

Module 4

Lighting Application

Lesson 16

Sports Lighting

Instructional objectives

1. List the factors responsible for sport lighting?
2. List the categories of users concerned with sport lighting.
3. State the grouping of games according to CIE.

Sports Lighting

This lesson addresses sports lighting application. Lighting for sports facility looks for comfort of four user groups namely Players, Officials, Spectators and Media. Players and officials should see clearly in the play area to produce best possible results the object used in the game. Spectators should follow the performance of the players. In addition to play area surroundings also need to be illuminated. Lighting should be such that it enables safe entry and exit. With increasing crowd level safety becomes more and more important. Media include TV and film, for whom lighting should provide lighting such that conditions are suitable for color picture quality as per CIE 83. This should be suitable for both general pictures as well as close up of players and spectators. Additionally, it should have provisions for emergency power supply to provide continuous transmission.

Criteria relevant for sports lighting are Horizontal Illuminance, Vertical Illuminance, Illuminance Uniformity, Glare restrictions, Modeling & shadows and Color appearance & rendering

Horizontal Illuminance

This becomes important as major part of view is illuminated playing area. Illuminance on the horizontal plane serves adaptation of the eye. It acts as a background, so adequate illuminance is important. For safe entry and exit adequate illumination is required in the circulation area also.

Vertical Illuminance

Sufficient contrast across players' body is essential for the identification of the player. This is possible only if sufficient vertical illumination is there. This is characterized by both magnitude and direction. Players need adequate vertical illumination, from all directions. Spectators and Media need illumination only in defined directions. Generally, if horizontal illuminance is taken care, vertical illuminance levels become adequate. Usually vertical illuminance is specified or measured at a vertical height 1.5 m above the play area. Apart from player recognition and picture quality vertical illuminance should enable observation of movement of ball (or object moving in the sport concerned) above the playing field by both players and spectators. Spectator's stands are also part of the environment and must also have adequate vertical illuminance, more from the safety point of view.

Illuminance Uniformity

Good illuminance is important in both the horizontal and vertical planes. If it be good it does away need for continuous adjustment of cameras. This is achieved by having Illuminance Uniformity. Uniformity of illumination is expressed by two indices:

$$(1). \quad U_1 = \frac{\text{Lowest Illuminance}}{\text{Highest Illuminance}}$$

$$(2). \quad U_2 = \frac{\text{Lowest Illuminance}}{\text{Average Illuminance}}$$

For best conditions of Illumination ratio of average illuminance in the horizontal plane to vertical plane should be between 0.5 and 2.0.

Glare

When disturbing brightness nears or enters field of view, glare is said to be there. As already caused at low levels it could cause discomfort or annoyance but can be disabling at higher levels. It is minimized by a proper choice of flood lights or luminaries, located suitably and aimed in appropriate direction.

Modeling and Shadows

Ability of lighting to reveal form and texture provides overall pleasant impression of players, ball and spectators. It depends on direction of the light, no. and type of light sources. Shadows from narrow beams are termed “hard” are deep. The while light from luminous side lighting termed “Flat” produce no shadows. These are two extremes and are not desirable. Later improved by few spotlights. Good quality pictures on TV require good modeling. Hence, for media to limit shadows about 60 % light must come from main camera side and 40 % from opposite side.

Color Appearance and Color Rendering

Good color perception is very important for complete recognition. Some color distortion is acceptable in the field but becomes important for media transmission.

Color has two distinct aspects:

- i. Color appearance of the light that takes care of color impression of the total environment, essentially due to the lamp.
- ii. Color rendering of the light, the ability to reproduce color of an object faithfully.

Depends on spectral energy distribution of light emitted. Color appearance obtained from color temperature varying between 2000 (warmer) to 6000 (cooler) K. Color rendering is specified by CRI or Ra. Maximum possible CRI being 100, which is comparable to day light situation. Higher the Ra more agreeable is the environment.

Table I lists the recommendations for various types of sports in terms of E' Average Minimum Horizontal Illuminance and Illuminance Uniformity indices.

Table I

Sport	Level of activity	E (lux)	U₁	U₂	R_a	T_k	Group
Athletics Indoor	t/r	200	0.3	0.5	65	2000	A
	Ca	300	0.4	0.5	65	4000	
	Cp	500	0.5	0.7	65	4000	
	Outdoor	t/r	100	0.2	0.3	20	
	Ca	200	0.2	0.3	20	2000	
	Cp	400	0.3	0.5	65	4000	
Badminton	t/r	300	0.4	0.6	65	4000	B
	Ca	600	0.5	0.7	65	4000	
	Cp	800	0.5	0.7	65	4000	
Basketball Indoor	t/r	300	0.4	0.6	65	4000	B
	Ca	400	0.5	0.7	65	4000	
	Cp	600	0.5	0.7	65	4000	
	Outdoor	t/r	100	0.2	0.3	60	
	Ca	200	0.3	0.4	60	2000	
						2000	
Cricket Indoor	t/r/Ca	750	0.5	0.7	65	4000	C
	Cp	1500	0.7	0.8	65	4000	
	Outdoor	t/r/Ca	100	0.4	0.5	65	
	Cp	200	0.5	0.6	65	4000	
Football Indoor	t/r	300	0.4	0.6	65	4000	B
	Ca	600	0.5	0.7	65	4000	
	Cp	800	0.5	0.7	65	4000	
	Outdoor	t/r	100	0.4	0.6	65	
	Ca	200	0.5	0.7	65	4000	
	Cp	500	0.5	0.7	65	4000	
Table Tennis	t/r	300	0.4	0.6	60	4000	C
	Ca	400	0.5	0.7	60	4000	
	Cp	600	0.5	0.7	60	4000	
Tennis Indoor	t/r	500	0.4	0.6	65	4000	B
	Ca	750	0.4	0.6	65	4000	
	Cp	1000	0.4	0.7	65	4000	
	Outdoor	t/r	250	0.4	0.6	60	
	Ca	500	0.4	0.6	65	2000	
	Cp	750	0.4	0.6	65	4000	

Here t – training amateur and professional
r – General recreation
C_a – National competition amateur
C_p – National and International competition, without media requirements
E – Average minimum horizontal illuminance
U₁ – Illuminance uniformity E_{\min}/E_{\max}
U₂ – Illuminance uniformity E_{\min}/E_{av}
R_a – color rendering index
T_k – correlated color temperature
Group – according to CIE 83.

Initial values are taken to be 1.5 times indicated minimum levels. CIE grouping into A, B, C denotes speed of action in descending order. One may observe small ball size and high speed of movement are grouped under C. These recommendations change as shown in Table II for media coverage for National TV, while that for International coverage are as shown in Table III and for HDTV as shown in Table IV

Recommendations for TV (National)

Table II

Group	Maximum Shooting distance	Illuminance level		Illuminance vertical		Uniformity Horizontal		Color Rendering	Color Temperature
		Main camera (lux)	Secondary camera (lux)	U ₁	U ₂	U ₁	U ₂		
A	≤ 25m	500	500	0.4	0.5	0.3	0.5	65	4000
	≤ 75m	700	500	0.4	0.5	0.3	0.5	65	4000
	≤ 150m	1000	700	0.5	0.6	0.4	0.6	65	4000
B	≤ 25m	500	500	0.5	0.6	0.3	0.5	65	4000
	≤ 75m	1000	700	0.5	0.6	0.3	0.5	65	4000
	≤ 150m	1400	1000	0.6	0.7	0.4	0.6	65	4000
C	≤ 25m	1000	700	0.5	0.6	0.4	0.6	65	4000
	≤ 75m	1400	1000	0.6	0.7	0.4	0.6	65	4000

Recommendations for TV (International)

Table III

Group	Maximum Shooting distance	Illuminance level		Illuminance vertical		Uniformity Horizontal		Color Rendering	Color Temperature
		Main camera (lux)	Secondary camera (lux)	U ₁	U ₂	U ₁	U ₂		
A	≤ 25m	700	500	0.4	0.5	0.3	0.5	65	4000
	≤ 75m	1000	700	0.5	0.6	0.3	0.5	65	4000
	≤ 150m	1400	1000	0.5	0.6	0.4	0.6	65	4000
B	≤ 25m	1000	700	0.5	0.6	0.3	0.5	65	4000
	≤ 75m	1400	1000	0.6	0.7	0.4	0.6	65	4000
	≤ 150m	1750	1250	0.6	0.7	0.4	0.6	65	4000
C	≤ 25m	1400	1000	0.6	0.7	0.4	0.6	65	4000
	≤ 75m	1750	1250	0.7	0.8	0.5	0.7	65	4000

Recommendations for HDTV

Table IV

Group	Maximum Shooting distance	Illuminance level		Illuminance vertical		Uniformity Horizontal		Color Rendering	Color Temperature
		Main camera (lux)	Secondary camera (lux)	U ₁	U ₂	U ₁	U ₂		
A	≤ 25m	1000	700	0.5	0.6	0.5	0.6	90	5500
	≤ 75m	1500	1000	0.6	0.7	0.6	0.7	90	5500
	≤ 150m	2000	1500	0.6	0.7	0.6	0.7	90	5500
B	≤ 25m	1500	1000	0.6	0.7	0.6	0.7	90	5500
	≤ 75m	2000	1500	0.6	0.7	0.7	0.8	90	5500
	≤ 150m	2500	1750	0.7	0.8	0.7	0.8	90	5500
C	≤ 25m	2000	1500	0.7	0.8	0.7	0.8	90	5500
	≤ 75m	2500	1750	0.7	0.8	0.7	0.8	90	5500

The recommended values are average Horizontal Illuminance values to be maintained throughout operation and installation. Therefore, initial values are taken 1.25 times these suggested values.

Vertical Illuminance is provided such that camera operators have free choice of camera angle. These levels are specified at a height of 1.5m above the playing area.

As seen from the recommendations, Illuminance uniformity is very stringent for TV or media although human eye is less sensitive and has ability to adjust, levels of uniformity required higher for TV coverage.

Metal Halide Lamps

Most sports installations employ metal halide lamps. They are similar to high pressure mercury lamps. It contains number of metal halides in addition to mercury. Halides are partly vaporized when normal operating temperature is reached. Hence dissociates into halogen and metal in the hot central region. Radiation attains the color of the metal employed.

Groups of halides include:

- 1) three band color radiators
- 2) multiline radiators
- 3) molecular radiators

Three band radiator are Indium (In), Titanium (Ti), Sodium (Na). Multi Line radiator are Dyspersium (Dy), Hofnium(Ho), Thallium(Tl); Titanium (Ti), Sodium (Na) and Dyspersium (Dy), Titanium (Ti), Sodium (Na). Molecular radiators are Stannic Chloride (SnCl_2) and Stannic Iodide (SnI_2) Essentially improve color rendering ability of a mercury vapor radiation.

Lecture Summary

1. Sports Lighting has four user groups in mind
 - a. Players
 - b. Officials
 - c. Spectators and
 - d. Media.
2. Category of sport is made as A, B or C depending on the size of the ball/object and place of the game. "C" denotes fast paced game with small sized object.
3. Horizontal Illuminance, vertical illuminance and illuminance uniformity are crucial for this category of lighting.
4. Color appearance is very important for media coverage.
5. Considering all user groups CRI of 65 and color temperature of at least 4000K is recommended.

Tutorial Questions

- Where do we use narrow beam flood lights?
- Where do we use wide beam flood lights?
- Why are lamps used for sports lighting operated at higher voltage than rated voltage?

Answer to Questions of previous lecture

- What are the factors which need to be considered while designing interior lighting?
 - Purpose of lighting or intended service
 - Class of interiors
 - luminaires best suited
 - Color effect

- Reflection from ceiling, walls & floor
- Why are shadows important while designing interior lighting?
Shadows are important for actuating the depth of object to be perceived
- What are the defects in interior lighting considering from brightness point of view?
Major defects from lighting systems arise due to too bright luminaires & too dark floor & interiors. So we should have light color interiors with large sources of low brightness
- What is the criteria for deciding the height of window?
If windows are located on only one wall then the height to the top of window should be greater than half of the width of room. If windows are located on the opposite walls then the height to the top of window shouldn't be less than one-sixth of the distance between the walls.
- Why is periodic check of the interior lamps required?
Periodic check is required because the lamps need to be replaced when they reach 70% of its life or illumination level falls below standard. Moreover regular maintenance is required to clean any accumulated dust / grease / moisture.