PLAQUETTE FIFA.XP 12/02/02 17:20 Page 40

Guide to the artificial lighting of football pitches

PHILIPS

This publication is the result of a joint co-operation with FIFA.

FIFA

This publication is the result of a joint co-operation with FIFA.

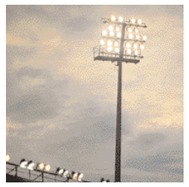
Fore more information:
info.sportslighting@philips.com

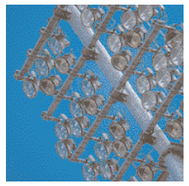
02/2002
Printed in France

Philips Lighting

PHILIPS

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 2





Guide to the artificial lighting of football pitches

This publication is the result of a joint co-operation with the FIFA.
For the guidance of FIFA officials, Member Associations and football pitch proprietors generally.

Fédération Internationale de Football Association
Technical Department • Hitzigweg 11 • CH - 8030 Zürich
Tel: 41-1/384 9595 • Fax: 41-1/384 9696
Internet: www.fifa.com

Philips Sports Lighting
Rue des Brotteaux • 01708 Miribel Cédex • FRANCE
e-mail: info.sportsligthing@philips.com

Conception
Press' Citron • Dijon • FRANCE

Reproduction in whole or in part is permitted provided the source is acknowledged.

PHILIPS

1 • Introduction ..... Page 4
1.1 ..... page 4 ..... Scope
1.2 ..... page 5 ..... Intent

2 • User requirements ..... Page 6
2.1 ..... page 6 ..... Objectives
2.2 ..... page 7 ..... Competition categories
2.3 ..... page 8 ..... Pitch dimensions
2.4 ..... page 9 ..... Obstacle free zones
2.5 ..... page 10 ..... Unobstructed view of the Pitch
2.6 ..... page 11 ..... Obtrusive light

3 • Lighting requirements ..... Page 12
3.1 ..... page 12 ..... Illuminance
3.1.A ..... Horizontal Illuminance
3.1.B ..... Vertical Illuminance
3.2 ..... page 14 ..... Illuminance uniformity
3.3 ..... page 16 ..... Calculation & measuring grids
3.4 ..... page 17 ..... Illuminance gradient
3.5 ..... page 17 ..... Glare
3.6 ..... page 18 ..... Colour properties of lamps
3.6.A ..... Colour temperature (Tk)
3.6B ..... Colour rendering (Ra)

4 • Lighting recommendations ..... Page 20
4.1 ..... page 20 ..... Types of facilities
4.2 ..... page 21 ..... Non televised Event
4.2.A ..... Introduction
4.2.B ..... Installation planning
4.2.C ..... Summary of lighting specifications for non televised events
4.3 ..... page 26 ..... Televised Events
4.3.A ..... Introduction
4.3.B ..... Installation planning
4.3.C ..... Camera positions
4.3.D ..... Summary of lighting specifications for televised events

5 • Annexes ..... Page 33
5.1 ..... page 33 ..... Measuring procedure
5.1.A ..... Introduction
5.1.B ..... Inspection prior to measurement
5.1.C ..... Measuring equipment
5.1.D ..... Measuring points
5.1.E ..... Measurement of horizontal illuminance
5.1.F ..... Measurement of vertical illuminance

5.2 ..... page 36 ..... Measurement record sheet
5.3 ..... page 39 ..... Glossary of terms FIFA lighting guide

PHILIPS

1 • Introduction

Championship lighting for champion players

Today, soccer is probably the most popular form of entertainment in the world. Events such as the FIFA World Cup, the Euro Championships, the Champions League and the Copa America capture the attention of almost everyone on the planet - thanks mainly to TV coverage. In fact, it is TV that has raised soccer to its current status and otherwise plays a leading role in sports development.

So for evening matches, when soccer and TV can take advantage of peak viewing, broadcasters require excellent lighting of the playing field. But although the lighting should provide perfect illumination of the players, and in some cases the spectators in the stadium too, it should never have a detrimental effect on vision. At all times players and fans must be able to enjoy optimum visual conditions without glare.

Lighting also plays a key role in recreational, non-televised soccer matches. Because recreational soccer is usually played in the evening after work, effective lighting maximises the opportunity for people to take part in the game. Although the lighting level will obviously be lower compared to televised games, the lighting quality should remain high in terms of uniformity, visual comfort and limitation of light pollution, especially in the residential areas where leisure sports facilities are often located.

As lighting is one of many considerations for a facility owner or event organiser, FIFA and Philips Lighting have decided to produce a second edition of the 'Lighting Design Guide for Football Pitches'. This new edition is more self-explanatory as regards lighting terminology (with both text and images to illustrate lighting concepts) and it contains an update on the new lighting technologies required for slow-motion replay and digital and enhanced broadcasting, which bring the action ever closer to the TV viewer.

This guide is divided into two main sections, 'Lighting requirements', where key lighting concepts are explained, and 'Installation planning', where guidelines are given for the creation of lighting systems in terms of location of equipment, choice of mounting height, lighting specifications and lamp characteristics.

We hope that this lighting guide will aid the planning process and support the continuing growth of high-quality facilities around the world. The champions of both today and tomorrow need good facilities in order to train and perform at their best.

January 2002

FIFA

Fédération Internationale de Football Association

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 6

2 • User Requirements

Objectives 2.1

The objective of an artificial lighting system is to “create conditions of good visibility for those who use or experience soccer facilities”.

The following persons are considered to be those persons who use or experience a facility. And form the basis for lighting specifications:

Competition categories 2.2

Five classes of lighting systems have been defined, from I to V. The categories are divided into the needs of televised and non-televised competitions, in order to group facilities by the needs of their users.

Television cameras require more light than the players on the field and spectators standing at the sidelines. While spectators sat far from the action have similar needs to that of Television cameras, due to the apparent small size of the ball caused by the long viewing distance.

While non-televised competitions need to provide satisfactory conditions for the players on the field and persons at the sidelines.

Televised Events
Class V ..... International
Class IV..... National

Non-televised competitions
Class III ..... National games
Class II ..... Leagues and clubs
Class I .....Training and Recreation

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 8

Pitch dimensions 2.3

Within the guidelines of the playing rules, pitch dimensions can vary from 105 m to 110 m in length, and from 68 to 75 m in width.

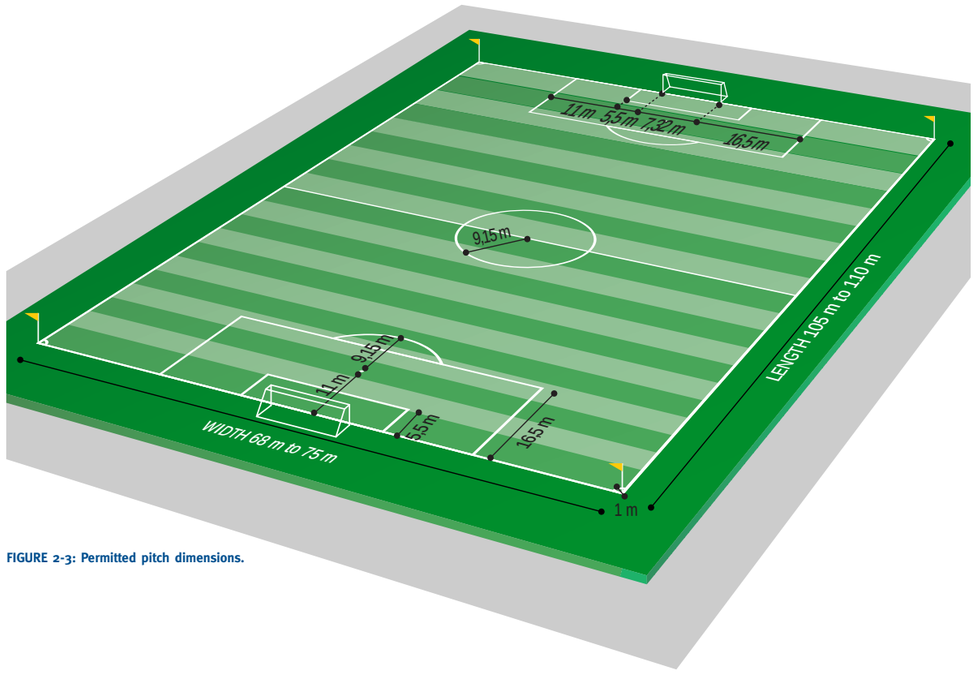


FIGURE 2-3: Permitted pitch dimensions.

Obstacle free zones 2.4

In order to promote player safety, no lighting structures shall be placed within 5 m of the pitch side lines or goal lines.

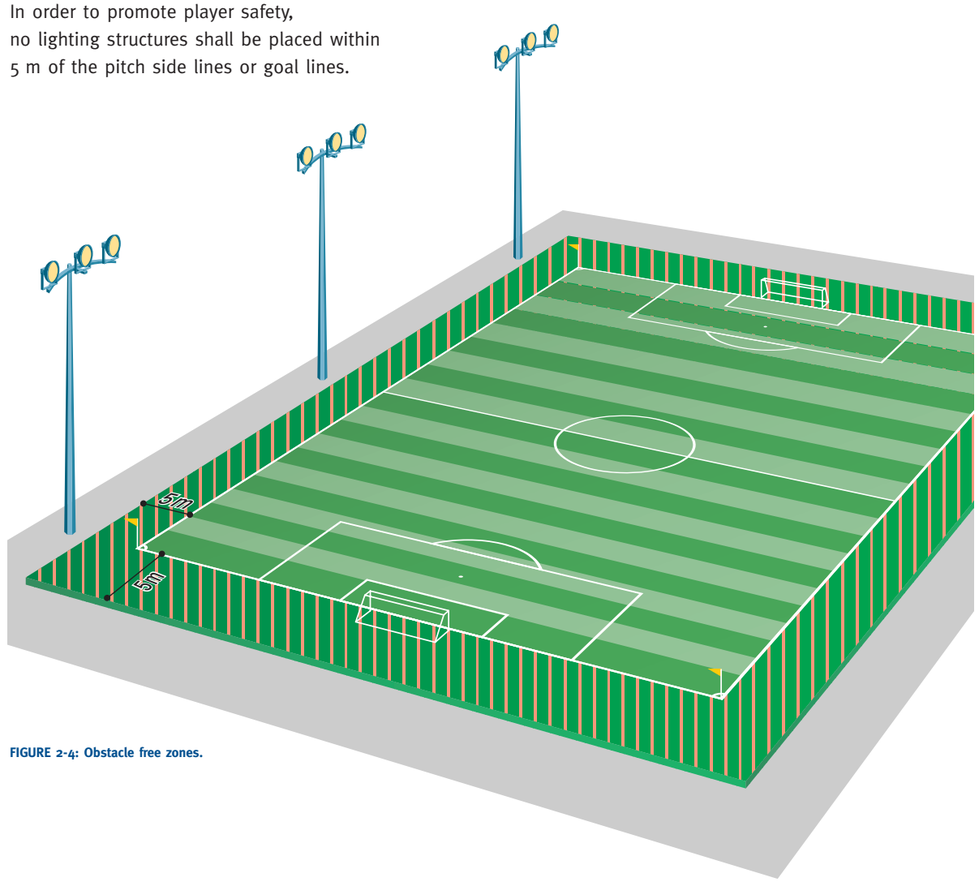


FIGURE 2-4: Obstacle free zones.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 10

Unobstructed view of the pitch 2.5

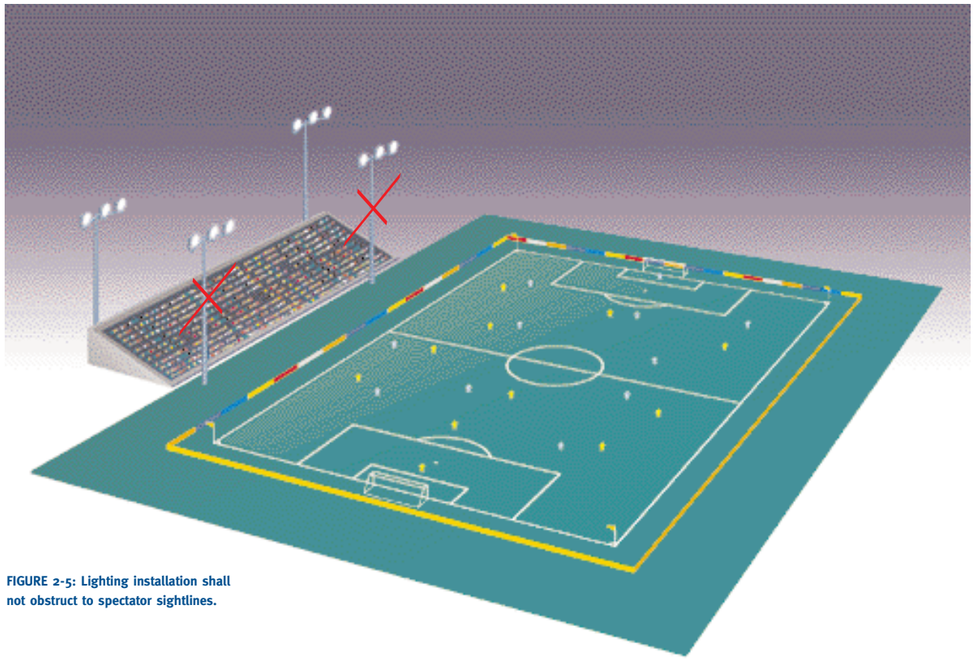


FIGURE 2-5: Lighting installation shall not obstruct to spectator sightlines.

Where spectator areas are provided, whether enclined seating blocks or at ground level, lighting structures shall be placed outside spectator sightlines.

This will usually mean moving the equipment behind spectators and will have the effect of increasing the required mounting height.

Obtrusive light 2.6

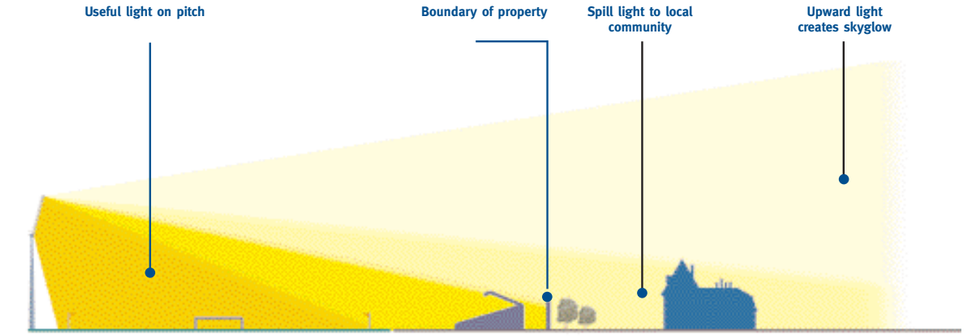


FIGURE 2-6: Element of obtrusive light.

Worldwide there is a growing awareness of light which might cause disturbance to persons living close to a lighting installation or might prevent observation of the night sky.

Recommendations now exist in some countries and should be considered as a positive step toward preserving our natural environment, reducing disturbances to people in their homes and hazards to persons viewing bright light sources directly.

The official term becoming widely used is that of “obtrusive light”. There are three key facets of “obtrusive light”.

“Stray or Spill Light”
Is the light falling on vertical surfaces or entering a property via windows etc, which causes most disturbance to residents living nearby.

“Intensity toward an observer”
The brightness or intensity of the installation from specific observer positions looking toward the installation.

“Upward” or “waste light”
The light emitted upward (above horizontal) from each floodlight. This effect is often referred to as “sky glow”.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 12

3 • Lighting Requirements

The original intent of providing a lighting system should always be kept in mind: "To create conditions of good visibility". As the competitive level increases, so too must the quantity and quality of the lighting provided, enabling players to perform faster, with a greater degree of accuracy, in the most suitable conditions. The following criteria are those used to specify, create and measure good lighting conditions.

Illuminance 3.1

The amount of light falling on a surface is termed illuminance ("E"), is often referred to as "lighting level" and is measured in "lux". It is independant of surface colour, texture, reflective properties and is easy to calculate and measured.

Illuminance can be calculated for any surface orientation, which must be specified. This could be the horizontal surface of the pitch, the inclined surface of a spectator tribune, or a plane in the direction of a television camera.

Horizontal illuminance (Eh) 3.1.A

The average "horizontal illuminance (Eh_{ave})" of the pitch surface serves to establish the adapted state of the eye and acts as a visual background against which players and ball stand out, enabling them to be identified quickly and clearly.

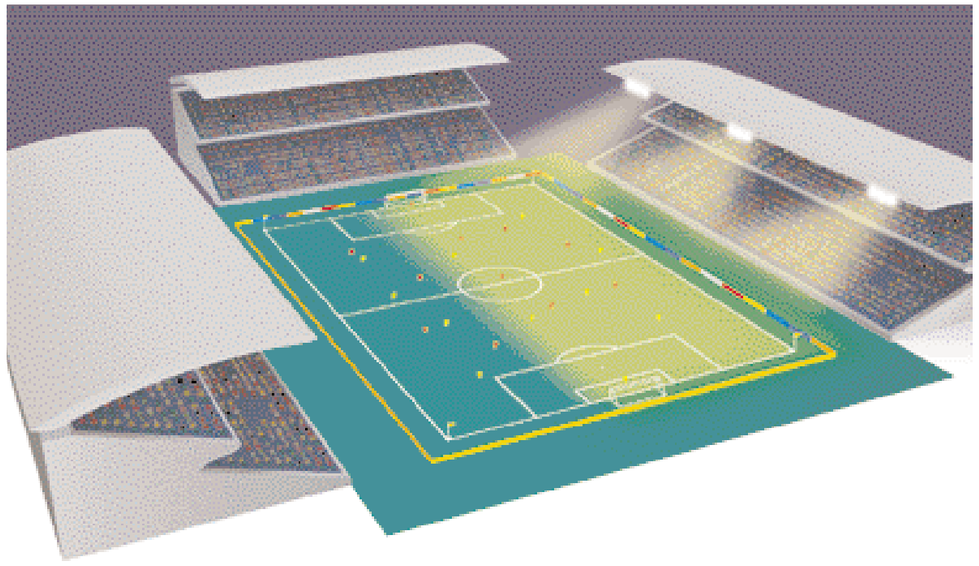


FIGURE 3-1-A: Visualisation of horizontal illuminance.

Vertical illuminance (Ev) 3.1.B

FIGURE 3-1-B-1: Light surrounding the player.

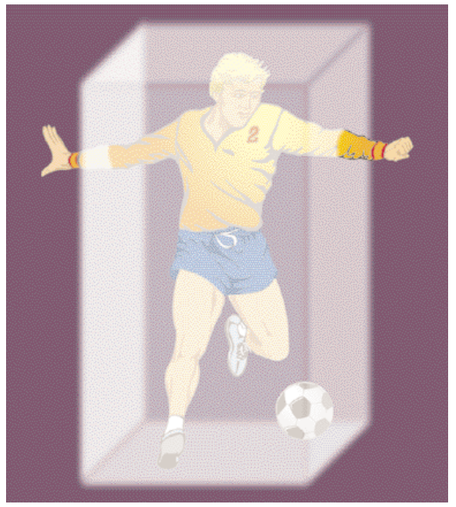


FIGURE 3-1-B-2: Simulated vertical planes of a player.

Vertical planes are used to simulate the light falling on the body of a player. The height chosen corresponds to the upper-body and face of a player and forms the basis of calculations.

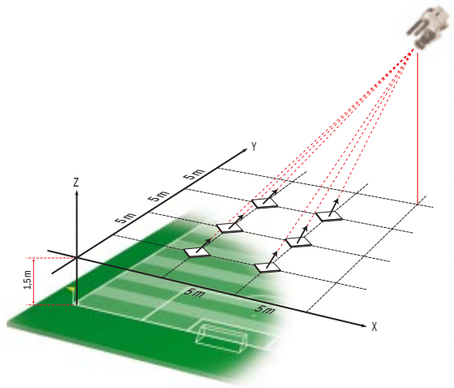


FIGURE 3-1-B-3: Calculation points perpendicular to camera axis.

Vertical illuminance is the light in the direction of a camera which is useful in creating a picture for a camera.

To ensure a camera receives sufficient light to create an image, it is necessary to specify and measure the vertical illuminance, perpendicular to each selected camera position.

Calculations and measurements shall be made 1.5 m above the pitch surface, in the direction of the camera.

Where portable cameras are used at pitch level it is sufficient to calculate the light on the four planes perpendicular facing the side lines.

Illuminance uniformity 3.2

Ideally the pitch surface should appear uniformly lit. Free from, exaggerated bright or dark patches in order to create stable visual conditions for people, television or photographic systems.

Uniformity is expressed by the two illuminance ratios: U1 & U2.

U1 limits the total range over which a person or camera must visually adapt and therefore contributes to **visual performance.**

$$U_1 = \frac{\text{Minimum pitch illuminance}}{\text{Maximum pitch illuminance}} = \frac{E_{min}}{E_{max}}$$

U2 defines the difference between the adapted state of a persons eye and the darkest point of the pitch and therefore contributes to **visual comfort.**

$$U_2 = \frac{\text{Minimum pitch illuminance}}{\text{Average pitch illuminance}} = \frac{E_{min}}{E_{ave}}$$

Values of U1 & U2 are defined in the chapters 4.2.C and 4.3.D of the section 4 “Lighting recommendations”.

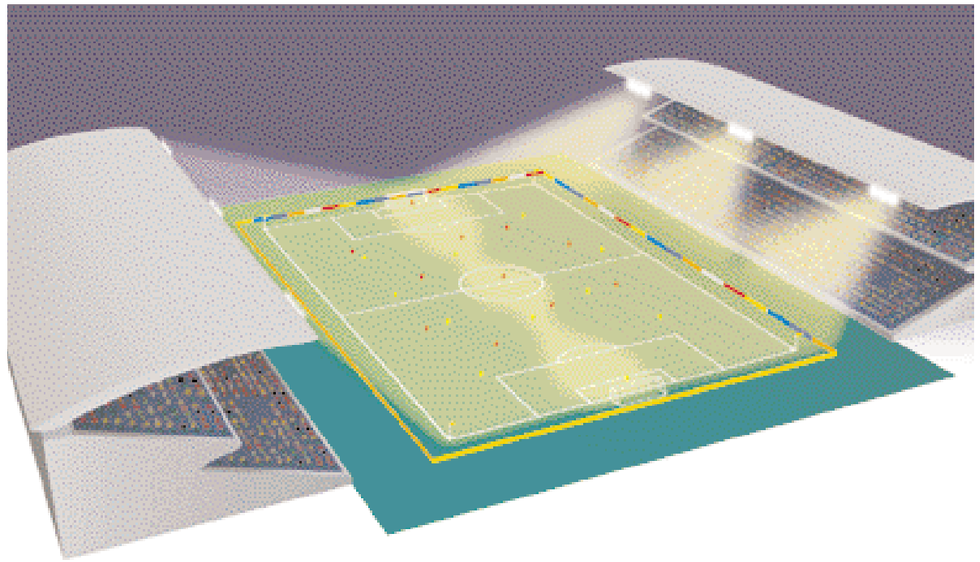


FIGURE 3-2-1: Poor uniform appearance

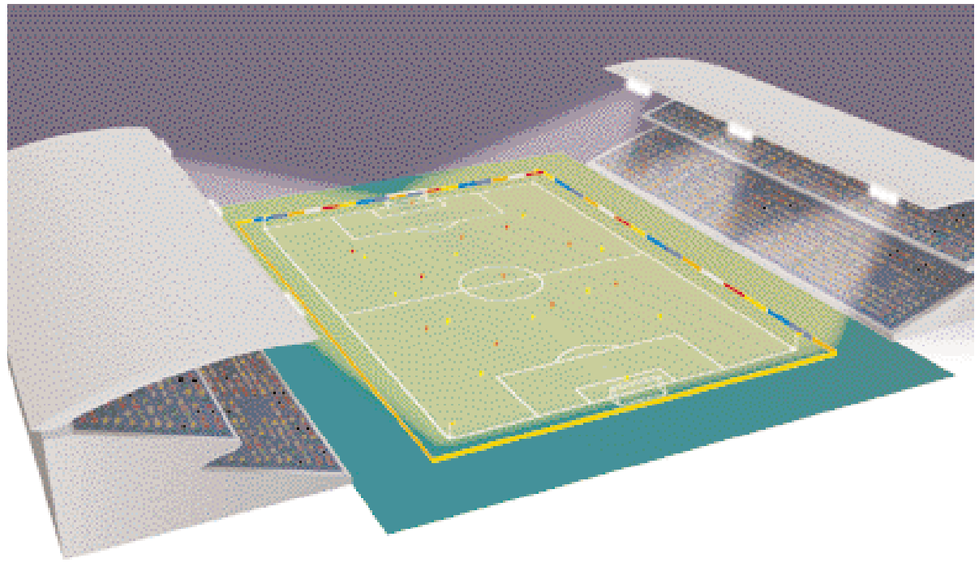


FIGURE 3-2-2: Good uniform appearance

Introduction
User requirements
Lighting requirements
Lighting recommendations
Annexes

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 16

Calculation & measuring grids 3.3

Calculations are necessary to simulate the performance of a lighting system before it is installed and measurements are used to verify that the system meets specified requirements after installation.

In order to be able to specify, calculate and measure the performance of a lighting installation, a pitch is divided into a grid of points, for which, horizontal and vertical illuminance calculations are made, uniformity ratios determined and illuminance gradient assessed.

The grids indicated are those preferred for the pitch dimensions of 105 m long by 68 m wide and 110 m long by 75 m wide. These arrangements enable different systems to be compared on an equal basis.

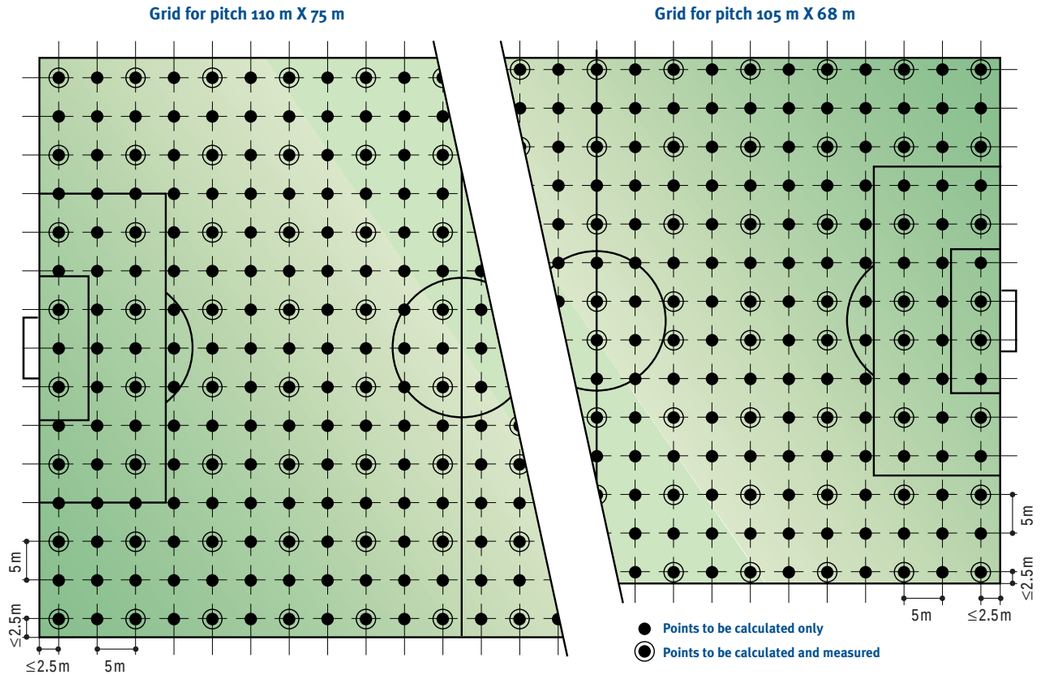


FIGURE 3-3: Calculation grid for pitch dimensions of 110 x 75 & 105 x 68

Note:
A grid spacing of 5 m is recommended making the setting out of grid points straight forward. This represents a rounding of the method used in the European Norm. EN 12193.

Illuminance gradient 3.4

While uniformity controls the overall visual conditions over the pitch, it is the illuminance gradient that prevents rapid changes in lighting level, between closely spaced points occurring.

Too high a rate of change of illuminance can cause sudden losses of picture brightness, for television and photographic systems. To avoid such occurrences, changes of illuminance between adjacent grid points should not exceed 20 %, in either horizontal or vertical planes for televised events and 55 % for non-televised events.

Glare 3.5

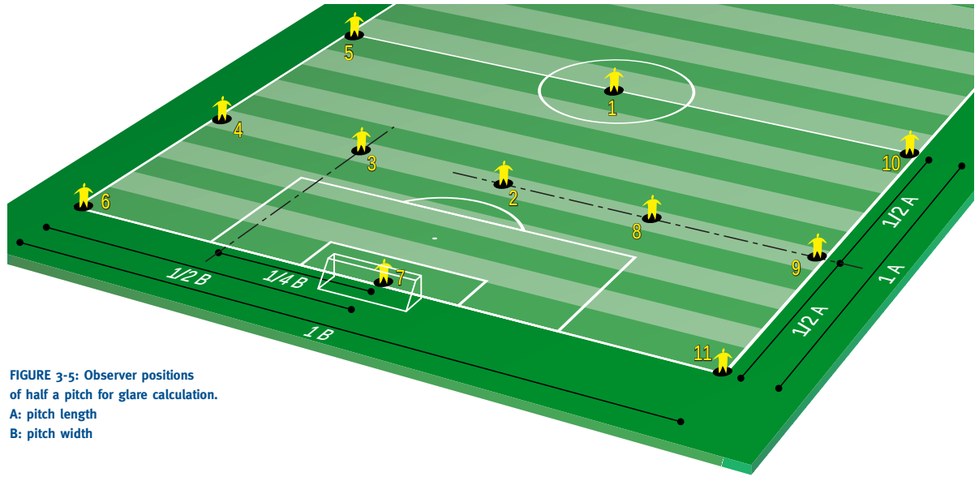


FIGURE 3-5: Observer positions of half a pitch for glare calculation.
A: pitch length
B: pitch width

A lighting system should be designed in order not to adversely affect the performance of players, referees, officials and the comfort of spectators.

Glare is caused by the difference (contrast) between the direct brightness of the installation (entering a person eye) and the brightness of the pitch. When the ratio of these two brightness is too high, this will cause visual disability or discomfort. One of the most effective ways to control glare is to select appropriate mounting heights and positions of equipment around the pitch.

The most critical zones being those around the goals, from the point of view of the goalkeeper, looking toward the corner flag. For this reason luminaires directed toward or across the goal area should not be placed above or around the corner flag. See Section 4: “Lighting Recommendations”.

A method of calculating glare has been defined, resulting in a “Glare Rating” also called GR. GR is assessed on a practical scale of 10 (un-noticeable glare) to 90 (unbearable glare). Glare Ratings should not exceed GR = “50” for any position on the pitch.

GR should in principle be calculated for the player (observer) positions indicated in figure 3.5, though lighting designers may add positions where they believe particular problems exist.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 18

Colour properties of lamps 3.6

Good colour perception is appreciated even at recreational and club levels, though becomes more critical for televised events, where natural colour reproduction is expected by today's broadcasters.

There are many types of light sources available and many names used to describe them, however light sources can be characterised by two key parameters:

Colour temperature ..... 3.6. A

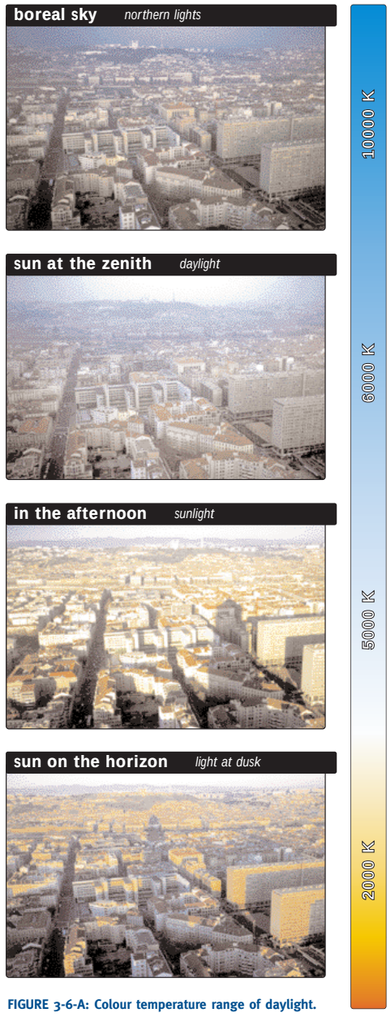


FIGURE 3-6-A: Colour temperature range of daylight.

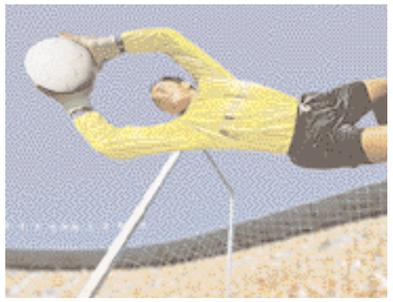
Colour temperature (also called Tk) describes the feeling or appearance of how warm (red) or cool (blue), a certain type of lighting appears to be; it is measured in “Kelvin” (K).

A suitable range of colour temperature lies between 2000 K and 6500 K for outdoor facilities and 3000 K to 6500 K for indoor facilities.

Lighting systems used in combination with daylight should have a colour temperature close to that of daylight. A camera system can only adapt to one colour temperature at a time. In addition the preferred photographic films for sports usage are daylight balanced to around 5500 K.
As can be seen in figure 3.6.A daylight conditions during late afternoon periods is around 5000 K.

Recommendations on preferred colour temperatures for both non-televised and televised events can be found in section 4 of this guide

Colour rendering ..... 3.6. B



Natural colour (daylight).

Poor colour rendering under artificial lighting.

Good colour rendering under artificial lighting.

Colour rendering (also called Ra) describes the capacity of a light source to faithfully reveal and reproduce the natural colours.
Colour rendering is ranked on a practical scale from Ra 20 to 100. Where the higher the index the better the colour accuracy.

The degree of colour accuracy of a sports lighting system depends upon the purpose of the installation.
For instance, recreational activity is less demanding than that of televised events where promotional materials must be reproduced accurately. High colour rendering contributes to the quality of televised and photographic images.

The following table describes colour rendering range by application. In general broadcasters want to create vivid colour rich images, which come from light sources having “good” colour rendering (≥ Ra 80).

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

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 20

4. Lighting Recommendations

It is recommended that the following lighting conditions should be available during competitions and therefore should be maintained in good condition throughout the life of the installation.

Types of facilities 4.1

Two types of facilities can be identified, which are separated not by type of building or spectators capacity but by their activity and lighting specification requirement. These can be characterised as, facilities for **non-televised events** or **televised events**.

An artificial lighting system should provide appropriate visual conditions for users of a facility while respecting the rights of persons in the neighbourhood of a soccer facility. A lighting system therefore needs to balance the needs of all persons who use or experience its effects.

The following recommendations are intended to help in the planning of new or renovation of existing facilities.

Non-televised events.

Televised events.

Non-televised events 4.2

Introduction 4.2.A

Facilities for non-televised events are those intended for both youth and senior levels of activity and competition.

Class III National games
Class II Leagues and clubs
Class I Training and Recreation

These types of facilities will usually be standalone, in residential areas, having no or little spectator capacity. The lighting for non-televised events should be planned so that the horizontal surface of the pitch can be uniformly illuminated by whichever column arrangement is chosen.

Installation planning 4.2.B

Corner column arrangements

Corner columns must be positioned outside the normal viewing directions of the players, and their proximity to goal and touch lines be considered.

Location of corner columns:
Corner columns shall be positioned a minimum of 10° behind the goal-line and 5° outside of the touch-lines.

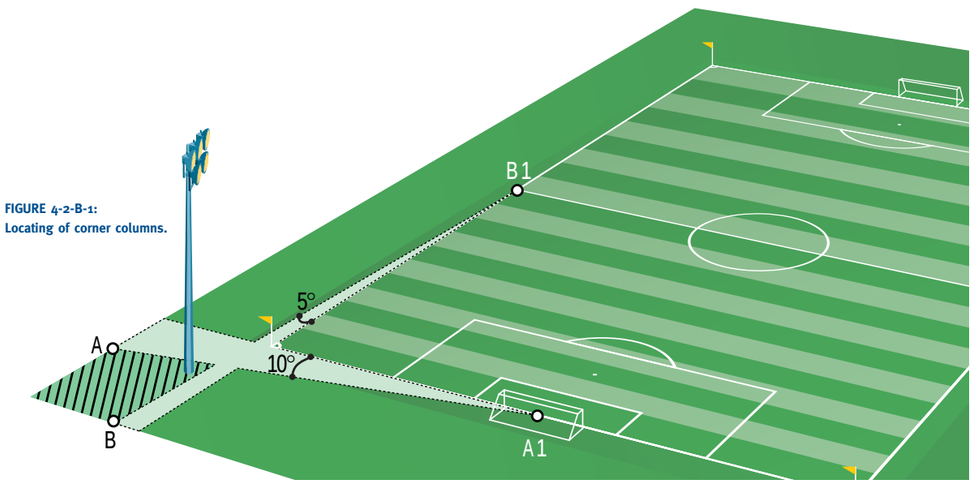


FIGURE 4-2-B-1:
Locating of corner columns.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 22

Determination of column height:
In order to create a uniform illumination, it is necessary that the floodlights mounted on a column can illuminate the quadrant of the pitch adjacent to that column.

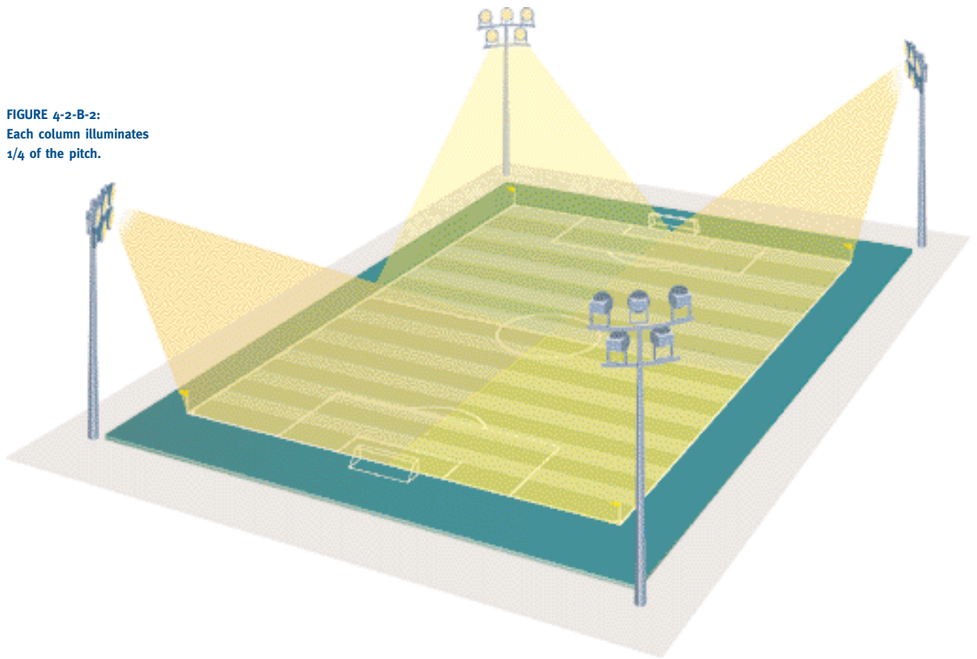


FIGURE 4-2-B-2:
Each column illuminates 1/4 of the pitch.

Column height is determined using the illustration below, where the angle subtended between the centre of the pitch and the lowest level of floodlights is ≥ 25° (hm = d x tan∝).

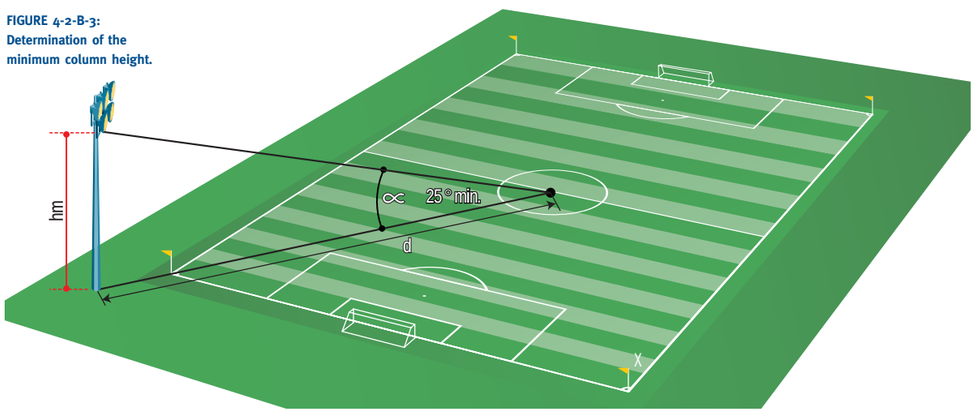


FIGURE 4-2-B-3:
Determination of the minimum column height.

Side lighting arrangement

Side lighting systems generally allow the use of lower columns than those of corner column systems. Popular configurations are four, six and eight column arrangements.

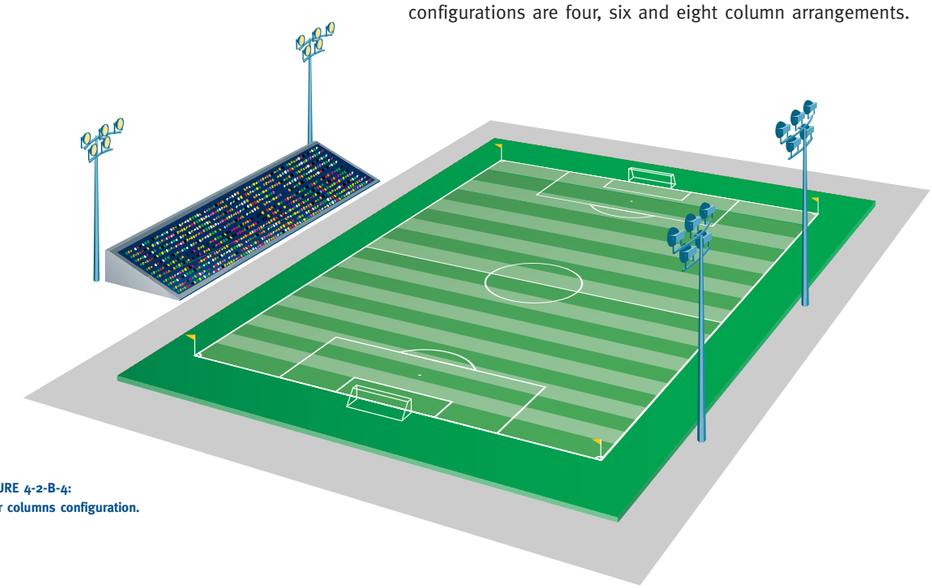


FIGURE 4-2-B-4:
Four columns configuration.

Four column side lighting systems are an alternative to that of corner columns, and can be accommodated next to spectator facilities. They have the advantage that only four installed points are required, though spill light is generally not as well controlled as either, six or eight column arrangements.

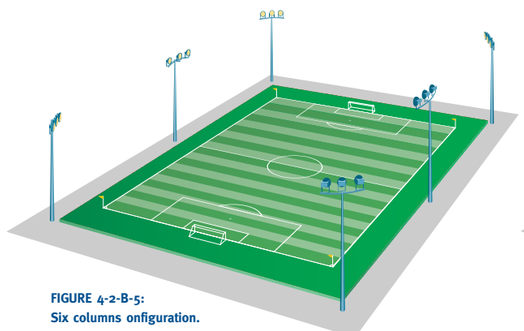


FIGURE 4-2-B-5:
Six columns onfiguration.

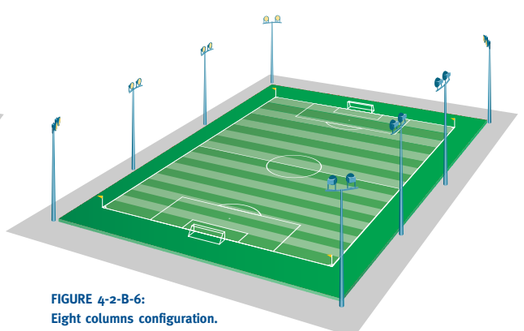


FIGURE 4-2-B-6:
Eight columns configuration.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 24

Six and eight column systems can be used to minimise the effects of spill light, while reduced column height keeps the installation in scale with urban development.

Permitted positioning of columns:
Columns should be located a minimum of 10° either side of the goal line, giving the goalkeeper an unobstructed view from the goal to the corner flag.

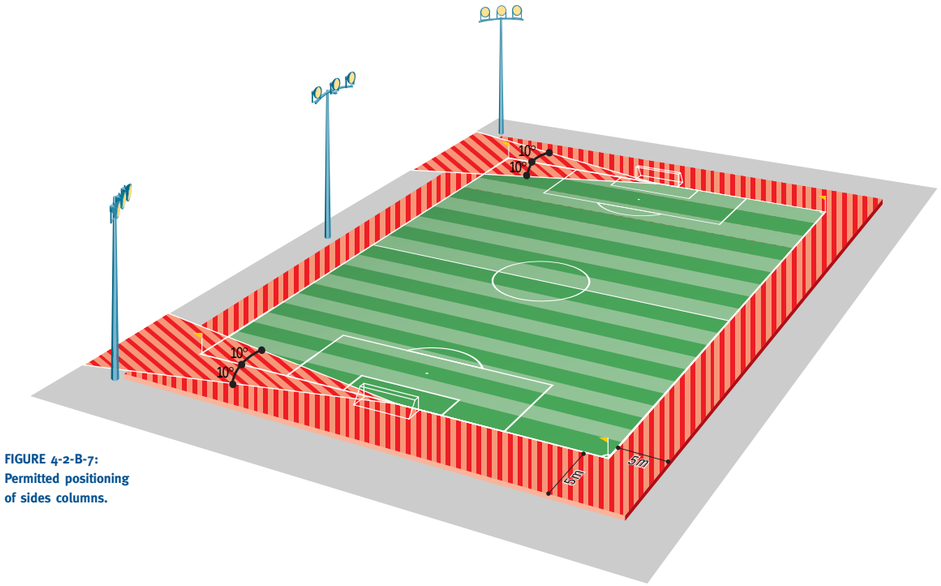


FIGURE 4-2-B-7:
Permitted positioning of sides columns.

Column height determination & transversal positioning:
Column heights should be selected so that the angle subtended between the pitch surface at its longitudinal centre line and the lowest floodlight is ≥ 25° (hm = d x tan∝). The use of columns lower than 15 m is not recommended due to the increase in visual discomfort associated with lower columns.

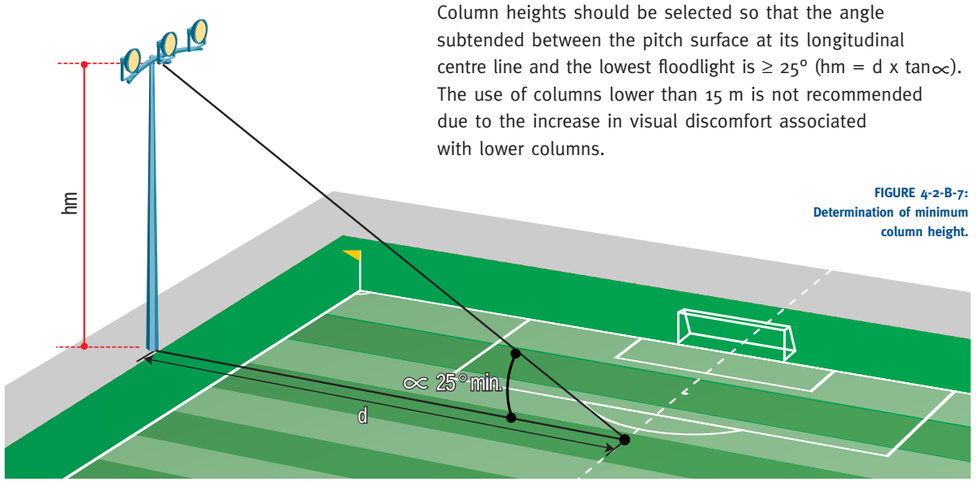


FIGURE 4-2-B-7:
Determination of minimum column height.

Summary of lighting specification for non televised events 4.2.C

The following table is a summary of the criteria to be considered for non televised events. It sets out the recommendations for horizontal illuminance, uniformity, glare rating and the properties of lamps for each level of activity.

Lighting specifications for NON TELEVISED events					
Activity level	Horizontal illuminance	Uniformity	Glare rating	Lamp colour temperature	Lamp colour rendering
Class.	Eh ave (lux)	U2	GR	Tk	Ra
National games Class III	500 *	0.7	≤ 50	Tk > 4000 K	≥ 80
Leagues & clubs Class II	200 *	0.6	≤ 50	Tk > 4000 K	≥ 65
Training & recreation Class I	75 *	0.5	≤ 50	Tk > 2000 K	≥ 20

TABLE 4-2-C

Notes :
* : All illuminance values indicated are maintained values.

- A maintenance factor of 0.80 is recommended, therefore initial values will be 1.25 times those indicated above.
- Illuminance gradient shall not be more than 55 % each 5 meters.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 26

Televised events 4.3

Introduction 4.3.A

Facilities for televised events are those intended for the following levels of competition:

- International Events Class V
- National Events Class IV

Installation planning 4.3.B

While lighting technology continues to change, attention to the basic allocation of space and determination of mounting heights play a fundamental role in the building up of a lighting system suitable for today's television broadcasters.

Corner tower arrangement

Tower implantation

Corner towers must be positioned outside the normal viewing directions for players with respect to their alignment with both goal lines and touch-lines.

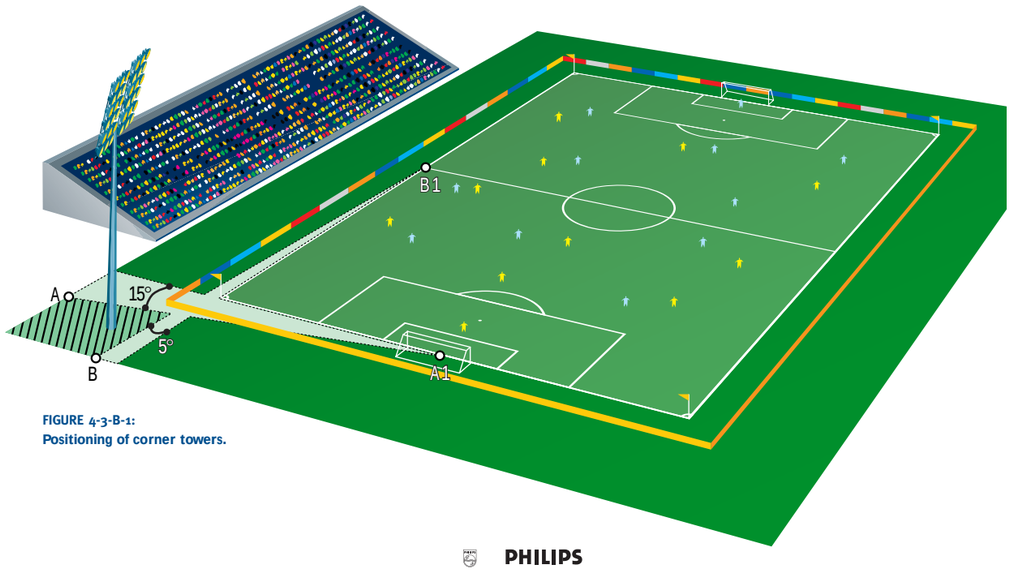


FIGURE 4-3-B-1:
Positioning of corner towers.

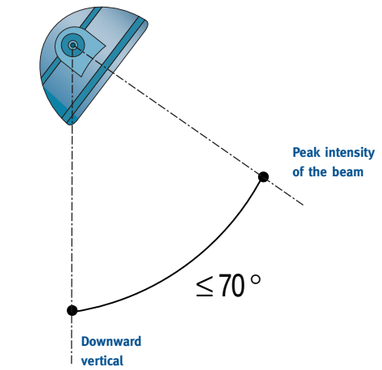


FIGURE 4-3-B-2:
Floodlight tilt angle must be ≤ 70°.

Maximum tilt angle of a floodlight

Luminaire elevation angles must be limited to 70° in order to control glare and the amount of light spilled outside of a facility. Where obtrusive light requirements are of great importance column heights may need to be increased marginally.

Head frame arrangement

Sufficient space should exist between floodlights in both height and width to prevent the light from one floodlight being cut off by an adjacent floodlight.

In cases where vertical head frames are used, the distance between rows should be increased to prevent light being cut off. Tilting the head frame forward (15°) ensures that the light emitted by the floodlights in the head frame upper rows are not cut off by those below, while maintaining compact head frame dimensions.

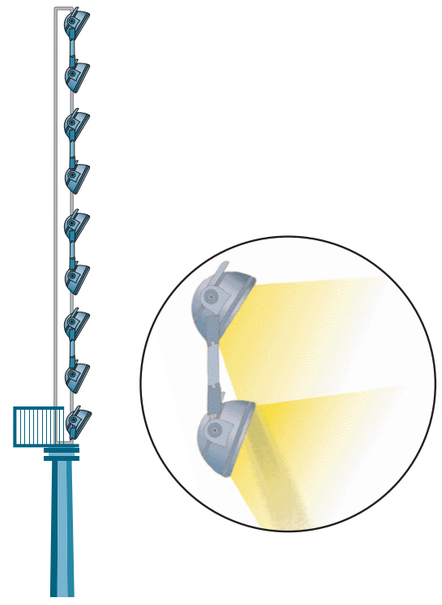


FIGURE 4-3-B-3:
Not recommended vertical headframes.

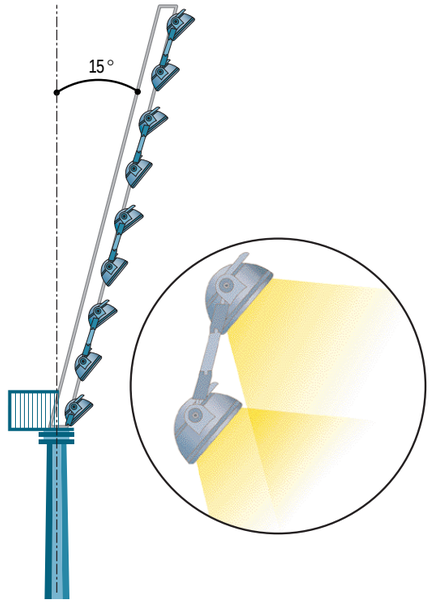


FIGURE 4-3-B-4:
Recommended tilt head frame forward 15°.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 28

Pre-determination of tower height:
Tower height must be selected in order that all parts of the field can be illuminated to the required standard for the number of cameras to be used.

Column heights can be initially estimated by ensuring that the angle subtended at the centre of the pitch to the head-frame center shall be not less than 25°, while ensuring that no luminaire is aimed above 70° from the downward vertical.

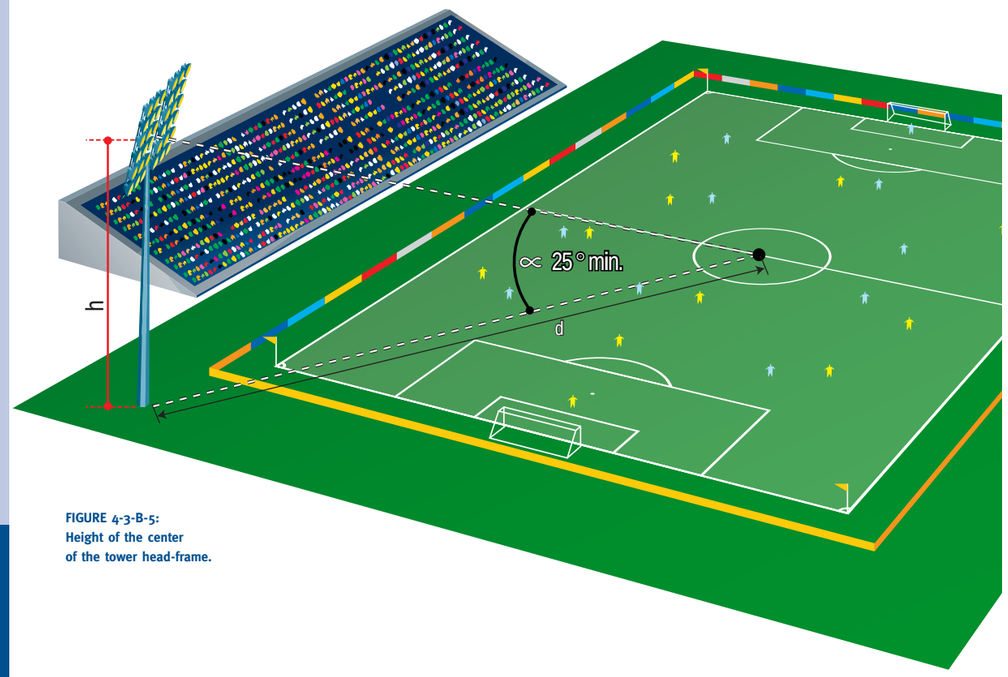


FIGURE 4-3-B-5:
Height of the center of the tower head-frame.

Side lighting arrangement

It is common practice to use roof structures as the support for a lighting system. In general roof mounted systems allow lighting to be brought closer to the pitch making the lighting system more effective, compared with the increased height and distance of corner tower systems.

Distributed side lighting systems tend also not to create harsh or disturbing shadows, thereby creating a more pleasant visual environment for both spectators at an event or watching a television broadcast.

Permitted longitudinal positioning of the floodlights:
In order to maintain good visual conditions for the goalkeepers and attacking players from the corners, lighting equipment shall not be placed within a zone of 15° either side of the goal line.

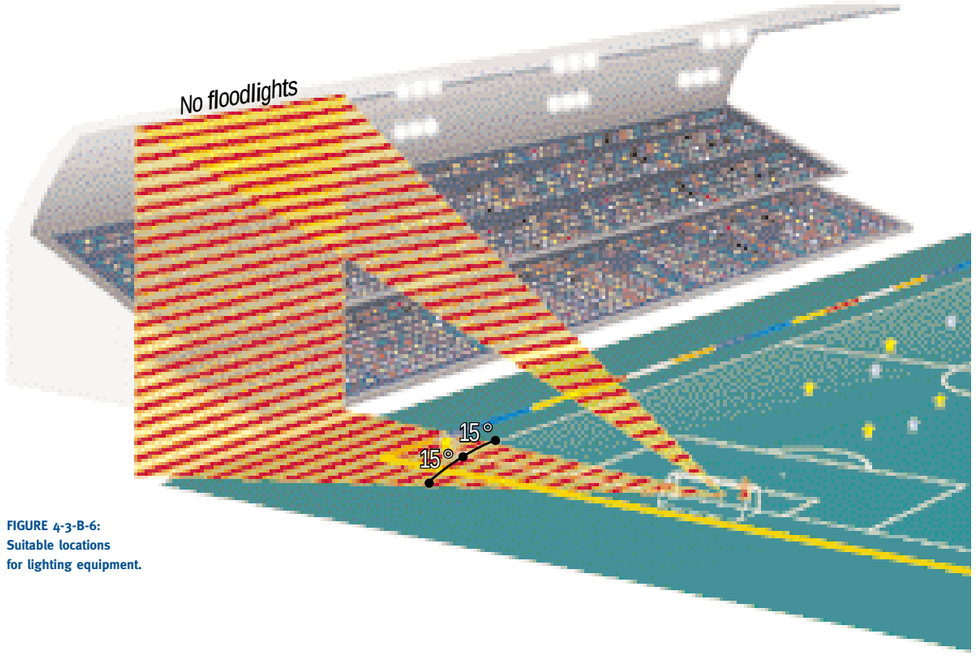


FIGURE 4-3-B-6:
Suitable locations for lighting equipment.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 30

Permitted transversal positioning of the floodlights
In most cases there will be two rows of luminaires mounted on the roof structure. One close to the leading edge of the roof, while the other will be located under the roof and behind the first row in order to provide sufficient illumination along the touch-lines.

Transversal positioning of the two rows of floodlights is defined by the elevation (Mounting height) and the (projected) distance to the pitch.

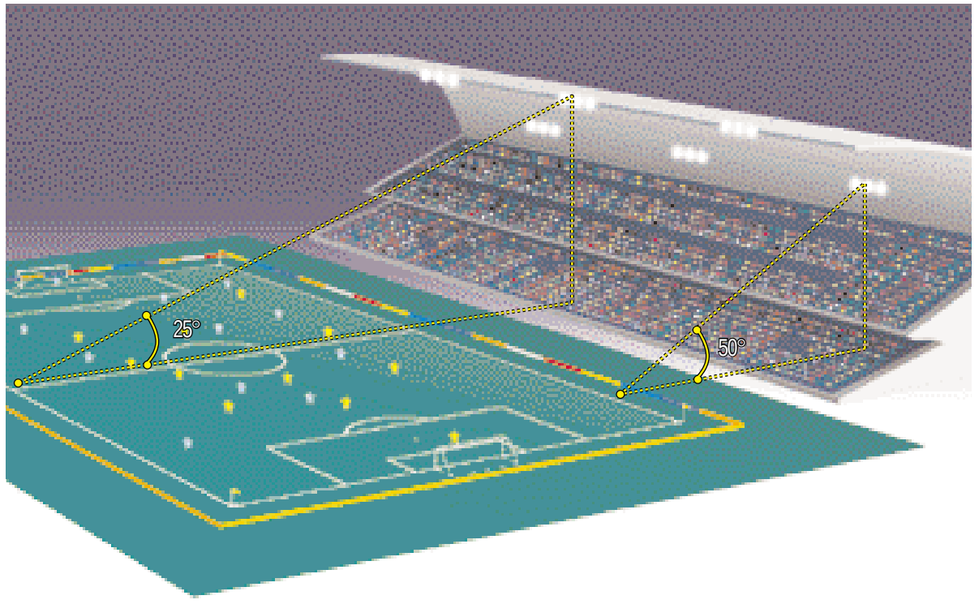


FIGURE 4-3-B-7:
Estimation of the two stand roof floodlight rows.

Camera positions 4.3.C

Camera views to be considered
There are many possible camera positions, which can be used to create or increase the televised experience.
The camera positions below are some of those popular today.
A lighting specification should take account of the actual camera positions to be used. Thereby ensuring each camera receives sufficient light, from which good quality pictures can be created. The illuminance level for each camera position and type can be found in table 4-3-D.

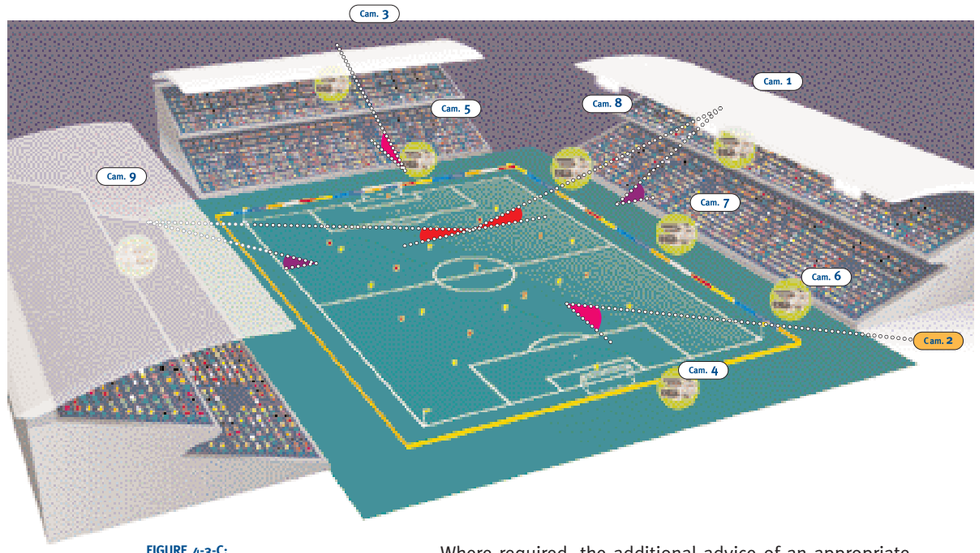


FIGURE 4-3-C:
Regular camera positions for televised events.

Basic Points of View (POV's) to be considered for FIFA events.

Camera 1 • Main continuity
Camera 2 • Across corner high level
Camera 3 • Behind goal high level
Camera 4&5 • Behind goal low level
Camera 6, 7 & 8 • Touchlines at pitch level.
Camera 9 • Reverse angle view

Minimum to consider Camera 1, 2, 4:
Use four vertical planes to simulate pitch side cameras.

Where required, the additional advice of an appropriate television broadcaster or regional consortium such as the EBU for Europe or OTI for the Americas can be sought.

Continuity of broadcasting
For all matches at the top level played in the evening, power failures should not lead to the cancellation or postponement of a match or televised broadcast, due to the lighting system being inoperable. To guard against this, a stadium should be equipped with two sources of power each independent of the other, arranged so that an uninterrupted flow of current is supplied to the lighting system in order to maintain a performance equal to that of "National Televised Events".
Refer to the FIFA document: "Football Stadia Technical Recommendations and Requirements"

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 32

Summary of lighting specification for televised events 4.3.D

The following table is a summary of the criteria to be considered for televised events. It sets out the recommendations for vertical and horizontal illuminance, uniformity, glare rating and the colour properties of lamps, for each class of activity.

Lighting specifications for TELEVISED events

Class	Calculation toward :	VERTICAL ILLUMINANCE *			HORIZONTAL ILLUMINANCE			PROPERTIES OF LAMPS	
		Ev cam Ave.	Uniformity		Eh. Ave.	Uniformity		Colour temperature	Colour rendering
		Lux	U1	U2	Lux	U1	U2	Tk	Ra
International Class V	Slow motion cameras	1800	0.5	0.7	1500 to 3000	0.6	0.8	Tk > 5500 K	≥ 80 pref. 90
	Fixed camera	1400	0.5	0.7					
	Mobile cameras (at pitch level)	1000	0.3	0.5					
National Class IV & continuity of broadcasting	Fixed camera	1000	0.4	0.6	1000 to 2000	0.6	0.8	Tk > 4000 K	≥ 80

TABLE 4-3-D

Notes :
* :Vertical illuminance refers to illuminance toward selected camera position.

- All illuminance values indicated are maintained values. A maintenance factor of 0.80 is recommended, therefore initial values will be 1.25 times those indicated above.
- In all Class: Glare Rating: GR ≤ 50
- In all Class: Illuminance gradient (each 5 meters) ≤ 20%.

5 • Annexes

Measuring procedure 5.1

Introduction 5.1.A

Measurements are required to verify that a lighting system meets the specified performances. The following parameters define a lighting specification, but cannot be measured directly.

Specification Parameter	Symbol
Average Horizontal illuminance	$Eh._{ave}$
Average illuminance to each camera	$Ev._{ave}$
Uniformity (min. / max. illuminance)	U1
Uniformity (min./average illuminance)	U2
Illuminance gradient.	Section 3-4
% Difference of illuminance between adjacent measuring points.	Section 4

They can however be calculated, using illuminance measurements taken from selected points on the pitch. See measuring grids section 3.3.

Inspection of installation prior to measurement 5.1.B

Before starting any measurements, it is useful to verify that the system has been installed in accordance with the design drawings and that any deviations are noted in the measurement report.

Check that:

1• All floodlights are functioning.
2• Floodlight quantity per switching level is correct.
3• Supply voltages to each location where luminaires are installed.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 34

Measuring equipment 5.1.C

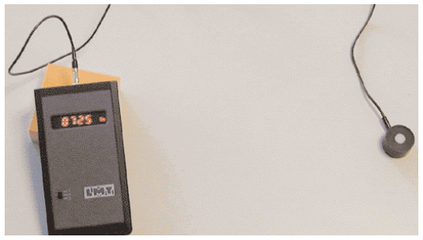


FIGURE 5-1-C: Illuminance meter with remote measuring cell.

Measurements should be made using a calibrated illuminance meter of a recognised quality. It should have been calibrated, within twelve (12) months of the measurement.

The meter's serial number and last calibration date should be noted within the measurement report.

FIGURE 5-1-C-bis:
Calibration date & serial number.

Measuring points 5.1.D

The points to be measured can be found in the section 3.3 of this guide; "calculation & measuring grids".
It is recommended to lay markers on the field at each point where a measurement will be made.

Measurement of horizontal illuminance 5.1.E

FIGURE 5-1-E:
Measurement of horizontal illuminance.

In order to measure horizontal illuminance correctly, the measuring cell must be placed at pitch level, with the measuring cell perpendicular to the upward vertical.
In addition, care should be taken to ensure that shadows are not cast across the measuring cell as this can significantly affect the expected results.

Measurement of vertical illuminance 5.1.F

The illuminance toward each camera should be recorded for that part of the pitch, it is intended to cover.
Measurements are taken at each pitch marker at a height of 1.5 m above the pitch surface.
The axis of the measuring cell must be perpendicular to that of the camera lens.

In order to ensure the cell is perpendicular with the camera axis the measuring cell can be fixed to a tripod fitted with a sighting device. Thereby ensuring an accurate measurement.

FIGURE 5-1-Fbis: Measuring of vertical (camera) illuminance.

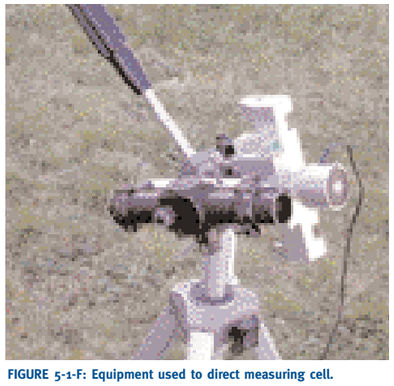


FIGURE 5-1-F: Equipment used to direct measuring cell.

PLAQUETTE FIFA.XP 12/02/02 17:20 Page 36

Measurement record sheet 5.2

Introduction

A measurement record sheet should be completed for each class of play and for both horizontal and vertical illuminance, as required. The number of measurements to be made will depend upon the size and type of facitlitiy: Televised or non Televised.

Project Name: .....

Measuring Equipment:

Type ..... **Calibration Date** .....

Switching Mode: .....

Measurement Type: (Tick in box)

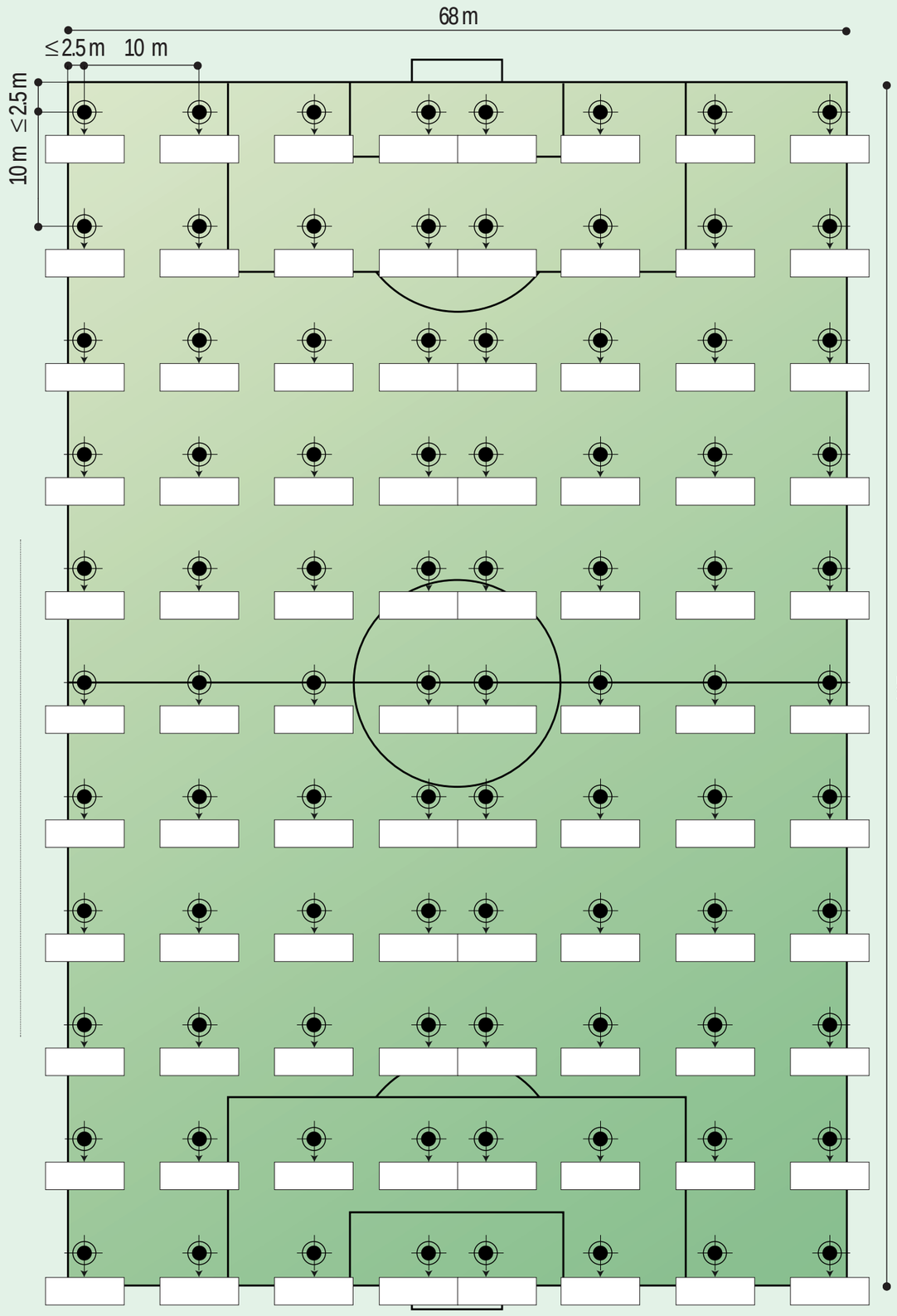
Horizontal illuminance ☐

Vertical illuminance toward camera ☐ Camera # ☐

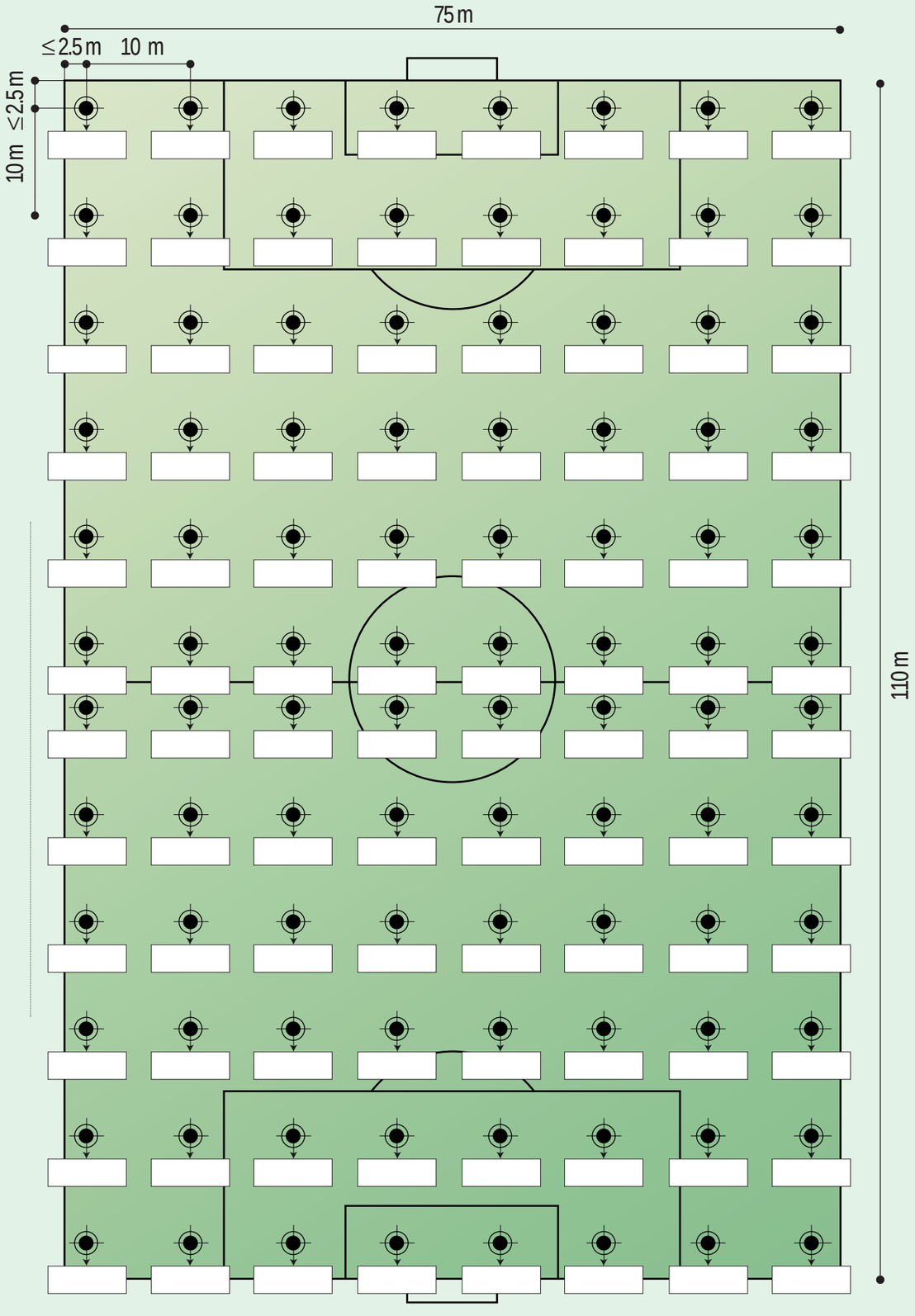
Vertical illuminance ☐ Indicate direction ☐

Illuminance		**Uniformity**		
$E._{min.}$	☐	U1	☐	Emin./Emax.
$E._{max.}$	☐	U2	☐	Emin./Emax.
$E._{ave.}$	☐	U2	☐	Gradient % OK

Signed on behalf of contractor ..... Signed on behalf of Consultant .....



PLAQUETTE FIFA.XP 12/02/02 17:20 Page 38



Glossary of terms FIFA lighting guide 5.2

Term	Symbol	Explanation
Illuminance	E	The quantity of light falling (incident) on a surface at a specific point, expressed in lux.
	E.ave.	Average horizontal illuminance as a result of either calculation or measurement. Using the points from section 3.3.
Initial illuminance	E.init.	The illuminance after the first 100 hours of use.
Maintained Illuminance	E.maint. E.ave.maint	The (average)illuminance below which the installation should not fall. After which the lamps should be replaced and or the installation cleaned.
Maintenance Factor		A factor less than 1. Initial illuminance x maintenance factor = the "maintained illuminance". This compensates for the depreciation in lamp output and luminaire surfaces.
Horizontal illuminance	Eh Eh.ave.	Light incident (falling) on a horizontal plane.
Vertical Illuminance	Ev	Light incident on a vertical plane 1.5 m above the pitch. (orientation to be specified)
Illuminance toward camera	Ecam	Illuminance on a plane 1.5m above the pitch and perpendicular to the lens axis of a specific.
Illumiance Uniformity	U1 U2	Describes how evenly light is distributed over the pitch surface and is expressed by the ratios of U1 & U2. Uniformity expressed as the ratio of Emin/Emax. Uniformity expressed as the ratio of Emin/Eave.
Lux		The unit of illuminance lumen / m^2, incident on a pitch surface. 1 Lux = 1 lumen/m^2
Lumens	Lm	The spectral power distribution of a lamp weighted by the eye sensitivity curve.
Eye sensitivity curve	V(α)	The human eye is more sensitive to some colours than others e.g it is 20 times more sensitive to green / yellow light than that of either red or blue.
Intial lumens		The output of a light source (lamp) after the first 100 hours of use.
Illuminance Gradient %		The difference in illuminance between two adjacent points on the pitch.
Mounting height	Hm	The mounting height of the luminaires with respect to a point on the pitch. Hm = distance "d" x tan δ.
Colour Rendering Index	Ra	The degree to which a specific light source reproduces a set of reference colours (Ra 8) compared with the same colours under daylight conditions. This index (Ra) is measured on a scale Ra 0 to Ra 100.
Colour Temperature	Tk	The colour appearance of the light, emitted by a light source in "Kelvin".
Glare Rating	GR	The degree to which a lighitng installation is disturbing to persons on or near the pitch. GR is defined by the Commission Interationale de l' Eclairage (CIE) in publication # 112 1994. "Glare Evalulation System for use within Outdoor Sports and Area Lighting"