QUALITY PROGRAMME

FIH

ENGINEERED FOR HOCKEY

Facilities guidance

SPORTS LIGHTING – TELEVISED OUTDOOR HOCKEY

Performance and operational requirements

VER. 1.4

FIH
INTERNATIONAL HOCKEY FEDERATION
FÉDÉRATION INTERNATIONALE DE HOCKEY

fih.ch/qp

Introduction

Advances in high definition digital TV technology means hockey can now be televised to a quality never previously possible. This creates new opportunities for the sport so the FIH, working with broadcasters and sports lighting companies have undertaken research to determine the best lighting that will allow the sport to maximise the quality of TV coverage.

Ideally all venues used for televised hockey will have a lighting system that complies with the appropriate category of performance, as described in this guide. Where, for whatever reason this is not possible, a venue may still be able to host televised hockey, but only if the cameras used to televise the event are able to compensate for the lower levels of lighting. Whenever such a venue is being considered a Broadcast Suitability Test should be undertaken in conjunction with the host broadcaster and tournament organisers. Details on how to arrange a Broadcast Suitability Test can be obtained from the FIH on request.

The Guide is intended for anyone involved in the planning or maintenance of hockey facilities that will be used for matches under sports lighting that will be televised, broadcast on–line or use video recording for high performance training and analysis. It provides the information needed to work through the process to ensure a good result is achieved for television viewing, players, spectators and for the environment. It does not necessarily include detailed specifications for all the various items that need to be considered when a sports lighting scheme is being developed, but it is a good starting point for planning the design, installation, and maintenance of such a lighting scheme. Where appropriate, references are made to more detailed information.

The FIH recommends that assistance from professionally accredited lighting engineers should be used in all installations. The lighting engineer should also ensue regular testing and maintenance of an installed lighting system is undertaken, including additional testing and maintenance before any FIH tournament. Further, owners of hockey pitches are reminded to address national regulations and ensure there are no conflicts particularly for the recommended lighting level modes and obtrusive light.

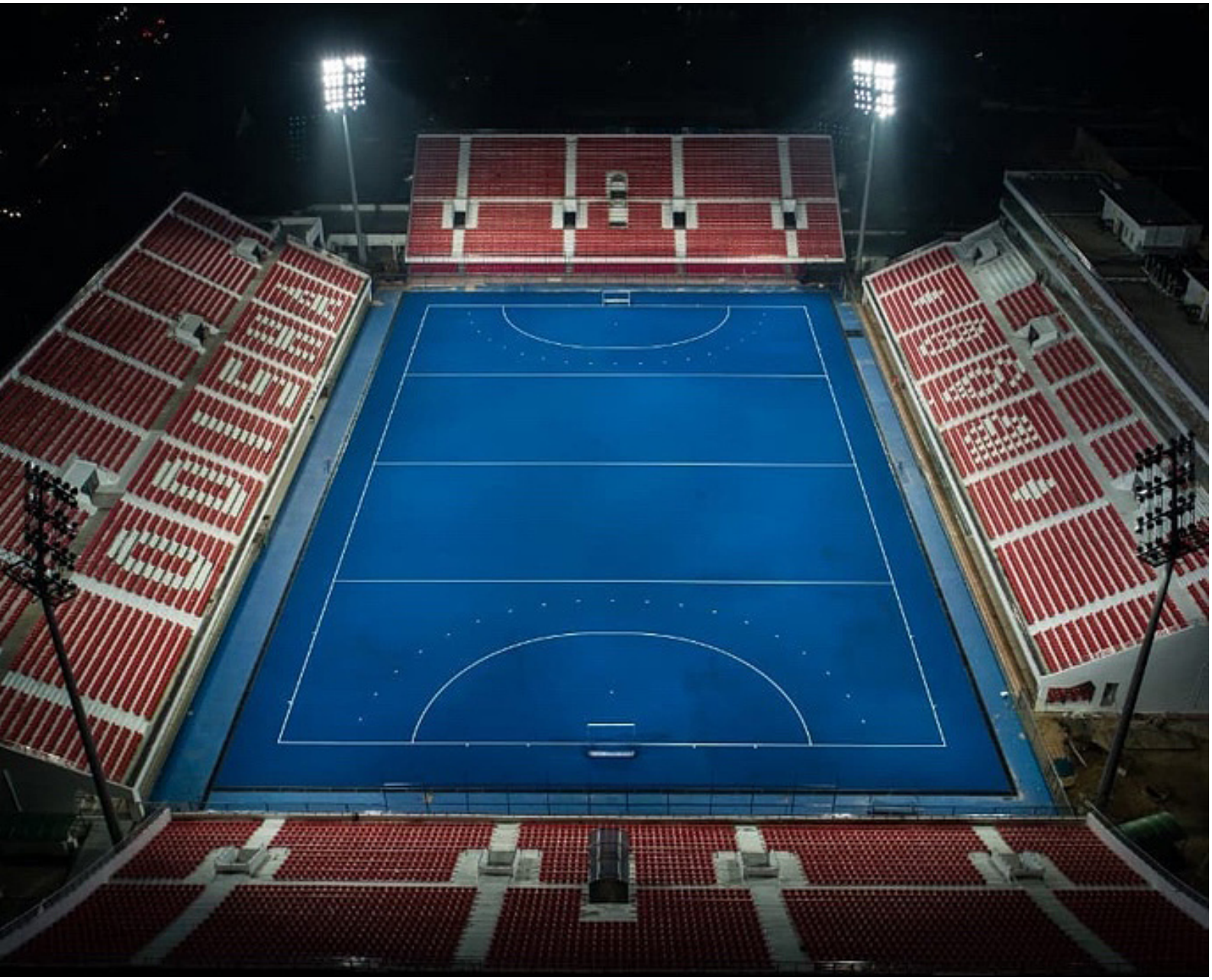
The FIH has also published a guide to sports lighting for non–televised hockey. This is available on our FIH website at www. fih.ch/qp.

Whilst every effort has been made to ensure the accuracy of the information contained in this Guide, any party who makes use of any part of it in the development of a hockey facility shall indemnify the International Hockey Federation (FIH), its servants, consultants or agents against all claims, proceedings, actions, damages, costs, expenses and any other liabilities for loss or damage to any property, or injury or death to any person that may be made against or incurred by the FIH arising out of or in connection with such use.

Compliance with the requirements detailed in the Guide by a User does not of itself confer on that User immunity from their legal obligations.

Compliance with the requirements detailed in the Guide by a User constitutes acceptance of the terms of this disclaimer by that User. FIH reserve the right to amend, update or delete sections of the Standard at any time, as they deem necessary.

Any questions about this Guide should be emailed to facilities@fih.ch.



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Design principles

The following principles should be considered and applied when designing a new hockey field lighting system or making alterations to an existing system:

1. It is essential that players' comfort and performance are not hindered by the field illuminance system;

2. Consideration of the relevant categories of competition that will be played on the field;

3. The lighting system should provide a level of illuminance that enables broadcasters to operate effectively;

4. The ability of match officials to perform effectively should not be hindered by the lighting system;

5. Spectators should be able to watch and enjoy the game without suffering any discomfort caused by the lighting system;

6. A successful lighting system will produce illuminance levels and uniformity that comply with the requirements of the relevant FIH lighting category, with soft shadows where possible;

7. The lighting system must be reliable and effective for the given location. The specific conditions that are relevant for the venue location should be carefully assessed;

8. The environmental impact of a lighting system should be fully assessed, and the design team should be committed to achieving an environmentally sustainable solution;

9. Every hockey venue is unique, and each will require a design solution that is appropriate for it and the illuminance levels required.

10. The hockey venue infrastructure and design may have an impact on the type of lighting system that can be used;

11. A lighting design should take account of the latest technological requirements for the broadcasting of hockey;

Key terms in sports lighting

Here are some key terms you may want to understand:

Colour temperature (Tk)

The colour temperature of the light emitted by a light source (measured in Kelvin).

Colour rendering index (CRI) (Ra)

The degree to which a specific light source reproduces a set of reference colours compared with the same colours under daylight conditions. Index measured on a scale of Ra0 to Ra100.

Darkness

When natural lighting is less than 100 lux.

Field of Play (FOP)

For lighting / broadcasting the FOP is defined as the Playing Area that measures 91. 40m by 55. 0m and the Perimeter Margins that extended outside the Playing Area (normally 5m at each end and 3m at each side). This gives the lighting FOP overall dimensions of 101. 4m x 61. 0m.

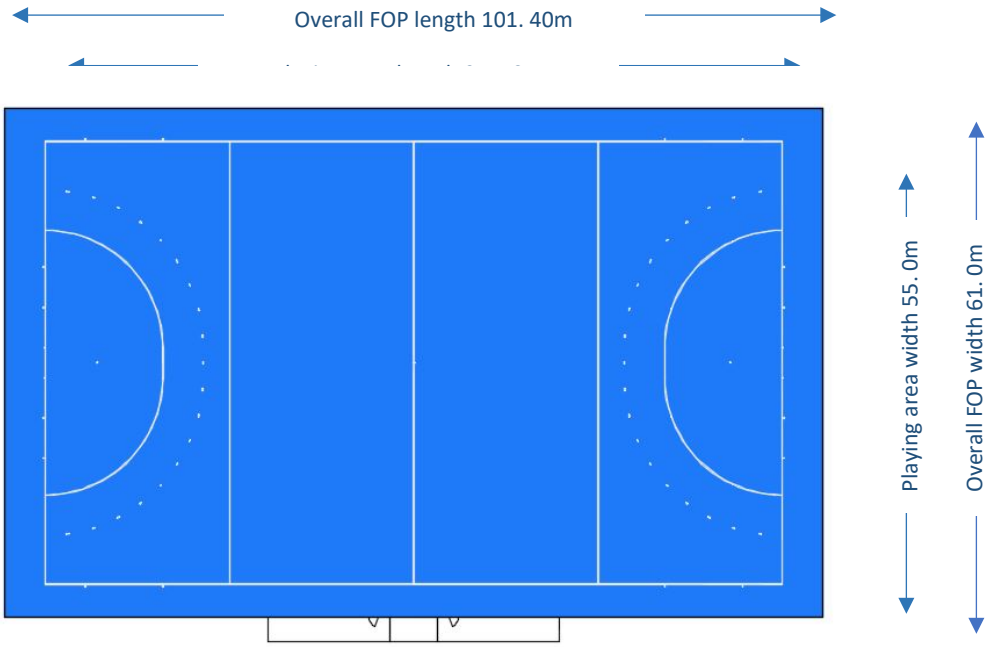


Figure 1– field of play

Flicker Factor (FF)

During broadcasts, some lighting systems can cause the picture to flicker during slow motion replays. The flicker is distracting and impairs the viewer's experience, so it should be eliminated where possible. The conditions that produce flicker will vary depending on the modulation of the flicker, the alternating voltage frequency, and the camera frame rate. The term 'flicker factor' refers to the amount of modulation of luminance on a given plane during a complete cycle. It denotes the relationship between the maximum luminance value and the minimum luminance value over a full cycle and is expressed as a percentage.

In all but the most extreme circumstances, it is possible to eliminate the flicker that is seen during slow motion replays. While the number of frames per second will vary depending on the technology used, an illuminance system with a flicker factor of less than 5% will eliminate perceived flicker for most technology used for sports broadcasting.

Glare

For outdoor hockey venues, a Glare Rating (GR) is given based on a mathematical glare formula.

Glare rating

The degree to which the lighting system is disturbing to a person on or near the field.

Horizontal illuminance

Light incidence on a horizontal plane above the pitch. This is the lighting level primarily assessed by the players.

Illuminance

A measure of how much luminous flux is spread over a given area and is required for the sport to be played.

LED

Light Emitting Diode

Main camera

The main fixed (or hard) camera(s) used for the filming of the game.

Main camera illuminance (MC)

Measurement of illuminance towards the designated main camera position.

Minimum adjacent uniformity ratio (MAUR)

Any rapid change in the illuminance level on a given plane will cause camera exposure inconsistencies. During a fast-moving hockey match, it is unrealistic to expect the camera settings to be changed successfully on a consistent basis when the camera and the subject are both moving rapidly. MAUR (or Uniformity Gradient) is used to ensure greater consistency in terms of camera exposure and thus greater freedom for the camera operator to provide dynamic pictures – MAUR is the maximum permissible difference between any two adjacent points on any given plane in any direction.

Orthogonal illuminance

Measurement of illuminance towards the four orthogonal camera positions.

Perimeter margin

The margin around the outside the playing area within the FOP.

Playing area

The area within the side and end lines.

Slow Motion Replay Zones (SMRZ)

The shooting circles and areas at either end of the field contained within the 5m dashed lines.

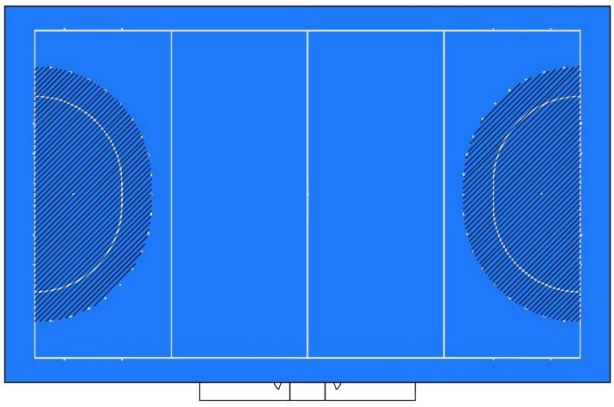


Figure 2 – slow motion reply zones

TM-21

Guidelines for using the LM-80 data to estimate the light source lumen maintenance beyond the LM-80 test period.

Uniformity

Describes how evenly light is distributed over the field surface and is expressed by the ratios of min/max (U1) and min/ave (U2).

Vertical illuminance

Light incidence on a vertical plane above the pitch. This is the lighting level primarily used by TV cameras, especially for long range cross field pictures. Unlike horizontal illuminance, both the position and orientation of the vertical surface must be known. As the angle of illumination decreases, the lumens per square meter decrease as well, until at grazing angles the surface is barely illuminated at all.

FIH Lighting Recommendations

The FIH specified three levels of lighting performance for broadcast quality outdoor 11 a-side hockey as follows:

<table>
<tr><td rowspan="3">TV1</td><td colspan="6">Venues hosting top level international hockey with matches scheduled in the hours of darkness. Broadcasters will use HDTV / 4K TV cameras in the main camera and orthogonal field camera positions.</td></tr>
<tr><td rowspan="2">Time of play</td><td rowspan="2">Type of broadcasting</td><td rowspan="2">4K cameras</td><td colspan="2">Slow Mo cameras</td><td rowspan="2">Use of Spider Cams</td></tr>
<tr><td>2 x</td><td>3 x</td></tr>
<tr><td>Night</td><td>TV</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td rowspan="3">TV2</td><td colspan="6">Venues hosting televised hockey that will take place during the hours of darkness. Broadcaster to use cameras principally positioned in the main camera position.</td></tr>
<tr><td rowspan="2">Time of play</td><td rowspan="2">Type of broadcasting</td><td rowspan="2">4K cameras</td><td colspan="2">Slow Mo cameras</td><td rowspan="2">Use of Spider Cams</td></tr>
<tr><td>2 x</td><td>3 x</td></tr>
<tr><td>Night</td><td>TV</td><td>✓</td><td>✓</td><td>✗</td><td>✓</td></tr>
<tr><td>TV3</td><td colspan="6">1. Venues hosting hockey with daytime play only, requiring high quality slow motion imagery – lighting being used to enhance dull natural light conditions

2. Venues hosting televised hockey that will take place during the hours of darkness, but where the ability to broadcast slow motion imagery is not required.

3. Venues hosting events during the hours of darkness, using on-line streaming (no TV).</td></tr>
</table>

The performance requirements for each category are detailed in Appendix B.

When designing a lighting system for a field, the specific requirements of the televised competitions planned for the venue must be considered. They may differ from the recommendations of this guide.

The sports lighting design process

The following principles should be considered and applied when designing a new

As every project is unique, it is not possible to have an exact prescription, but in broad terms the following process should be followed to avoid pitfalls:

- Determine the level of competition and objectives at the venue.
- Initial lighting design by a professionally accredited sports lighting engineer to help define difficulties, to raise questions, and to enable the necessary budget to be assessed.
- Detailed lighting design with input from venue management, broadcasters, architects, engineers, and knowledgeable hockey participants. Careful consideration should be given to the integration of lighting with existing or designed structures to ensure that the aiming is according to the lighting design, and that the commissioning and maintenance of luminaires is possible.
- After lamp installation, aiming should be checked against the lighting design and measurements taken to ensure the results are in line with the requirements.

Surface colours and reflection properties

When designing the lighting system, the colour of the playing surface and surround infrastructure that will form the background to the field should be considered. Research undertaken by the FIH has resulted in the FIH defining the preferred colour for the playing area and perimeters is Signal Blue (RAL Classic 5005). This colour is now being incorporated into the requirements for venues wishing to host top level FIH events. For further details see www.fih.ch/facilities

Camera positions

It is very important that the fixed camera positions are established before a lighting system is designed. The numbers, types and location of the cameras will differ event to event and broadcaster to broadcaster. The key positions, from a lighting perspective are the Main Camera, normally located above the field within the main grandstand and the fixed orthogonal cameras located at ground level on the four sides of the field.

Appendix A shows the camera positions specified in the current (2018) edition of the *FIH Outside Broadcast Production Guidelines and Technical Specification* – when designing a lighting system for broadcast quality lighting the designer should verify this is the applicable specification for the events the venue is planning to host.

Depending on the level of broadcast hockey intended for a venue, the lighting design needs to consider factors:

Main Camera position

The main camera position is normally within a grandstand or on an elevated platform along one side of the field. This means the camera is looking down onto the FOP. The primary consideration for the vertical illumination is the height and angle of the camera in relationship to the FOP.

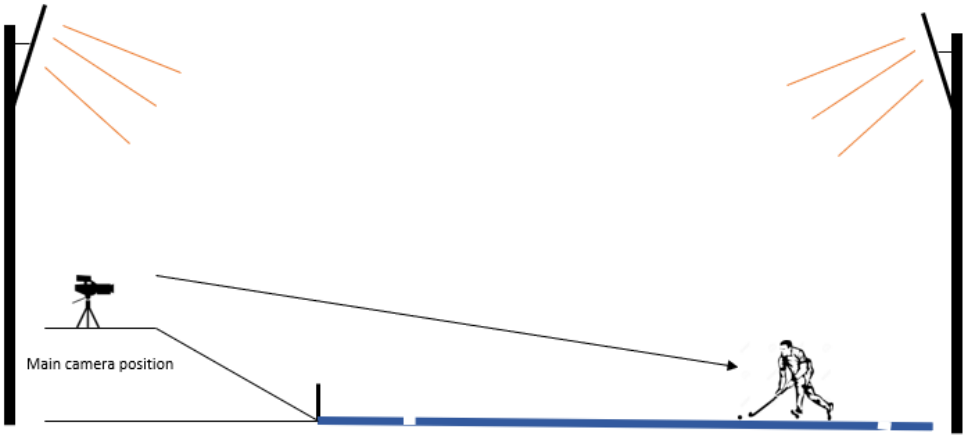


Figure 3 – relationship of Main Camera to FOP

Fixed orthogonal camera positions

For higher level broadcast events, cameras are also position at ground level on each of the four sides of the FOP.

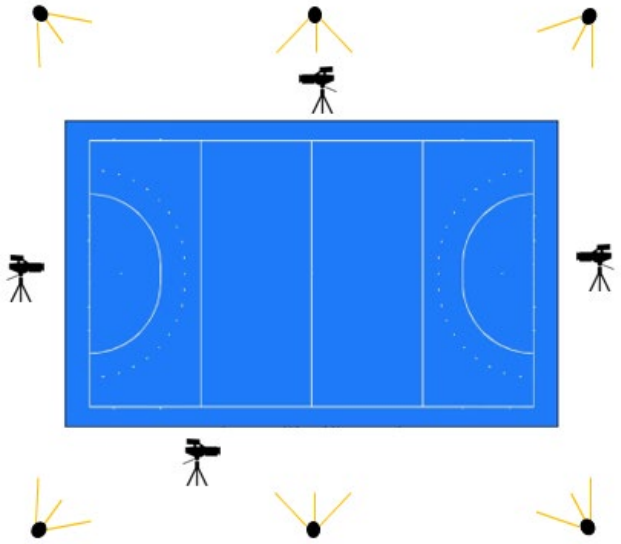


Figure 4 – typical position of fixed field cameras

Selecting the most appropriate lighting system

Metal Halide Lighting

For the last 30 plus years, the Metal Halide light source has been the principal source of sports lighting and is still a viable source today. Metal Halide technology is a form of High Intensity Discharge (HID) lighting and is like that used for street lighting, etc. In HID lighting, electricity heats the metal halides for several minutes until they vaporize inside a bulb to give off the light. The bulbs are housed inside a lamp that has reflectors that focus the light downward and outward at the required angles and trajectory. The lamps produce a white light. Life expectancy of metal halide bulbs can vary greatly, depending on the level of illumination and frequency of turning on and off. As hockey requires a certain minimum level of illumination to be played in a satisfactory and safe environment it is important that the concept of lumen maintenance is fully understood when considering lamp replacement and life expectancy.

LED lighting

The light-emitting diode (LED) is one of today's most energy-efficient and rapidly-developing lighting technologies. Advances now mean they are a viable alternative to Metal Halide lighting for sports field applications. They work by allowing an electrical current to pass through a microchip converting the electricity into light. With a new technology, it is important to you do your research to ensure that you invest in a robust product, with a solid warranty, that provides quality lighting. LEDs use heat sinks to

absorb the heat produced and dissipate it into the surrounding environment. This keeps the LEDs from overheating and burning out. Thermal management is generally the single most important factor in the successful performance of an LED light over its lifetime. The higher the temperature at which the LEDs are operating, the more quickly the light will degrade, and the shorter their useful life will be.

LUMINAIRE (LAMP) POSITIONING

Suitable lighting for broadcast quality hockey may be achieved by either mounting luminaries on the roof tops of the stadium or by mounting the luminaires on columns along either side of the field.

Note: Experience suggests using a combination of roof mounted and column mounted lights can result in less uniform light distribution and should only be used after careful consideration.

If the luminaries are column mounted, the columns must always be situated outside the perimeter margins of the field, and to provide a glare free environment for players, officials and media, the columns should not be placed within an area of:

- 10° beyond the end lines from the centre of the goal
- 15 ° before the end line from the centre of the goal
- 5° beyond the side lines from the centre line

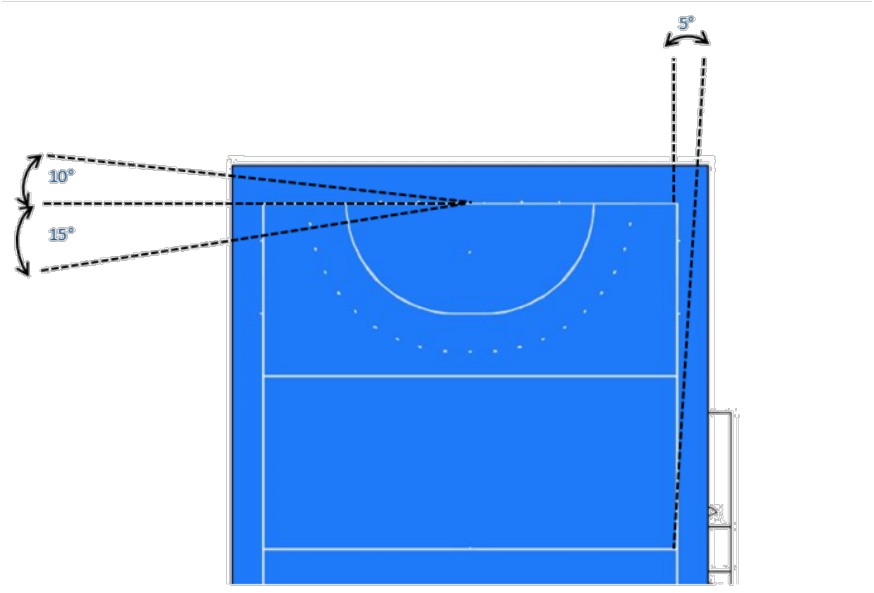


Figure 5 – restricted zones for column positioning

Lumen maintenance for metal halide lighting

The performance of metal halide lighting will change with time. Initially, systems will show a drop-in performance, before levelling off for most of their service life. To ensure the recommended average illuminances are achieved during the whole of the period of operation, the lighting levels detailed in this guide are described as "maintained" values. When designing the lighting system, the lighting engineer should determine the maintenance factor by which they will deteriorate so that an initial value can be calculated, and a maintained value is achieved. A maintenance factor of at least 1. 40 is normal metal halide sports lighting, unless it is based on newer technology that provide "Constant Light" which guarantees that target levels are maintained, rather than predicting performance based on numerical factors.

Lumen maintenance for LED lighting

LED light sources typically have a long life but do lose light as the diodes age. It is important to make sure that the LED source you are purchasing is operating in a manner that supports this statement. All manufacturers should provide L90, L80, and L70 data that is reported in accordance with TM-21.

Commissioning

The luminaires must be aimed according to the lighting design and this should be followed by measurements to ensure that the installation meets the requirements of this guide. Measurements should be carried out using a calibrated illuminance meter.

- Before measuring, the supply voltage should be checked.
- On field measurements may vary from computer predicted results. On new installations, this should be on the positive side of the average light levels required. For existing fields if the average light level is below computer predicted light level averages the light levels should be reviewed by a professional sports lighting engineer to determine if safety or broadcast ability is impacted.
- A measurement record sheet should be used to record the results. A template report is given in Appendix C of this Guide.
- For testing, a grid of maximum size 5m x 5m should be laid out with a point in the centre of the field and covering the FOP and perimeter margins.

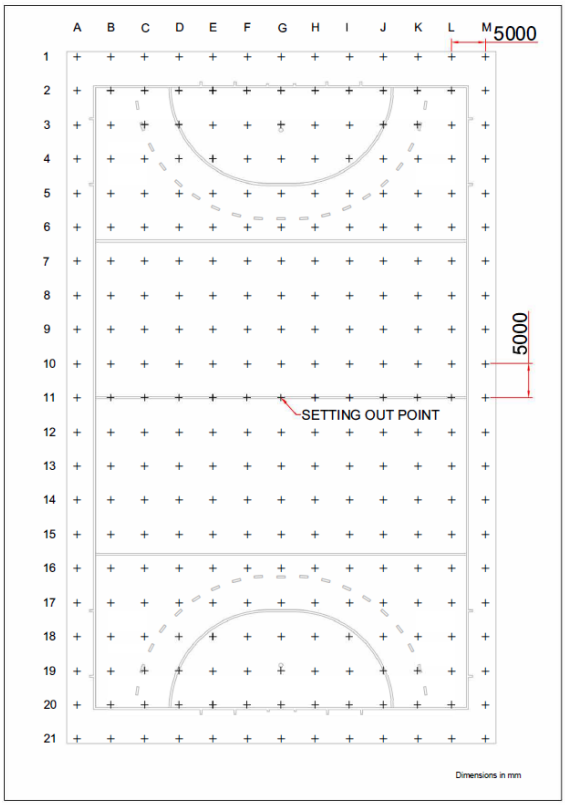


Figure 6 – light test measuring grid – dimensions in mm

Test engineers

Tests are normally undertaken by an independent lighting engineer or a sports lighting installation contractor. They should ideally be operating an ISO 9001 or ISO 17025 certified quality system that includes the testing of sports lighting.

Light Meter

Tests should be made with a photometric cell, accurate to 1%, connected to a digital display. The light meter should have been calibrated within 12 months of the lighting test date.

Measuring heights

All vertical measurements should be made with the light meter mounted on a suitable pole or tripod, so it is 1. 0m above the Hockey Turf.

Horizontal measurements may be made with the light meter placed on the Hockey Turf or with the meter mounted on a suitable pole or tripod, so it is 1. 0m above the Hockey Turf.

Vertical illuminance – main camera (EV_{mc})

Measurements should be made with the photometric cell at 105° to the horizontal aimed towards the main camera. At each grid position measurements shall be made with the photometric cell aimed towards the main camera position, as shown on Figure 7.

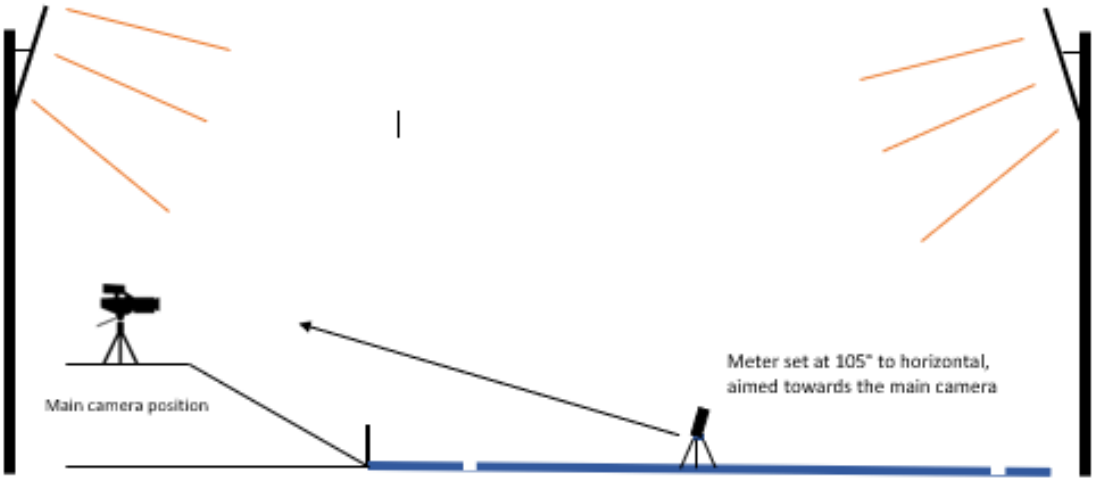


Figure 7 – Main Camera tests – photocell angle

Note: An angle of 105° has been adopted in recognition that most hockey stadium have main camera positions located with grandstands that have quite shallow rakes. If lighting is being designed for a main camera position within a grandstand with a steep rake the angle may be adjusted to 120° to the horizontal.

Vertical illuminance – orthogonal directions (Ev_{od})

Measurements should be made with the photometric cell held at 90° to the Hockey Turf. At each grid position measurements shall be made in the four directions shown in Figure 8. Direction A should be towards the boundary containing the Main Camera Position.

Note: It is recommended that when testing a TV2 category field, the vertical illuminance in the four orthogonal directions is also measured and reported to aid broadcasters.

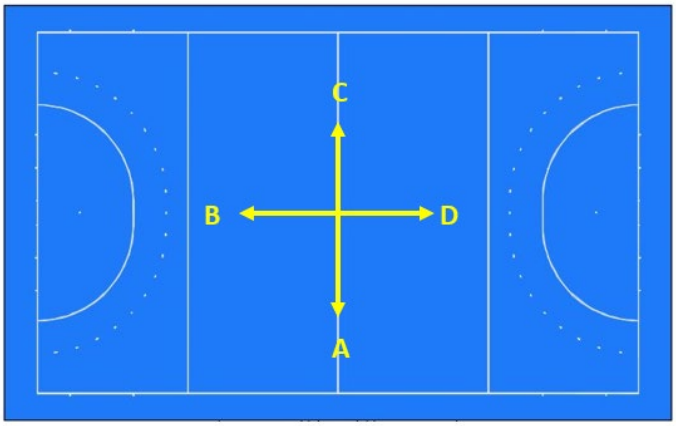


Figure 8 – vertical illuminance – orthogonal test directions

Horizontal illuminance measurements (Eh)

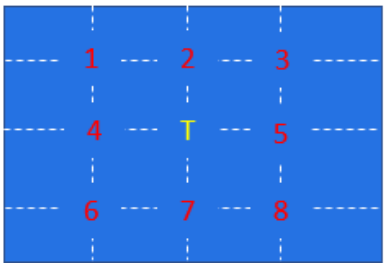
Measurements should be made with the photometric cell facing upwards at 180° to the playing surface.

Flicker measurements

Flicker measurements should be made at each point on the measurement grid.

Minimum adjacent uniformity ratio

MAUR for vertical and horizontal illuminance to the main camera should be calculated for each test position, as shown in the example below.



Reference point T: Ev = 1248 lux. MAUR ≥ 0. 65

Minimum lux at adjacent reference points (1 – 8) = 1248 x 0. 65 = 811 lux

Test Conditions

Tests shall only be made in darkness and when weather conditions will not impede measurements (i.e. not in rain, mist, fog or snow, etc.).

Lighting systems based on metal halide lamps

Prior to any tests the sports lighting lamps should have been used for a minimum of 10 hours prior to the test to ensure consistency.

After switching on the lighting to undertake a test, sufficient time shall be allowed to ensure the lamps have warmed up. The required warm-up time depends on the type of

lamps used and can be obtained from the lamp manufacturer's specifications. Before making measurements, the supply voltage should be checked.

Warranty and Guarantee

Warranties vary greatly in length and coverage. We recommend obtaining warranty documents from each manufacturer being considered, that clearly states what is covered. Product warranties are a good gauge of a manufacturer's confidence in their products. Periods covered can range from 12 months to 25 years, and details of covered items and conditions vary greatly. The FIH recommends you request warranties that include guaranteed light levels (performance), parts, labour, and lamp replacements. Financially funded reserves are a gauge as to whether the manufacturer is committed to their warranty.

Appendix A – camera positions as detailed in *FIH Outside Broadcast Production Guidelines and Technical Specification* (2018 edition).

		Type	Lens	Mount	Location	Designation for lighting tests
1		Cable	22:1	Tripod/Fluid Head	Centre line	Main camera position
2		Cable	72:1	Tripod/Fluid Head	Centre line, left of camera 1	
3		Cable	72:1	Tripod/Fluid Head	23m left of camera 1	Orthogonal camera position
4		Cable	14:1 WA	Hand Held	Corner to 23m line, right of camera 1	
5		RF/Cable	14:1 WA	RF Steadi/Hand Held	Corner to 23m line, left of camera 1	
6		Cable	Min. 72:1	Tripod/Fluid Head	End line/shooting Circle, right of camera 1	
7		HiMo/SSM	Min 72:1	Tripod/Fluid Head	End line / Shooting Circle, left of camera 1	
8		Cable	22:1	Tripod/Fluid Head	High behind Goal, left	Orthogonal camera position
9		Cable	22:1	Tripod/Fluid Head	High behind goal, right	Orthogonal camera position
10		SSM	Min 72:1	Tripod/Fluid Head	Reverse Centre Line	Orthogonal camera position
11		Cable	14:1 WA	Hand Held	Centre Line	
12		MiniCam	WA	Locked Off	Goal right, top corner of goal	
13		MiniCam	WA	Locked Off	Goal left, top corner of goal	

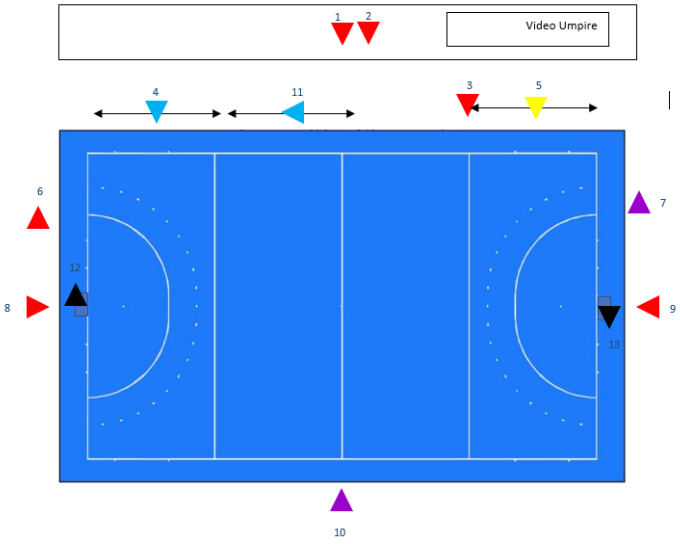


Figure 9 – camera positions

Appendix B – FIH Standard*s for broadcast quality lighting for 11 a-side hockey (Outdoors)*

FIH TV Lighting category TV1				
Maintained average illuminance (lux)	Vertical illuminance – main camera		E_{vmc}	≥ 1650
	Vertical illuminance – orthogonal field cameras	Dir. A	E_{vod}	≥ 1200
		Dir. B		
		Dir. C		
		Dir. D		
	Horizontal illuminance		Eh	≥ 2000
Illuminance uniformities	Vertical illuminance – main camera	$E_{v\,min} / E_{v\,max}$	Uv1	≥ 0. 60
		$E_{v\,min} / E_{v\,ave}$	Uv2	≥ 0. 65
	Vertical illuminance – orthogonal field cameras	$E_{v\,min} / E_{v\,max}$	Uv1	≥ 0. 50
		$E_{v\,min} / E_{v\,ave}$	Uv2	≥ 0. 60
	Horizontal illuminance	$E_{h\,min} / E_{h\,max}$	Uh1	≥ 0. 65
		$E_{h\,min} / E_{h\,ave}$	Uh2	≥ 0. 70
	Minimum adjacent uniformity ratio	MAUR	Vertical	≥ 0. 65
			Horizontal	≥ 0. 65
Flicker factor				≤ 5%
GR-Max				< 50
CRI				>75
Colour temperature (K)				> 5000 < 6200
The maximum vertical illuminance shall be within the SMRZ				
The minimum vertical illuminance of the FOP shall not be within a SMRZ				
Both SMRZ shall have the same quality of lighting				
The maintained average vertical illuminance in Direction A shall be greater than the average vertical illuminance in directions B, C or D				
As far as reasonably practicable the vertical illuminance in each orthogonal direction of TV2 should comply with the requirements of lighting category TV1.				

FIH TV Lighting category TV2				
Maintained average illuminance (lux)	Vertical illuminance – main camera		Ev_{mc}	≥ 1400
	Vertical illuminance – orthogonal field cameras	Dir. A	Ev_{od}	
		Dir. B		
		Dir. C		
		Dir. D		
	Horizontal illuminance		Eh	≥ 1650
Illuminance uniformities	Vertical illuminance – main camera	Ev_{min} / Ev_{max}	Uv1	≥ 0. 60
		Ev_{min} / Ev_{ave}	Uv2	≥ 0. 65
	Vertical illuminance – orthogonal field cameras	Ev_{min} / Ev_{max}	Uv1	
		Ev_{min} / Ev_{ave}	Uv2	
	Horizontal illuminance	Eh_{min} / Eh_{max}	Uh1	≥ 0. 65
		Eh_{min} / Eh_{ave}	Uh2	≥ 0. 70
	Minimum adjacent uniformity ratio	MAUR	Vertical	≥ 0. 60
			Horizontal	≥ 0. 60
Flicker factor				≤ 15%
GR-Max				< 50
CRI				>75
Colour temperature (K)				> 4000 < 6200

FIH TV Lighting category TV3				
Maintained average illuminance (lux)	Vertical illuminance – main camera		Ev_{mc}	≥ 750
	Vertical illuminance – orthogonal field cameras	Dir. A	Ev_{od}	
		Dir. B		
		Dir. C		
		Dir. D		
	Horizontal illuminance		Eh	≥ 1000
Illuminance uniformities	Vertical illuminance – main camera	Ev_{min} / Ev_{max}	Uv1	≥ 0. 35
		Ev_{min} / Ev_{ave}	Uv2	≥ 0. 45
	Vertical illuminance – orthogonal field cameras	Ev_{min} / Ev_{max}	Uv1	
		Ev_{min} / Ev_{ave}	Uv2	
	Horizontal illuminance	Eh_{min} / Eh_{max}	Uh1	≥ 0. 65
		Eh_{min} / Eh_{ave}	Uh2	≥ 0. 70
	Minimum adjacent uniformity ratio	MAUR	Vertical	
			Horizontal	≥ 0. 60
Flicker factor				≤ 30%
GR-Max				< 50
CRI				>65
Colour temperature (K)				> 4000 < 6200

Appendix C – template test report

Project name:						
Field identification:						
Date of installation:						
Required lighting category:	FIH TV1		FIH TV2		FIH TV3	
Date of tests:						
Testing company:						
Technician:						
Light meter model:						
Date of light meter calibration:						

Summary

Property		Result				Requirement			Pass / fail
						TV1	TV2	TV3	
Vertical illuminance – towards main camera						≥ 1650	≥ 1400	≥ 750	
Vertical illuminance – orthogonal directions		Dir A	Dir B	Dir C	Dir D	≥ 1200			
						≥ 1200			
Horizontal illuminance (lux)						≥ 2000	≥ 1650	≥ 1000	
Vertical illuminance – main camera uniformity	Uv1					≥ 0. 60	≥ 0. 60	≥ 0. 35	
	Uv2					≥ 0. 65	≥ 0. 65	≥ 0. 45	
Vertical illuminance – orthogonal dir. uniformity		Dir A	Dir B	Dir C	Dir D				
	Uv1					≥ 0. 50			
	Uv2					≥ 0. 60			
Horizontal illuminance uniformity	Uh1					≥ 0. 65	≥ 0. 65	≥ 0. 65	
	Uh2					≥ 0. 70	≥ 0. 70	≥ 0. 70	

Property		Result	Requirement			Pass / fail
			TV1	TV2	TV3	
Minimum calculated MAUR	Vertical		≥ 0. 65	≥ 0. 60		
	Horizontal		≥ 0. 65	≥ 0. 60	≥ 0. 60	
Flicker factor			≤ 5%	≤ 15%	≤ 30%	
GR-Max			< 50	< 50	< 50	
CRI			>75	>65	>65	
Colour temperature			5000 – 6200K	> 4000 K – 6200K	> 4000 K – 6200K	

Specific questions for Category TV1	
Is the maximum vertical illuminance within the SMRZ?	
Is the minimum vertical illuminance of the FOP outside of the SMRZs?	
Is the quality of lighting the same in both SMRZ?	
Is the average vertical illuminance in Direction A greater than the average vertical illuminance in directions B, C and D?	

Results

Tables showing the individual results (based on a 5m x 5m grid) for the following tests should be attached to the report:

1. Horizontal illuminance (lux)
2. Vertical illuminance towards main camera (lux)
3. Vertical illuminance orthogonal direction A, towards the main camera (lux)
4. Vertical illuminance orthogonal direction B (lux)
5. Vertical illuminance orthogonal direction C (lux)
6. Vertical illuminance orthogonal direction D (lux)

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