3.3
COURT LIGHTING

Trends in tennis identify strong and growing demand for evening participation and lighting is an increasingly important element to any tennis venue.

Quality court lighting assists to increase the capacity and use of courts over 12 months of the year. It enables diversity in programming and activities, assists in maximising usage and introduces new revenue streams to venue operations.

This section provides detail on the following topics:

Primary audience

This section has primarily been designed for:

- Community tennis clubs, associations, venue operators and educational institutions
- Local government
- State and Territory Member Associations
- Architects, planners, developers, designers and builders.

Definitions

Ballast – Equipment used with discharge light sources (e.g. Metal Halide) for stabilising discharge.

Colour appearance – Quality of colour of a light source independent of brightness.

Colour rendering – General expression of the ability of a light source to show colours of objects accurately.

Contrast – Difference of two parts of a visual field seen simultaneously or successively (e.g. brightness, colour).

Discharge lamp – Light source in which light is produced by electric discharge through a metal vapour, gas, or combination.

Fluorescent lamp – Tubular discharge light source in which most light is emitted by a combination of fluorescent material deposited on the wall of the glass tube and ultraviolet radiation.

Geotechnical engineer – Professional branch of civil engineering concerned with the behaviour of earth materials and the physical properties of soil and rock.

Glare – Visual condition in which there is a discomfort or impairment of vision, or both, caused when parts in the field of view are excessively bright in relation to general surroundings.

Glare Rating (GR) – Numerical value representing the degree of discomfort glare, higher values correspond to greater glare from the lighting system.

High Intensity Discharge (HID) – Type of electrical gas-discharge lamp (e.g. Metal Halide).

Illuminance – Quality and quantity of light emitted and arriving at a surface, divided by the area of the surface (unit: lux).

Illumination – General expression for the quantity of light arriving at a surface (physical measure illuminance).

Initial illuminance – Value of average illuminance initially provided by new or recently cleaned lighting systems.

Incandescent lamp – Light source in which light is produced by a filament, heated to emit light by the passage of an electric current.

Light-Emitting Diode (LED) – Semiconductor device, emitting visible radiation when initiated by an electric current.

Light-Emitting Diode driver – Electrical device which regulates the power to an LED, providing a constant quantity of power and responding to the changing needs (e.g. temperature). The driver can either provide for fixed illumination or enable the LED to dim as required.

Light source Lumen Depreciation factor (LLD) – Ratio of the lumen output of a light source after a given time in operation to initial lumen output.

Luminaire – Equipment that houses the light source(s) and directs the light to desired sections.

Luminaire Dirt Depreciation (LDD) – Efficiency of a new / clean luminaire compared to the efficiency of the luminaire due to accumulation of dirt on the luminaires surfaces.

Luminance – Physical quantity corresponding to the brightness of a surface in a specific direction.

Maintained illuminance – Defined level below which the average illuminance is not allowed to fall.

Metal halide lamp – High Intensity Discharge (HID) light source producing light by an electric discharge through a vapour.

Mounting height – Vertical distance between the luminaire and the ground / floor.

Principle Playing Area (PPA) – Area of a tennis court enclosed within the baseline and doubles court side lines, where the ball is considered in play according to the rules.

Total Playing Area (TPA) – Includes the PPA and areas immediately adjacent to (the surface area between the defined court area and the fence line or adjacent court) which a player might reasonably expected to travel during play.

Uniformity – Rate of change of illuminance over a defined area.

Uniformity gradient – Rate of change of illuminance over a defined area, typically only the highest value is recorded (i.e. worse).

Uniformity ratios – Two ratios (min & max), each providing a numerical representation of the uniformity of illuminance over a given area over a given area (i.e. best and worse values).

Lighting Standards

AS2560.1 – Part 1 General Principles of Outdoor Sports Lighting* provides the basic principles on which outdoor sports playing field lighting should be provided.

Standards can be purchased online via the Standards Australia – Search and Buy a Standard website at **Australian Standards Online.**

AS2560.1 do not apply to specialist lighting systems intended for television coverage or specific standards of competition. They do cover the visual requirements of participants, officials and spectators and the following levels of play:

- Recreational and residential
- Club competition and commercial
- International and national*

**Lighting standards for this level of play are provided as minimum only and are determined by individual event rules*

The vast majority of lighting installations at Tennis Australia affiliated venues **fall within the Club Competition and Commercial level of play.** Only venues that host regular Tennis Australia and ITF sanctioned events should consider permanent lighting to International or National level. These venues will require individual specific planning, design and development advice and are not documented in detail within this resource.

Always check the relevant Australian Standards for any recent updates as Standards are subject to change.

In addition to the Australian Standards referred to above, the following additional information sources have also been referenced in this section:

- AS4282 (1997) – Control of Obtrusive Effects of Outdoor Lighting.
- **AS2560.2.1 (2003) – Part 2.1 Lighting for Outdoor Tennis** provides a greater level of detail and identifies the design, standards and technical parameters required specifically for the lighting of outdoor tennis courts.
- ITF Guide to lighting tennis courts.
- Tennis Australia National Tennis Facility Planning and Development Guide.
- Tennis Queensland Technical Manual for the Design Construction and Maintenance of Tennis Facilities.
- Musco Lighting and Jasstech Solutions.

KEY HIGHLIGHTS

What you need to know

- A number of lighting design options and solutions can meet Australian Standards, however ensure that each or all are appropriate to the venue and site conditions.
- Every 2-3 years or when lighting performance appears to change, engage an electrical contractor or original supplier to conduct a performance assessment to advise on the potential options for improvement (e.g. more regular maintenance, globe replacement, system upgrade).
- Life cycle costs including capital, power supply, operational and maintenance should all be factored in when evaluating various lighting solutions.
- If replacing or upgrading existing lighting, ensure a qualified electrical engineer (in conjunction with the relevant power authority) assesses the power supply needs at the venue. Additional requirements such as increasing the power supply may add significant costs to lighting projects.

3.3.1 LIGHTING PURPOSE

Lighting for tennis should be designed and installed so that visual tasks by participants, officials and spectators can be performed clearly, comfortably and safely. Parameters that determine the effectiveness of lighting systems are:

- Suitable luminance and colour contrasts over the playing area
- Sufficient light to all parts of the playing area
- Correct distribution of light
- Adequate glare control
- Surrounding pathway and gate entry localised lighting to the court

Achievement of these objectives is determined by quality and quantity of lighting installed for the desired level of play. Minimum recommended requirements are outlined in **Table 3.3.1 Lighting Standards**. The higher the level of play, the higher class of lighting should be selected. If building a venue with capacity to host professional or high level tournaments, consult Tennis Australia directly to ensure lighting selection meets relevant standards.

Lighting purpose and needs of the venue should be agreed at the design and layout stage of planning so equipment and supporting structures are located to provide the required uniformity of illumination, minimise glare and obstruction to participants, and protect play from the obtrusive effects of outdoor lighting

3.3.2 TENNIS REQUIREMENTS

Tennis court lighting levels should be developed based on the intended standard of play, which also determines layout requirements.

Standards

Standards of play refer to the highest level of competition expected to be played at an individual venue.

Table 3.3.1 Lighting Standards provides information regarding recommended minimum lighting levels suitable for recreational, community and club competition. Lux and uniformity levels are measured for both the PPA and TPA (refer to definitions and **Figures 3.3.1-3.3.2**) and when combined assess the performance and suitability of lighting and the level of play.

The minimum standards provided do not meet criteria for all events at national and international level. Therefore consultation must take place with Tennis Australia during planning stages of projects. Lighting standards at national and international level are determined on an individual basis by factors including event rules and broadcast requirements.

Table 3.3.1
Lighting standards

Level of Play	Maintained horizontal illuminance* (LUX)		Minimum horizontal uniformities				Maximum Glare rating GR_{max}	Minimum Colour Rendering Index $R_{a\,min}$
	PPA	TPA	PPA		TPA			
			U_{1min}	U_{2min}	U_{1min}	U_{2min}		
Recreational and Residential	250	150	0.6	0.3	0.2	0.1	50	65
Club competition and commercial	350	250	0.6	0.4	0.3	0.2		
International and national**	1000	500	0.7	0.5	0.5	0.3	50	65

Notes
*Values of illuminance measured at the time of commissioning and installation (i.e. initial or close to) should be higher than the maintained illuminance values

** Lighting standards for this level of play are provided as minimum only and are determined by individual events rules

Lower level professional events have reduced lighting requirements. To ensure the correct lighting for the level of event are achieved contact Tennis Australia.

Visually impaired players are more susceptible to glare interfering with tennis activity and spectating. Indoor or covered courts minimise glare, providing a more comfortable and safe environment through enhanced vision.

The ITF provides further guidance on lighting which can be found here https://www.itftennis.com/technical/facilities/facilities-guide/lighting.aspx

Figure 3.3.1 TPA

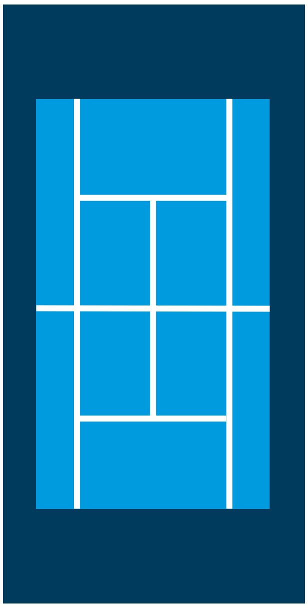
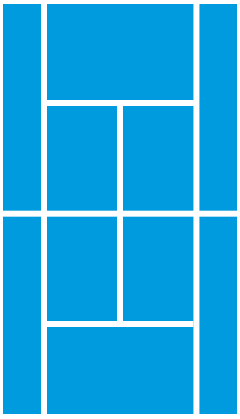


Figure 3.3.2 PPA



Measures

While meeting the standard lux levels is important in lighting installations, the consistency of light is critical and is measured by uniformity. Where uniformity is poor, the eye struggles to follow the flight of the ball and predict its speed.

Lux level readings are measured via a calibrated light meter and should be conducted by a qualified professional. The collection of lux level readings across the PPA and TPA areas contribute to a court's overall uniformity levels.

While lux level readings taken on individual grid points may fall below the recommended lux levels, the overall uniformity measures are the critical measure of lighting performance.

Uniformity is expressed by two illuminance ratios: U1 (minimum) and U2 (maximum). Uniformity tries to limit bright or dark patches on the field of play to create a consistent visual condition.

Uniformity ratio is often the determining factor for eligibility to host high level, national and international events. Both lux average and ratio need to be met, with uniformity more challenging to achieve. Different standards are required for various levels of professional events. Technology with variable outputs is recommended so venues can switch modes between events, competition and social play.

Pole design

AS2560.1 (2002) standards do not recommend a specific range of pole diameters to be used. Pole provision must be assessed in conjunction with the manufacturer and/or supplier specifications for lamps and housings, and should be designed and engineered to accommodate their weight, wind loading and site specific ground conditions.

Spectator area lighting

Spectator requirements must be considered as part of lighting design. Larger venues will require a higher level of illuminance to satisfy spectator needs where there are longer viewing distances to courts.

Ancillary area lighting

For the visual comfort of spectators and to maintain safety levels for users, when floodlighting is non-operational lighting levels around venues should be a minimum of 10 lux.

3.3.3
PLANNING CONSIDERATIONS

Consideration of lighting needs and the associated standards is required at design and layout stage of planning. This ensures the location of equipment and supporting structures support the required uniformity of illumination, minimise obtrusive effects to the environment and limit obstructive impact on play (e.g. glare).

Designing for requirements

Achieving lighting solutions that meet venue and user needs is dependent on a range of factors, including:

- Type of venue and its level of use for different types of play (social, coaching, competition)
- Programming, including potential for or frequency of court use at night time
- Local council planning conditions, permissions and requirements, including permits, development applications, zoning, heights, design impacts and operating times and restrictions
- Ground condition capacity to accommodate the lighting installation, levels of risk, cost or design compromises that may need to be made
- Site obstructions such as underground services and existing trees that may be protected under government legislation or local by-laws.
- Electrical supply conditions, limitations and current compliance with electrical standards, as well as the capacity of the venue (and local power suppliers) to cater for increased demand from lighting installations.
- Other sports (where lighting requirements may be different to the needs of tennis)

For professional and high standard events, lighting should be considered together with other infrastructure criteria, contact Tennis Australia to discuss individual event needs.

Provision for upgrade

During initial planning and design, consider the requirements of future upgrades to your lighting infrastructure. Planning for this early in the project can help to reduce costs of upgrades. Options to prepare for a higher level installation may include:

- Height, strength and position of poles
- Structural allowances for fixing of additional luminaires
- Provision of suitable electrical power

If considering moving, reusing or retrofitting existing poles, Structural Engineer certification will be required.

Obtrusive effects of lighting

Floodlighting spill and glare can impact the surrounding local community, in particular neighbouring residential properties. Every effort should be made to limit the impact and conform to local planning guidelines and the Australian Standard AS4282 (1997) – Control of Obtrusive Effects of Outdoor Lighting.

Lighting spill is the degree to which a lighting installation falls beyond the area being lighted and is disturbing to a person near the playing area. If required, ensure the luminaires provided can be fitted with spill shields to reduce spill light. New design specifications for sports lighting must consider cut-off reflectors and high efficiency from the sport light fittings.

The impact of glare can range from preventing performance of tasks to causing discomfort or nuisance. Some glare from light sources is unavoidable and the need to limit glare may conflict with other requirements, with compromise necessary to control effectively. This may mean exclusion of luminaires from certain positions or mounting at specific heights.

In addition to identifying planning constraints in the design and budgeting of lighting projects, it is important to consider the future lighting needs for the venue. It can be financially advantageous to make allowances during an initial lighting installation rather than retrofitting later.

Consideration of additional underground services, housing for future luminaires or increased electrical supply at the time of installation is strongly recommended for all lighting projects.

Lighting suppliers

When procuring lighting suppliers ensure they have the following:

- Required approvals and certifications to sell luminaires in Australia
- Warranty terms and conditions that cover the full cost of replacement and stipulate required maintenance and service intervals.
- Relevant experience in tennis court lighting (research to verify)
- Satisfaction of previous customers regarding design, supply, installation and operational performance (consult with other clubs / operators on their experiences)

3.3.4 TYPES OF COURT LIGHTING

Tennis courts require lighting technology with high brightness to illuminate large areas, requiring specific types of luminaires. There is a range suitable lighting equipment on the Australian market, with different systems providing various cost and operational benefits. Types of light sources commonly used in tennis are (refer to definitions for descriptions):

- Fluorescent
- High Pressure Discharge (Metal Halide (MH))
- Light Emitting Diodes (LED)

In comparison to traditional lighting such as Fluorescent and Metal Halide, LED technology is increasingly recognised as the preferred lighting option due to performance outputs, operational advantages, cost efficiencies and environmental benefits. **Table 3.3.2 Lighting Technologies Comparison** provides information on the key differences and benefits of LED technology versus traditional lighting. For the purpose of providing comparative information, Metal Halide (MH) lamps have been described in further detail alongside LED.

Metal Halide (MH)

MH are the preferred choice of HID lamps for tennis courts because of advantages such as good colour rendition (producing very clean and natural light) and high lumen output. The working principle of each type of HID lamp vary, however all HID lights require a control gear called ballast which starts and operates the lamp (e.g. dimming).

A key feature of these lamps is the 'warm up period' which refers to the time taken to start-up until the heat and pressure inside the tube is high enough for the lamp to reach the optimum brightness. This means light output is not instantaneous, and can take a longer time to restart if turned on and off quickly.

MH lamps generally have good life span however at the end of useful life will become less energy efficient and fade in brightness and colour of the emitted light. With MH it should be assumed the lamps will be replaced and the fittings cleaned multiple times during the service life of the luminaires.

Light Emitting Diodes (LED)

High quality LED lighting is constructed using specific materials to produce extremely durable technology that is resistant to low temperatures and vibrations, whilst allowing light outputs to be brighter and more concentrated. It is the components of an LED and how light is generated that leads them to behave differently and have a longer lifespan than other types of bulbs.

LEDs do not burn out the same way other lamps do, however they will still depreciate over time and this is influenced by factors including the quality of the product, power supply to regulate optimum voltage (referred to as driver) and ambient temperature (unless designed accordingly).

Periodic maintenance of LED lighting such as cleaning fittings is required. It can be generally assumed LED light engines will not fail requiring replacement parts and that frequent switching on and off will not impact on the service life.

Selection Criteria

Light sources of the same type can still have different properties. When selecting a lighting system, the following should be considered to identify the best balance for intended use:

- Luminous efficacy (how well the light source produces visible light)
- Initial and running costs
    1. Annual cost of owning the installation (cost of obtaining money at the current interest rate)
    2. Annual depreciation (money to be set aside annually to allow replacement at the end of its useful life)
    3. Total energy costs per annum (based on total system wattage, hours of operation and cost of energy)
    4. Total annual maintenance costs (i.e. light source replacement, cleaning and other component replacement costs)
- Estimated lifespan
- Colour appearance and rendering
- Size and shape of the source (visual appearance)
- Light source run-up and restrike times
- Ability to control luminaires using control management system or similar (including controllability / dimming).

Preparation of a lifecycle cost analysis of different lighting systems in association with a lighting specialist will help to quantify the financial implications and benefits of both systems. The lifecycle cost analysis should include initial capital costs, operating costs and projected maintenance expenditure over the life of each installation (refer Financial Management section for further information on calculating a lifecycle cost analysis).

Table 3.3.2
Lighting technologies comparison*

	Advantages
LED	• **Long life** – LEDs do not have components of other lamps that cause bulbs to burn out so take longer to depreciate • **Energy efficient** – Higher lumen output per watt and less energy lost as heat, contributing to lower running costs • **Reliability** – Resistant to temperature fluctuations and robust design (i.e. no movable or delicate parts such as glass) • **Instantaneous illumination** – Operate at full brightness once turned on • **Environmental** – Do not contain toxic materials dangerous for the environment (e.g. mercury), solar compatible • **Versatile** – Dimmable, remote control options, spill control, fittings can be retrofitted to existing systems
MH	• **Life span** – MH bulbs offer a reasonable life span • **Excellent colour rendering** – Emitting light close to a natural sunlight • **Large variety of wattages and forms** – MH lamps are available in many varieties allowing for a range of applications • **Light output is fully restorable** – New (or near new) performance restored during each maintenance cycle
	Disadvantages
LED	• **Light output is only partially restorable** – During a maintenance (cleaning only) cycle • **Price** – initial capital costs higher than traditional lighting, although lower operational costs and longer lifecycle
MH	• **Power supply** – Additional power may be required to manage strike up ay in reaching full output • **Higher lumen depreciation** – Some models lose initial brightness faster as the lamp operates • **Replacement costs** – Bulbs can be expensive to manufacture and purchase • **Delayed restrike**** – Lamps take time to warm-up and restart (restrike) if the lamp has been running at optimal temperature • **Environmental** – MH bulbs contain small portions of the toxic element mercury which requires special disposal

*Subject to engineering certifications

** When power is restored following a breakdown, LED light sources will give full light immediately, whereas HID / MH can take 5-20 minutes to restrike and longer to reach full output (in the absence of an available circuit to facilitate)

The Moe Tennis Club (in Victoria) chose to upgrade its Metal Halide lighting system to a new LED system which reduced glare, minimised light spillage and provided improved operational efficiency. The club replaced the lighting on 10 courts to LED technology at a cost of $300,000.

3.3.5 LIGHTING DESIGN CONFIGURATIONS

Locations of lighting is determined by many site specific factors, with early consultation between architects and lighting designers essential to ensure provision is made for suitable locations and mounting of equipment. Installations are often limited by physical constraints which can be mitigated if addressed at design stage. A well-considered design and layout of floodlighting infrastructure is critical to ensure:

- Required uniformity of illumination
- Minimise glare to participants and obstruction to play
- Limit the obtrusive effects of outdoor lighting.

Multi-use

Line marking for multiple uses may impact lighting design, preferred pole locations and performance requirements if floodlighting for some or all activities is required. In all situations, lighting poles must be located outside all relevant fields of play and associated run-off areas for all uses.

Configurations

Tennis court lighting configurations generally consist of two main types: high-tower corner lighting and low-level side lighting. Examples of lighting types and configurations provided in **Figures 3.3.3 and 3.3.4** (design options) are for information purposes only as generic options. It is recommended that a qualified lighting contractor be engaged to advise on the optimal lighting arrangement, lighting levels required, adherence to Australian Standards and site conditions and constraints, in addition to compliance with any ITF court run off requirements.

High tower corner lighting

High-tower corner lighting is typically used for multiple court configurations as high-tower masts are ideally located outside each corner of the court enclosure. High-towers are generally no higher than 15m in height.

Regardless of the configuration, ensure the lighting bases are flush with the surrounding surface or well defined to not become a trip hazard

Side lighting

Side lighting can be configured in a number of designs. Typically for a single court they are provided in four or six pole designs with poles ranging from 8m to 12m in height. For all lighting installations, poles must be installed outside court run-off areas.

Diagrams provided are illustrative only.

Variations on pole configurations can be achieved if performance outcomes are able to be met. Different lighting types will produce different results in a range of settings and professional lighting advice should be sought to ensure proposed design can meet long-term requirements and standards.

Pole and mounting heights

Pole and mounting heights of luminaires should be determined by appointed lighting specialist and site constraints. Factors including the required lighting levels, proximity of neighbouring properties, glare control and lighting spill levels need to be considered when designing the most appropriate pole height.

Figure 3.3.3
Corner lighting design option

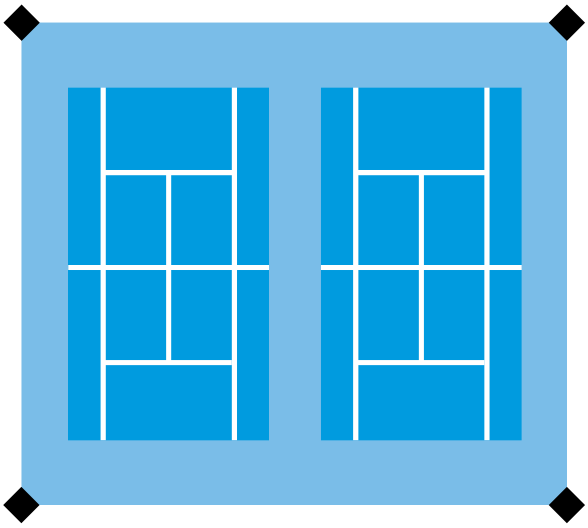
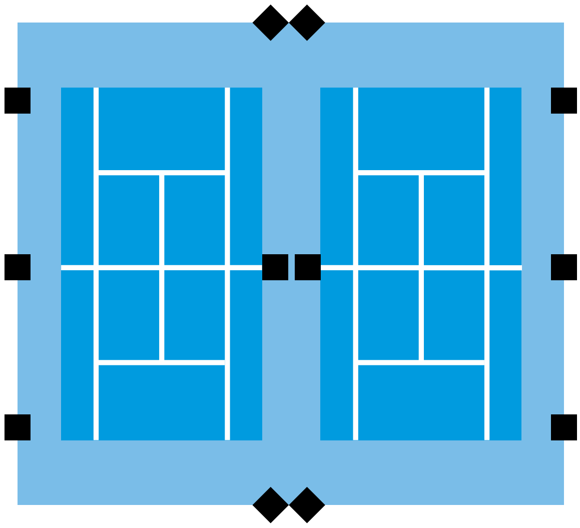


Figure 3.3.4
Side lighting design option



It is essential that any lighting installation and associated pole design considers compliance with relevant ITF court run-off requirements. Designs where lighting poles are located within the fenced court enclosure area (even if located close to enclosure fence line) run the risk of creating non-compliance court run-offs, are a safety hazards for players and can obstruct changing of ends for wheelchair players.

3.3.6
CONSTRUCTION REQUIREMENTS

Locations of poles and mounting heights must be decided in consultation with the architect and lighting designer to accommodate physical site constraints and cleanliness of location (i.e. climatic conditions, air pollution).

The power supply to existing or planned tennis venues is an important factor when planning and designing floodlighting. Power to the site may exist, but in many cases, achieving performance of 250-350 lux or greater may require a power upgrade to existing sites or the installation of new sub-station infrastructure which can be a costly exercise.

For the same lighting output LED installations may not require the same level of power supply or upgrade as Metal Halide. It is recommended that an electrical engineer be consulted to define requirements for each specific installation.

A careful evaluation of the available power utility is important and the application of back up sources is required for all sports lighting equipment. Both the normal preferred power and back-up power should be fully sized to allow 100% of the sports lighting to work if the normal preferred power source is lost.

Ground conditions

All lighting designs will be impacted by the immediate site and associated ground conditions. Prior to any lighting system design taking place, a geotechnical investigation into local soil conditions will be required to inform the recommended pole installation method, the depth of footings and foundation design required. This should be undertaken by a qualified structural engineer.

Refer to **Section 2.3 Site Assessment** for additional information on evaluating ground conditions.

3.3.7 MAINTENANCE AND OPERATION

Maintenance

Lighting contractors should provide information on the recommended maintenance regime and instructions and this should include the following information:

- Light source types
- Replacement intervals
- Cleaning frequency
- Maintenance tasks
- Depreciation of illuminance

Commitment to frequent light source replacement (as required), cleaning and maintenance schedule alongside original selection of a quality system will determine the lighting performance and overall lifecycle. Cost of servicing needs to be considered, as the likelihood of effective and regular maintenance taking place increases when lights can easily be reached and maintained.

Allowance for Depreciation

Reduction in illuminance (light loss factor) of all lighting systems will occur over time due to:

- Light source lumen depreciation (LLD) – influenced by type of source selected
- Luminaire Dirt Depreciation (LDD) – influenced by design of luminaires, location and cleaning cycle adopted.

Also referred to as Depreciation Factor, Maintenance Factor is a statement of the amount by which the lighting performance of the system will fall, compared to its performance after 100 hours of use. For instance, if the Maintenance Factor of an installation is 0.8, the lighting levels will never fall below 80% of the values after 100 hours of use provided the system is properly maintained.

When designing lighting, the as-new performance must be high enough to ensure that lighting levels will still be adequate when all degrading factors have taken effect.

A documented justification of the calculation Maintenance Factor should be provided in conjunction with detailed lighting designs.

Measuring lighting performance

Lux level readings are measured via a calibrated light meter and should be conducted by a qualified professional. The collection of lux level readings across the PPA and TPA areas contribute to a court's overall uniformity levels. While lux level readings taken on individual grid points may fall below the recommended lux levels, the overall uniformity measures are the critical measure of lighting performance. Uniformity is expressed by two illuminance ratios: U1 (minimum) and U2 (maximum). Uniformity tries to limit bright or dark patches on the field of play to create a consistent visual condition.

Table 3.3.3 Lighting Performance provides further information about what the assessment criteria terms mean and how the lux test can be interpreted.

Table 3.3.3
Lighting performance

Criteria	Definition
Total Lux	The sum of all lux readings taken across the TPA
Grid points	The number of lux readings taken across the TPA
Average lux	The **Total Lux** divided by the number of **Grid Points**
Maximum	The highest single lux reading taken across all grid points
Minimum	The lowest single lux reading taken across all grid points
Min/Av. ratio (U1)	The lowest single reading (**Minimum**) divided by the average of all readings (**Average lux**)
Min/Max ratio (U2)	The lowest single reading (**Minimum**) divided by the highest single reading (**Maximum**)

Fitting an 'hours run indicator' to lighting systems tracks operating hours. This allows venue operators to keep track of energy use and will provide valuable information for repair and maintenance purposes and in identifying additional environmental benefits.