QUALITY PROGRAMME

ENGINEERED FOR HOCKEY

Facilities guidance

LIGHTING FOR NON-TELEVISED HOCKEY

Performance & operational requirements

VER. 2.2

INTERNATIONAL HOCKEY FEDERATION
FÉDÉRATION INTERNATIONALE DE HOCKEY

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Foreword

The FIH believes that good sustainable hockey facilities are fundamental to the development of hockey opportunities for everyone, from the youngest beginner to the international class player. The move to synthetic turf playing fields means there is an increasing desire to use them over an extended period each day and this will often entail the use of artificial sports lighting. However, it is important that the lighting is of an appropriate type and quality for four fundamental reasons:

- to ensure the safety of players and others involved in the game
- to provide better viewing for spectators and television where applicable
- to ensure the effective use of money spent on capital and operating costs over time
- to be environmentally sensitive.

As far as sports lighting is concerned, outdoor hockey 11 a-side fields and Hockey5s courts can be divided into facilities that are lit to standards that allow good quality broadcasting of games and these that are intended for non-televised matches. This Guide is aimed at those wishing to artificially light facilities for non-televised matches. It provides information about the things to consider when installing or perhaps upgrading sports lighting on hockey fields and Hockey5s courts.

Non-specialists reading this Guide should not be put off by the technicalities in some sections. If it conveys the message that sports lighting is a little more complex than erecting a few columns and mounting some lights on top then it has served its purpose, and the more detailed sections will be of direct benefit to lighting engineers involved in the design installation.

The FIH recommends that assistance from professionally accredited lighting engineers should be used in all installations. 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.

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.

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

This edition of the FIH lighting Guide has been developed with the assistance of England Hockey, Loughborough University, and representatives of the sports lighting industry.

International Hockey Federation
May 2018, Updated November 2020

Introduction

Unless played in good daylight, hockey like all other sports requires good lighting for it to be played safely and enjoyably. This is true whether the game is being played at the recreational level or at an international event.

As with all projects, the budget available is a key factor in determining the outcome. There is a growing awareness of the added value of good quality lighting for any sports venue. Both the contract price and life-cycle operating costs should be considered in determining the supplier for your project. Even though it requires investment, lighting represents only a modest proportion of the total cost of a hockey field and, as a rule, it is true to say that where the right lighting is installed the users, players, spectators, and venue owners are never disappointed. However, if a poor, second rate system is installed this almost always leads to complaints and eventually to a very costly change or upgrade.

The Guide is intended for anyone involved in the planning or maintenance of hockey facilities from local recreational pitches through to play at the elite national level (increasingly international hockey and Hockey5s is televised and therefore requires superior artificial lighting). It provides the information needed to work through the process to ensure a good result is achieved for players, spectators, television viewing, 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.

Key terms in sports lighting

Here are some key terms you may want to understand:

Average maintained horizontal illuminance (Eh) – This is the average quantity of lux over the horizontal playing surface.

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

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

Glare rating – The degree to which installation is disturbing to a person on or near the pitch.

Horizontal illuminance – Light incident on a horizontal plane 1m above the pitch

Illuminance uniformity – Two measurements are normally undertaken:

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

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

L90, L80, L70 – The point at which the output of a LED light source has depreciated to 90%,80% or 70% of its original output based on LM-80 & TM-21 projection methods

LED – Light Emitting Diode

LM-80 – Approved method of measuring the lumen maintenance of the LED packages, arrays, and modules at various temperatures.

Lumens (Lm) – The unit of illuminance in lumen/m2 (1 lux = 1 lumen/m2)

Obtrusive Light – The amount of light spill and glare that leaves the premises

Quantity of light required (illuminance) – This is the amount of light (measured in lux) that is required for the sport to be played.

Uniformity –Describes how evenly light is distributed over the field surface and is expressed by the ratios of min/max and min/ave.

Switching Modes – Lighting should be designed to include various levels of light that are appropriate to the level of play.

TM-21 – Guidelines for using the LM-80 data to estimate the light source lumen maintenance beyond the LM-80 test period.

Recommendations – Non-Televised Hockey (Outdoors)

The FIH recommends lighting levels for non-televised outdoor hockey, Hockey5s and hockey training be as detailed below. These guidelines are based on what players find acceptable to allow hockey to be played in a safe and suitable environment. Three lighting levels are detailed based on the various levels of competition and training that may be played on a field.

- Class I is considered suitable for high-level non-televised national and international competitions

- Class II is considered suitable for training and club competitions

Lighting for Development & community level training is not normally a separate category of lighting but is achieved through switching or diming of a Class I or I Class II lighting system.

Class of play[1]	Eh maintain lux	Horizontal uniformity ratio		UG	GR-Max	CRI (Ra)	Colour temp. (Tk)*
		U1	U2				
Class I	≥ 500	≥ 0.50	≥ 0.70	0.65	<50	>65	>4000
Class II	≥ 350	≥ 0.50	≥ 0.70	0.65	<50	>65	>4000
Development & community level training	≥ 200	≥ 0.40	≥ 0.60	0.60	<50	>65	>4000

Eh maintain	Minimum horizontal maintained illumination, measured in lux
U1	Minimum/Maximum illuminance
U2	Minimum/Average illuminance
UG	**Uniformity Gradient – the r**ate of change of illuminance between adjacent (grid) values
GR-Max	Glare rating
CRI	**Colour Rendering Index**
Colour temperature	A way to describe the light appearance provided by a lighting. * The same colour temperature lamps should be used for a venue

[1] Please note the classes have been reversed from the previous edition of this lighting guide

The seven steps to a successful lighting scheme

The development of a sports lighting scheme may be broken into seven key stages:

Stage 1 – Project conception

- Scope out project brief and demonstrate the need for sports lights
- Consult with key stakeholders (national or state hockey association, proposed users, local authority planners,)
- Determine the lighting standards required for level of competition
- Identify planned use, time, and hours of use per week
- Engage with lighting specialist for initial consultation and determine outline feasibility
- Outline budget (capital and revenue)
- Identify risks: planning challenges, unsecured finance, etc

Stage 2 – Feasibility

- Appoint an accredited lighting consultant
- Conduct electrical surveys to assess power supply (your appointed lighting engineer should be able to help)
- Hold informal talks with relevant planning department
- Design feasibility: explore viable options (advantages and disadvantages)

Stage 3 – Outline

- Engage with specialist lighting engineer to produce layouts and project and specification
- Engage and consult with residents, particularly those most affected by the scheme
- Obtain budget estimates, review funding
- Submit planning application

Stage 4 – Procurement

- Obtain quotations from specialist lighting suppliers / contractors
- Select and appoint lighting contractor

Stage 5 – Installation

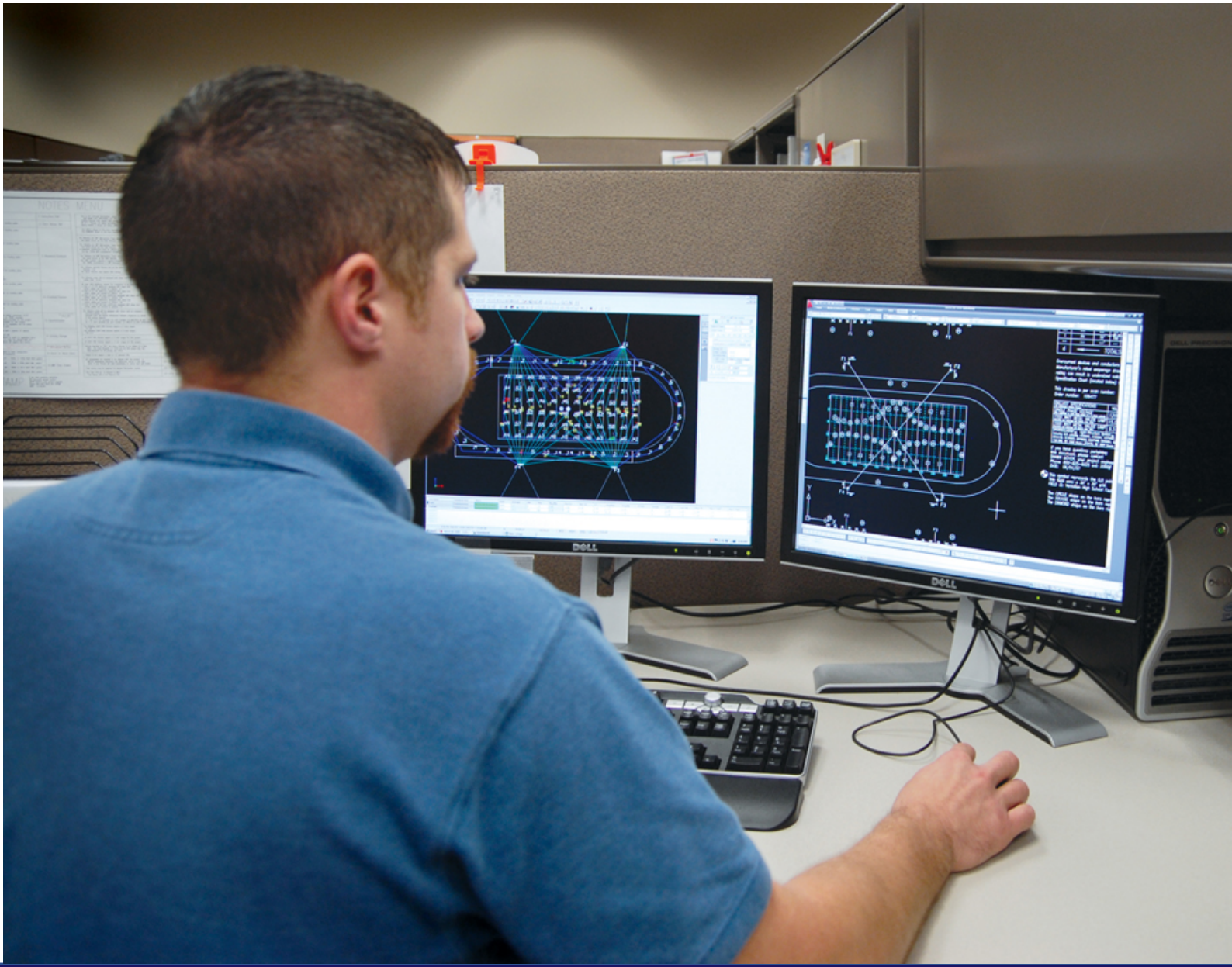
- Site preparation
- Electrical works, including power supply
- Supply and installation sports lights
- Testing

Stage 6 – Handover

- Sign off
- Performance and electrical certification

Stage 7 – Maintenance

- Annual general maintenance (in accordance with manufacturer guidelines and warranty conditions)
- Periodic re-testing and certification



Planning

Increasingly lighting a hockey facility will require some form of building or planning approval. Applications to light a sports field can be contentious as neighbours raise concerns about increased, use, noise, and light pollution. Before applying, it is recommended you consult with the relevant authorities be undertaken so that the level of information required can be determined in advance. This is likely to require a lighting spillage drawing showing the levels of light pollution and their impact on the surrounding neighbourhood. Lighting engineers or specialist lighting contractors can provide these.

Consideration should be given to the visibility of the lighting columns and a field's location in relation to nearby residential properties. The use of screening and tree planting can significantly reduce light and noise levels and the visual impact of columns. If the visual impact of lighting columns is major concern, consider using retractable columns.

Experience shows it is often advisable to research the impact of other similar local sports facilities with lighting so that persuasive arguments can be put forward to counter any concerns. Consideration may need to be given to the hours and pattern of use. On receiving your building / planning consent, conditions may be attached, and it is vital that you fully understand the impact of these on your ability to deliver the planned sports activities and income generation. For example, a planning authority might limit the number of games under lights per week or specify a cut-off time at which the lights need to be turned off each evening.

Selecting the most appropriate lighting system

In today's sports lighting market, there are two predominant light sources.

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 a metal for several minutes until it vaporizes 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 blubs 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 (see page 10) 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.

Which option is best for your hockey field?

At present, there is no clear favorite. Both light sources have advantages and disadvantages; the main considerations are described below:

	Metal halide lighting	LED lighting
Cost of lighting system	Metal halide lighting systems are a lower cost solution	
Directionality	Metal Halide lights typically emit light over 360°, meaning much of these emissions have to be reflected and/or redirected to the target area, which can mean losses and lower overall system efficiency	Depending on the fixture optics, LEDs can emit light over 180°. This is an advantage because light is usually desired over a specific target area (rather than fully around the bulb). This can help increase the energy efficiency of LED lights.
Running costs		The luminous efficacy of an LED luminaire is significantly higher than that of a metal halide luminaire, so, for the same lighting level, the energy costs will be lower.
Maintenance costs	All lighting systems need periodic maintenance (cleaning of lens, realignment of lamps, etc).	

	Metal halide lighting	LED lighting
Maintenance costs	Metal halide lamps contain many components operating under extreme conditions. These require servicing and replacing through the life of the lighting system.	High-quality LED lamps have much longer life cycles and require less maintenance than metal halide lamps, meaning their maintenance costs are much lower.
Life cycle costs	Although LED systems are far more energy efficient and have lower maintenance costs, studies are questioning if the savings made can offset the initial higher capital outlay, due to the limited operating periods of an outdoor sports lighting system (often just a few hours per day, during the playing season). A full life cycle cost analysis should be undertaken for each specific installation to determine which light source makes most economic sense.	
Ability to rapidly turn lights on and off or to dim the levels of illumination	Metal halide lamps require a period to reach their optimum operating temperature and must be allowed to cool down before being turned on again.	LED lighting can be turned off and on without delay.
Ability to dim the levels of illumination	Only available with sophisticated metal halide lighting systems and diming can reduce the energy efficiency of the blub and or its operating life.	Readily available with LED lights
Glare control	Controlling glare is an important characteristic of a sports light.	
Long-term availability	As a lighting system is often expected to last for 15 to 20 years, considering the long-term availability of spare parts is important.	
	Many in the industry think the production of replacement components for metal halide lamps will, at some point become uneconomic, making the lighting systems obsolete. However, this is not predicted soon.	LED technology is advancing rapidly, and today's state of the art technology may become outdated in the relatively near future.

Design and system considerations

There are several components that need to be included in an accurate comparison of lighting proposals. Initial costs as well as the cost of ownership over time should be considered.

The chart below shows the three main components of a lighting system, and the three basic design and procurement functions that need to be considered. All will incur costs and need to be considered at the initial planning and feasibility stages of a project. In order to compare quotations from the various suppliers biding for a project, you should make sure they have included costs for each of these.

	Lighting components	Electrical control components	Columns and structural components
Design	✓	✓	✓
Supply	✓	✓	✓
Installation	✓	✓	✓

The provision of an adequate electricity supply is a very important consideration. Clearly, the electrical supply must have the capacity to power the proposed lights, as well as cater for any existing loading on the site (the lighting, water heaters (showers, etc) possibly heating, refrigeration, cooking, air conditioning etc.). To know whether an existing supply has the capacity, it should be assessed, and the requirements of the proposed lighting system added. If the supply capacity is less than the total (with a margin for safety and future expansion), an upgrade will be needed. It is important to know this at an early stage of a project as power supply upgrades can be very expensive, and an appropriate financial provision will need to be in the project costs

The design and dimensions of the concrete foundations for the lighting columns will need to be based on the soils and wind exposure characteristics of the particular site. The chemical properties of the soils are also important, since they can affect the type of cement needed in the concrete. The mechanical properties of the soils are important since they will determine the dimensions of the foundation.

10 year life-cycle cost evaluation

Other considerations should be the cost of owning the system over time. We recommend you ask bidders to furnish a minimum of 10-year life-cycle costs to include maintenance, parts replacement, and necessary re-lamping. A typical evaluation is shown in the table below. It is based on 2000w metal halide technology.

As some LED technology can offer significant reductions in life cycle operating costs it is important to ask the LED supplier(s) to provide a full lighting design, product

datasheet, energy consumption data, and warranty documentation so you can understand the LED technology being offered and fully evaluate the difference between a metal halide and a LED lighting system.

Regardless of source technology, the basics of lighting maintenance remain the same: re-lamping (metal halide), cleaning, monitoring, aiming, alignment, and troubleshooting must be allowed for in the calculations.

		Metal Halide		LED	
A	Energy consumption				
	Number of luminaires	32		32	
	kW demand per luminaire	x 2.16 kW		x 1.15 kW	
	kW rate (per hour)	x €0.15		x €0.15	
	Annual usage hours x 10 years	x 3,000		x 3,000	
	Total Energy Consumption	= €31,104	= €31,104	= €16,560	= €16,560
B	Demand charges, if applicable	**=**_____	**+**_____	**=**_____	**+**_____
C	Spot re-lamping and maintenance over 10 years. Assume 3 repairs at € 1,000 each if not included	= €3,000	= €3,000	= €3,000	= €3,000
D	Group re-lamps over 10 years — minimum required	**=** 1		= 0	
	€250 lamp and labour	x €250			
	Number of luminaires	x 32			
	Total Re-lamping	= €8,000	+ €8,000	= 0	
E	TOTAL 10-Year Life-Cycle Operating Cost		= €42,104		= €19,560

Warranty and Guarantee

Warranties vary greatly in length and coverage. We recommend obtaining warranty documents from each manufacturer 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.

The sports lighting design process

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 play and objectives at the venue. For example, 11 a-side full field and cross field training and mini hockey.
- 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, 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 installation, aiming should be checked against the lighting design and measurements taken to ensure the results are in line with the requirements.

Column placement

Columns must always be situated outside the overrun area as shown in the figures below. The FIH recommend they be ideally sited a minimum of 5m beyond the back-lines and 6m behind the side-lines.

A qualified lighting designer can determine the most advantageous arrangement based on the level of play and site conditions.

Side column arrangement

This method usually provides a more uniform lighting result and may be economically more feasible as pole height requirements are typically reduced. Four, six, or eight column layouts are acceptable.

Experience shows that end columns should ideally be positioned behind the end lines to maximise good illumination for goal keepers.

Corner column arrangement

A corner column system can be utilised, but care should be taken that columns are situated so that there is sufficient vertical illuminance as this can sometimes prove difficult in the central area of side-lines. Heavy shadowing from players is a drawback to this design as well as higher potential for glare. Positioning some lighting on the roof over spectator stands may help if of adequate height.

Column heights

Column/mast heights are often a contentious issue with planning departments and those with properties adjacent to a hockey field. Whilst lower columns may be less visually intrusive, higher columns allow greater light uniformity over the field and greater control of light spillage as the lamps can be angled more acutely. Therefore, unless the visual impact of the column/mast is a major concern, 18m high columns are considered the optimum height.

Recommended column heights & positions – full size hockey field

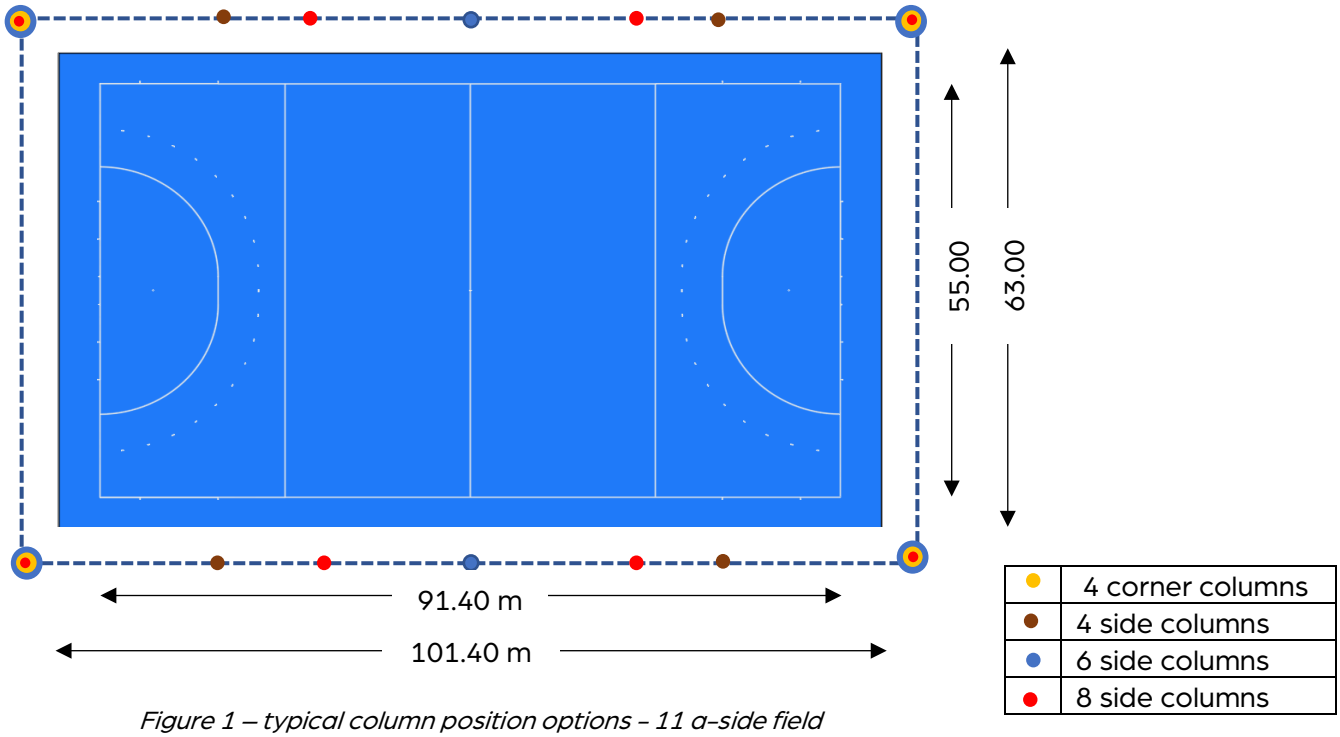


Figure 1 – typical column position options - 11 a-side field

Quantity	Column Height		Setback from field boundary
	Side arrangement	Corner arrangement	
4	18 meters	21 meters	5 / 6 meters
6	18 meters	n/a	5 / 6 meters
8	15 meters	n/a	5 / 6 meters

Recommended column heights & positions Hockey5s courts

Quantity	Column Height		Setback from field boundary
	Side arrangement	Corner arrangement	
4	–	15 meters	3 meters
6	12 meters	–	3 meters

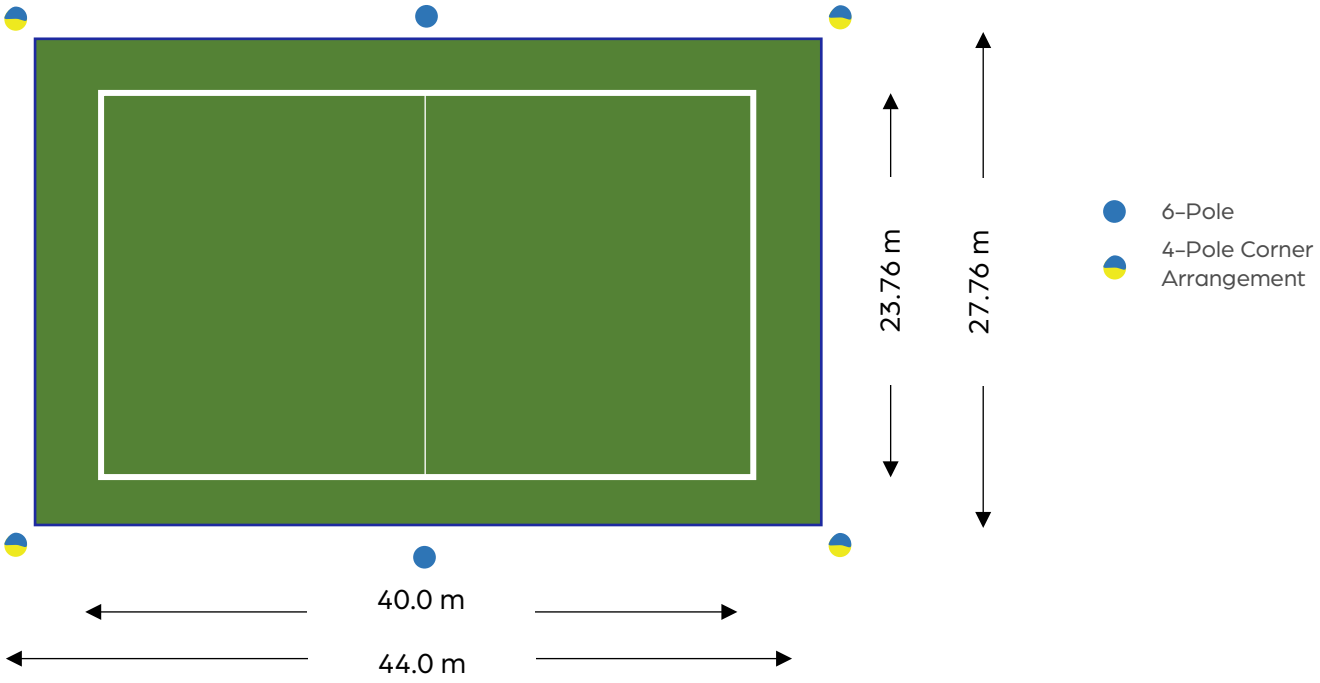


Figure 2 column position options – Hockey5s court

Light spillage

The provision of sports lighting can often be contentious, particularly if the hockey facility is adjacent to residential areas or within a particularly sensitive location. Local consultation should be undertaken; neighbours should be informed of the lighting proposals at an early stage before it is too late to make changes to address any concerns neighbours may have.

Obtrusive light is wasted light that is directed up in to the sky or beyond the boundary of a sports facility. Reference should be made to CIE 150 (issued by the International Commission on Illumination) or local regulations. A good quality hockey lighting installation will achieve the lighting requirements and at the same time not impose on surrounding residents or services. Many Municipal (Local) Authorities have published classifications for the night-time environment and lighting levels for particular sites. Some have set limits on acceptable levels of obtrusive light, while others may refer to national guidance. Highway Authorities may also set limits on lighting spillage onto roads, or on the source intensity of the lights, seen from the road. There are also strict limits on lighting in aerodrome and airport runway approach corridors. The wider visibility of the field from the surrounding areas should also be considered and screening can help to protect particularly sensitive viewpoints.

The FIH encourages all hockey field owners to be "good neighbours". The lighting equipment supplier can assist in assessing the issue and provide drawings showing maximum lux and candela at any points of concern on adjacent properties. This is critical for some of the emerging LED technology as many of these fixtures have proven to take optical design backwards in terms of glare to surrounding areas. Do not hesitate to investigate a supplier's reputation, abilities, and past experiences in working with local authorities and private property owners regarding glare and spill issues.

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 lighting design. Measurements should be carried out using a calibrated illuminance meter.

- For testing, a grid of maximum size 10m x 10m should be laid out with a point in the centre for lighting venues at non-televised events and 5m x 5m for lighting venues at televised events.
- Before measuring, the supply voltage should be checked.
- Metal halide lamps should have been used for a minimum of 10 hours to ensure consistency.
- After switching on Metal halide lighting, sufficient time should 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.
- Measurements should be undertaken from the highest switching mode working back down to the training mode.
- Infield 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. Examples are shown at the rear of this guide.

Maintenance factors/constant light

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 the majority 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 so the 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.

FIH Facilities Guidance

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 the guide 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.

FIH reserve the right to amend, update or delete sections of the guide at any time, as they deem necessary.

Any questions about this document should be addressed to:

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FIH facilities guidance – helping you win

This Standard is part of a series of facilities documents produced by the FIH. Other information that might assist you is available at www.fih.ch/facilities. It includes:

- Facilities Guidance – Outdoor Hockey Facilities
- Facilities Guidance – GEN 2 multi-sports areas
- Facilities Guidance – HOCKEY5s Courts
- Facilities Guidance – Sports Lighting for Non-Televised Outdoor Hockey
- Facilities Guidance – Sports Lighting for Televised Outdoor Hockey
- Facilities Guidance – Hockey Field Irrigation
- Facilities Guidance – Indoor Hockey

- Hockey Turf and Field Standards – Part 1 FIH Approved Hockey Turfs
- Hockey Turf and Field Standards – Part 2 – 11 a-side hockey fields
- Hockey Turf and Field Standards – Part 3 – HOCKEY5s courts

- FIH Approved Field Equipment – Hockey Goals
- FIH Approved Field Equipment – HOCKEY5s Rebound Boards
- FIH Approved Field Equipment – Team Shelters
- FIH Approved Field Equipment – Technical Officials Booths
- FIH Approved Field Equipment – Indoor Hockey goals
- FIH Approved Field Equipment –Indoor Hockey side-board

Project Name: _____

Project Number: _____

Field Identification: _____

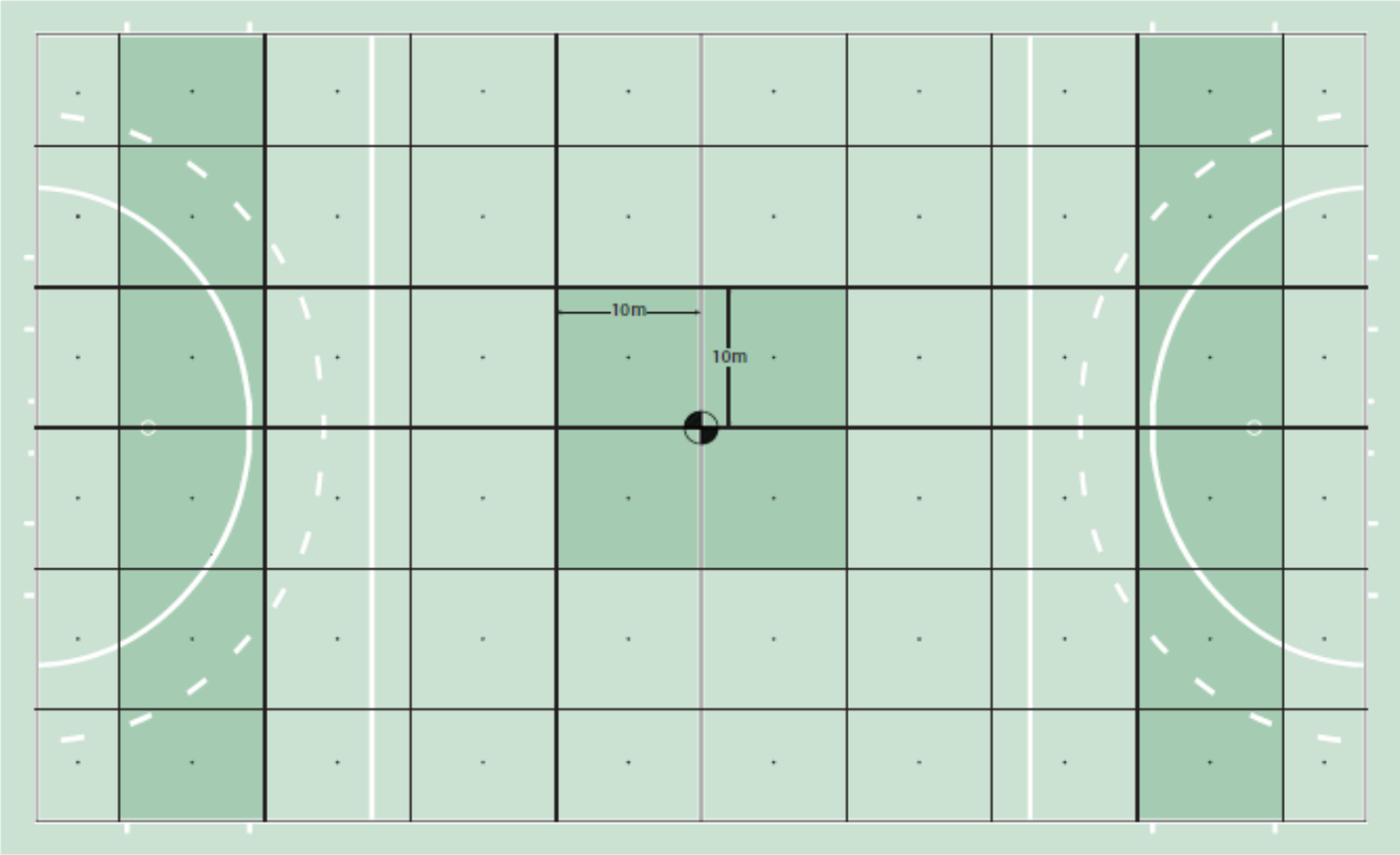
Date Readings Taken: _____

Technician: _____

Conditions: _____

Light Meter: _____

Last Calibration: _____



Commissioning of a new lighting system should include readings at each location.

We recommend annual sampling of highlighted areas for comparison against previous readings to gauge playability for the season.

Broadcast requirements may entail more readings and professional evaluation.

Notes: _____

Average: _____ Min/Max: _____ CV: _____

Maximum: _____ Min/Avg: _____ Deviation: _____

Minimum: _____ Target Points: _____

Project Name: _____

Project Number: _____

Field Identification: _____

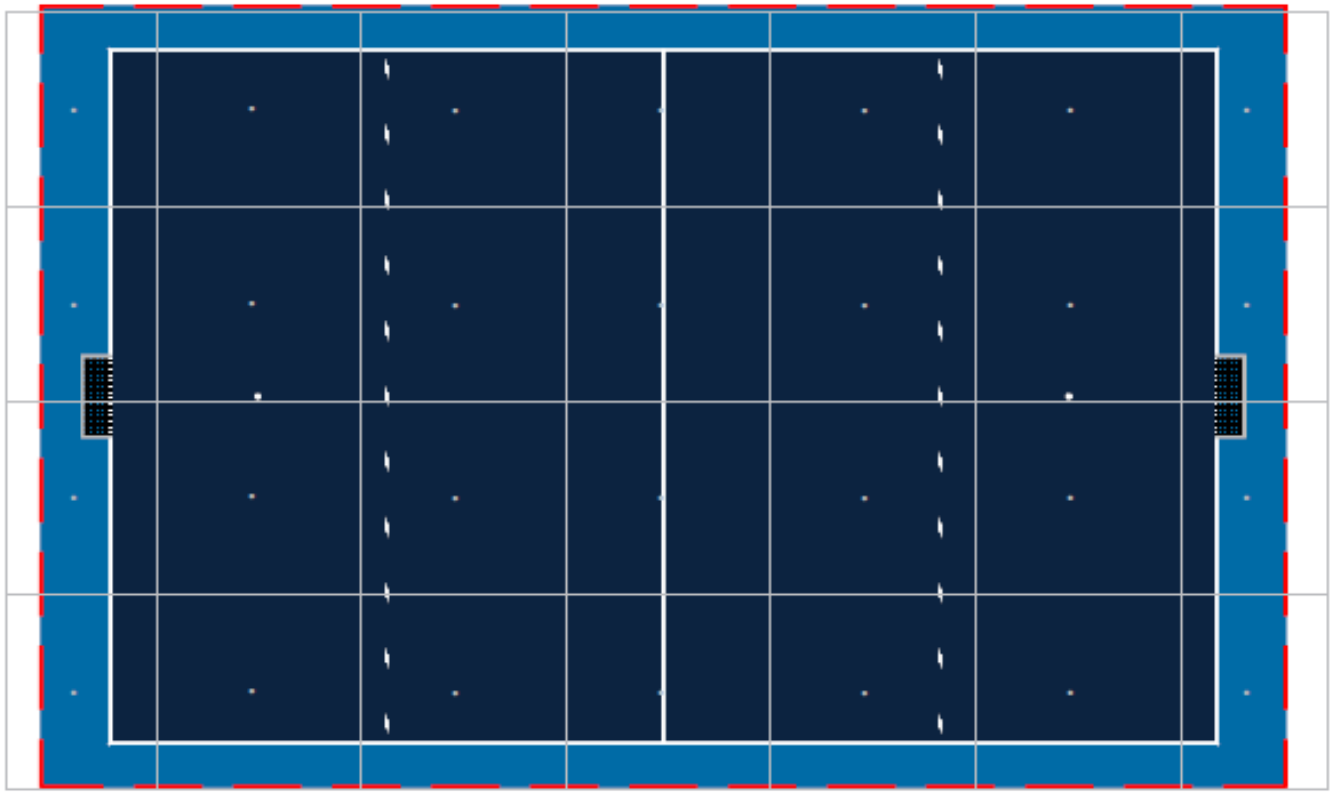
Date Readings Taken: _____

Technician: _____

Conditions: _____

Light Meter: _____

Last Calibration: _____



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