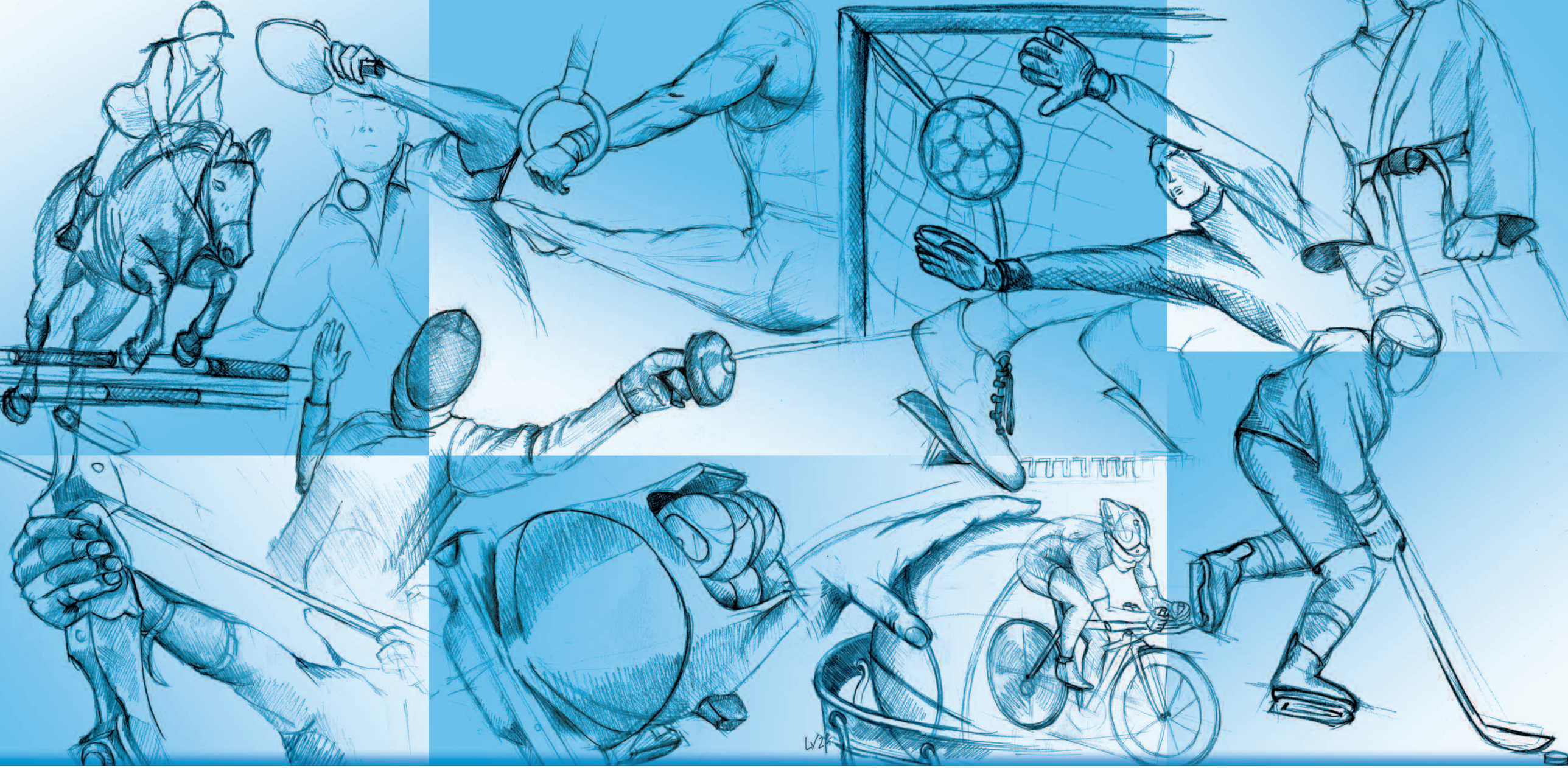

Contacts

Philips Lighting
Being the world's leading supplier of sports lighting, Philips has an extensive experience in implementing projects from individual tennis courts to Olympic stadiums. For further information, contact your local Philips Lighting organisation or send an e-mail to the following address: info.sportslighting@philips.com

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Guide to the artificial lighting of indoor and outdoor sports venues

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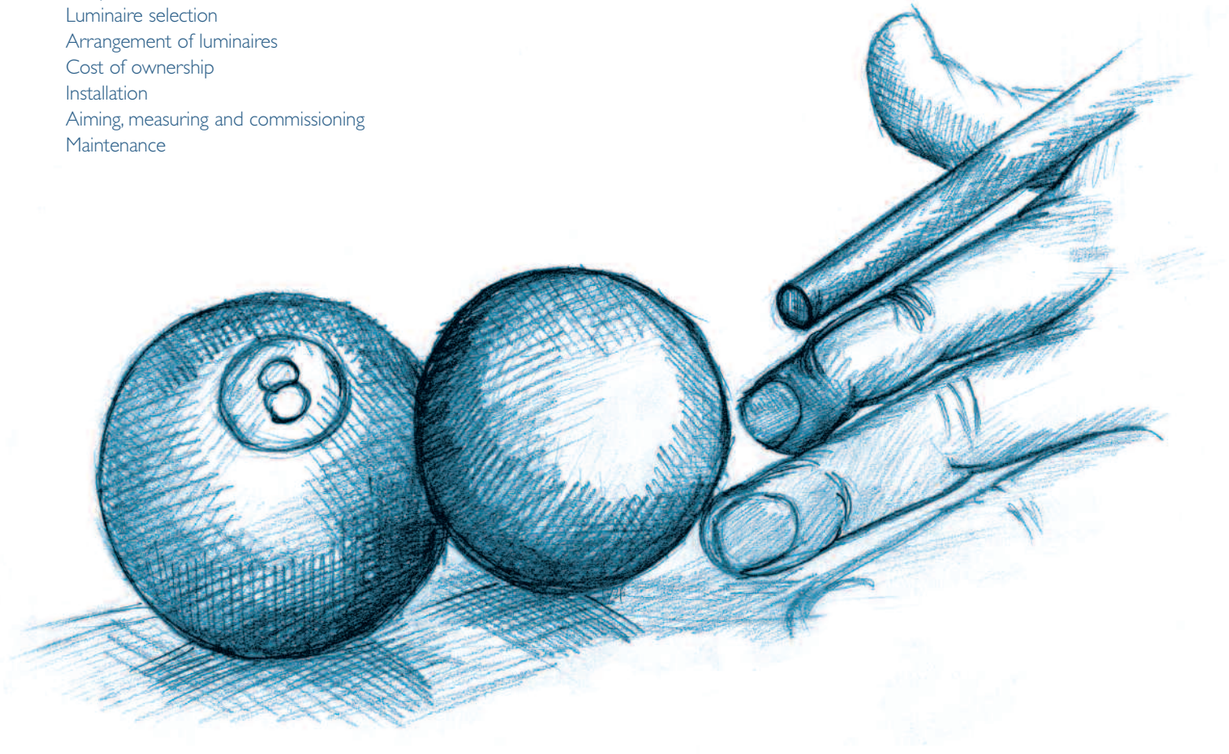

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Introduction

This guide makes recommendations for lighting installations for indoor and outdoor sports venues and is intended for anyone involved in the management, development or improvement of such venues.

Why is good lighting necessary for sport?

All sporting events require good light to enable the sport to be played properly, the best results to be achieved and to provide enjoyment for participants and spectators, whether they are present in the venue or watching at home on television. To maximise the use of limited space and expensive facilities, venues are increasingly being used for a range of different sports and even for other events as well, such as concerts, theatre performances and exhibitions. This needs to be taken into account in the lighting design. Media coverage, and television coverage in particular, is playing an ever-increasing part in sporting events and this means there is a demand for lighting that will enable excellent image quality whilst also limiting the glare and distraction for players, spectators and referees. This media exposure has also encouraged more people to take an interest in sport and this, in turn, has led to a demand for better venues. The quality of the lighting installation is one of the main factors that determine the quality of a venue.

The reality

Sometimes the lighting is not given proper consideration and an inadequate lighting system is installed. This almost always proves to be a false economy and at some stage the participants, spectators and television companies demand an upgrade – at considerable extra cost. The end result is that the work is effectively carried out twice. When venues are developed and refurbished it is important to incorporate energy-efficient installations so that wastage can be reduced to a minimum. How can all these factors be taken into account to achieve a good lighting scheme? The objective of this guide is to give sports venue owners/managers, architects, engineers and site technicians the necessary basis to enable them to proceed with a lighting project for a new or existing indoor or outdoor sports venue.

How is the guide structured?

The guide starts by giving an overview of the key terms used and the important issues in sports lighting. This is followed by the lighting design process for indoor and outdoor sports venues. The 'Recommendations' section is then divided into two parts:

- Non-televised venues: indoor and outdoor
- Televised venues

Whether or not events are going to be televised is crucial for the lighting decision-making process. EN12193 is the European norm for sports lighting, and this is often used as a basis outside Europe as well. It should be noted that the relevant national recommendations for sports lighting may also need to be taken into account. You are advised to contact a sports lighting specialist for guidance. Contacts details are given at the end of this guide.
This guide is designed as an 'umbrella' guide for all GAISF sports where sports lighting is a key issue. It does not therefore go into each sport in detail. The specialised detailed guide for the following sports associations should also be referred to: FIFA (football) • FIBA (basketball) • ITF (tennis) • FIH (hockey) • IAAF (athletics).

Key terms in sports lighting

Glossaries with key terms are usually found at the end of a guide. This section not only gives basic definitions of specific terms but also gives sound practical advice and has therefore been placed at the front. Good sports lighting design aims to achieve three things. Firstly, to ensure optimum visibility for participants and spectators (including television spectators); secondly, to create a visually satisfying and interesting scene; and, thirdly, to ensure that the lighting system integrates well with the surrounding architecture. What factors need to be taken into account to achieve this?

Quantity of light required (illuminance)

This is the amount of light (measured in lux) that is required for the sport to be played. The faster the sport and the smaller the playing object, the higher the lighting level required. Normally several different settings or 'switching modes' are recommended so that the lighting system can be used efficiently at all levels, from 'training mode' (non-televised) right through to 'international TV' mode (televised).

Average maintained horizontal illuminance (Eh)

This is the average quantity of lux to be achieved over the agreed maintenance cycle period for an installation. Maintenance includes replacement of lamps and cleaning of luminaires.
Where there is television coverage, it is becoming increasingly common for minimum lighting levels to be specified in the industry. This is also true for the vertical illuminance described below.

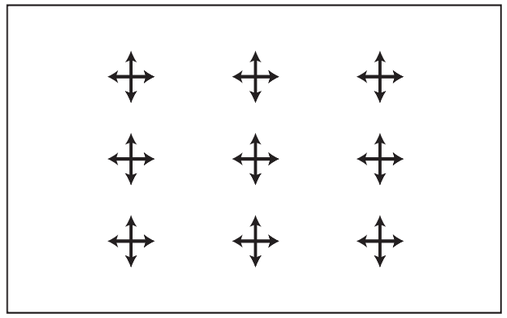
Light surrounding the player

Average maintained vertical illuminance (Ev)

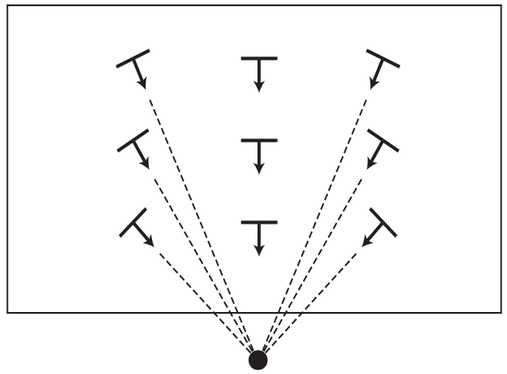
Vertical illuminance
This is the quantity of light on a vertical plane and should be calculated for unrestricted camera positions.

Camera illuminance
This is the quantity of light that shines in the direction of a fixed camera position. Calculations should be carried out using the actual angles perpendicular to the camera positions. The side of a player forms the reference for a television camera. The camera illuminance should ideally also be considered for the ball in flight, as this reading will differ from the camera illuminance at ground level. For diving, the camera illuminance should be considered from the diving point to the surface of the water.
It may be important to provide TV shots of the spectators. The contrast ratio between the participants and the spectators should therefore be considered (as a rule of thumb, 15% of the average camera illuminance level can be assumed, but see the section on theatrical effects).
The point of reference: This is generally defined as being 1.5m from the ground, except for some sports such as swimming and diving.

Vertical illuminance



Camera illuminance



Illuminance uniformity

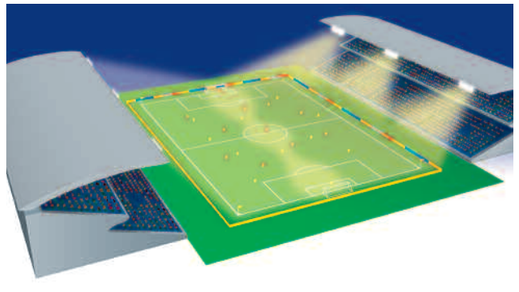
There are two measurements that are normally taken:

Minimum/Average: This is the ratio of the lowest to the average level of illuminance.

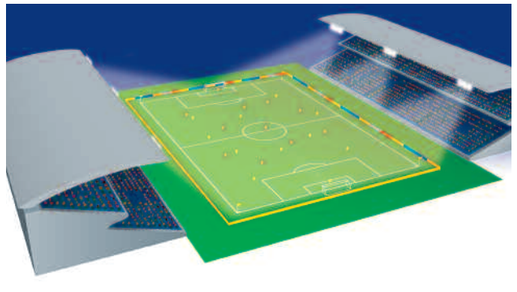
Minimum/Maximum: This is the ratio of the minimum to the maximum level of illuminance.

An adequate level of uniformity is required to create balanced lighting conditions so that people's eyes and the television cameras do not continually have to adapt to a different light level.

Poor uniform appearance



Good uniform appearance



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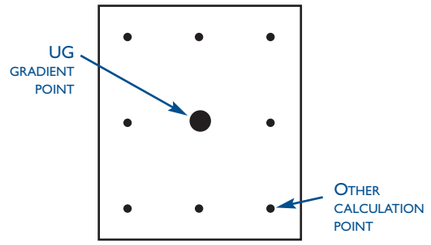
Uniformity gradient

As a television camera pans over a match or tournament, the differences in illuminance levels will affect the image quality. It is therefore not only the uniformity that needs to be considered, but also the gradient of change between the calculation points. The UG is expressed as a ratio of the illuminance at a single point to the 8 adjacent grid points, as shown in the diagram on the right.




NATURAL COLOUR (DAYLIGHT)


POOR COLOUR RENDERING UNDER ARTIFICIAL LIGHTING


GOOD COLOUR RENDERING UNDER ARTIFICIAL LIGHTING

Modelling and shadows

Modelling defines the ability of the lighting to reveal form and texture. This can affect how attractive a scene looks. Shadows can cause serious problems on a field of play.

A classic example is ice hockey, where the side barriers around the perimeter of the playing area can create a harsh shadow at the edges of the ice pitch if the luminaires are not positioned correctly.
To reduce harsh shadows a ratio of 60/40 should be used as a rule of thumb to determine the maximum number of luminaires on one side of a sports arena in relation to the number of luminaires on the other side.

Colour rendering

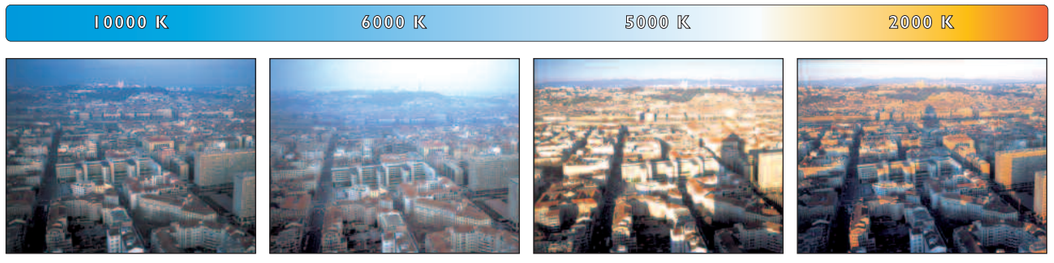
Colour rendering is the ability of a light source to reproduce surface colours accurately. A colour rendering index (Ra) is used to describe the performance of a lamp.

Definition	Colour Rendering Index
Colour matching (advertising)	Ra 91-100
Good colour rendering	Ra 81-90
Moderate colour rendering	Ra 51-80
Poor colour rendering	Ra 21-50

Colour temperature (colour appearance)

This is the apparent colour of the light source and is often described as 'warm', 'white' or 'cool'. The colour temperature is defined in degrees Kelvin (K). The lower the value, the warmer the colour appearance. For example, 2700 K has a warmer colour appearance than 4000 K.

The colour temperature is used to help create the ambiance in a space and should not be confused with the colour rendering. If there is to be television coverage, it is not recommended to mix colour temperatures.



BOREAL SKY NORTHERN LIGHTS SUN AT THE ZENITH DAYLIGHT IN THE AFTERNOON SUNLIGHT SUN ON THE HORIZON LIGHT AT DUSK

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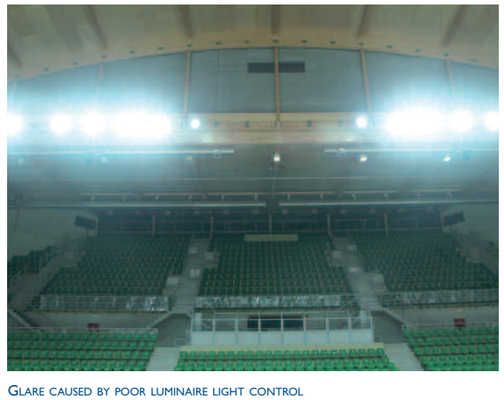
Glare

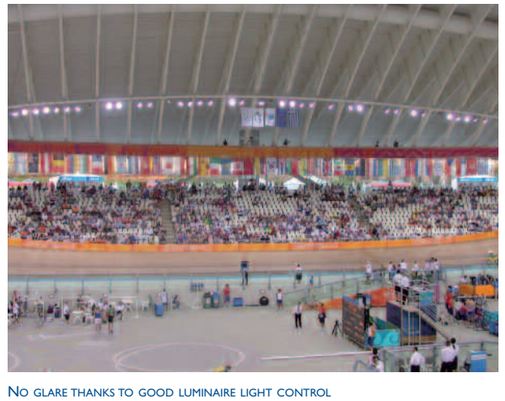
'Glare' is a controversial issue. There are mathematical formulae for calculating glare, but whether or not people will experience glare in a sporting situation is something that is very subjective. Obviously, if someone looks straight at a 2 kW luminaire at close range they will experience 'glare', but in the majority of other situations it is less clear whether an individual will experience glare from the lighting. Below are the key parameters that determine glare.

Specific recommendations are given in the sections on indoor sports, outdoor areas and outdoor stadiums. It is strongly recommended that a sports lighting specialist is consulted to ensure glare is reduced to a minimum.

CIE glare assessment
At outdoor sports venues a glare rating based on the CIE document 112 should be determined with 'observers' positioned on the playing field and in the stands.
There are currently no specific quantifiable recommendations in terms of European norms for the reduction of glare in indoor sports lighting. EN12193 makes reference to CIE publication 117. Due to the almost infinite number of installation possibilities, it is very difficult to devise an accurate system for measuring indoor glare. Below are the key parameters that determine glare.
Specific recommendations are given in the sections on indoor sports, outdoor areas and outdoor stadiums.

Factors which influence glare
- Viewing angles. It is essential to consider which sports are going to be played and to anticipate what the key viewing angles will be. Luminaires should be arranged in such a way as to take account of these viewing angles.
- Luminaire light control. If the luminaire has the facility to control the light produced by the lamp this can play a significant part in determining the amount of glare. This is one of the reasons why it can be a false economy simply to opt for the cheapest lighting solution.
- Maximum tilt angle of luminaire. The aiming angle of a luminaire must be limited to control glare.
- The intensity of the source in relation to the installation height. This should be adapted to suit the relevant situation.


GLARE CAUSED BY POOR LUMINAIRE LIGHT CONTROL


NO GLARE THANKS TO GOOD LUMINAIRE LIGHT CONTROL

Emergency escape lighting

To ensure orientation and a safe escape for spectators and players in an emergency, refer to EN1838 for emergency lighting.

Switching mode

Lighting should be designed to include different levels of light that are appropriate for the relevant level of play. The different levels of play are outlined at the beginning of the 'Recommendations' section. This is also relevant from the point of view of energy consumption.
The following levels or 'switching modes' are commonly used:
- Training
- Competition
- Emergency TV
- International TV

Emergency (continuity) television lighting and hot restrike

A sports arena should ideally have a backup power source in case the principal power supply fails. If high-intensity discharge lamps are to be used, the lighting installation should incorporate an 'emergency TV' switching mode with 'hot restrike' luminaires. A hot restrike system enables a high-intensity discharge lamp to be re-lit straight away in the event of a temporary power failure, instead of having to wait for up to 15 minutes before the lamp can restart. This is not only essential for television coverage, because the loss of images for up to 15 minutes is unacceptable, but also for the participants and spectators because the lack of lighting will totally disrupt play.

Obtrusive light

It is uncontrolled light that is directed up in to the sky or beyond the boundary of a sports facility.
Reference should be made to CIE 150 or local regulations.

The sports lighting design process

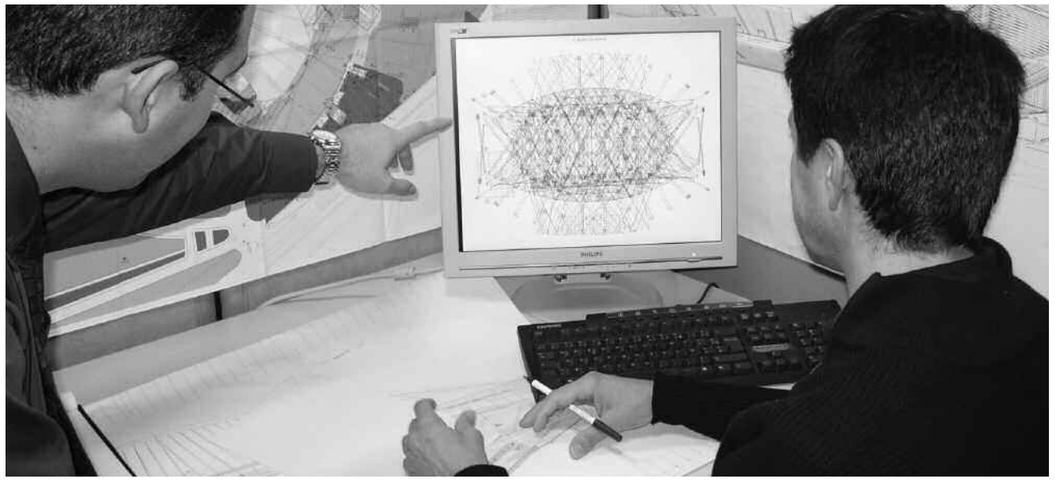
Whether for an indoor or outdoor venue, each sports lighting project is unique due to the many different organisations that are involved in the process. Below are a number of general guidelines to help prevent fundamental errors being made.

Project definition

The short and long-term objectives for the sports arena should be clearly defined, taking into account the potential use of the arena for other events. Is there going to be television coverage?
What sports will the venue be used for?
It is important to consult a lighting expert, broadcasting companies and sports specialists at an early stage in the project definition process.

Lighting study

Once the objectives have been defined, a lighting study needs to be carried out. See the list of contacts at the back of this guide. The lighting study will define the necessary quantities, types and positioning of the luminaires in order to achieve the set objectives.
The quality of the lighting study will depend on the standard of information supplied to the designer. Below are some of the questions which should always be answered.



Questions for indoor and outdoor venues

Questions relating to indoor and outdoor venues

- What fixtures are there that might obstruct the output of light (e.g. structural beams and stands)?
- At what height are the fixing positions?
- How will access be ensured to allow for aiming, commissioning and maintenance of luminaires?
- What sports will be played here?
- What classes of play are likely and expected?
- Is there an emergency (continuity) electrical supply?
- What other events will the sports venue be used for?
- What different electrical circuits are planned? (This is crucial for the planning of the 'switching modes'. See the section on emergency escape lighting)
- Will the space be used for other events in the future? How will this affect the lighting requirements?
- What power supply is going to be installed?
- What natural light enters the arena and where does it fall at times when sports are being played?
- Will there be TV coverage?

See the sections on 'indoor sports venues' and the 'outdoor sports venues' for questions relating to specific types of venues.

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Lamp selection

The principal factors for lamp selection are: luminous output, lamp life, energy consumption, colour rendering and colour temperature (appearance). It is important to find the right balance between these factors in order to create a successful lighting installation.

Fluorescent

Advantages:
- Low energy consumption
- Long lamp life
- Good colour rendering
- Cool to the touch

Disadvantages:
- Not suitable if there is to be TV coverage.
- Bulky source, so difficult to control and focus light.
- Only possible if lighting is positioned lower than 8-10 metres.
- Only used for indoor venues.

Sodium discharge

Advantages:
- Long lamp life
- High efficacy (efficiency)
- Cheap to replace

Disadvantages:
- Low colour rendering, so not suitable for TV coverage.
- Risk of poor focusing due to large size of source.

Metal halide high-intensity discharge

Advantages:
- Suitable for TV coverage
- Very good colour rendering
- Excellent focusing possible due to small size of source

Disadvantages:
- Shorter lamp life
- More expensive source

Luminaire selection

A preliminary decision must be made about the lighting design approach. Essentially there are two possible approaches:

Direct lighting
This is the most common approach because the system is likely to be very efficient. If there is to be TV coverage, this is the only option because adequate vertical illuminance is required.

Indirect lighting
In some indoor installations, such as swimming pools, this can be a useful solution because the users will not be able to see the light source. However, the approach relies heavily on the reflective properties of the ceiling, the positioning and the light output ratio of the luminaires chosen and the planned cleaning cycle. TV coverage is not possible with this solution. Only luminaires for direct lighting can be used.

Other considerations include

- All luminaires must conform to EN60598, which is the norm for luminaire electrical safety.
- IP rating. Resistance to dust and water for outdoor application.
- Maximum ambient temperature. This is particularly relevant for indoor venues.
- Luminaire wind drag factor. This will determine the required strength of the supporting structure outdoors.
- Weight.
- Ease of maintenance. Consider how accessible the lamp is and how easily the reflector can be cleaned.
- Ease of installation.
- Manufacturer's technical support. What level of technical competence can the manufacturer offer?

Arrangement of luminaires

The luminaires should be arranged in a manner that is appropriate for the type of sports to be played. For example, for football luminaires should not be positioned behind the goal area. The appropriate horizontal and vertical illuminance level (if there is to be television coverage) needs to be determined in conjunction with the necessary uniformity and glare control.

Luminaires must be positioned in such a way as to prevent glare for participants and judges. Consider the sports being played and the various normal viewing angles.

For example, when players are serving in tennis, they do not want luminaires at the far end of the court to be in their line of vision when they hit the ball.

In larger, multi-purpose halls with fluorescent or discharge lighting it is usual to arrange the lighting in rows between the courts, thus reducing the risk of glare in the players' field of vision.

More specific recommendations are given in the sections on 'indoor sports venues' and 'outdoor sports venues'.

Khalifa Stadium, Doha Qatar

Cost of ownership

There is a wide variety of lighting systems available on the market and there can be a temptation to choose the cheapest solution. In most cases you get what you pay for and the cheapest luminaires may have reduced photometric efficiency, be made from low-quality materials or the manufacturer may have little expertise and provide poor levels of support.

A cost-of-ownership study should be carried out, taking into account the following factors:

Quantifiable aspects

- Initial cost of luminaires and lamps
- Number of luminaires needed to achieve the required result
- Ease of installation
- Ease of maintenance
- Quality of luminaire materials/likely lifetime of product
- Power consumption
- Competent support from the manufacturer – is this available? If not, what will a consultant cost?
- Cost of gear replacement
- Efficiency of the gear system, taking into account ballast losses.

Less quantifiable aspect

Even in non-televised events, the competitors, judges and spectators attach great importance to their sport and expect the lighting to work effectively.

In the case of televised events, the sponsorship for the event and the status of the venue depend very much on the performance of the lighting. It is not wise to rely on a poor system. There have been occasions when the lighting has failed twenty minutes into the match, causing an important match to be abandoned and leading to the potential loss of millions in future sponsorship deals.

A good quality lighting system is a simple way to ensure optimum conditions for an event to take place and the right ambiance to ensure the event is enjoyed by the participants and the spectators, both in the arena and at home.

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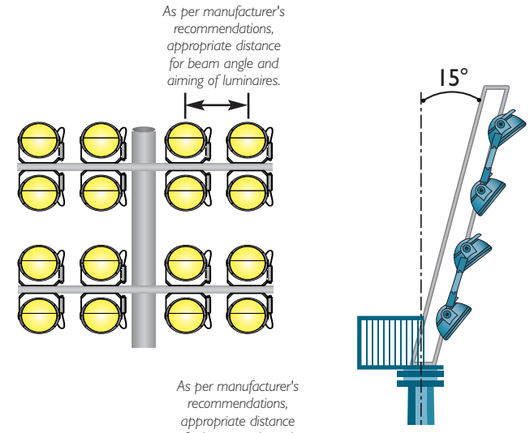
Installation

It is important that the luminaires are installed as indicated in the lighting study, and that sufficient space is allowed for the necessary movement and for the luminaires to be aimed in the correct direction. The aiming point could easily be at the other end of the sports area. There must be access to the luminaires for commissioning and maintenance/cleaning and sufficient space must be allowed to accommodate the width of the beam.

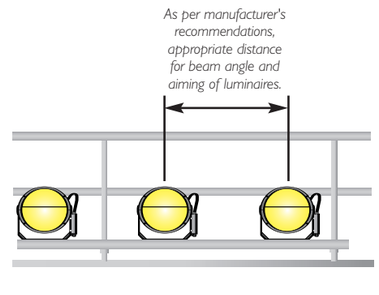
Headframe mounting

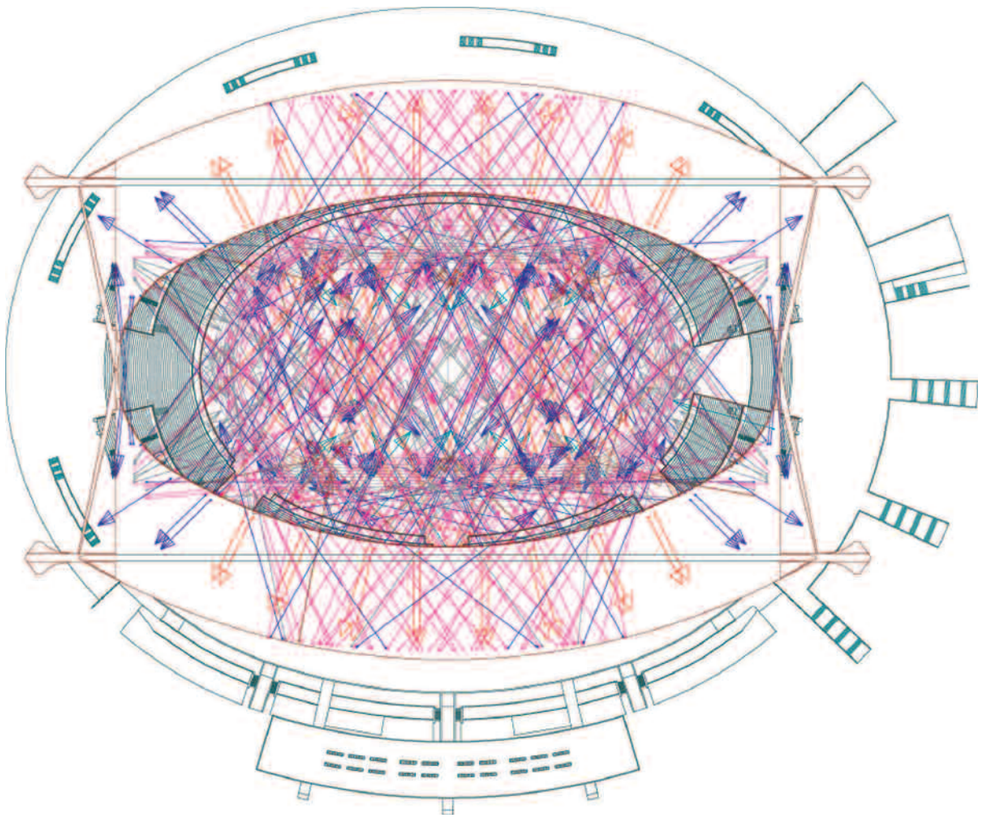
To prevent the light from one luminaire being cut off by an adjacent luminaire, it is important to allow on appropriate distance between luminaires as indicated by the luminaire manufacturer should be included.



Catwalk mounting

Luminaires should be installed in accordance with the lighting design. They should be accessible from the catwalk for aiming and for lamp replacement. They should be installed in such a way as to prevent the light being cut off by any structural elements.





Aiming, measuring and commissioning of luminaires

Luminaires should be aimed as indicated in the lighting design. It is recommended that this is done by a sports lighting specialist at the time of commissioning. It is wise to carry out preliminary measurements before final commissioning to enable last-minute adjustments to be made. At the final stage commissioning measurements should be carried out and signed by the person who took them together with the consultant. Voltage measurements should be taken at the ballast and at the lamp.

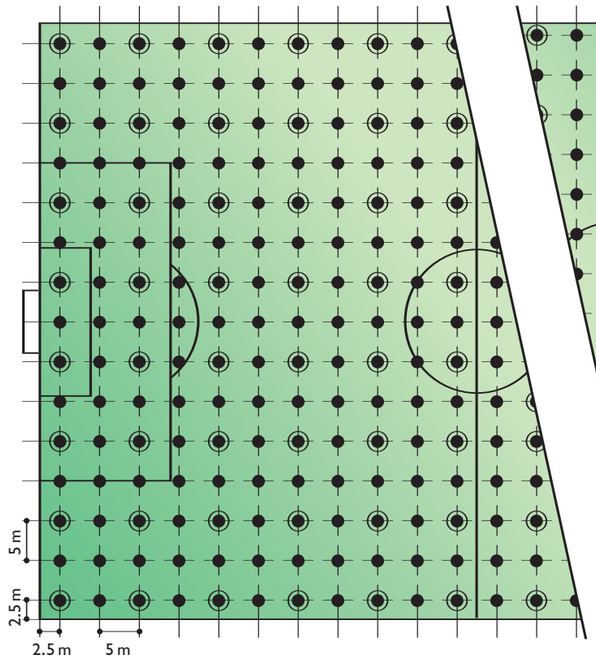
When measuring the different switching modes, it is advisable to start at the highest level, e.g. 'International TV' and to then work downwards; this prevents the need to let discharge lamps warm up.

Maintenance

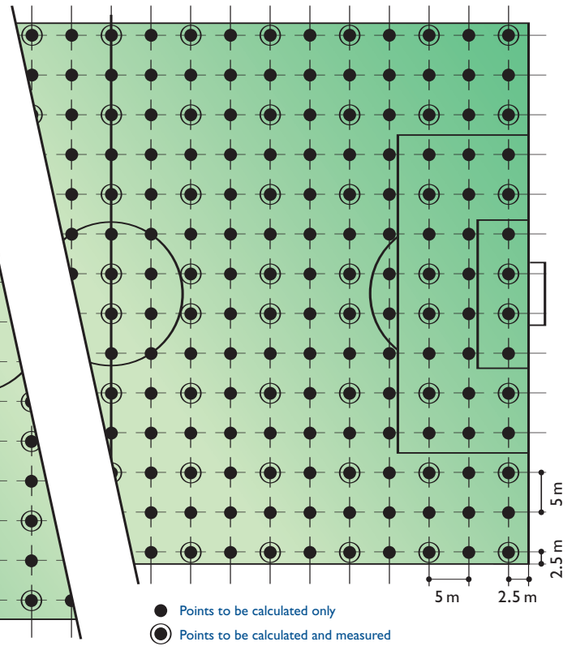
A good maintenance plan is essential to ensure a long luminaire life. Dirt collects on the front glass and reduces the output. The performance of lamps diminishes over time.

A good lighting study should include information about the replacement and recommended periodic cleaning of the luminaires.

Example grid for pitch 110 m X 75 m



Example grid for pitch 105 m X 68 m



The spacing of the measuring grid for specific sports is defined in the Federation recommendations and EN12193.

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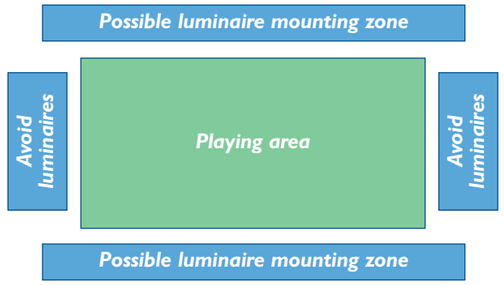
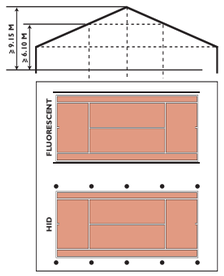
Indoor sports halls

The layout for lighting in multi-purpose halls

Most indoor sports halls are suitable for a wide variety of sports and events. These may be staged at anything from local club level to international competition level.
For this reason, the requirements to be fulfilled by the hall need to be defined at the outset. Additional adjustments can then be made for specific sports. A key consideration when positioning the luminaires is glare prevention. An example of mounting positions for a multi-purpose indoor hall is shown on the right side. It should be noted that this is a generic diagram and it is always important to carry out a lighting study for each specific project: If there is a polished / varnished floor surface thought should be given to the reflections caused by the luminaires and the viewing positions (camera / spectators).



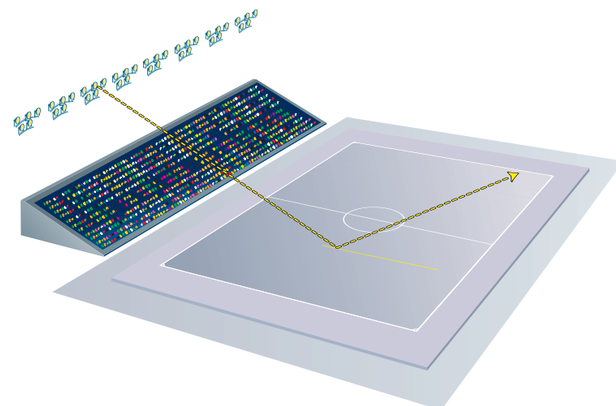
Tennis



Refer to the 'Guide to the artificial lighting of tennis courts' for detailed information. Luminaires should be positioned at a minimum height of 9.144 metres above the court surface at the net and at a minimum height of 6.096 metres at the base lines. Account should be taken of the window position so the luminaires are not in the players' line of vision.

Ice hockey

The diagram on the right shows how luminaires can be positioned to avoid glare. The reflective properties of ice are similar to those of a mirror. Luminaires should be positioned at a steep angle to reduce reflection into the eyes of the players and to enable television cameras to operate effectively.



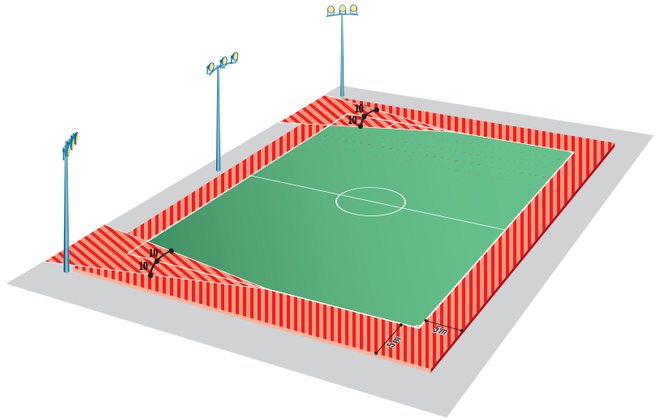
Sports grounds and stadiums

Lighting configurations

There are many possible different lighting configurations for sports grounds, but broadly speaking they fall into three categories:

- Lighting from columns or masts
- Lighting from the spectator stand
- A combination of the above.

Sports lighting is increasingly being positioned within the stand, if there is an appropriate mounting height, it reduces the amount of obtrusive light (also called light pollution) and improves architectural integration.

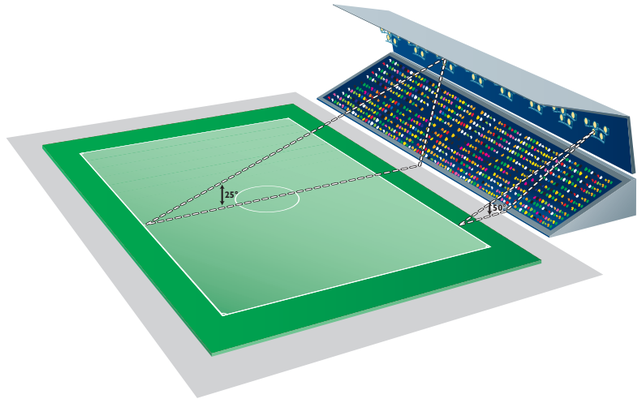


Sports grounds with no spectator stand

If there is no spectator stand or the spectator stand is not high enough (a lighting study will show this), then columns or masts are required. The diagram on the right shows some of the possible configurations and the zones where it is permitted for masts to be positioned for general sports fields.

Sports grounds with a spectator stand

Ideally, lighting should be designed to be an integral part of the spectator stand because it is one of the factors that determine the optimum height of the structure. A lighting study should be carried out to determine if the stand is high enough and whether the distance from the pitch is appropriate for the required horizontal and vertical illuminance levels and uniformity. If the structure is too low, there will be an increased risk of glare. A sports lighting specialist will be able to advise on this. The diagram below is generic; a lighting study should always be carried out because each stadium has a different layout.



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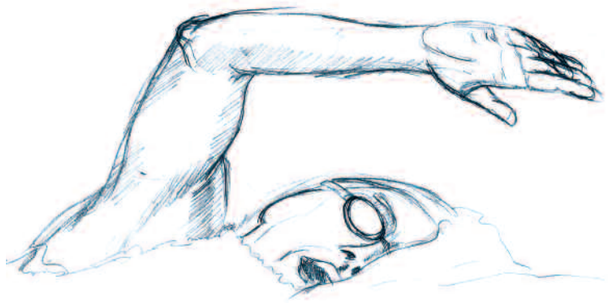
Swimming and diving

Swimming: A key factor to be considered for all types of swimming pools is how to position the luminaires in relation to the spectators and the television cameras without creating glare or unwanted reflections for the participants. It is not always easy to get this balance right. Water acts as a reflective surface and, furthermore, this surface moves (+/-20°), thus increasing the reflective area. Lighting levels for TV coverage should be calculated at water level as this is the point of reference.

Diving: The factors that affect the positioning of luminaires for swimming also apply to diving. The vertical illuminance from the diving position to the water surface should also be calculated.



Winter sports

Downhill skiing

For all sports, lighting makes it possible to continue play after dark. As the days are shorter in the winter, this is especially applicable for snow sports.

As the skiers travel downhill, they pass level with each luminaire on the slope. It is therefore important that the lighting is positioned so that it cannot be seen by the skier. Usually the lighting is aimed across and down the slope. However, this can mean that there is not sufficient vertical illuminance for the cameras that are facing up-hill, so it is necessary to aim some luminaires up hill.

Other considerations

Theatrical effects and dynamic lighting

Theatrical effects are increasingly being included in sports arenas where it is appropriate to add drama to the sporting action. For example, for fencing and boxing the ring is lit as the focal point, with little or no light on the spectators. A good sports lighting system makes it possible to add shutters; these can be used to cut the light quickly so that the event can be opened or closed in a theatrical way. In addition to this, dynamic coloured lighting can be added to complete the theatrical experience.

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Recommendations

Recommendations for non-televised events

The following tables show the class of play followed by the recommended minimum average horizontal illuminance level and the minimum/average level of uniformity. The minimum colour rendering level is then given and, in the case of outdoor sports, this is followed by the maximum permitted glare rating.

Non-televised outdoor lighting recommendations

Class	Horizontal illuminance	Uniformity min/ave	Colour rendering	Glare rating
American football, Athletics, Basketball, Cycle racing, Equestrian sports, Fistball, Football, Handball, Netball, Rugby and Volleyball				
I	500	0.7	>60	<50
II	200	0.6	>60	<50
III	75	0.5	>20	<55
Note: For Class III athletics and equestrian sports the minimum illuminance is 100 lux as per EN12193. For athletics this can be reduced to 50 lux for running sports. For Cycling Class II: 300 lux (0.7). Class III: 100 lux.				
Swimming (Aquatic sports)				
I	500	0.7	>60	<50
II	300	0.7	>60	<50
III	200	0.5	>20	<55
Note: For diving, vertical uniformity should also be considered. Class I: 0.8 Eh/Ev. Class II: 0.5 Eh/Ev. Class III: 0.5 Eh/Ev.				
Tennis				
I	500	0.7	>60	<50
II	300	0.7	>60	<50
III	200	0.6	>20	<55
Note: Values refer to 'Total Playing Area' as defined by ITF.				
Baseball, Bandy, Cricket, Hockey, Ice hockey, Ice skating, Motorcycling and Softball				
I	750	0.7	>60	<50
II	500	0.7	>60	<50
III	300	0.7	>20	<55
Outfield for Baseball, Cricket and Softball				
I	500	0.5	>60	<50
II	300	0.5	>60	<50
II	200	0.3	>20	<55
Bobsleigh and Luge				
I	300	0.7	>60	<50
II	200	0.5	>60	<50
III	50	0.4	>20	<50
Boules sport (Lawn, Raff and Petanque)				
I	200	0.7	>60	<50
II	100	0.7	>20	<50
III	50	0.5	>20	<55
Archery				
I, II, III	200	0.5	>60	-
Vertical illuminance				
	Target	Uniformity min/ave		
I, II, III	750	0.8		
Alpine & Freestyle skiing				
I	150	0.5	>60	<50
II	100	0.4	>20	<50
III	50	0.3	>20	<55
Ski Jump landing area				
I	300	0.7	>60	<50
II	200	0.6	>20	<50
III	200	0.6	>20	<55
Note: Run Down, Class I 50 lux (0.5), class II 50 lux (0.3), class III 20 lux (0.3)				

Horizontal and vertical values: All illuminance levels shown are average.

Classes of play

Class I: Top-level competitions, both national and international. There are usually large numbers of spectators and long viewing distances.

Class II: Mid-level competition, matches at regional or local club level with medium-sized groups of spectators and average viewing distances.

Class III: Low-level competition and recreational sport. This normally involves small numbers of spectators and short viewing distances.

These three classes can be further grouped into five categories due to the grey areas between the different levels of sport:

Level of competition:
- International and national: Class I
- Regional: Class I and II
- Local: Class I, II and III
- Training: Class II and III
- Recreational: Class III

The GAISF sports have been grouped together in a similar way to the sports in the European norm. These classes of events do not take account of television coverage; this is dealt with separately in recommendations for televised events.

Non-televised indoor lighting recommendations

Class	Horizontal illuminance	Uniformity min/ave	Colour rendering	Glare rating
Aikido, Basketball, Bodybuilding, Cycle racing, Fistball, Floorball, Football, Handball, Ju-Jitsu, Judo, Karate, Korfball, Netball, Powerlifting, Sambo, Sepaktakraw, School sports (physical education), Sumo, Taekwondo, Volleyball, Weightlifting, Wrestling, Wushu.				
I	750	0.7	>60	n/a
II	500	0.7	>60	n/a
III	200	0.5	>20	n/a
Boxing				
I	2 000	0.8	>80	n/a
II	1 000	0.8	>80	n/a
III	500	0.5	>80	n/a
Note: Vertical illuminance at 1.5ms should be >50% of Eh.				
Athletics, Dancing, Equestrian sports, Gymnastics, Roller Sports and Wall climbing				
I	500	0.7	>60	n/a
II	300	0.6	>60	n/a
III	200	0.5	>20	n/a
Note: For wall climbing Class I: 500 lux vertical. Class II: 300 lux vertical. Class III: 200 lux vertical				
Swimming (Aquatic sports)				
I	500	0.7	>60	n/a
II	300	0.7	>60	n/a
III	200	0.5	>20	n/a
Note: For diving, vertical uniformity should also be considered. Class I: 0.8 Eh/Ev. Class II: 0.5 Eh/Ev. Class III: 0.5 Eh/Ev.				
Tennis				
I	750	0.7	>60	n/a
II	500	0.7	>60	n/a
III	300	0.5	>20	n/a
Note: Values refer to 'Total Playing Area' as defined by ITF.				
Badminton, Basque pelota, Cricket, Cricket nets, Curling, Fencing, Hockey, Ice hockey, Ice skating, Raquetball, Squash and Table tennis				
I	750	0.7	>60	n/a
II	500	0.7	>60	n/a
III	300	0.7	>20	n/a
Note: For fencing, Class I: 500 lux vertical. Class II: 300 lux vertical. Class III: 200 lux vertical. Cricket net Class I: 1500 lux (0.8). Class II: 1000 lux (0.8). Class III: 750 lux (0.8)				
Billiards				
I	750	0.8	>80	n/a
II	500	0.8	>80	n/a
III	500	0.8	>80	n/a
Boules sport (Lawn, Raff and Petanque)				
I	500	0.8	>60	n/a
II	500	0.8	>60	n/a
III	300	0.5	>20	n/a
Bowling, Archery, Shooting				
I	200	0.5	>60	-
II	200	0.5	>60	-
III	200	0.5	>60	-
Vertical illuminance				
	Pins	Target 25 m	Target 50m	Uniformity min/ave
I, II, III	500	1000	2000	0.8

Horizontal and vertical values: All illuminance levels shown are average.

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Recommendations for televised events

If there is to be television coverage, the illuminance and uniformity towards the camera need to be considered. Vertical illuminance may also need to be calculated.

Measurements should be taken 1.5 m above the playing surface. For swimming, calculations should be made at water level.

Major events

	Horizontal Illuminance	Uniformity Mn/Ave	Uniformity Mn/Max	Vertical Illuminance	Uniformity Mn/Ave	Uniformity Mn/Max	Colour Rendering	Glare Rating
HDTV	1500-3000	0,8	0,7	2200	0,7	0,6	>90	<50
Slow-motion Camera	1500-3000	0.8	0.6	1800	0.7	0.5	>80	<50
Fixed Camera	1500-3000	0.8	0.6	1400	0.7	0.5	>80	<50
Mobile Camera	1500-3000	0.8	0.6	1200	0.5	0.3	>80	<50

Average horizontal and vertical illuminance ratios: It is recommended that the ratio for horizontal illuminance (Field of Play) is between 0.75 and 1.5 of the vertical illuminance for cameras. Where there is HDTV all horizontal values for other cameras are as for HDTV.

National events

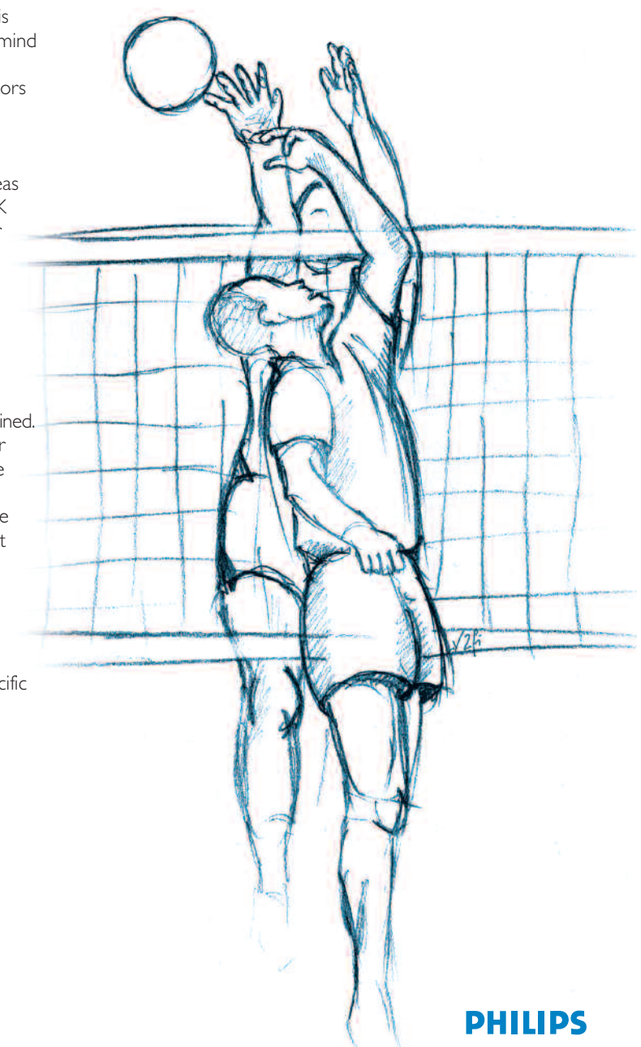
	Horizontal Illuminance	Uniformity Mn/Ave	Uniformity Mn/Max	Vertical Illuminance	Uniformity Mn/Ave	Uniformity Mn/Max	Colour Rendering	Glare Rating
Camera	1000-2000	0.7	0.5	1000	0.6	0.4	>80	<50

Camera requirements for good television images
Although with new television camera technology the levels of light required to produce an image are lower, there is still a risk of inconsistent image quality. It is with this in mind that the figures have been chosen.
The quantity of light needs to be coordinated with factors such as colour rendering and colour temperature.

Colour temperature
The same colour temperature should be used in all areas of the sports arena. A value between 4200K and 5600K is normally recommended. For outdoor sports a higher K value is normally chosen.

Colour rendering
The colour rendering index should be no less than 80 and it should preferably be 90.

Positioning of luminaires
The positions of the television cameras should be determined. Given that illuminance should be calculated perpendicular to the camera, the positioning of the luminaires should be considered in order to ensure sufficient illuminance. For example, if the angle between the luminaire and the player is too steep it will be difficult to achieve sufficient camera illuminance. It is strongly recommended that professional advice is sought on how to carry out the lighting study. The table gives television lighting recommendations which are designed to cover all of the sports included in this guide. The speed of the sport and the viewing distances will determine the specific requirements for a sports installation.



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List of federations and associations

referred to in this GAISF guide:

Aikido (IAF)
American football (IFAF)
Aquatics (FINA)
Archery (FITA)
Athletics (IAAF)
Badminton (IBF)
Bandy (FIB)
Baseball (IBAF)
Basketball (FIBA)
Basque pelota (FIPV)
Billiards (WCBS)
Bobsleigh (FIBT)
Bodybuilding (IFBB)
Boules (CMSB)
Bowling (FIQ)
Boxing (AIBA)
Cricket (ICC)
Curling (WCF)
Cycling (UCI)
Dancing (IDSF)
Equestrian sports (FEI)
Fencing (FIE)
Fistball (IFA)
Floorball (IFF)
Football (FIFA)
Gymnastics (FIG)
Handball (IHF)
Hockey (FIH)
Ice hockey (IIHF)
Ice skating (ISU)
Ju-Jitsu (JJIF)
Judo (IJF)
Karate (WKF)
Korfball (IKF)
Luge (FIL)
Motorcycling (FIM)
Netball (IFNA)
Powerlifting (IPF)
Raquetball (IRF)
Roller sports (FIRS)
Rugby (IRB)
Sambo (FIAS)
School sports (ISF)
Sepaktakraw (ISTAF)
Shooting (ISSF)
Skiing (FIS)
Softball (ISF)
Squash (WSF)
Sumo (IFS)
Table tennis (ITTF)
Taekwondo (WTF)
Tennis (ITF)
Volleyball (FIVB)
Weightlifting (IWF)
Wrestling (FILA)
Wushu (IWUF)