

Guidance Note 2/18

Guidance for lighting of televised sporting events



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Scope of this document

This document is addressed to designers, architects, planners and decision makers who are involved in the design of arenas, stadia and sport facilities that require artificial lighting in order to broadcast televised events in the United Kingdom.

The document refers to existing lighting standards and good practice and it is not meant to be a substitute for these, but rather to provide high-level understanding of the processes and consultation required in setting up a coherent lighting brief to meet the needs of the sports persons, spectators, broadcasters and viewing audience. It discusses the design requirements and how to approach the delivery of this type of work.

Relevant bodies and standards

The main sources of guidance and standards for sport and broadcast lighting are written by:

- Professional bodies such as the ILP and CIBSE
- National and international standards organisations such as BSI, CEN and CIE
- Sport federations
- Television companies

Television companies are the main reference for the most up-to-date technical requirements for broadcast lighting. It is fundamental to appreciate that, even for a large venue with thousands of spectators attending the event, the potential audience of a television broadcast can reach millions of spectators: thus good broadcast conditions are fundamental to a successful event. Approaching television companies during the venue design stage is advisable in order to implement the correct requirements. Most television companies have documents that summarise lighting requirements for a specific type of production. These documents can be extremely detailed and technical and will provide location of cameras, measurement grids, illuminance, colour rendering, and colour quality requirements.

Professional bodies and lighting associations such as CIBSE, BSI and CIE provide guidance and standards for lighting applications. Most of these documents are meant to provide a base layer of understanding of the requirements for sports lighting but in most cases do not provide a complete description of broadcast requirements*. Most of the documents prescribe values of illuminance and uniformity. These values are an indication and a good reference but should be always discussed with the relevant stakeholders. Note that the technological progress is far quicker than any standardisation panel, thus values and requirements may be out of date so it is advisable to consult a broadcast specialist.

Sport federations and national governing bodies provide a number of guidance documents which summarise the requirements in order to provide ergonomic conditions for players, match officials and spectators of a specific game. Among general requirements are specific lighting conditions. However, these tend to refer only to the area within which the sporting activity takes place and broadcasters tend to require other areas to be covered.

Design guidance and relevance

It is clear that TV viewers form the major audience for sporting events and must be considered without sacrificing the enjoyment of the live audience present at such events and the need for the lighting to create the right atmosphere in the venue. At the same time, the requirements and comfort of the participants in the event must not be forgotten.

Because there are several different standards and guidance documents, and different bodies providing them, it is often

* One exception is, for example, the CIE TC 5.26, which specifically covers the lighting of sporting events for television and film broadcasting. But even then, there may be other event-specific requirements which need considering. For example, uniformity or glare requirements may be higher than in the CIE documentation.

very difficult to structure a workflow in order to progress with a good design. For this reason, it is proposed that each body and set of requirements and guidance documents is considered for their specific expertise.

For example, a given sporting federation will understand the mechanics of a specific game in an attempt to prevent glare sources from becoming visible to players and match officials (for example along the line of sight of a player throwing or receiving a ball or along the line of sight of

a match official looking at the action). FIFA, for example, provides a diagram showing the exclusion zones. These exclusion zones must be considered in the design of the venue.

Good design guidance, provided by lighting and professional body standards, allows the designer to select contrast between action and spectators, the type of light source, and the light colour to be provided. Some standards are more detailed than others and it is very important that the designer reads all those

Table 1: Summary of areas of investigation and the recommended path

Aspect of lighting design	Sport federation	Professional bodies	Television companies
Position of luminaires	Exclusion zones based on athletes and judges.	Generic guidance.	Exclusion zones based on camera locations.
Glare and angles	Exclusion zones based on athletes and judges.	Requirement for glare target, no specific guidance on exclusion zones.	Exclusion zones based on camera locations.
Illuminance requirements, ratios and uniformity	Sport-specific, most of the time not detailed.	Detailed, may be less onerous than production-specific requirements.	Generally, very specific and clear. If available should be used as the main source.
Flicker requirements	Not specified	Some very generic requirements.	Production-specific, however flicker free is becoming the standard.
Colour rendering	Basic requirement in most cases.	Detailed, may be less onerous than production-specific requirements.	Very onerous due to sponsor logos. TLCI12 is becoming the new metrics for colour rendering for broadcast applications.
Colour temperature	Basic requirement in most cases.	Detailed, may be less onerous than production-specific requirements.	Generally, very specific and clear. If available should be used as the main source.
Finishes in the venue	Can be very detailed.	Not specified	Production-specific (to limit camera exposure range).
Spectator lighting	Considered only for safety.	Detailed, may be less onerous than production-specific requirements.	Generally, very specific and clear. If available should be used as the main source.
Event continuation	Focused on safety of users.	Focused on safety of users.	Production-specific.

appropriate to the project to have an overview of the requirements. Of more importance is to note that up-to-date production requirements most likely exceed and supersede these.

For this reason, the final check is to consider the broadcast requirements by the production and television companies. These will allow the designer to select the correct technology and finalise aiming angles and other aspects of the design.

Table 1 summarises the area of investigation and the recommended path.

Project phases

The delivery of a sports broadcast lighting project can be described in four main phases. These are:

Briefing stage

The main goal at this stage is to ensure that the lighting requirements are clear, understood and agreed by client and stakeholders. It is important to appoint a lighting designer and a broadcast specialist who have the correct expertise to advise regarding the latest technological trends. The deliverable for this stage is the briefing document.

Concept design stage

This is when the main geometry of the venue is determined, when the aiming logic and high-level lighting design strategies are discussed. Even if this is an early stage, it is advisable that full luminaire aiming is carried out. This allows the designer to define the correct positions, quantities, weights and electrical load for the lighting system. The deliverable for this stage is a concept design, informing the geometry of the venue and the principles of the lighting design. A report including calculations and drawings is commonly provided.

Detailed design stage

This is the stage when the geometry of the venue is already defined and design work focuses on the detailed aspects of the

installation. The position of fixtures, product specifications, bracket design, maintenance, and access are usual topics. The deliverables for this stage include detailed aiming drawings, lighting specifications and a technical calculation report clearly demonstrating to the stakeholders the predicted performance of the lighting system.

Construction and commissioning

During construction the designer is often required to oversee the installation and to provide assistance with mock-ups and aiming. Commissioning of a sports lighting system can take several days and is likely to require a degree of fine tuning. Measurements, aiming and testing will be carried out with illuminance meters, luminance meters, cameras and flicker meters. After the commissioning is completed, the deliverable is a report summarizing the performance of the lighting system. The report is useful to demonstrate that the venue achieves the required lighting goals.

Project deliverables and commissioning of sport broadcast

Project deliverables for specialist lighting traditionally include specifications, drawings and calculations. Calculations are presented as a table of numbers or as false colour plots of illuminance over a standardised measurement grid.

It is important to understand that meeting illuminance requirements is only the first step to providing good broadcast lighting. In order to demonstrate that a lighting design meets requirements, especially during the development of the detailed design and before construction, it is advisable to produce a set of photometrically accurate renderings of the venue that demonstrate the quality of the lighting effect achieved. These renderings can show the venue from camera positions and check contrast, uniformity and glare and facilitate the review and discussion from stakeholders and broadcasters.

The traditional measurement for illuminance and uniformity has recently been expanded to include flicker factor and glare. The broadcast companies use camera equipment to acquire footage and test events in order to validate a design. The quality of this footage is used to determine whether broadcast requirements are met. Filming is one of the simplest and most effective ways to demonstrate compliance for a design as cameras are high precision measurement instruments. It is pointless to argue that bad footage is not a conclusive proof of a poor lighting design or installation.

Team structure and requirements

The client should ensure that all relevant parties are represented in the design team. It is critical that both a competent lighting designer and a competent broadcast specialist are included. This will prove more valuable throughout the project as it will minimise risks of dealing with broadcast requirements at too late a stage.

By not doing so, dealing with broadcast requirements only at detailed design stage may result in the requirement for unforeseen mitigation measures to address shortfalls, which could include the provision of a complete temporary overlay for broadcast lighting with all associated programme and cost implications.

The Construction, Design and Management (CDM) Regulations 2015 applies to all construction projects whether new sites or modifications to existing installations. It places a responsibility on the client to appoint a principal designer, designer or contractor only when they have taken reasonable steps to ensure that the organisation or individual they propose to appoint is competent, i.e. has the skills, knowledge, experience and capability necessary to fulfil the role. The CDM Regulations not only require the designer to be competent in design but to also understand construction and maintenance requirements.

By the same token, designers and organisations should only accept such a role if they have the required skills, knowledge, experience and capability.

Competency can be evidenced through the designer providing details of their training, experience and knowledge of lighting design relevant to the application being considered, in this case sports lighting and broadcasting.

All designers should have the appropriate level of professional indemnity (PI) insurance to provide the designer with cover for claims made due to any problems encountered with work, advice or process.

Main lighting design principles

This section provides a high-level understanding of the main design principles for sport broadcast lighting.

Vertical illumination

Often a value of vertical illuminance is tabled as the main lighting requirement. This is because in most sporting events the vertical plane is the plane where the relevant action is being recorded.

It is important to know that for a camera, the average value is not important, what matters is the minimum value of illuminance, which represents the hardest condition for filming. Thus most of the requirements specify the minimum value of maintained illuminance over a grid.

Other values are then derived from the above maintained minimum illuminance by the appropriate uniformity ratios.

Uniformity and ratios of illumination

There are several ratios that describe uniformity over a set of measurement grids. The main ratios are used to control the occurrence of hot spots over the filming area (minimum/maximum and minimum/average) and to ensure that correct modelling light is available (vertical:horizontal). These requirements are quite stringent and it may be advisable

to consider the effects of indirect lighting in the calculations. This will allow improvement of aiming angles and glare. Spectator illumination and ratio of lighting performance from action to ancillary areas is used to create separation. For this reason, it is common that audiences have to be illuminated less than the field of play and the target is set as an upper limit.

Aiming angles and glare

A common approach to control glare is to provide an aiming angle range; for example, by limiting the tilt of luminaires or by defining a series of locations where no luminaire can be installed. This is described in sport federation and governing body documents and can be derived from experience and in some cases is indicated by broadcasting companies.

Aiming angles are kept low to reduce glare but need to be increased to improve modelling. This conflict between requirements can be mitigated by considering the indirect component of lighting in the simulations. The increased vertical illuminance will allow lower angles to be applied to the aiming, thus reducing glare while the increased illuminance will determine a higher ratio for modelling.

Reflections on specular surfaces can be a cause of glare and create problems for cameras. For example, the track of a velodrome will require careful aiming to minimise reflections and glare on the polished wooden surface. Similarly, the reflections of lights on the water surface of a swimming pool will need to be considered as early as possible in the design so that gantries are positioned correctly in the ceiling.

Colour quality

Correlated colour temperature and colour rendering need to be suitable for the class of event. In some very large events, it may be necessary that the same lamps are used throughout a series of venues. This is to ensure consistency of colours for the entire production. For some smaller

events, the requirement could be relaxed with lower colour rendering and wider range of colour temperatures. Considerations also have to be made when artificial lighting is supplemented with daylight.

Colour quality for broadcast is estimated by the index TLCI12. This is akin to using Colour Rendering Index, but with a series of more saturated samples and with a dedicated colour model that matches camera performance. Although this new metric is not yet endorsed by the lighting industry, it is well known and acknowledged by the broadcasters. For this reason, it is advisable that TLCI12 is provided as part of the product specifications.

Light flicker

Light flicker has become a common issue in current television productions. Flicker is a type of temporal light artefact which is defined as a change in visual perception induced by a fluctuation of the illuminance with time. It is commonly observed with traditional lamps which pulse at 100Hz (or 120Hz depending on the country). Flicker is also observed when pulse-width modulation (PWM) dimming for solid-state lighting (LED) systems is used. Flicker can be recorded in super slow-motion footage but also in normal footage (where a rolling shutter is used). Flicker is commonly addressed by cross phasing the lighting installation (the goal is to minimise flicker lighting) or by using electronic high-frequency ballasts or by avoiding PWM dimming (the goal is to provide flicker-free lighting).

Daylight

Indoor events usually require full daylight blackout to remove variability in the lighting conditions. Polarising filters can be used in order to control the daylight component but will require fine tuning once production requirements are understood.

Main cameras

The concept of a 'main camera' is slowly being abandoned as new productions lean towards an interactive spectator experience, where spectators actively select the viewing angle in real time. For this reason, all requirements have to be met in the four vertical planes rather than just towards a main camera.

Typical range of values

The following list illustrates a typical requirement for a broadcast quality lighting system. Note that the list is generic and has to be considered as an example and not mandatory requirements. Higher targets and narrower tolerances may be required.

- Minimum maintained vertical illuminance on grid in 4 directions >1400 lux
- Uniformity (min:avg) >0.7
- Ratio of vertical to horizontal illuminance >1:2
- Uniformity (min:avg) >0.8
- Uniformity gradient <5% over 1m
- Glare (GR) <35 (indoor venue) or 40 (outdoor event)
- Flicker factor <1% (flicker free)
- Colour rendering Ra >90 with R9 >50, TLCI >85
- Colour temperature 5000-6000K with fixtures within 10 mired
- Spectator spill lighting on 12 rows <25% of average illuminance on FOP

Summary

It is important that good lighting is provided in order that those participating in the sporting activities have the right visual information when undertaking such events under artificial lighting conditions. This also extends to the spectators so that they can see what is happening and have a sense of atmosphere.

The broadcasting requirements of sporting events need to be a major factor in the

design of any stadiums and sporting venues. The sporting organisations, clients, architects and lighting designers need to understand the broadcaster's requirements, which not only include the event area but also cover other areas such as crowd reaction, interviews, and entrances to mention just a few. Cameras are also no longer in fixed locations but they track action and are even attached to vehicles, sports equipment and participants all of which need some consideration.

Broadcasting and lighting technologies are also evolving at a pace and perhaps outstripping standards so it is important that all parties are working together at the beginning of any project to ensure the overall requirements of all participants in the events are achieved.

Glossary

BSI British Standards Institution

CDM Construction, Design and Management (CDM) Regulations

CEN European Committee for Standardization

CIBSE Chartered Institution of Building Services Engineers

CIE International Commission on Illumination

CIE TC CIE Technical Committee

FIFA Fédération Internationale de Football Association

ILP Institution of Lighting Professionals

PWM Pulse-Width Modulation

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