LED Lighting Standards

Kentucky High School Athletic Association

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Standards of Lighting

The standards in this manual were originally adopted by the Kentucky High School Athletic Association as a result of recommendations by a Standards Advisory Committee. These standards were adopted by the Board of Control in July, 1999, and the most recent revisions were made in February, 2021. These recommended standards apply to the lighting of all athletic activities sponsored by the KHSAA or its member schools.

These standards incorporate the most current data available regarding the lighting, electrical, and structural issues that apply to installation of a safe, effective lighting system.

The standards are divided into recommended minimums and desirable features. The minimums establish criteria important to the proper conduct of KHSAA activities and include evaluation of operating costs over the expected life of the lighting system. Desirable features are established to give added values where appropriate for a facility's needs.

These recommendations will be used in selected sports as part of the criteria used to determine championship sites when the KHSAA makes site selections. The standards as originally published comply with the requirements of and recommended by the Department of Facilities Management for the Kentucky Department of Education.

Current lighting standard applies to state of the art LED products. Prior approved HID lighting standard is also acceptable for use.

I. Recommended Minimum Standards

These minimum standards are recommended for all lighting installations after the date of adoption of these standards. Any modification in existing lighting systems after this date should be done so as to result in a lighting system in compliance with these standards. To be in compliance, a system must meet all recommended minimum standards.

PART 1 – GENERAL

1.1 LIGHT LEVELS

A. Preferred LED Technology

LED is the preferred lighting system technology due to energy efficiency, increased lifespan, reduced maintenance, and minimal light depreciation over the operating life of a typical sportslighting system.

LEDs can be manufactured with a broad range of correlated color temperatures (CCT). Currently, the most efficient LEDs for sportslighting are around 5700K.

B. Sustaining target light levels over time

Lighting manufacturers will provide a guarantee that light levels will be sustained over the life of the system.

Additionally, manufacturers will provide lumen maintenance data of the luminaires used per TM-21-11, and will incorporate the lumen maintenance projections into the lighting designs to ensure target light levels are achieved throughout the guaranteed period of the system. Per IES guidelines, lumen maintenance hours should be reported based on the 6X multiplier of testing hours.

C. Performance Requirements - Quantity

Playing surfaces shall be lit to an average target light level as specified in the following chart. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified beginning on page 13 of these standards with the light meter held horizontally 36 inches above the field surface.

D. Performance Requirements - Quantity

Uniformity of the lighting shall be such that the highest measure of quantity of light on the field is not greater than the lowest measurement per the ratio listed in the table below. On the entire field area, the change in the quantity of horizontal footcandles should not occur at a greater rate than 10 percent per 10 feet, except for the outside perimeter readings which may change at a greater rate.

Area of Lighting	Target Light Levels	Maximum to Minimum Uniformity Ratio	Uniformity Gradient	Coefficient of Variation
Baseball/Softball	50 fc Infield 30 fc Outfield	2:1 Infield 2.5:1 Outfield	1.5	0.17
Football/Soccer/ Lacrosse/Field Hockey/Rugby Less than 2000 spectators Up to 5000 spectators 5000 or more spectators	 30 fc 50 fc 100 fc	 2.5:1 2:1 1.7:1	1.5	0.21
Gymnasium / Basketball No spectators With spectators	 50 fc 80 fc	 3:1 2.5:1	 2.0 1.5	 0.25 0.21
Natatoriums	Consult an experienced lighting manufacturer or lighting specialist			
Tennis	50 fc	2:1	1.5	0.17
Track Competitive Use General Use (Walking)	 30 fc 5 fc	 5:1 N/A	2.0	0.30
Combination / Multipurpose	Highest minimum for activites played on the field	Lowest minimum for activites played on the field	Lowest minimum for activites played on the field	Lowest minimum for activites played on the field

E. Glare for Participants

To achieve placement of lights in positions that enhance playability, pole heights, pole locations, and luminaire placements should be as shown on the layouts in the appendix.

1.2 ENVIRONMENTAL LIGHT CONTROL

Many facilities are located near residential properties or roadways, creating the possibility of spill and glare onto adjoining properties. Consideration should be given to this issue during the initial lighting design stage to minimize this effect. Some communities are implementing ordinances designed to minimize light pollution. Contact your local planning committee or zoning board.

The lighting equipment manufacturer should assess both spill and glare at all areas of concerns on adjacent properties. Manufacturer should provide both an illumination summary for spill light and an environmental glare impact summary for areas of concern. The environmental glare impact summary should show the maximum candela an observer would see when facing the brightest light source from any direction. For areas of concern, a good guideline is to keep glare from the brightest source below 5,000 candela. This is equal to roughly half what a low beam car headlight would be. Measurements are taken at the point of concern, at 60 inches above the ground.

Check local ordinances for light control restrictions.

Do not hesitate to investigate a manufacturer's reputation, abilities, and past experiences in working with local authorities and private property owners regarding glare and spill issues.

1.3 LIFE-CYCLE COSTS

A life-cycle operating cost analysis should be considered when evaluating lighting systems. Owners should expect a quality lighting system to last a minimum of 25 years.

These standards provide a Life-Cycle Operating Cost Evaluation form on page 11 to assist with the process. Items that should be included are energy consumption based upon the facility's expected usage, cost for maintenance, and any additional savings in energy or labor cost provided by automated on/off control systems.

Contract price and life-cycle operating cost should both be considered in determining a lighting manufacturer for the project.

1.4 CONTROL AND MONITORING SYSTEM

A remote control and monitoring system will provide ease of operation and management for your facility. Manufacturers providing systems with a 25-year warranty will use this system to ensure your lighting performs as required.

A. Remote Monitoring

The system should monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The manufacturer should notify the owner of outages within 24 hours, or the next business day.

B. Remote Lighting Control

The system should allow owner and users with a security code to schedule on/off system operation via a web site, phone, or email up to 10 years in advance. Manufacturer should provide and maintain a two-way TCP/IP communication link. Trained staff should be available 24/7 to provide scheduling support and assist with reporting needs.

The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges, such as full scheduling capabilities for all fields, to only having permission to execute "early off' commands by phone.

Control unit should accept and store 7-day schedules, be protected against memory loss during power outages, and should reboot once power is regained and execute any commands that would have occurred during outage.

C. Management Tools

Manufacturers should provide a web-based database of actual field usage and provide reports by facility and user group.

D. Communication Costs

Manufacturers should include communication costs for operating the control and monitoring system for a period of 25 years.

E. Cabinet Construction

Control and Monitoring Cabinet should be constructed of aluminum and rated NEMA Type 4 Cabinet should contain custom-configured contactor modules for 30, 60, and 100 amps, labeled to match field diagrams and electrical design. Manual Off-On-Auto selector switches should be provided.

1.5 WARRANTY AND GUARANTEE

A product warranty provided by the manufacturer is a good gauge of confidence in their products. New generation LED technology comes with warranty periods of up to 25 years and includes guaranteed light levels, parts, labor, shipping costs, luminaire replacement, energy usage, monitoring and control services, spill light control, and structural integrity.

PART 2 – PRODUCT

2.1 LIGHTING SYSTEM CONSTRUCTION

A lighting system should consist of lighting, electrical, and structural components designed to work together as a system that is durable and provides safety features.

A. Outdoor lighting systems should consist of the following:

1. Galvanized steel poles and crossarm assembly. Wood poles, direct burial steel poles, or direct burial steel stub base poles are not allowed.
2. Pre-stressed concrete base embedded in concrete backfill allowed to cure for 12 to 24 hours before pole stress is applied. Alternate may be an anchor bolt foundation designed so that the steel pole and any exposed steel portion of the foundation is located a minimum of 18 inches above final grade. The concrete for anchor bolt foundations should be allowed to cure for a minimum of 28 days before the pole stress is applied.
3. All drivers and supporting electrical equipment mounted remotely in aluminum enclosures approximately 10' above grade. The enclosures shall include driver, controller, fusing and surge protection for all luminaires. Safety disconnect per circuit for each pole structure must be located in the enclosure.
4. Wire harness complete with an abrasion protection sleeve, strain relief, and plug-in connections for fast, trouble-free installation.

B. Retrofit sportslighting systems:

By retrofitting new LED technology onto an existing sportslighting structure and reusing electrical supply wiring, you can achieve quality lighting results with state of the art technology while reducing costs often associated with entirely new outdoor lighting systems. A retrofit lighting system should consist of the following:

1. Poletop luminaire assembly that includes new crossarms, factory-aimed luminaires, and a method of attachment to existing poles.

2. Electrical components enclosure and wire harnesses as described in Sections 2.1.A.4 and 2.1.A.5

3. Inspections for existing equipment

a. Structure – the structure must be evaluated to ensure that it meets the requirements of the new luminaire load. Often LED luminaires are much heavier than HID luminaires and have increased windloads. It may not be possible to replace luminaires at a 1:1 replacement ratio. Consult the pole manufacturer, if possible.

b. Electrical Supply – the electrical supply wiring should be in good condition and sized appropriately for the new loads. Insulation and leakage current tests should be conducted.

c. Lighting protection – LED lighting loads can be more sensitive to lightning and other surge events than older HID lighting loads. Verify that the lightning grounding of existing structure meets current electrical code. Ground resistance should not exceed 25 ohms. If the condition of the lightning down conductor cannot be determined (e.g. encased in a concrete pole), it is recommended to supply new.

C. Interior sports lighting systems:

1. All luminaires shall consist of a die-cast aluminum heatshink for heat dissipation, and a shatter-resistant glare reduction visor.

2. If driver is integral in luminaire, it should have a dedicated heatsink for longevity.

D. Manufacturing Requirements

All components should be designed and manufactured as a system. All luminaires, wire harnesses (if provided), and electrical components enclosures should be factory assembled, aimed, wired,
and tested for reduced installation time and trouble-free operation.

E. Durability

All exposed components should be constructed of corrosion-resistant material and/or coated to help prevent corrosion. All exposed steel should be hot-dip galvanized per ASTM A123. All exposed hardware and fasteners should be stainless steel of at least 18-8 grade, passivated and polymer coated to prevent possible galvanic corrosion to adjoining metals. All exposed aluminum should be powder coated with high performance polyester. All exterior reflective inserts should be anodized; coated with a clear, high gloss, durable fluorocarbon; and protected from direct environmental exposure to prevent reflective degradation or corrosion. All wiring should be enclosed within the crossarms, conduit, pole, or electrical components enclosure.

F. Lightning Protection

All outdoor structures should be equipped with lightning protection meeting NFPA 780 standards.

G. Safety

All system assemblies should be UL Listed for the appropriate application.

2.2 STRUCTURAL PARAMETERS

A. Location

Poles should be located as shown on the drawings in the appendix to these standards. Whenever possible, poles should be located outside of fences to avoid causing an obstruction or safety hazard to the participants.

B. Foundation Strength

Project-specific foundation drawings stamped by a registered Kentucky structural engineer illustrating that the foundation design is adequate to withstand the forces imposed from the pole, luminaires, and other attachments to prevent the structure from leaning should be provided by the manufacturer.

C. Support Structure Wind Load Strength

Poles and other support structures, brackets, arms, bases, anchorages, and foundations should be determined based on the 50-year mean recurrent isotach wind maps for the appropriate county per the Kentucky State Building Code. Luminaire, visor, and crossarm should withstand 150 mph winds and maintain accurate aiming alignment.

D. Structural Design

The stress analysis and safety factor of the poles should conform to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

E. Soil Conditions

The design criteria for these specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not available, the foundation design can be based on soils that meet or exceed those of a Class 5 material as defined by 2001 IBC, Table 1804.2-1-A.

2.3 ELECTRICAL PARAMETERS

A. Electrical System

Electrical system comprises a main service panel, control and monitoring (or contactor) cabinet(s), as well as branch circuits feeding all light poles and luminaires, including equipment grounding conductors. Electrical system design shall conform to National Electric Code.

B. Disconnect

There should be provided at each pole a disconnect located at the minimum height required by code to allow disconnecting of electrical power of the pole. This disconnect should allow for lockout/tagout in addition to overcurrent protection provided at the distribution panel for the each individual circuit.

C. Fusing

Each luminaire should be individually fused with UL Listed fused equipment rated for use with the system. Fusing shall be located in the remote electrical enclosure located at ground servicing height on the pole.

D. Lightning Protection

Each pole should be equipped with lightning protection as established by NFPA 780.

E. Surge Protection

Surge protection should be provided at each pole equal to or greater than 40 kA for each line to ground (common mode) as recommended by IEEE C62.41.2 -2002.

F. Rigid Conduit

It is recommended that all wiring above grade be internal to the light pole. If necessary to run outside the pole, all conductors should be within a rigid metallic, or liquid-tight flex conduit.

G. Lockable Electrical Components Enclosures

Electrical components enclosures that are designed to be opened should be lockable and kept locked except during times of maintenance or servicing. Access should be by means of a key or special tool.

H. Underground Supply Wiring

Supply wiring should be buried to depths required by NEC or applicable local code. Copper wire is recommended. Do not share neutrals nor equipment grounding conductors.

I. Strain Relief

Wire harness should be supported within the pole as required by electrical code with a strain relief at the top of the pole. For poles taller than 80 feet, a midpoint strain relief should also be supplied.

J. Voltage Drop

The voltage drop to the disconnect switch located at the light poles should not exceed 3% of the rated voltage per IESNA RP-6-01.

K. Underwriter Laboratory Listing

The lighting and electrical equipment should have a UL Listing to confirm that the equipment has passed the safety tests of Underwriters Laboratory, not only as to the individual components, but also as to the use of the components in the configuration of the lighting system on the field.

PART 3 – EXECUTION

3.1 FIELD QUALITY CONTROL

A. Illumination Measurements

Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, City's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements should be conducted in accordance with IESNA RP-6-01, Annex B.

B. Correcting Non-Conformance

If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles, uniformity ratios, and maximum kilowatt consumptions are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be liable to any or all of the following:

1. Manufacturer shall at his expense provide and install any necessary additional luminaires to meet the minimum lighting standards. The Manufacturer shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.
2. Manufacturer shall minimize the Owner's additional long term luminaire maintenance and energy consumption costs created by the additional luminaires by reimbursing the Owner the amount of $1,000.00 (one thousand dollars) for each additional luminaire required.
3. Manufacturer shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications.

II. Desirable Features

The following practices are recommended for increasing the lighting system performance.

4.1 WARRANTY

When comparing products, the manufacturers' warranty should also be evaluated. The quality of the warranty reflects a manufacturer's confidence in the long-term durability of their equipment. Considerations include the extent of the equipment covered, the duration of the warranty, and whether the warranty provides a guarantee of light levels during the warranty period. From the owner's perspective, the warranty offers the opportunity to reduce

costs for equipment repair. Comprehensive warranties covering parts, labor, and shipping costs are available for up to 25 years.

4.2 TV QUALITY LIGHTING

Lighting for televised events involves considerations in addition to spectators and participants. It is recommended that cities wishing to light facilities for television broadcasts use consultants and lighting manufacturers with experience and knowledge in that area. For facilities with greater than 5000 spectators or that plan on hosting televised events, the facility should be lit according to the NCAA lighting standards for television broadcasts. To access these standards online, go to http://www.ncaa.org, then use the site's search feature to search for "Best Lighting Practices."

4.3 MULTI-LEVEL LIGHTING

Additional energy savings can be obtained through the use of multi-level lighting. The multi-level lighting will allow the system to operate at the light level that is most appropriate for the activity taking place. For example, a facility may only be used for competitive play a few hours a day with the remainder being used for practice or recreational use. The multi-level lighting would allow for the lights to be operated in the high mode for competition events, while operating on a medium, or a low light level during the remainder of the time, thus conserving energy.

4.4 ENTERTAINMENT PACKAGES/LIGHT SHOWS

Entertainment packages are often included in control systems and can incorporate predesigned and custom light shows, along with audio to further enhance the player and spectator experience.

4.5 AUXILIARY BRACKETS

Sports lighting manufacturers can provide accommodations for mounting auxiliary equipment such as speakers on sports lighting poles. This ensures poles will be sized to accommodate the weight, dimensions, and wind load (EPA) of the additional equipment Brackets shall be welded to the pole and fabricated from hot-dip galvanized steel with a covered hand hole access and internal wiring in the pole.

4.6 FIELD PERIMETER LIGHTING

The parking areas, major areas used for passage, and areas immediately bordering the facilities should be lighted to an average of approximately 2 footcandles. Care should be taken to eliminate darkly shadowed areas.

4.7 EMERGENCY LIGHTING FOR SPECTATOR SEATING AREA

Consideration should be given to providing emergency lighting for spectator seating areas in case of loss of power at indoor and outdoor facilities. Refer to local codes for specific requirements as they apply to athletic facilities.

4.8 SERVICING OPTIONS

Consideration should be given to the method of servicing the top of the pole for lamp replacements and other maintenance concerns that can't be reached with a ladder. The preferred method of servicing should be with a bucket truck or crane. However, when accessibility is restricted due to pole locations, an alternative method should be utilized. Acceptable alternative methods include steps, safety cables, and platforms.

For additional information, contact the KHSAA office at:

KHSAA
2280 Executive Drive
Lexington, Kentucky 40505
Phone:859/299-5472
Fax:859/293-5999

SPORTS LIGHTING LIFE-CYCLE OPERATING COST EVALUATION

This form will assist you in comparing 25-year life-cycle operating costs from multiple manufacturers. Bid proposals should be evaluated based upon compliance with the specifications, contract price, and the following life-cycle operating cost evaluation.

BID ALTERNATE A
MANUFACTURER: _____

A.	Energy consumption ____ Number of luminaires x ____ kW demand per luminaire x ____ kW rate x ____ annual usage hours x 25 years		
B.	Demand charges, if applicable	+	
C.	Spot replacement of luminaire or components over 25 years Assume ____ repairs at $ ____ each if not included Assume $_____ for each luminaire replacement if warranty does not include shipping costs.	+	
D.	Extra energy used without control system ____% x Energy Consumption in item A.	+	
E.	Extra labor without control system $____ per hour x ____ hours per on/off cycle x ____ cycles over 25 years	+	
F.	**TOTAL 25-Year Life-Cycle Operating Cost**	=	

BID ALTERNATE B
MANUFACTURER: _____

A.	Energy consumption ____ Number of luminaires x ____ kW demand per luminaire x ____ kW rate x ____ annual usage hours x 25 years		
B.	Demand charges, if applicable	+	
C.	Spot replacement of luminaire or components over 25 years Assume ____ repairs at $ ____ each if not included Assume $_____ for each luminaire replacement if warranty does not include shipping costs.	+	
D.	Extra energy used without control system ____% x Energy Consumption in item A.	+	
E.	Extra labor without control system $____ per hour x ____ hours per on/off cycle x ____ cycles over 25 years	+	
F.	**TOTAL 25-Year Life-Cycle Operating Cost**	=	

SPORTS LIGHTING SUBMITTAL INFORMATION

Design Submittal Data Checklist and Certification

This form will assist you in comparing proposals from various lighting manufacturers. All items listed below should comply with your project's specification and be submitted according to your pre-bid submittal requirements.

Included	Tab	Item	Description
	A	Letter/Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	On Field Lighting Design	Lighting design drawing(s) showing: a. Field Name, date, file number, prepared by b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), Illuminance levels at grid spacing specified c. Pole height, number of luminaires per pole, horizontal and vertical aiming angles, as well as luminaire information including wattage, lumens and optics d. Height of light meter above field surface e. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance (CV), coefficient of utilization (CU) uniformity gradient; number of luminaries, total kilowatts, average tilt factor; light loss factor. f. Lighting designs shall provide guaranteed target illuminance levels and shall display the LM-80 lumen maintenance data used to calculate illuminance.
	C	Off Field Lighting Design	Lighting design drawings showing spill light levels in footcandles as specified.
	D	Photometric Report (glare concerns only)	Provide photometric report for a typical luminaire used showing candela tabulations as defined by IESNA Publication, LM-79-08. Photometric data shall be certified by laboratory with current National Voluntary Laboratory Accreditation Program or an independent testing facility with over 5 years experience.
	E	Life Cycle Cost calculation	Document life cycle cost calculations as defined on the Life Cycle Operating Cost Evaluation. Identify energy costs for operating the luminaires, maintenance cost for the system including spot maintenance and shipping costs. All costs should be based on 25 Years.
	F	Luminaire Aiming Summary	Document showing each luminaire's aiming angle and the poles on which the luminaires are mounted. Each aiming points shall identify the type of luminaire.
	G	Structural Calculations (if required)	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar, and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of Kentucky.
	H	Control and Monitoring	Manufacturer shall provide written definition and schematics for automated control system to include monitoring. They will also provide examples of system reporting and access for numbers for personal contact to operate the system.
	I	Electrical distribution plans	If bidding an alternate system, manufacturer must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of Kentucky.
	J	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed per the number of years specified.
	K	Warranty	Provide written warranty information including all terms and conditions.
	L	Project References	Manufacturer to provide a list of project references of similar products completed within the past three years.
	M	Product Information	Complete set of product brochures for all components, including a complete parts list and UL Listings.
	N	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications.
	O	Compliance	Manufacturer shall sign off that all requirements of the specifications have been met at that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in item N – Non-Compliance.

Manufacturer:_____ Signature:_____

Contact name:_____ Date:_____/_____/_____

Appendix

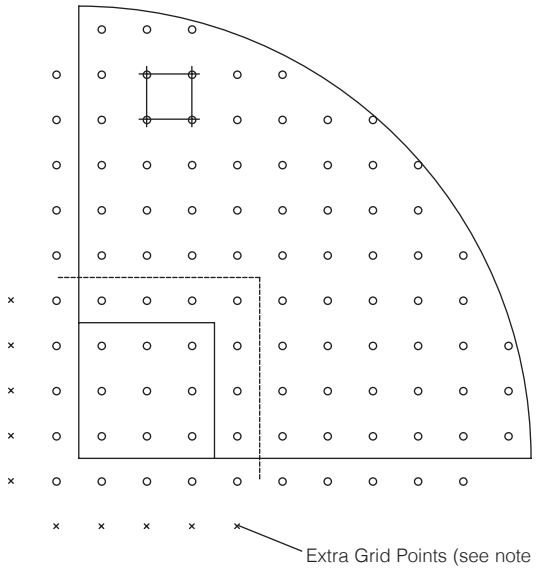
Typical Facility Information

Area of Lighting	Playing Dimensions	Lighted Area Dimensions	Grid Spacing
Baseball, Infield	90' x 90'	150' x 150'	30' x 30'
Baseball, Outfield	Dimensions Vary	Dimensions Vary	30' x 30'
Softball, Infield	60' x 60'	100' x 100'	20' x 20'
Softball, Outfield	Dimensions Vary	Dimensions Vary	20' x 20'
Football	360' x 160'	360' x 180'	30' x 30'
Soccer	360' x 180'	360' x 180'	30' x 30'
Lacrosse	330' x 180'	330' x 180'	30' x 30'
Field Hockey	300' x 180'	300' x 180'	30' x 30'
Tennis	78' x 36'	100' x 60'	20' x 20'
Gymnasiums	90' x 50'	100' x 50'	10' x 10'
Track and Field	Dimensions Vary	Dimensions Vary	30' x 30'

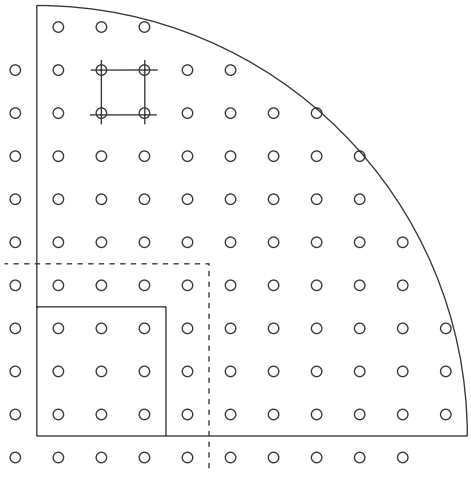
* Baseball and softball fields are pie-shaped. Outfield areas are derived from the overall area less the lighted infield area.

Light Level Grid Point Layouts

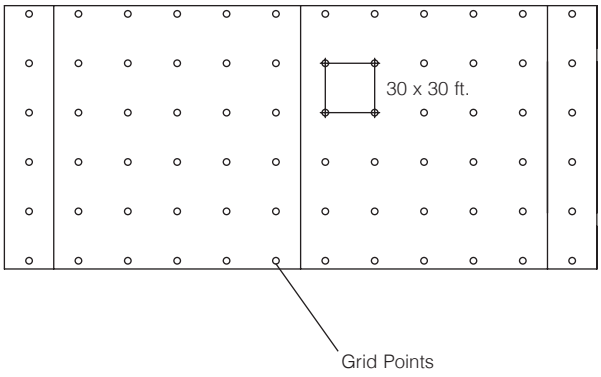
Baseball
300' radius field shown



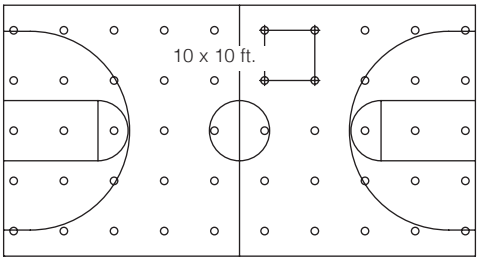
Softball
200' radius field shown



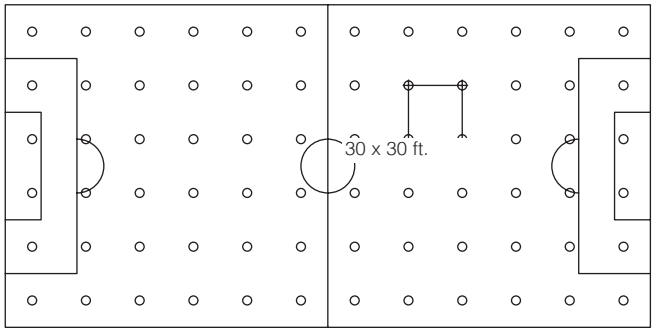
Football
360' x 160' field shown



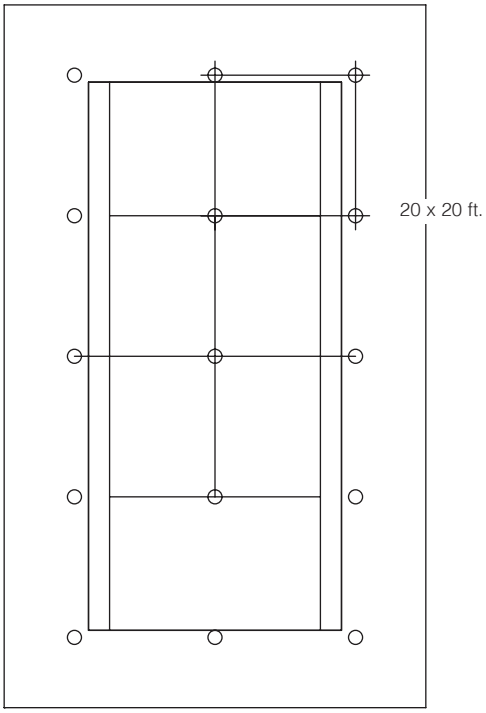
Gymnasium
94' x 50' court shown



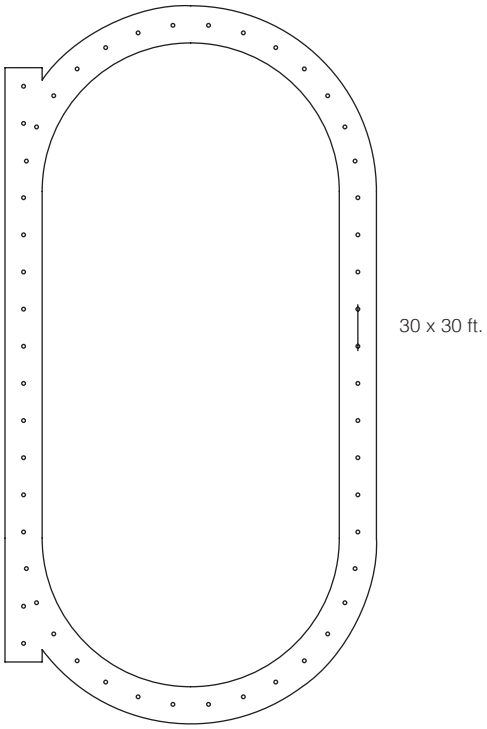
Soccer
360' x 180' field shown



Tennis
78' x 36' court shown

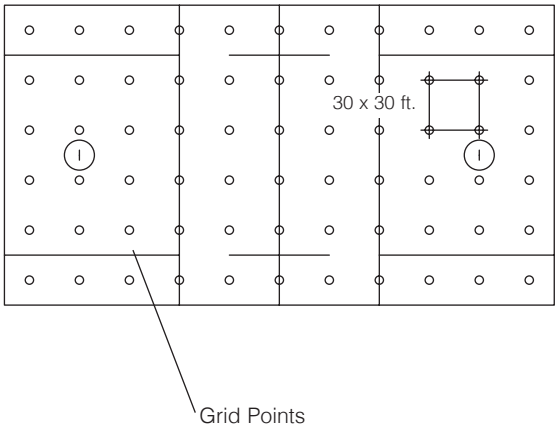


Track
400 meter, 8 lane track shown



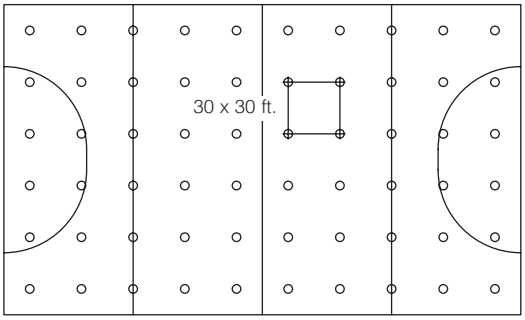
Lacrosse

330' x 180' field shown

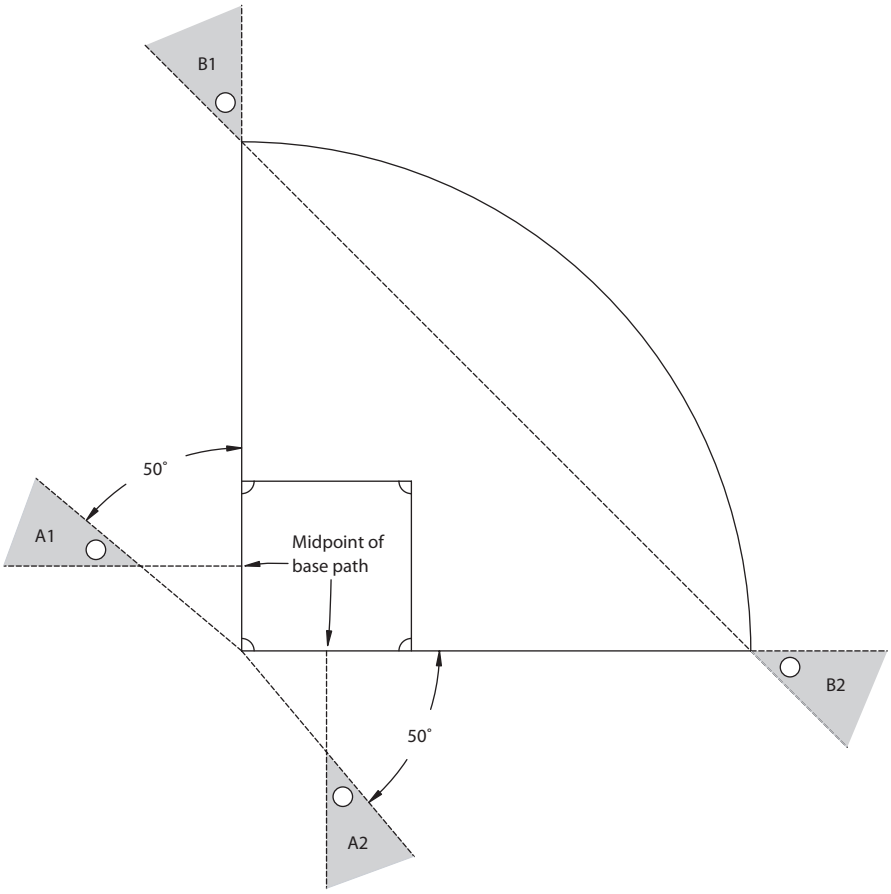


Field Hockey

300' x 180' field shown



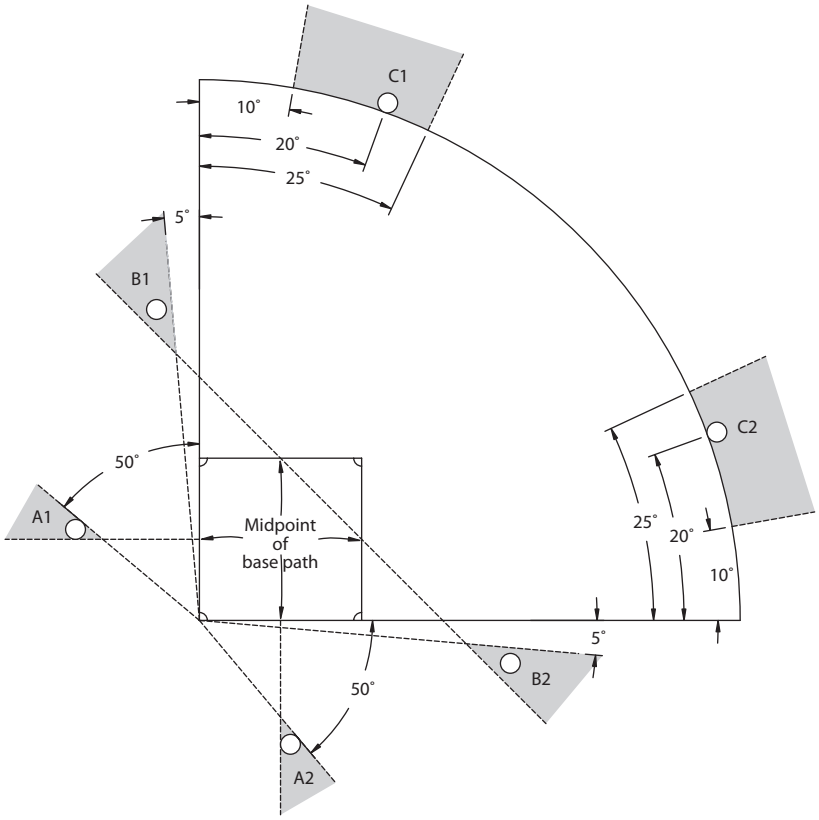
Pole Location Diagrams



4-Pole Softball Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas.
2. For fields with a radius of 250 feet or greater, a 6-pole design is recommended.
3. Line drawn through the two "A" pole locations should be behind home plate to ensure lighting the portion of the ball the batter sees as it crosses home plate.
4. Vertical aiming angle should be 25 degrees minimum on luminaires aimed to the infield and 21 degrees minimum on luminaires aimed to the outfield. The angles are measured from below a horizontal plane at luminaire height.

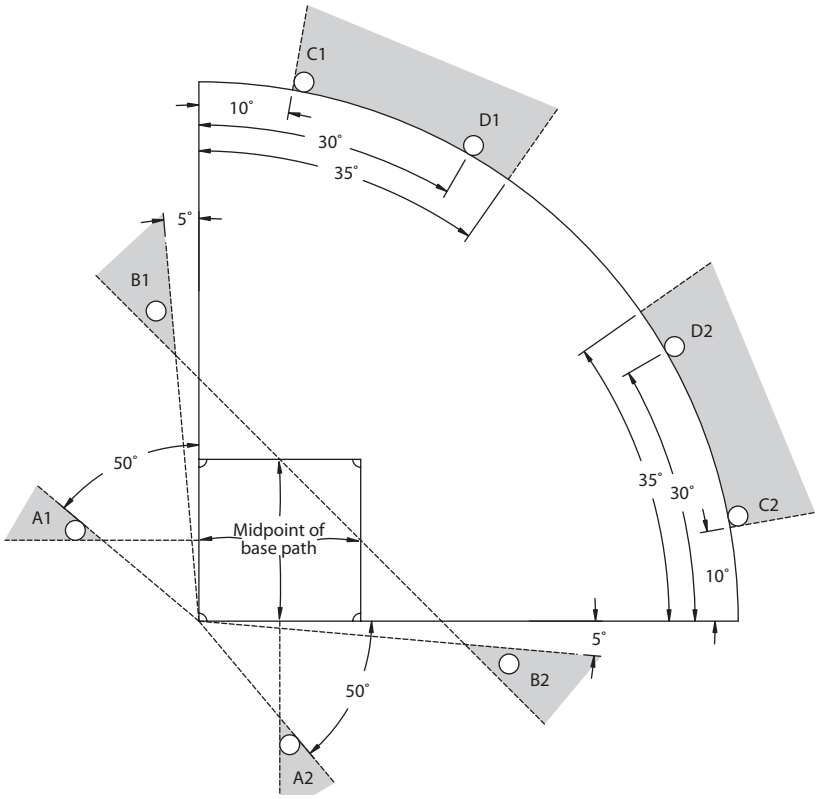
Note:
IES standards have not addressed issues for 4-pole design on softball fields. Design criteria are based upon actual practices used on 250' and smaller fields and standards adopted by Little League Baseball® and ASA Softball based upon testing done on their facilities.



5* or 6-Pole Baseball/Softball Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas.
2. For fields with a radius of 320 feet or greater, an 8-pole design is recommended.
3. Line drawn through the two “A” pole locations should be behind home plate to ensure lighting the portion of the ball the batter sees as it crosses home plate.
4. Consideration should be given to locating “B” poles further toward the outfield locations. This positioning towards the outfield foul pole allows the ball to be lighted in a more constant perpendicular illuminance as it travels from the infield to the outfield.
5. Vertical aiming angle should be 25 degrees minimum on luminaires aimed to the infield, and 21 degrees minimum on luminaires aimed to the outfield. The angles are measured from below a horizontal plane at luminaire height.
6. If the distance between home plate and the backstop is greater than 40 feet, an additional grid should be created to include 10 additional grid points. The average light level for this additional grid should meet or exceed the design criteria for the outfield points.

* If the lighting designer can demonstrate that glare from a pole in center field would be less than 1000 candela (as measured at home plate, 5' above the field surface) then the more economical 5-pole design would be acceptable.



7* or 8-Pole Baseball/Softball Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas.

2. Line drawn through the two “A” pole locations should be behind home plate to ensure lighting the portion of the ball the batter sees as it crosses home plate.

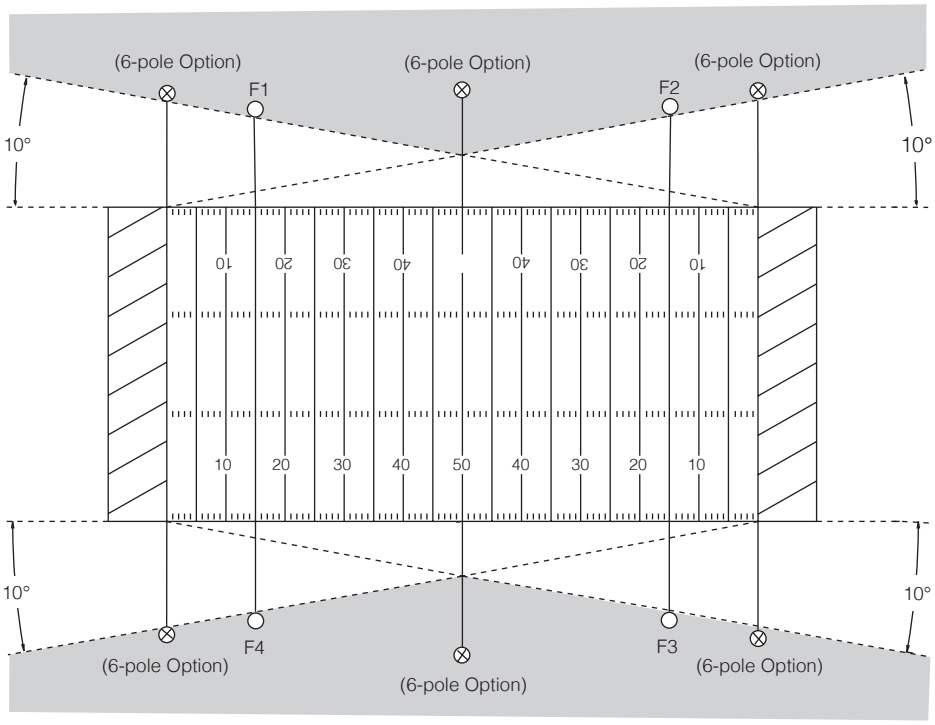
3. Consideration should be given to locating “B” poles further towards outfield locations. This positioning towards the outfield foul pole allows the ball to be lighted in a more constant perpendicular illuminance as it travels from the infield to the outfield.

4. “B” poles may be located 10 feet closer to the infield as long as they maintain a position outside the 5 degree arc. The shaded area is preferable.

5. Vertical aiming angle should be 25 degrees minimum on luminaires aimed to the infield, and 21 degrees minimum on luminaires aimed to the outfield. The angles are measured from below a horizontal plane at luminaire height.

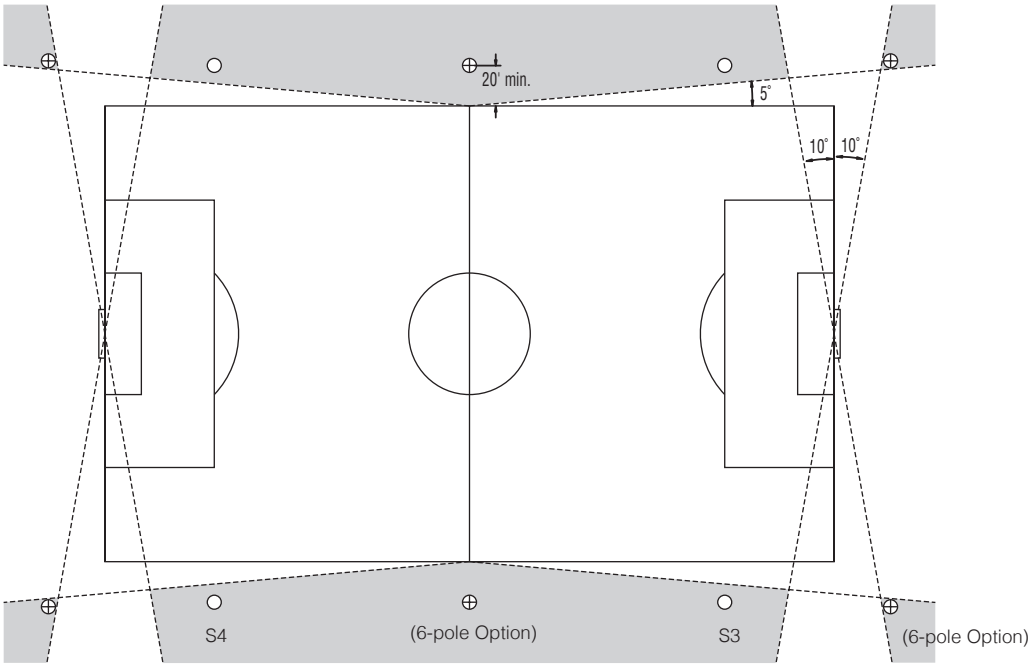
6. If the distance between home plate and the backstop is greater than 40 feet, an additional grid should be created to include 10 additional grid points. The average light level for this additional grid should meet or exceed the design criteria for the outfield points.

* If the lighting designer can demonstrate that glare from a pole in center field would be less than 1000 candela (as measured at home plate, 5' above the field surface) then the more economical 7-pole design would be acceptable.



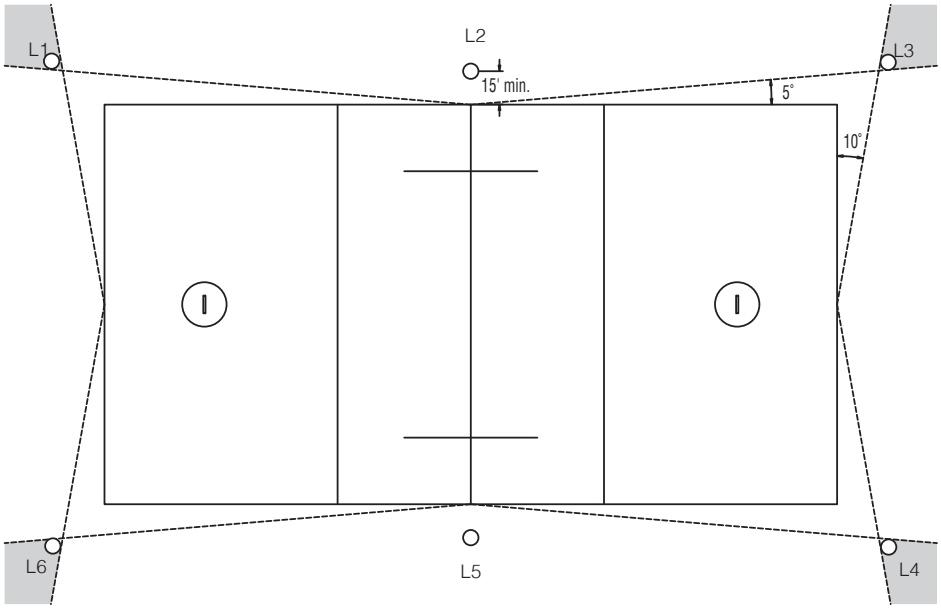
Football Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas. All poles should be at least 30 feet from the sideline.
2. On a 4-pole design, the optimum location is on the 15 yard line.
3. For the 6-pole option, the setback of middle poles will depend on the presence of bleachers. The optimum location for the corner poles is between the goal line and the corner of the field.
4. Poles should be positioned so as not to pose a potential injury hazard.
5. Vertical aiming angle should be 21 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.



Soccer Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas. All poles should be at least 20 feet from the sideline.
2. On a 4-pole design, the optimum pole locations are (.35 x field length) from center of field.
3. In general, football lighting standards apply to soccer with the following considerations:
    a. Soccer field length generally ranges from 300 to 360 feet; width varies from 160 to 225 feet.
    b. A corner kick is a specific visual task and general consideration should be given to facility design specifically for soccer.
    c. The corner grid point shall be lit to no less than 90% of the average light level.
4. For combination football and soccer facilities, soccer should take precedence.
5. Vertical aiming angles should be 21 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.

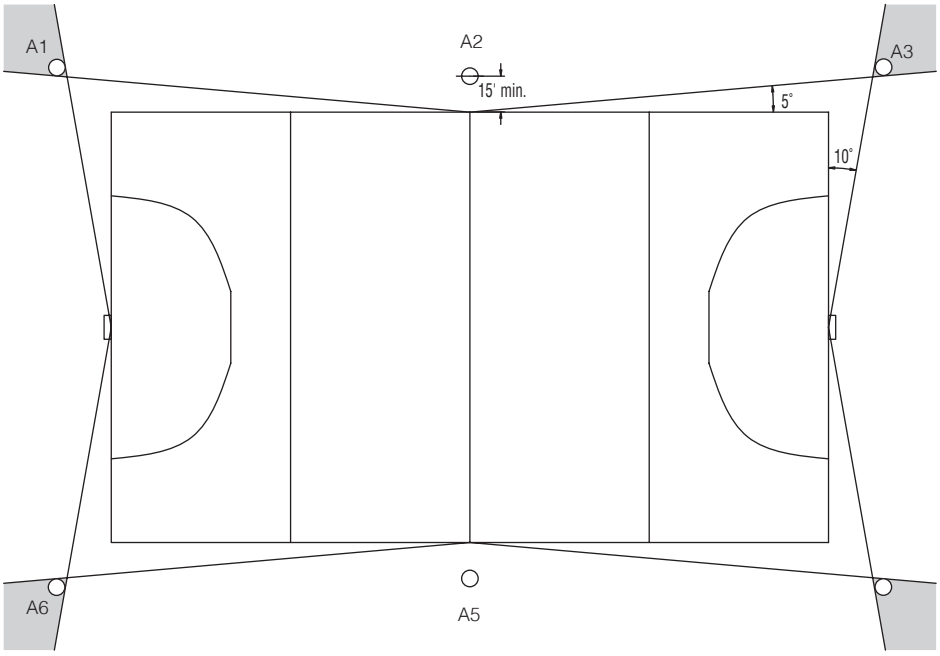


Lacrosse Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas. All poles should be at least 15 feet from the sideline.

2. Vertical aiming angle should be 21 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.

3. A 4-pole design utilizing corner location is permissible providing minimum aiming angles can be achieved.



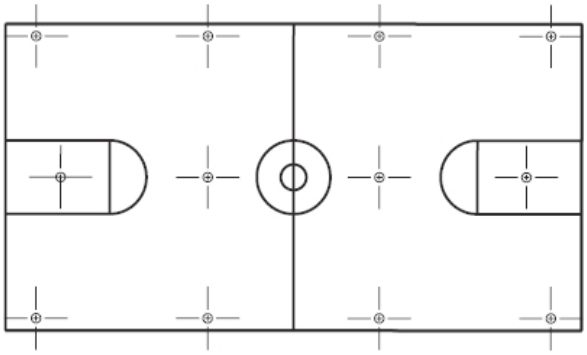
Field Hockey Field

1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas. All poles should be at least 15 feet from the sideline.
2. Vertical aiming angle should be 21 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.
3. A 4-pole design utilizing corner location is permissible providing minimum aiming angles can be achieved.

12 Luminaire Design

Designed for lighting in gymnasiums with no special provision for spectators such as smaller high schools or training facilities.

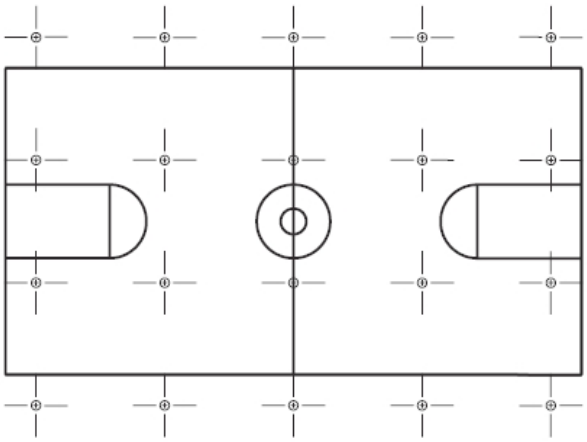
• 54 footcandles maintained



20 Luminaire Design

Ideal for college, semi-professional, or large high schools with facilities for spectators of 5000 or less. Suitable for facilities where lighted surfaces are 50' x 94' with 22' mounting heights.

• 80 footcandles maintained

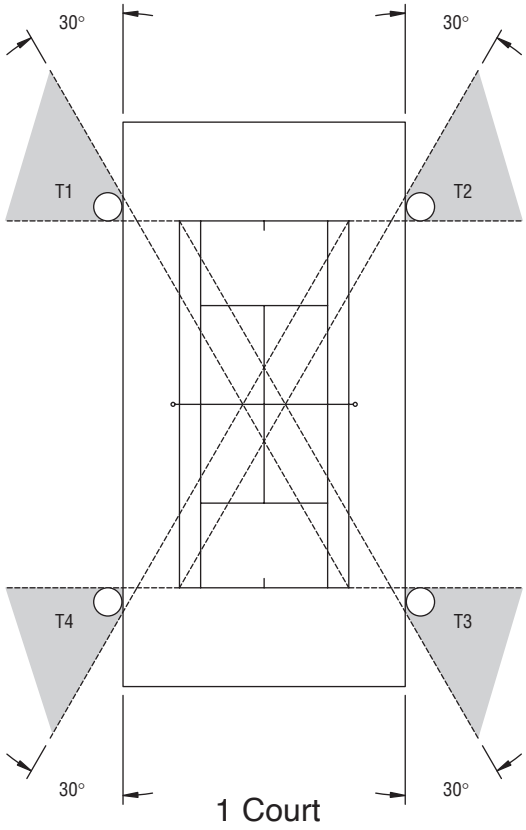


Gymnasium

1. For new facilities or upgrades, it is recommended to consult a lighting professional for optimal fixture placement.

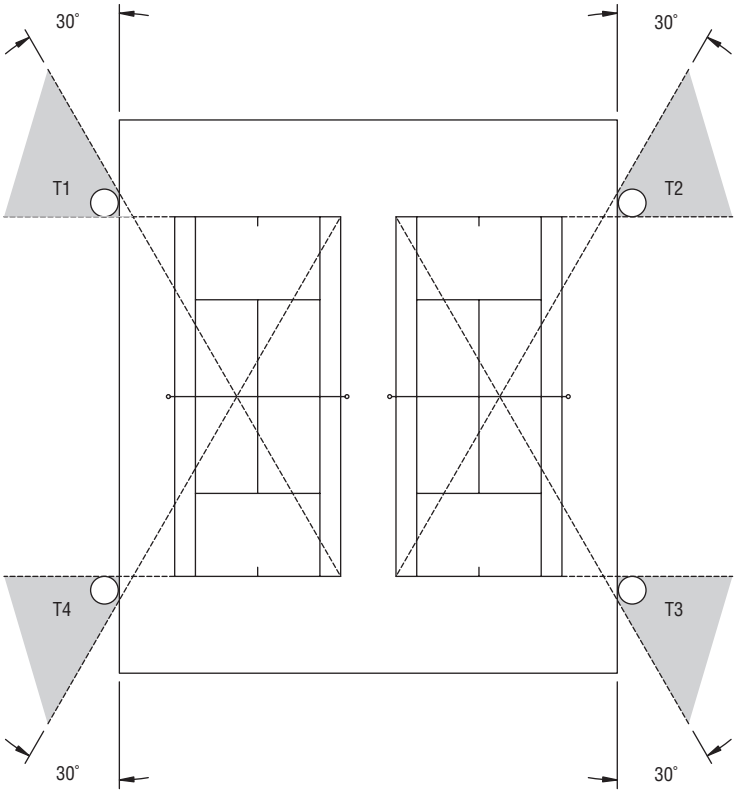
2. Optimal fixture placement and mounting heights will impact playability and minimize glare and skip glare.

3. As a general rule, due to mounting heights, lower wattage fixtures are used, commonly 1000 watt.

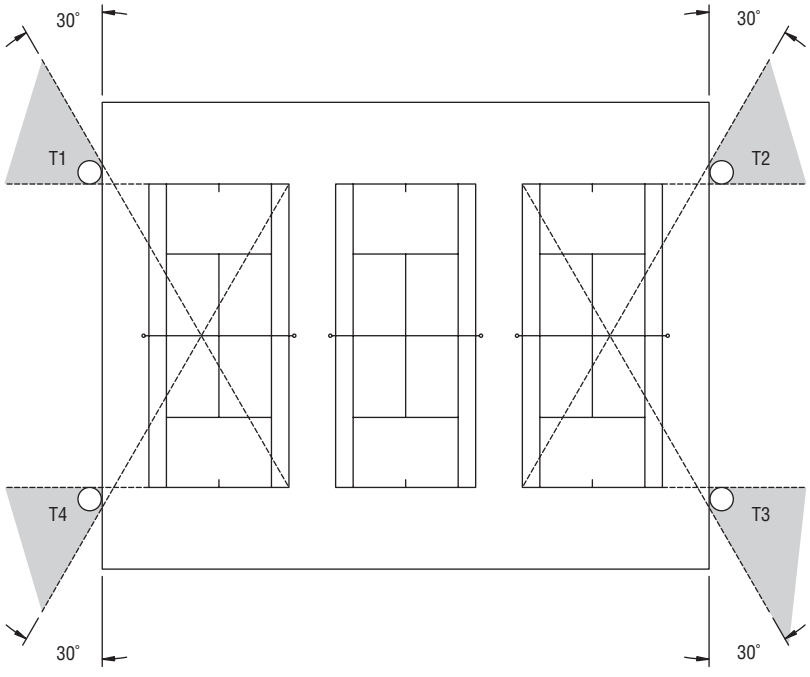


Tennis Courts

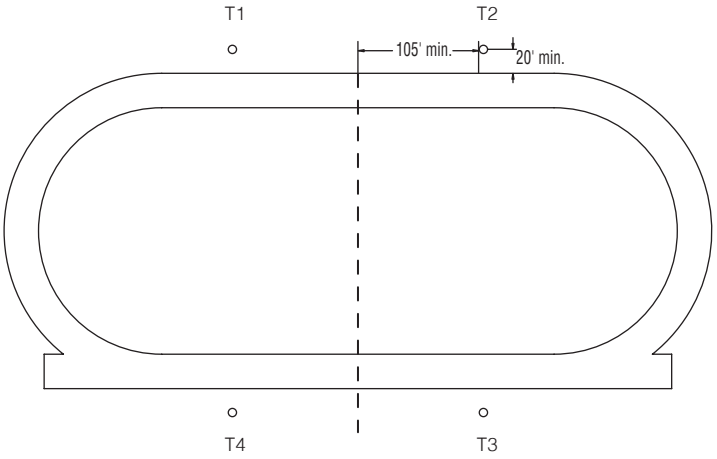
1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas.
2. It is not generally recommended to use a 6-pole layout with poles located at net lines. This position may be directly in the server's sight line with toss when the ball is served.
3. Vertical aiming angles should be 25 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.



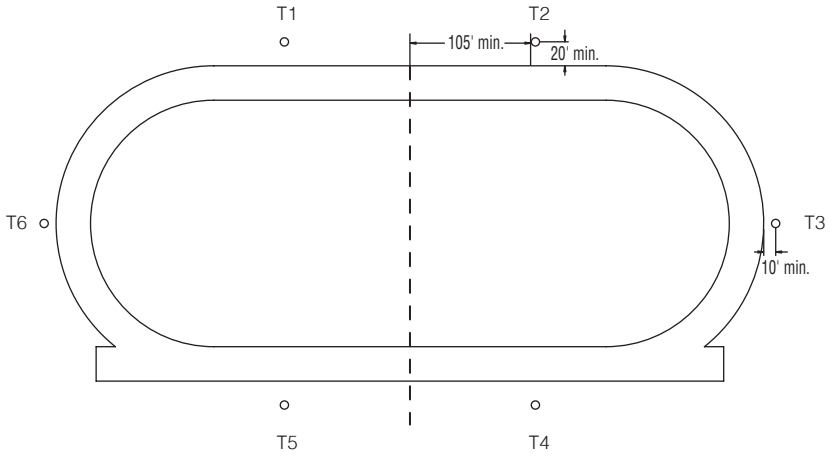
2 Courts



3 Courts



4-Pole Track



6-Pole Track

400 Meter, 8 Lane Track

1. These pole locations are for typical stand-alone tracks.
2. For tracks built in conjunction with a football or soccer field, use the standard pole locations on the football design (page 19) or soccer design (page 20).
3. Vertical aiming angles should be 21 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.

ANNUAL SYSTEM OPERATION & MAINTENANCE CHECKLIST

School Name_____ **Field Name**_____

Date of Inspection_____ **Voltage/Phase**_____ **Date Installed**_____

Type of Pole_____ **Type/# of Luminaires**_____

Inspected By_____ **Contact Number**_____

WARNING! Turn off electricity at power source and at safety disconnect on poles

	OK	Needs Repair	Notes
Service Entrance & Pole Distribution Boxes			
Check service panel for proper markings. • Emergency information should be visible.			
• Warning stickers, wiring diagrams, circuit labels, and other servicing information signs should be posted and clarly legible.			
Test reset action on all service breakers. • Snap all breakers on and off to ensure firm contact.			
Check the wiring.* • Insulation around wiring should show no signs of deterioration.			
• Wiring should show no heat discoloration.			
Check all taped connections.* • Signs of wear should be replaced.			
Make sure no live parts are exposed. • Bare wires and exposed connections should be wrapped with insulated covering.*			
Padlocks for service entrance & distribution boxes should be in place and operational.			
Poles			
Check that poles aren't leaning.			
Check wood poles for decay or twisting. Twisted pole may require re-aiming of fixtures. • Effective Sept. 1, 1944, wood poles are no longer approved on new installations.			
Check base-plate of steel poles for signs of deterioration. • Check anchor bolt for signs of corrosion.			
• Check grouting under pole to make sure proper drainage exists.			
Check bolts and fittings for tightness. • Check all metal parts for signs of corrosion.			
Check to see that wiring covers are in place.			
Check all cables and conduits. • Pull on conduit to check for looseness.			
• Check for loose fittings and damaged conduit.			
• All cables should be straight and properly strapped.*			
• If cables are exposed to the elements, make sure the insulation has the proper rating.*			
Check overhead wiring. • Wiring should be properly secured.*			
• Check that new growth on tree branches and limbs won't obstruct or interfere with overhead wiring.			
Check pole climbing equipment (if provided) • Check inspection cards on climbing harness and pole equipment. Are inspections up to date?			
• Check for proper cable tension. Cable should not be loose.			
Luminaires			
Check fixture housings. • Housings should show no sign of cracking, large dents, and/or water leakage.			
Check lenses. • Clean lenses.			
• Replace broken lenses.			
Replace burned-out lamps.			
Check luminaire fuses. • Fuses should be the correct size.			
• All fuses should be operational.			
Insulation covering on wiring should show no signs of wear or cracking.			
Ground wire connections must be secure.			
Check around ballasts for signs of blackening. (metal hallide)			
Check that capacitors aren't bulging. (metal hallide)			
Check aiming alignment of all fixtures. • On wooden poles, see if crossarms are still aligned with the field and horizontal.			
Ground			
Check grounding connections.*			
Check nearby metal objects. • make sure metal bleachers and other metal objects are located at least 6' from the elctrical components.			
*Metal objects, such as bleachers, must have their own individual grounding system.			
Check that capacitors aren't bulging. (metal halide)			
Check aiming alignment of all luminaires. On wooden poles, see if crossarms are still aligned with the field and horizontal.			

Lighting Performance Testing

To verify that your field meets the KHSAA recommended standards, complete the performance testing information below.

The inspection must be done using a light meter calibrated within the last 12 months. The light meter should be held horizontally 36 inches above the middle point of each square in the grid.

Baseball/Softball

To obtain average footcandle value:

Record light readings within each square.

Infield = Total of infield readings ÷ 25

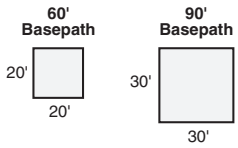
Outfield = Total of outfield readings ÷ number of readings.

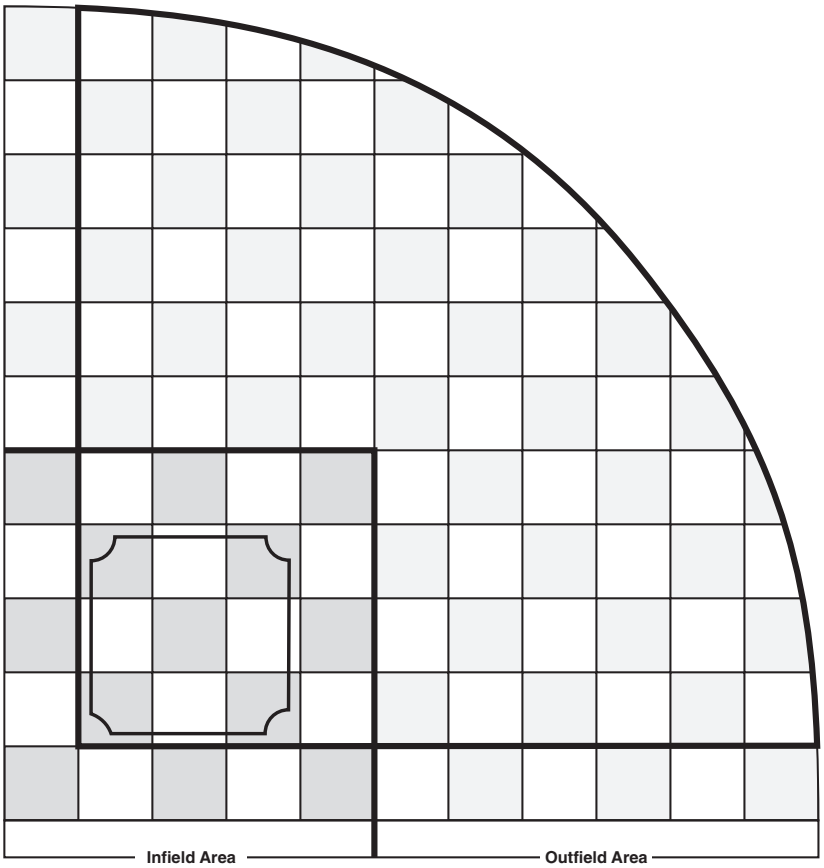
To obtain uniformity ratio for infield or outfield:
Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

For example:

61 footcandles ÷ 31 footcandles = 2.1





Football

To obtain average footcandle value:

Record light readings within each square.

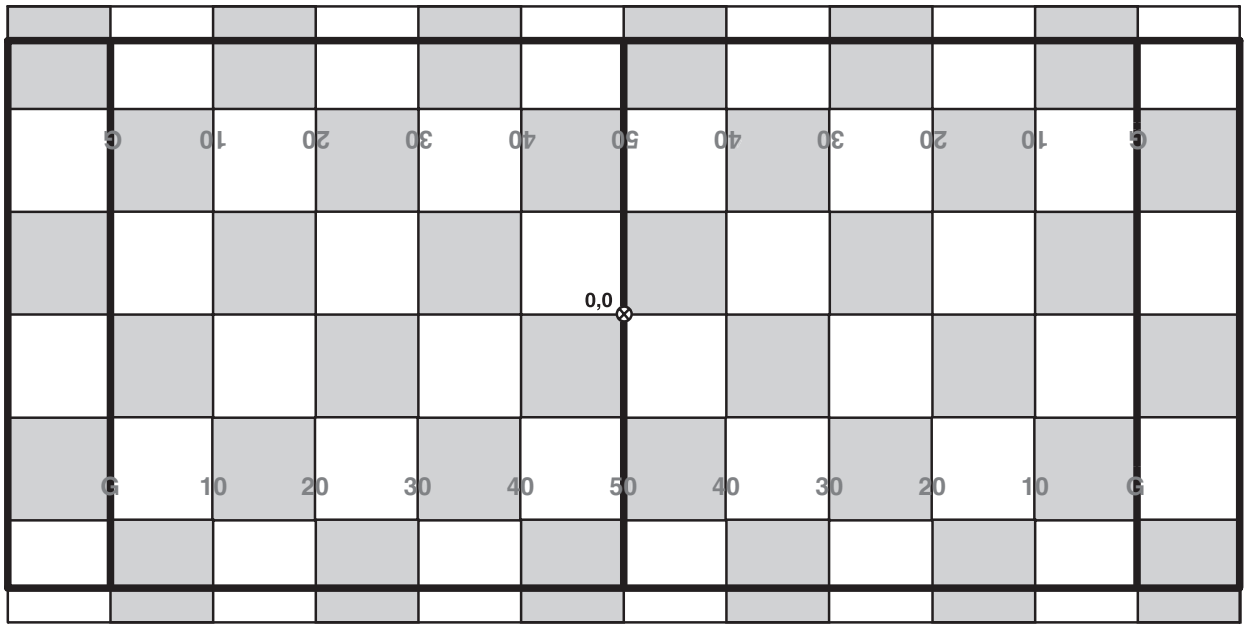
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

30' x 30' grid



Soccer

To obtain average footcandle value:

Record light readings within each square.

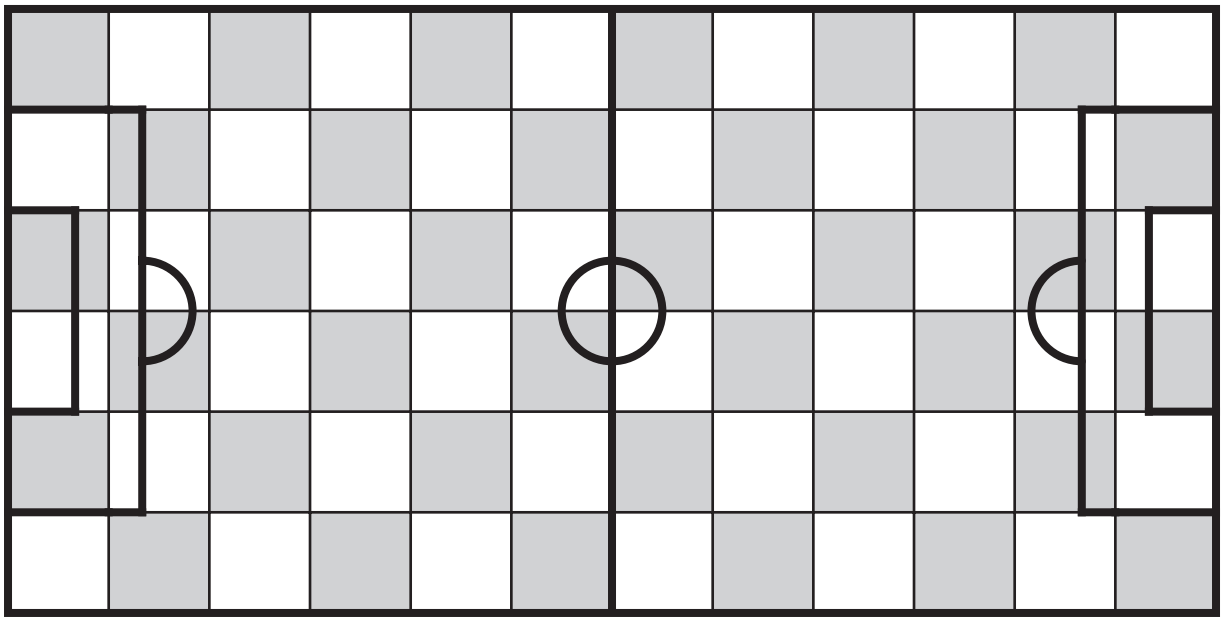
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

30′ x 30′ grid



Lacrosse

To obtain average footcandle value:

Record light readings within each square.

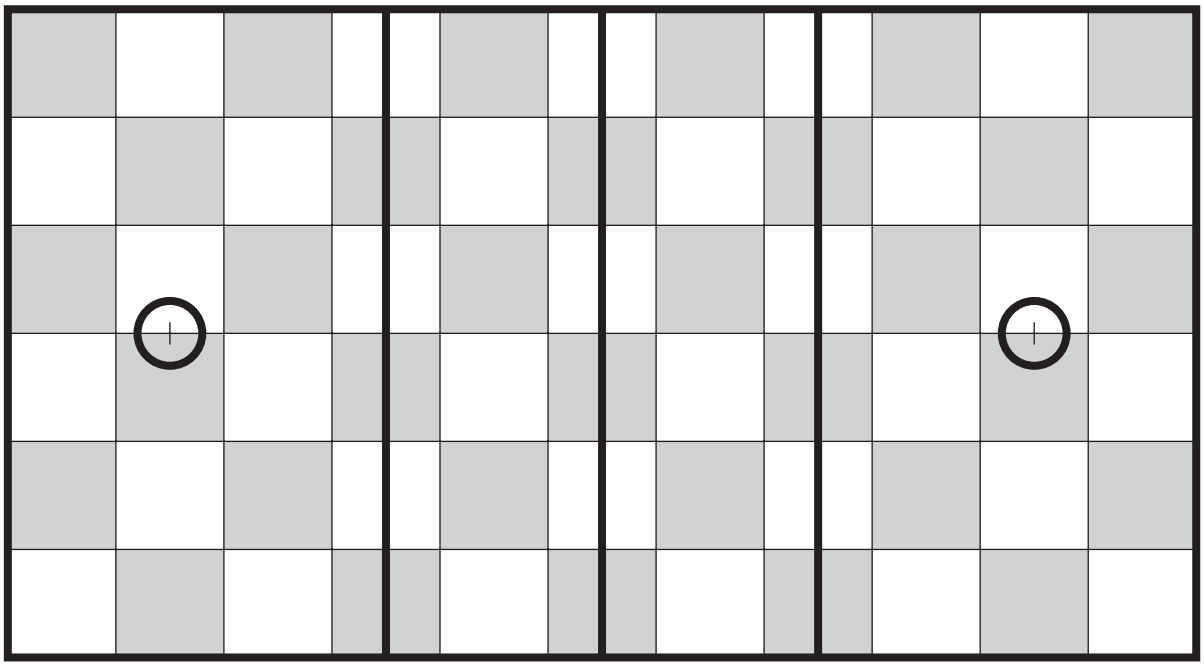
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

30′ x 30′ grid



Field Hockey

To obtain average footcandle value:

Record light readings within each square.

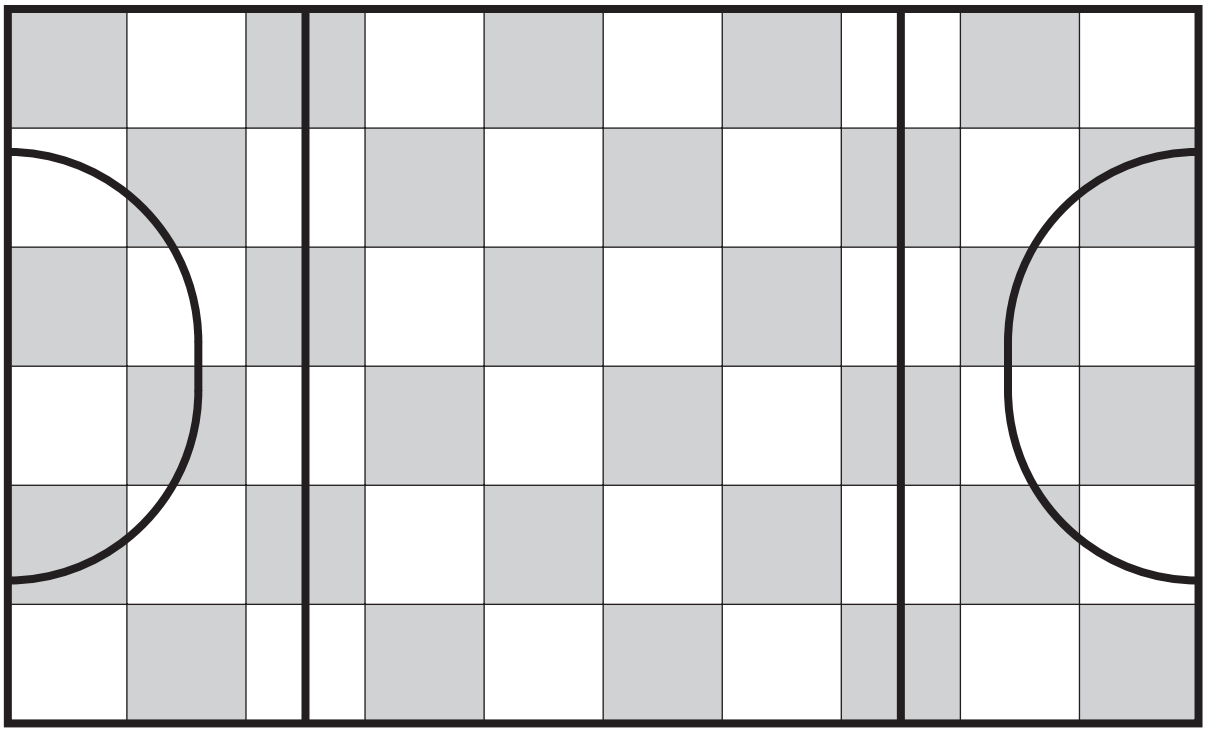
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

30′ x 30′ grid



Gymnasium

To obtain average footcandle value:

Record light readings within each square.

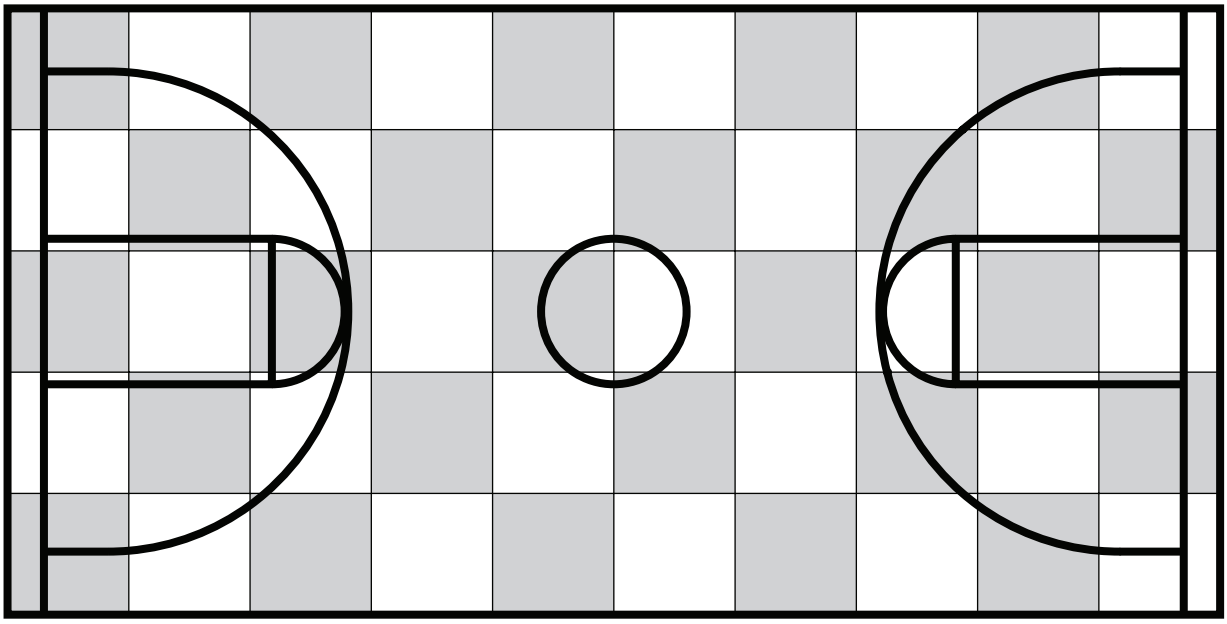
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

10′ x 10′ grid



Tennis

To obtain average footcandle value:

Record light readings within each square.

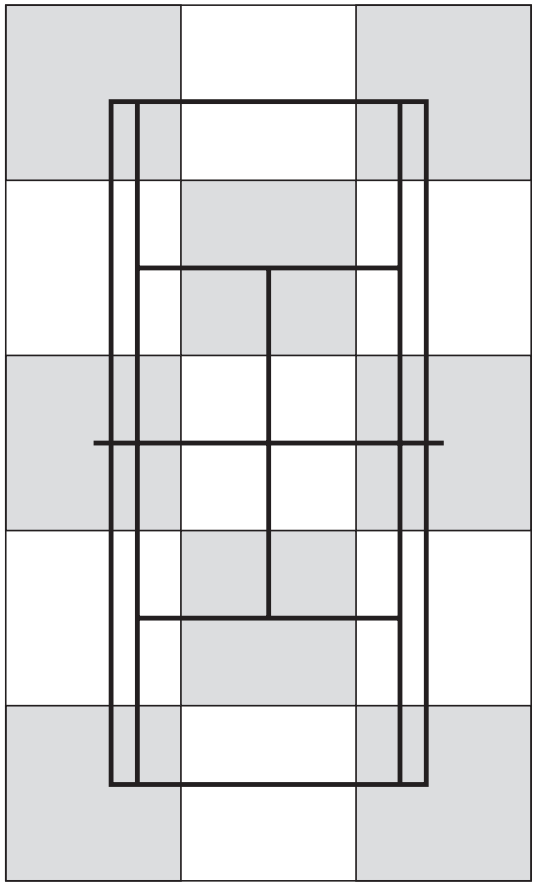
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

20′ x 20′ grid



Track

To obtain average footcandle value:

Record light readings within each square.

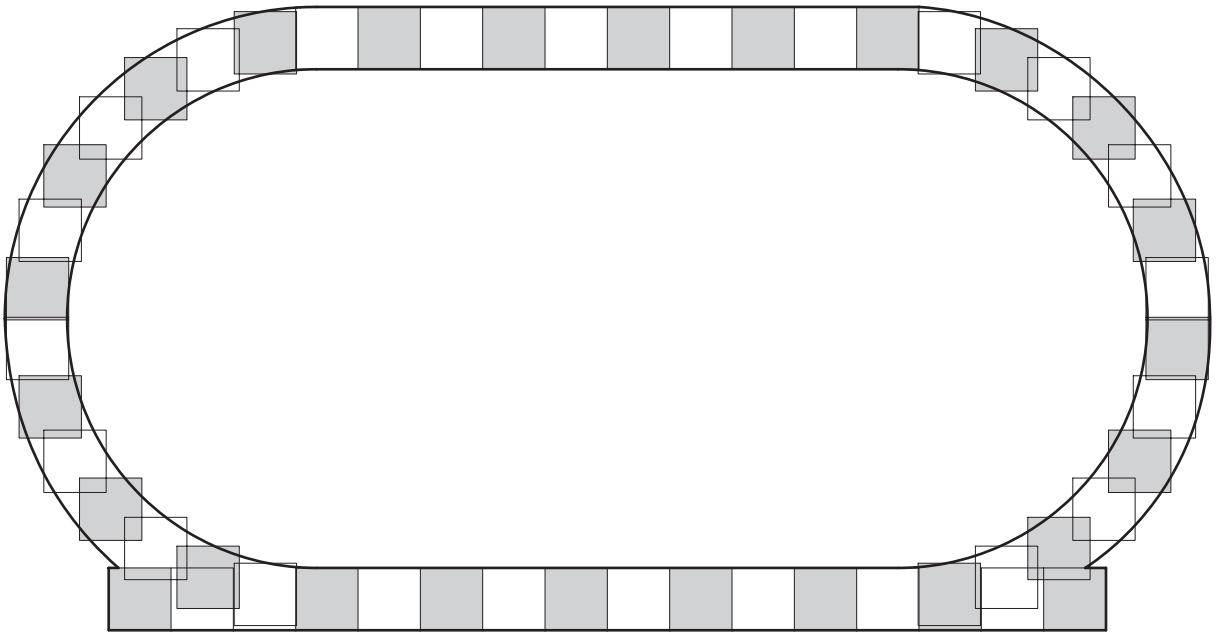
Total all readings, divide by total number of readings taken.

To obtain uniformity ratio:

Divide highest (maximum) light level reading by the lowest (minimum) light level reading:

Maximum reading _____ ÷ Minimum reading _____ = _____ Uniformity ratio

30′ x 30′ grid



GLOSSARY

Aiming Angles (vertical) The degrees below horizontal that light luminaires are aimed at the field. Angles are measured from a horizontal plane at luminaire height. Critical in safe, playable lighting design.

Coefficient of Variation The ratio of the standard deviation for all of the footcandle values to the mean. A maximum ratio is specified.

Color Rendering Index The ability of a light source to reproduce colors accurately, compared to the same colors under daylight conditions.

Color Temperature The color appearance of a light source, measured in Kelvin.

Controller A device that regulates the output of an LED driver to control LED luminaire lumen output.

Driver A power source that delivers the proper operating current to LED luminaires.

Footcandle The measurement of light on a surface. One footcandle equals one lumen spread over one square foot.

Glare Light that interferes with the ability to see. Luminaire design, proper aiming angles, and pole locations are key to limiting glare for participants and spectators.

IESNA Illuminating Engineering Society of North America. An organization that develops recommendations for sports lighting.

Lumen A quantity measurement of light, used mostly in measuring the amount of light an LED creates.

Luminaire NEMA Type A classification of luminaires. For example, a Nema 2 luminaire gathers light in a narrow, focused beam, allowing it to be projected a long distance. A Nema 5 projects light a relatively short distance in a very wide beam. Most lighting designs use various combinations of Nema types to get the desired results.

NEC National Electric Code. A national safety code for electrical systems that is the basis for most local codes.

NFPA National Fire Protection Association. An organization that establishes and publishes various codes such as the Lightning Protection Code and the National Electric Code.

Overturning Moment The amount of force applied to a lighting structure, mostly from wind. Pole foundations must be designed to withstand this force.

Remote Electrical Components Enclosure A weatherproof enclosure that allows the electrical gear to be moved from the top of lighting structures to a lower point where it can be serviced easily.

Smoothness The change in light levels between measuring points. The less change between points, the more even the lighting. (See also Uniformity.)

Spill Light Wasted light that falls off the field or is projected into the sky. Systems that can re-direct spill light back onto the field save dollars and keep neighbors content.

Target Light Levels The lowest average amount of light for which a lighting system should operate over its extended life to ensure performance requirements.

Underwriters Laboratories Independent, non-profit, product safety testing and certification organization. Visit www.ul.org for additional information.

Uniformity The smoothness of light on the field. Also called uniformity ratio. A design criteria to assure that light is distributed evenly across the entire field. A max/min ratio of 2:1 means that the brightest point is no more than double any other point.

Uniformity Gradient The ratio between any two adjacent illuminance values on the field. A maximum ratio is specified.

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M-2082-enUS-4