of the length of the inner limit of the track, w the width of the track as defined in figure 2.

4 General principles of the lighting installation

4.1 Reference grid for calculation and measurement

The verification of the lighting levels provided by a lighting installation requires lighting measurements on site. It is then advisable to define a specific grid in such a way that the lighting designer and customer can have a common ground when carrying out lighting calculation and measurement. These grids are generally rectangular. The illuminances are calculated or measured at every centre of grid rectangles. The grid limits are defined in 3.4. The reference level of the grid is generally the ground for horizontal illuminance evaluation or at one meter above for vertical illuminances, unless stated otherwise. The grid points are completely determined by the length and the width of the reference area or, for a track (see figure 2), by the quarter of the length of its inner limit and its width as described in 4.1.1.

4.1.1 Grid size for calculation and measurements for particular sports

In principle the grid size necessary for calculation and measurement depends on the sports area under consideration, the geometry of the installation, the luminous intensity distribution of the luminaires used, the required accuracy and the photometric quantities to be evaluated. Although this dependance cannot be described in a simple way, in practice the maximum grid size can be estimated as:

$$p = 0{,}2 \cdot 5^{\log d} \qquad (1)$$

where:

p is the grid size;
d is the longer dimension of the reference area.

The number of points in the longer dimension is given by the nearest odd whole number of d/p .

The resulting spacing between the grid points is used to calculate the nearest odd whole number of grid points in the shorter dimension. This will give a ratio of length to width of a grid cell near to 1.

NOTE: The formula (coming from CIE Report X005) has been derived under the assumption log p proportional to log d, where:

p = 0,2 m for d = 1 m
p = 1 m for d = 10 m
p = 5 m for d = 100 m

4.1.2 Grid size for calculation and measurements for multi-sports facilities

Where there are several marked playing areas within a total area (e. g. multi-use sports hall) a calculation and measurement over the whole area can be made, using the dimensions of this whole area to determine the number of grid points according to the formula in 4.1.1. However checks should be performed for any separate playing area within the total area, using the grid specified for the particular sport, for instance when there are specific users or competitions (e. g. badminton, basketball, volleyball).

4.1.3 Application

The calculation grid is defined in order to verify the specified performance of a new installation. The measurement grid can be the same as the calculation grid, however this will usually lead to an excessive number of measuring points. It is therefore recommended that a reduced number of points are taken and measured values compared to calculation at these points. This reduced grid should be agreed between the designer and the client and used as the basis of checking the installed performance. The numbers of calculation points are defined for most of sports in the grouped tables of lighting requirements (see annex A). It will be noticed that the proposed calculation grids in 4.1.1 are such that the number of points for length or width is odd and always allows a measurement grid every two points while keeping a symmetric repartition of the points over the reference area. An example of measurement points is given in figure 1 and figure 2 with encircled points.

NOTE: Further guidance on measurement grids can be found in CIE XXX (TC 5.11).

The average illuminance is determined as the mean arithmetical value obtained from all the points. For new installations calculation of initial illuminances have to be compared to actual measurements. The initial illuminances are calculated from the maintained illuminances given in the tables of requirements in annex A, taking into account an appropriate maintenance factor.

p_w: calculation grid increment widthwise
b: width of the principal area PA
p_l: calculation grid increment lengthwise
d: length of the principal area PA
w: width of the reference area
w_p: calculation grid width
l: length of the reference area
l_p: calculation grid length
•: calculation point
⊙: calculation and measurement point

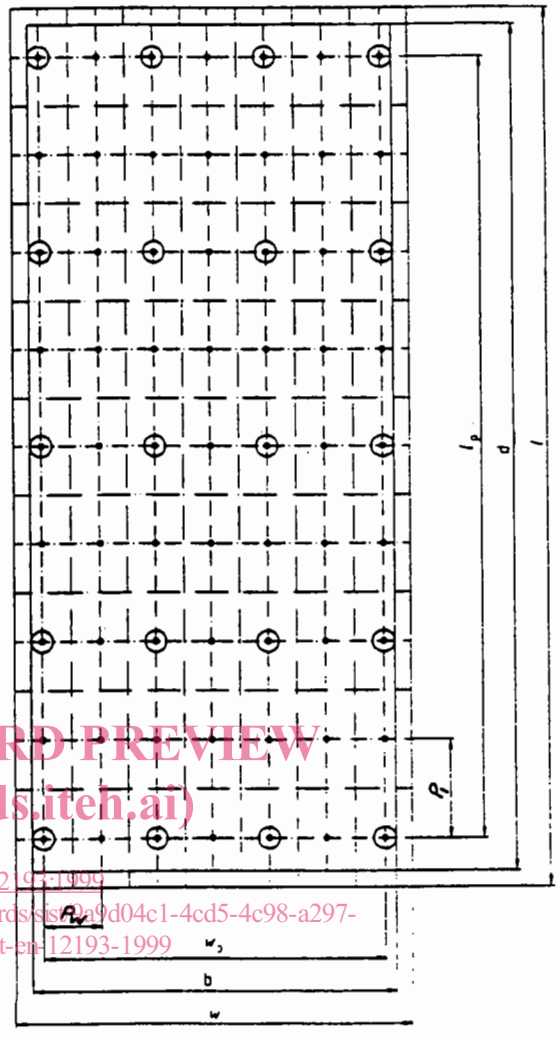
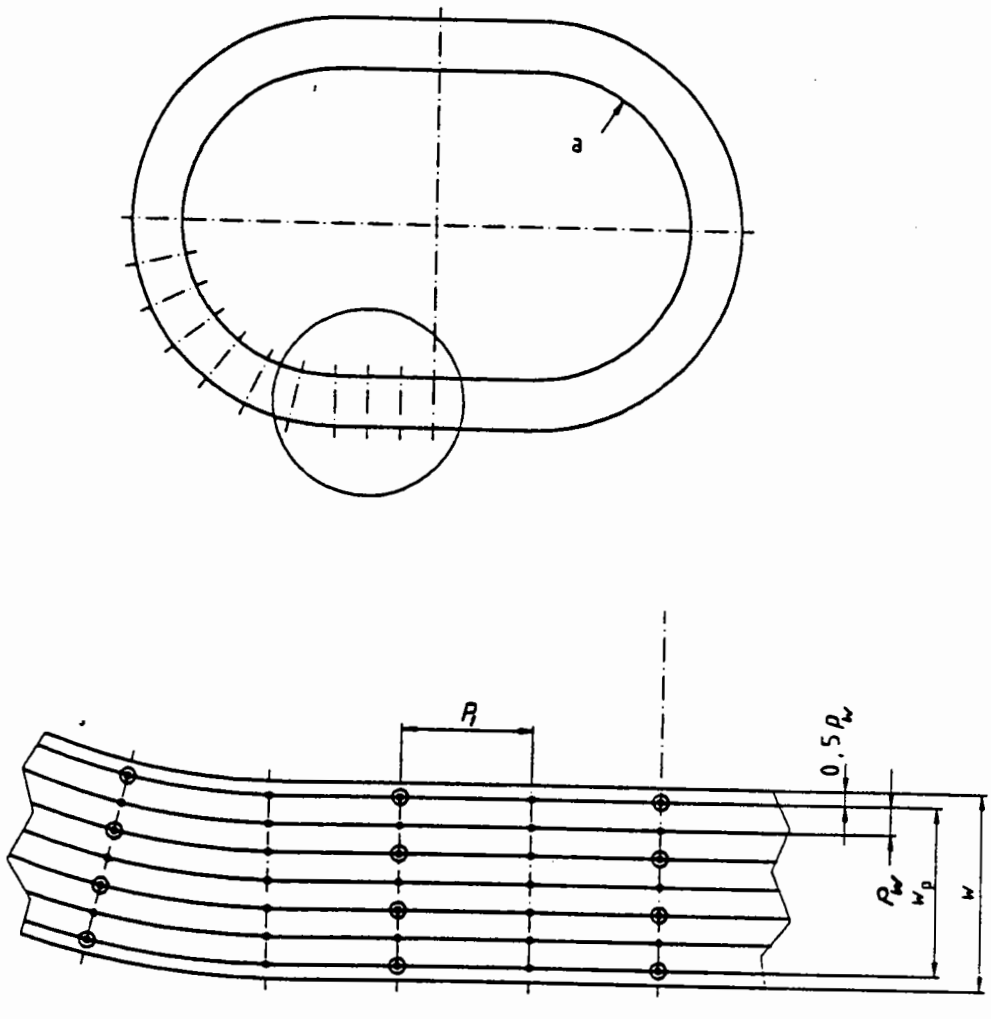


Figure 1: Reference area, calculation grid points and an example of measurement grid points



a: inner limit of the track
w: width of the track
w_p: calculation grid width
p_l: calculation grid increment lengthwise
p_w: calculation grid increment widthwise
• : calculation point
⊙ : calculation and measurement point

Figure 2: Reference area, calculation grid points and an example of measurement grid points for a track

4.2 Measuring equipment

The selection of an appropriate measuring equipment is important for correct measurement.

NOTE: Details of the performance requirements for photometric equipment is given in CIE Publication 69.

4.3 Measurement record

The following details shall be included in the photometric measuring record:

a) Nomenclature of the sports ground;
b) Date and time of measuring;
c) Type of installation and geometric details of luminaires installation;
d) Type and number of lamps, control gear, dimmers and luminaires where relevant;
e) Age of the luminaires and lamps; number of hours the lamps have operated;
f) Time of the last cleaning and number of hours the lamp have operated since this last cleaning;
g) Operating voltage while measuring;
   – if the operating voltage differs from the nominal voltage of the lamp while measuring, a correction factor for the luminous flux has to be considered,
   – the operating voltage has to be measured close to the lamps or the ballasts for discharge lamps.
h) Ambient temperatures of the measuring units and luminaires;
i) An indication of reflectance of the bordering surfaces (in case of interiors);
j) Climatic conditions in case of exterior installations;
k) Type of measuring unit, manufacturer, serial number, class, calibration;
l) Note the location and aiming of any luminaires which are abnormally not operating during the survey.

4.4 Tolerated differences

A difference between the measured and calculated values is likely to occur as a result of:

a) tolerances in manufacturing luminaires, lamps, etc.;
b) tolerances in the photometric measurements;
c) tolerances in position and aiming of luminaires.

Taking these tolerances into account, the differences between the measured and calculated average values shall be ≤ 10 %. Additional differences can be caused by voltage variation, which have to be taken into account.

4.5 Maintenance

The lighting level provided by a lighting installation will decrease throughout life as a result of:

– depreciation of the lamps and the luminaires;
– dirt accumulation on the lamps and the luminaires;
– depreciation of room surfaces;
– lamps survival rate.

Planning the maintenance operation is therefore essential if the original design parameters are to be met throughout the life of the installation. As such, it is expected that lamp change and cleaning intervals will form a part of the lighting design for a specific area.

The maintenance factor shall be agreed between the designer and customer at the outset. This shall include the planned maintenance programme on which the maintenance factor is based. If no maintenance factor is agreed, a value of 0,8 shall be used.

NOTE: To define maintenance factor for indoor installations, information can be taken from CIE Publication 97.

Special consideration shall be given to the location of luminaires to ensure that maintenance can be carried out with the minimum of disruption.

4.6 Spectator area lighting

For the visual comfort of spectators rather than safety or emergency reasons, the lighting level shall be at least 10 lx.

4.7 Safety for participants and the continuation of an event in case of lighting failure

4.7.1 Safety lighting for participants

Participants safety is ensured by the safe stopping of an event which might otherwise be dangerous to continue in the absence of lighting.

The lighting level for the safe stopping of an event is a percentage of the level for that class (see 5.1). This applies to the following sports and percentages listed below.

– Swimming	5 % for a minimum period of 30 s
– Indoor gymnastics	5 % for a minimum period of 30 s
– Indoor and outdoor equestrian	5 % for a minimum period of 120 s
– Speed skating	5 % for a minimum period of 30 s
– Bobsleigh and tobbogans	10 % for a minimum period of 120 s
– Ski jump and landing	10 % for a minimum period of 30 s
– Ski slopes	10 % for a minimum period of 30 s
– Cycle racing	10 % for a minimum period of 60 s

The safety lighting shall come on on the instant the general lighting fails and last for at least the period specified.

4.7.2 Continuation of a sport

For the continuation of a sport, the lighting level shall be at least the Class III level specified for that sport (see tables of annex A).

4.8 Glare restriction

Glare shall be limited to avoid a reduction in visual performance.

4.8.1 Indoor

NOTE: Some measures for limiting glare may be taken from CIE Publication 117.

Measures for limiting glare have been developed for working areas mainly with a horizontal viewing direction and a regular layout of ceiling mounted luminaires. It may be necessary, therefore, to take additional measures for limiting glare in indoor sports facilities, depending on the type of sports.

NOTE: For example, the risk of glare caused by high brightness light sources in the player's field of view at some critical point in the game, can require special attention to the positioning and screening of light sources to avoid this effect. On the other hand, the viewing direction of a sports participant is constantly changing, whereas in working areas, discomfort glare is aggravated by a relatively fixed viewing position and direction. In indoor sports facilities however, there can be frequently occuring viewing directions for some sports, where discomfort glare should be limited as far as possible. For these sports, additional notes are added to the tables of requirements in annex A.

In situations similar to working conditions described in prEN 12464 glare should be evaluated using the unified glare rating (UGR) method. The limiting value shall be equivalent to those specified in prEN 12464.

4.8.2 Outdoor

Glare rating values (GR) used in the tables of requirements in annex A apply. The glare rating shall be calculated for agreed observer positions and angles of view.

NOTE: CIE Publication 112 has been taken into account to define the GR values for most sports.

4.9 Surface colours and reflection properties

Surface colours shall be chosen taking into account the usual tasks involved in the intended activities including knowledge of the colours of objects to be viewed against the background in question.

NOTE: These surfaces should be matt to avoid glare due to the reflection of bright sources.

5 Requirements for the lighting of sports most practised in Europe

5.1 General requirements

Annex A contains 28 tables of requirements to which, in addition, the following general points apply.

a) All illuminances quoted in the tables are maintained and apply to the principal area (PA).

Furthermore, when total areas (TA) are specified in the tables, their illuminance requirements shall additionally be a minimum of 75 % of those of the principal area (PA) of the sport being considered.

b) In multi-purpose halls better colour rendering than that stated in the tables can be required to reveal the pitch markings.

c) Reference area dimensions are rounded and given only as an indication in order to determine the number of grid points. For exact dimensions the individual sporting federation should be contacted. For some sports there is a variation in the dimensions of the playing area that affects the number of grid points. Typical minimum and maximum dimensions are shown in the tables together with the corresponding number of points.

d) The tables of requirements are based primarily on the needs of the participants. It is necessary to ensure a minimum vertical component. This shall not be less than 30 % of the horizontal level.

e) It is important that the standard of play and spectator viewing distance are both taken into account in selecting the class of lighting to be used. The higher the standard of play and the longer the spectator viewing distance, the higher the class of lighting that shall be selected.

f) Semi-cylindrical illuminances can also be taken into account but no guidance levels have been provided as actual values will be dependant on both viewing positions and type of installation.

The following explanations and table 1 assist in the selection of the lighting class.

Lighting Class I: Top level competition such as international and national competition which will generally involve large spectator capacities with long potential viewing distances. Top level training can also be included in this class.

Lighting Class II: Mid level competition such as regional or local club competition which generally involve medium size spectator capacities with medium viewing distances. High level training can also be included in this class.

Lighting Class III: Low level competition such as local or small club competition which generally do not involve spectators. General training, physical education (school sports) and recreational activities will also come into this category.

Table 1: Selection of the lighting class

Level of competition	Lighting class		
	I	II	III
International and National	*		
Regional	*	*	
Local	*	*	*
Training		*	*
Recreational/School sports (Physical education)			*