Lighting Standards

# North Carolina High School Athletic Association

# TABLE OF CONTENTS

# LIGHTING INFORMATION FOR SPORTS FACILITIES

The North Carolina High School Athletic Association has amended lighting standards in support of the Health and Safety Initiative to help assure a safer playing environment, to guide schools in understanding new lighting technologies available and to establish methods to maintain their lighting systems. These updated standards were approved by the NCHSAA Board of Directors on September 9, 2019 and apply to the lighting of all high school athletic activities sponsored by the NCHSAA 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 safer, more effective lighting system.

The standards are divided into recommended minimum standards and desirable features. The minimum standards establish criteria which are important to safely conduct NCHSAA activities. The desirable features are established to provide guidelines for lighting systems that give added values of durability, energy-efficiency, environmental sensitivity to spill and glare issues, and that are more cost-effective to own and operate.

NCHSAA play-off events are intended to be held only at sites that meet the minimum standards.

## I. Recommended Minimum Standards

To ensure the safety of participants and spectators, the proper design for a sports-lighting system should address three primary areas of technology: Lighting, Structural, and Electrical. An effective sports-lighting system involves a combination of lighting, structural, and electrical components engineered to assure the standards are met as defined by this document. These standards require the manufacturer to design, fabricate, and provide a warranty for the complete lighting system to the performance criteria established by the IESNA (Illuminating Engineering Society of North America), the NEC (National Electric Code), and the IBC (International Building Code) and contained within this document.

These standards are recommended for all lighting installations after the date of adoption. Any modification to an existing lighting system after this date should be done so in compliance with these standards. To be in compliance, a system must meet all of the recommended minimum standards. These specifications should be considered as advisory in nature and non-regulatory.

### A. Lighting

#### 1. Quantity

The IESNA "Recommended Practice for Sports and Recreational Area Lighting" RP-6-15 provides design criteria for sports facilities. Maintained average illuminance is defined as the average illuminance below which the light level should not fall throughout the system's life. Actual values are calculated from measurements taken on the specified surface at the time maintenance is to be carried out.

The preferred method of design should provide a constant light level over the light-level guarantee period. The acceptable alternative is to apply a recoverable light loss factor.

**a. Preferred Technology**

**i. LED**

As light emitting diode (LED) technology improves and costs decrease, LED lighting systems become more viable for sports facilities. LED light sources can have a much greater lifespan than metal halide light sources with significantly less lumen depreciation over typical sports lighting operating hours. For example, a metal halide light source may reach 70% lumen maintenance in as little as 2,100 – 3,000 hours while an LED light source may take 100,000 hours or more.

**b. Acceptable**

**ii. Constant illumination – Metal Halide**

By utilizing a series of power adjustments, a lighting system is able to provide "constant light levels" and greatly extend the life of the lamps. In addition, this generation of lighting has high performance optic characteristics that enable reductions in the quantities of luminaires needed to meet design targets, lowering installation and operating costs. Light levels are typically guaranteed for up to 10 years with this technology.

**ii. Prior Technology – Metal Halide**

For prior technology lighting systems, the specified light levels should be derived by applying Light Loss Factors to the Initial lighting designs in the manner shown in the IESNA Lighting Handbook Reference and Application, Tenth Edition, page 10.24.

Initial light levels are to be based on footcandles as calculated from the photometric report of the luminaire (per the lamp manufacturer's 100-hour lamp lumens) x Ballast Factor x Voltage Factor x Ambient Temperature Factor X Lamp Tilt Factor.

In determining the target average light values, a recoverable light loss factor of 0.7 is to be applied, in addition to the adjustment for the above mentioned non-recoverable Light Loss Factors.

Target Light Levels = Initial Light Levels X Recoverable LLF Recoverable LLF = LLD x LDD = 0.70

Quality manufacturers are willing to provide guarantees of lighting performance.

**c. Initial and Target/Constant Light Levels**

The average initial light levels (for prior metal halide technology systems only) and target/constant light levels, should be as stated below:

NOTE: For facilities 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."

**Average Light Levels (Initial and Target [maintained] Levels)**

| Area of Lighting | Initial Light Levels (Avg) | Target Light Levels (Avg) |
|---|---|---|
| Baseball/Softball Infield Area | 71.5 footcandles | 50 footcandles |
| Baseball/Softball Outfield Area | 43 footcandles | 30 footcandles |
| Football/Soccer/Lacrosse/Field Hockey/Rugby (Practice Fields or facilities with 2000 seats or less) | 43 footcandles | 30 footcandles |
| Football/Soccer/Lacrosse/Field Hockey/Rugby (Facilities with up to 5000 spectators) | 71.5 footcandles | 50 footcandles |
| Football/Soccer/Lacrosse/Field Hockey/Rugby (Facilities with 5000 or more spectators) | 143 footcandles | 100 footcandles |
| Tennis | 71.5 footcandles | 50 footcandles |
| Gymnasiums (For practice or recreational purposes only) | 71.5 footcandles | 50 footcandles |
| Gymnasiums (For hosting events with spectators) | 114.5 footcandles | 80 footcandles |
| Track and Field (Track oval only) | 29 footcandles | 20 footcandles |
| Track and Field (For areas where field events will take place) | 43 footcandles | 30 footcandles |

**Note**: Combination/Multipurpose areas must meet the highest average among the standards for activities played on the field.

2. **Quality**

Uniformity is a measure of relationships of the illuminances over an area and helps to ensure the quality of the lighting on a project. This is particularly important for high-speed sports conducted on a playing field. To ensure the highest quality of light, three separate uniformities are defined. They are maximum to minimum illuminance uniformity ratio, uniformity gradient, and coefficient of variation. The quality of the lighting should be determined on a basis of these three measurements.

**NOTE:** For facilities 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."

**a. Maximum to Minimum Uniformity Ratio**

The uniformities of the playing field should be measured by comparing the maximum reading to the minimum reading. This ratio should not exceed the value given on the following chart.

| Uniformity | | | |
|---|---|---|---|
| **Area of Lighting** | **Max to Min Ratio** | **Uniformity Gradient** | **Coefficient of Variation** |
| Baseball/Softball Infield Area | 2.0:1 | 1.5 | 0.17 |
| Baseball/Softball Outfield Area | 2.5:1 | 1.5 | 0.21 |
| Football/Soccer/Lacrosse/Field Hockey/Rugby (Practice Fields or facilities with little or no spectator seating) | 3.0:1 | 1.5 | 0.25 |
| Football/Soccer/Lacrosse/Field Hockey/Rugby (Facilities with up to 5000 spectators) | 2.0:1 | 1.5 | 0.21 |
| Football/Soccer/Lacrosse/Field Hockey/Rugby (Facilities with 5000 or more spectators) | 1.7:1 | 1.3 | 0.13 |
| Tennis | 2.0:1 | 1.5 | 0.17 |
| Gymnasiums (For practice or recreational purposes only) | 3.0:1 | 2.0 | 0.25 |
| Gymnasiums (For hosting events with spectators) | 2.5:1 | 1.5 | 0.21 |
| Track and Field (Track oval only) | 4.0:1 | 2.0 | 0.30 |
| Track and Field (For areas where field events will take place) | 3.0:1 | 2.0 | 0.30 |
| **Note**: Combination/Multipurpose areas must meet the highest average among the standards for activities played on the field. | | | |

**b. Uniformity Gradient (UG)**

The ratio of greater footcandles to lesser footcandle levels between any two adjacent points in the defined grid should not exceed the value given on the following chart.

**c. Coefficient of Variation (CV)**

The maximum ratio of the standard deviation for all of the footcandle values to the mean should not exceed the value given on the following page.

**3. Light Source**

**a. Light Emitting Diode (LED)**

The life of an LED is significantly longer than metal halide, and depreciation is more gradual early in life. It is recommended to obtain the lumen maintenance report per TM-21-11, of the luminaire being proposed. Projected lumen maintenance hours should be reported (based on 6x testing) values and not calculated values.

LEDs can range in CCT from below 3000 K to over 6000 K. Currently, the most efficient LEDS for sports lighting are about 5700 K. This is acceptable per the IES position statement, PS-09-17.

**b. Metal Halide**

Metal halide lamps are recommended for sports lighting applications due to their ability to provide high luminous efficacy, good color rendering, and good optical control characteristics. In general, 1500-watt luminaires are the most economical solution for exterior facilities, and 400-watt luminaires are typically most economical for indoor facilities. Standard correlated color temperature (CCT) is about 4200 K.

**4. Light Level Documents**

**a. On-Field Performance**

Lighting equipment manufacturers should provide drawings showing the horizontal footcandle quantity at each point of measurement on the field. The drawings should indicate both the initial and target average horizontal illuminance levels at each measurement point on the field. The drawings should contain any relevant light loss factors in determining the predicted illuminance levels. For designs where constant light is utilized, a single set of drawings showing target illuminance levels is sufficient.

An additional drawing may be necessary to evaluate the initial spill and glare values required to meet local ordinances.

**b. Environmental Light Control**

For areas of concern the glare from any one luminaire should not exceed 7,500 candela (measured at 60 inches above ground level) for rural areas and 10,000 cd for suburban areas per IES RP-6-15 viewed from the primary area of concern which could be a property line or adjacent neighborhood.

**5. Measurement of Light Quantity**

**a. Area of Light Quantity**

The areas for which measurements are to be taken and the points of measurement within that area are shown in the appendix. It is important that measurements be taken at all of the points to meaningfully establish that the standards for quantity and standards are being met for the facility.

**b. Methods of Measuring Light Quantities**

The light sensing surface of the light meter should be held 36 inches above the playing surface with the sensing surface horizontal so that it detects light coming downward to the sensing surface from all directions around the ball field. Testing equipment for measurement of light should be a cosine and color-corrected light meter regularly calibrated in footcandles.

**c. Grid Spacing**

Submitted computer models depicting the measurements of light should be generated on a grid of a specified number of points covering a stated area on an equally spaced grid. See the chart shown in the appendix for the exact specifications for the area to be lighted, grid spacing, and minimum number of grid points for each field.

**6. Maintained Alignment**

**a. Luminaire Alignment**

The sports lighting manufacturer's warranty should include accurate alignment of the luminaires. The current technology of lighting equipment has precise intense beams — the misalignment of individual luminaires by a few degrees can significantly impact the appearance of the field. Misaligned luminaires can also result in undesirable glare for players, spectators, and neighbors. Luminaires should be rated to withstand 150 mph wind gust.

**b. Pole Alignment**

Twisting or leaning of poles can also result in misalignment of luminaires, thereby altering the quantity and quality of light on the field. Wood poles should not be used due to the potential of the longitudinal fibers of the pole to twist. The foundation for the poles should also be designed with sufficient strength to prohibit the pole from leaning, which could likewise misalign the lights. Foundations should be certified by a Registered Professional Engineer licensed in the State of North Carolina.

**7. Pole Locations**

Pole locations should be positioned, as established by the layouts shown in the appendix, to keep the lights out of glare zones as defined in the IESNA RP-6-15, thus enhancing playability. Wherever possible, poles should be located outside of fences to avoid causing an obstruction and safety hazard to the play of the game.

**8. Vertical Aiming Angles**

To enhance playability on the field, reduce glare, and minimize spill light, minimum pole heights should be defined in the project specifications based on site conditions to ensure proper vertical aiming angles. Refer to notes about minimum vertical aiming angles in the appendix. Certain sites may require steeper vertical angles due to enhanced spill and glare concerns.

**9. Aiming Recapture**

The lighting equipment should include a mechanical device for recapturing the original aiming when it is necessary to move the luminaire.

**10. Ballast (Metal Halide) or Driver (LED) Weight**

The ballast or driver for each luminaire, as well as luminaire fusing, should be mounted off the luminaire and crossarm and be mounted onto the pole at stepladder height (approximately 10') to avoid problems of misalignment of the luminaire caused by the additional weight. Additionally, this creates safer conditions and a more economical solution for servicing and maintenance. This is commonly referred to as a remote ballast or remote driver system. Refer to page 18 and page 63 of the IESNA RP-6-15 "Recommended Practice for Sports and Recreational Area Lighting" for advantages of remote ballasts and drivers.

**11. Aiming Diagram**

The manufacturer should supply a drawing showing the aiming alignment of each luminaire with the measurement referencing the field and the pole locations.

## B. Life-Cycle Costs

Schools in North Carolina continue to struggle with operating budgets. Because the efficiency of lighting systems currently available can vary greatly, schools should complete a life-cycle operating cost analysis 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 to assist with the process. Items that should be included are energy consumption based upon the facilities expected usage, cost for spot relamping and 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.

## C. Electrical

**1. Electrical System**

Electrical system shall consist of main service entrance panel, contactor cabinet for safe on/off operation, and branch electrical circuits feeding poles and luminaires. System design should conform to National Electric Code.

**2. Fusing**

Each lighting 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.

**3. Disconnects**

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

**4. Grounding**

All poles, luminaires, and distribution panels should be grounded according to National Electric Code recommendations. It is important to verify the ground and grounding connections.

**5. Lightning Protection**

Each pole or structure supporting lighting equipment should be equipped with lightning protection as established by NFPA 780 (National Fire Protection Association).

If lightning grounding is not integrated into the structure, it may be necessary to supplement with grounding electrodes, copper down conductors, and exothermic weld kits.

**6. 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

**7. Enclosed Rigid Cover**

All conductors above grade should be enclosed in rigid metallic or liquid type flex conduit unless they are in the interior of the pole.

**8. Lockable Hinged Enclosures**

All enclosures of electrical conductors that are hinged and designed to be opened should be lockable and should be kept locked except during times of access for operation or service. Access should be by means of lock or special tool.

**9. Electrical Conductor Wires**

All electrical conductor wires for distribution of power around the playing field should be buried underground at depths as required by NEC or by applicable local code that may supersede NEC. Conductor wires should be copper. No shared neutral is allowed.

**10. Drawings of the Electrical System of the Lighting Structure**

The lighting equipment manufacturer should provide a drawing of the entire electrical system from the light luminaires at the top of the pole to the base of the pole that shows compliance with these standards and provides sufficient information for maintenance personnel.

**11. Drawings of Electrical Distribution**

The electrical designer should provide electrical drawings certified by a Registered Professional Engineer licensed in the State of North Carolina. These drawings should illustrate the electrical system from the base of the pole to the transformer provided by the utility company. These drawings should be in compliance with and/or be approved by the local authority regulating electrical systems and should incorporate the lighting system designs provided by the lighting manufacturer.

**12. Underwriter Laboratory Listing**

The lighting and electrical equipment on ballfield and court lighting structures 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.

**13. Non-Compliance with the Standards**

Deviation from these standards for electrical systems may occur only after approval of written documentation signed by an electrical engineer licensed in the state. The documentation should state the reason why it is necessary to deviate from the standards and state how a safe electrical system will be achieved using the alternate standards.

**14. Strain Relief**

The wiring harness should be supported at the top of the pole by a stainless-steel wire mesh grip matched to the size and number of conductors within the harness. There should not be more than 13 conductors supported by a single wire mesh grip. If the pole height is greater than 80 feet, an interim wire mesh grip support should be located approximately half way down the pole.

**15. Voltage Drop**

The installing contractor should verify that voltage drop does not exceed 3% of nominal voltage.

## D. Structures

**1. Strength of Foundation**

There should be calculations and documentation certified by a Registered Professional Engineer licensed in the State of North Carolina, illustrating that the foundation design is adequate to withstand the forces imposed from the pole, lighting luminaires, and other attachments to prevent the structure from leaning or failing.

**a.** Foundations should be made of reinforced concrete and should provide for pole attachment at a minimum of 18 inches above the ground to avoid corrosive deterioration.

For a foundation using a pre-stressed concrete base embedded in concrete backfill the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection, actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.

**b.** Poles and other support structures, brackets, arms, bases, anchorages, and foundations shall be determined based on the 50-year mean recurrent isotach wind maps for the appropriate county per the North Carolina State Building Code, which uses the International Building Code (IBC) as a basis for the building code standard. Luminaire, visor, and crossarm shall withstand 150 mph winds and maintain luminaire aiming alignment.

**c.** Any backfill of excavated soil should be replaced with concrete to ensure adequate compressive strength, which will avoid leaning and misalignment of the pole.

**d.** The design criteria for these specifications are based on soil design parameters as outlined in the geotechnical report. If a geotechnical report is not provided by the school, the foundation design shall be based on soils of a Class 5 material as defined by 2015 IBC, Table 1806.2.

**2. Strength of Pole**

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

**a.** Galvanized steel and concrete are the recommended pole materials.

**b.** Recommended foundation types include: direct buried prestressed concrete poles, direct buried prestressed concrete base with a slip fit steel pole shaft, or a poured-in-place concrete foundation with anchor bolts and a base plate galvanized steel pole. It is recommended that all pole bases be of concrete construction in the ground and to a point 18 inches above the ground to avoid corrosive deterioration. Foundations designed with direct embedment steel components are not recommended.

**3. Retrofits**

Modifications to any existing poles may require permitting from the local building official. Should the local building official determine that a permit is not required the building code still requires the work done in a manner that meets code. As such, structural calculations should be furnished to demonstrate compliance with the building code requirements for alterations to existing structures.

Any new luminaire modification to existing poles should not result in exceeding the wind loading or (EPA – effective projected area or weight by 5% of the current load per the IBC building code).

**4. Lightning**

All structures should meet the NFPA 780 lightning protection code as referenced in section 3-1.1.

## E. Quality Assurance

1. Field observation of the foundations should be made by the Lead Architect and/or the structural/geotechnical design consultant to ensure proper installation.
2. Upon completion of the installation of the lighting system, it is in the best interest of the school system that the light levels be tested in order to ensure compliance to these lighting standards by the manufacturer supplying the system and the contractor who has installed the system. A formal light test, using a calibrated light meter, should be conducted in the presence of the contractor, owner, lighting design team or associated consultants, and lighting manufacturer's representative, to verify initial light levels. The light meter should be held in a horizontal position at the locations determined by the computer light scan originally supplied by the manufacturer. The readings should be recorded and compared to the original initial light level predictions. If the uniformities and overall foot-candle average of the readings do not meet or exceed the specified levels, the contractor/manufacturer of the system should be required to bring the system into compliance. Final testing should be conducted in accordance with IESNA publications LM-5-04 and IESNA RP-6-15.
3. To help ensure the safety of the players and spectators, it is recommended that each school or school district develop a regularly scheduled maintenance program. Regardless of source technology, the basics of lighting maintenance remain the same: relamping (metal halide), cleaning, monitoring, aiming alignment, and troubleshooting. At a minimum, the following items should be addressed:

**a. Visual Testing**

Should be performed annually prior to the start of a season on lamps, lenses, conduit, pole, fuses, ballasts, drivers, grounding connections, and breaker boxes to ensure integrity and performance of the system. (Refer to Maintenance Checklist provided in the Appendix)

**b. Performance Audits**

Audits should be performed annually prior to the start of a season on light levels, lamps, lenses, conduit, pole, fuses, ballasts, drivers, grounding connections, and breaker boxes to ensure integrity and performance of the system. (Refer to the Maintenance Checklist and the Lighting Performance sections provided in the Appendix)

4. Group relamping (metal halide) should occur according to the manufacturer's recommended time frame such that the required maintained average light level is sustained.
5. Facilities with existing wood poles should conduct an annual inspection of aiming, alignment, and external electrical components. Additionally, core tests of the wood poles should be performed as recommended by the testing company or local utility.

## F. Security and Parking Lot Lighting

There should be sufficient lighting in and around athletic facilities to prevent unsafe and inappropriate actions. The parking areas, major areas utilized for passage, and areas immediately bordering the facilities should be lighted to the minimum levels required to meet local codes and the recommendations found in the IESNA publications RP-20-14 "Lighting for Parking Facilities."

### G. 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 building codes for specific requirements as they apply to athletic facilities.

# II. Desirable Features

The following practices are recommended for increasing the durability, energy efficiency, environmental sensitivity and cost effectiveness of the facility itself.

## A. Lighting

**1. Energy Efficiency**

When comparing metal halide systems, differences of more than 40% in the cost of operating lighting equipment can occur depending on the efficiency of the design of the equipment.

As light emitting diode (LED) technology improves and costs decrease, LED lighting systems become more viable for sports facilities. When considering multiple systems the Life-Cycle Operating Cost Evaluation tool on page 10 can be helpful.

**2. Dimming**

Additional flexibility can be obtained through the use of dimming. The multi-level lighting will allow the system to operate at the light level that is most appropriate to the activity taking place at any given time. 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 low light level during the remainder of the time, thus conserving energy.

**3. Environmental Spill and Glare Control**

Many facilities are, or soon will be, located near residential properties, creating the possibility of spill and glare onto adjoining properties. Plus, many communities have enacted lighting ordinances that must be adhered to. Consideration should be given to this issue during the initial lighting design stage, so as to minimize this effect. The lighting equipment manufacturer can assist in assessing this issue and provide drawings showing maximum footcandles at any point of concern on adjacent properties. 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. See section A.4.b. for standards.

## B. 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 and labor are available for up to 25 years.

## C. Entertainment Packages

Optional entertainment packages can come with remote control of predesigned light shows to further enhance the player and spectator experience.

## D. Servicing Issues

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 documents to assist in planning and installing lighting,
contact the Commissioner at the NCHSAA office:

Chapel Hill, NC 27517
Phone: (919) 240-7401

## LIFE-CYCLE OPERATING COST EVALUATION

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

**BID ALTERNATE A:**

| | | | |
|---|---|---|---|
| **A.** | **Energy consumption**<br>____ Number of luminaires x ____ kW demand per luminaire x ____ kW rate x ____ annual usage hours x 25 years | | |
| **B.** | **Demand charges, if applicable**<br>____ demand rate x ____ max kW consumption x ____ 12 months x 25 years | + | |
| **C.** | **Spot relamping and maintenance over 25 years (relamping not applicable for LED)**<br>Assume ____ repairs at $ ____ each if not included | + | |
| **D.** | **Group relamps during 25 years (relamping not applicable for LED)**<br>____ annual usage hours x 25 years / lamp replacement hours x $125 lamp & labor x number of luminaires | + | |
| **E.** | **Extra energy used without control system**<br>____% x Energy Consumption in item A. | + | |
| **F.** | **Extra labor without control system**<br>$____ per hour x ____ hours per on/off cycle x ____ cycles over 25 years | + | |
| **G.** | **TOTAL 25-Year Life Cycle Operating Cost** | | |

**BID ALTERNATE B:**

| | | | |
|---|---|---|---|
| **A.** | **Energy consumption**<br>____ Number of luminaires x ____ kW demand per luminaire x ____ kW rate x ____ annual usage hours x 25 years | | |
| **B.** | **Demand charges, if applicable**<br>____ demand rate x ____ max kW consumption x ____ 12 months x 25 years | + | |
| **C.** | **Spot relamping and maintenance over 25 years (relamping not applicable for LED)**<br>Assume ____ repairs at $ ____ each if not included | + | |
| **D.** | **Group relamps during 25 years (replamping not applicable for LED)**<br>____ annual usage hours x 25 years / lamp replacement hours x $125 lamp & labor x number of luminaires | + | |
| **E.** | **Extra energy used without control system**<br>____% x Energy Consumption in item A. | + | |
| **F.** | **Extra labor without control system**<br>$____ per hour x ____ hours per on/off cycle x ____ cycles over 25 years | + | |
| **G.** | **TOTAL 25-Year Life Cycle Operating Cost** | | |

## SUBMITTAL INFORMATION
## Design Submittal Data Checklist and Certification

This form will assist you in comparing proposals from various lighting manufacturers. All items listed below are mandatory, shall comply with the specification, and must 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:<br>a. Field Name, date, file number, prepared by<br>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<br>c. Pole height, number of luminaires per pole, horizontal and vertical aiming angles, as well as luminaire information including wattage, lumens and optics<br>d. Height of light meter above field surface<br>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.<br>f. Manufacturers shall provide constant light level or provide both initial and maintained light scans using a maximum 0.70 Light Loss Factor to calculate maintained values. |
| | C | Off Field Lighting Design | Lighting design drawings showing initial spill light levels along the boundary line (defined on bid drawings) in footcandles. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights. |
| | D | Photometric Report | Provide photometric report for a typical luminaire used showing candela tabulations as defined by IESNA Publication LM-35-02, (LM-79-08, for LED). 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 lamp replacement, and group relamping costs. All costs should be based on 25 Years. |
| | F | Environmental Light Control Design | Environmental glare impact scans must be submitted showing the maximum candela from the field edge on a map of the surrounding area until less than 7500 candela for rural areas or 10,000 for suburban areas is achieved. |
| | 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 North Carolina. |
| | 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 North Carolina. |
| | 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:** ______/______/______

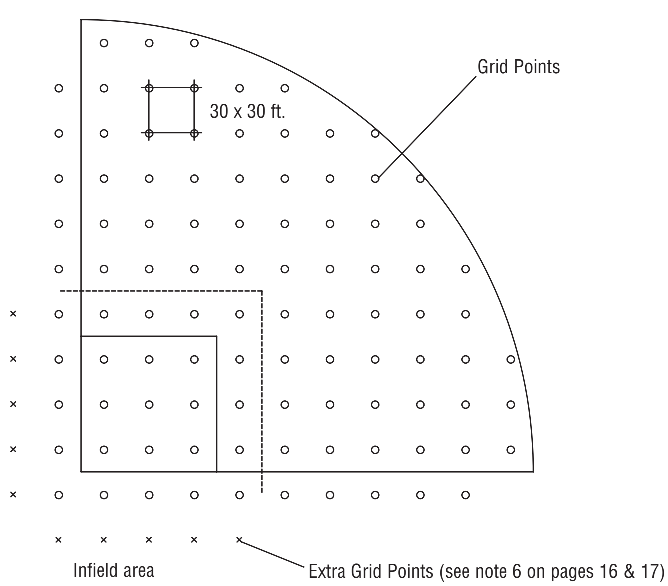
# APPENDIX

## Field Dimensions, Grid Spacing, and Grid Points of Typical Facilities

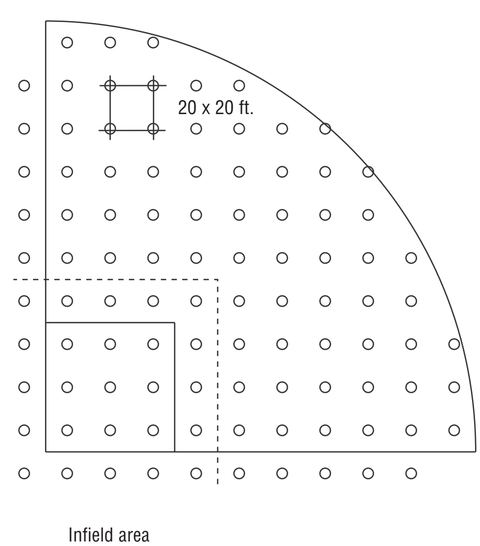
| Typical Facilities | | | |
|---|---|---|---|
| **Area of Lighting** | **Playing Dimensions (feet)** | **Grid Spacing (feet)** | **Minimum # of Grids** |
| Baseball, Infield | 90' x 90' | 30' x 30' | 25 |
| Baseball, Outfield | Dimensions Vary | 30' x 30' | Varies |
| Softball, Infield | 60' x 60' | 20' x 20' | 25 |
| Softball, Outfield | Dimensions Vary | 20' x 20' | Varies |
| Football | 360' x 160' | 30' x 30' | 72 |
| Soccer | 360' x 180' | 30' x 30' | 72 |
| Lacrosse | 330' x 180' | 30 ' x 30' | 66 |
| Field Hockey | 300' x 180' | 30' x 30' | 60 |
| Rugby | 330' x 180' | 30' x 30' | 66 |
| Tennis | 78' x 36' | 20' x 20' | 15 |
| Gymnasiums | 94' x 50' | 10' x 10' | 50 |
| Track and Field | Dimensions Vary | 30' x 30' | Varies |

## Light Level Grid Point Layouts

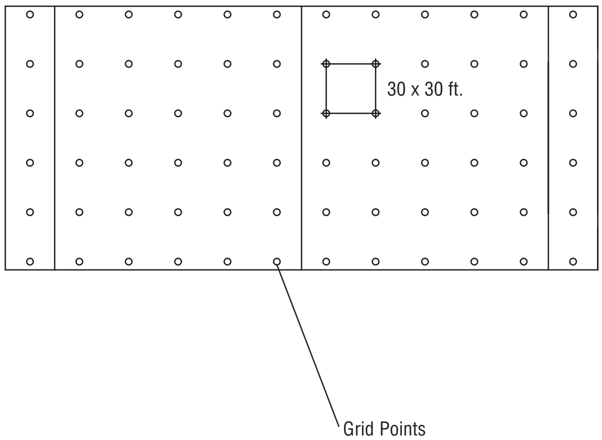
### Baseball
300' radius field shown



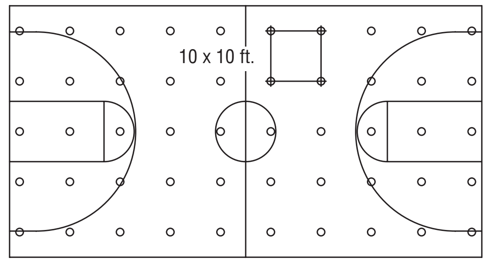

### Softball
200' radius field shown



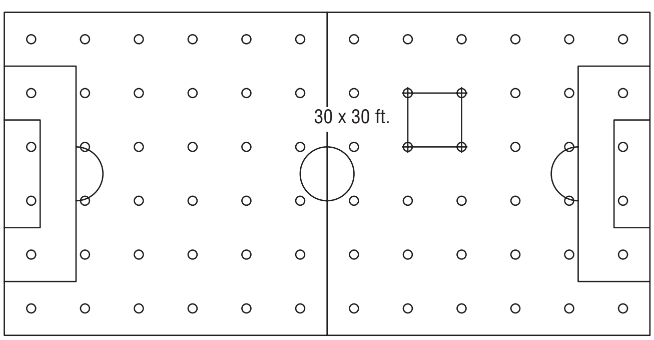
**Football**
360' x 160' field shown



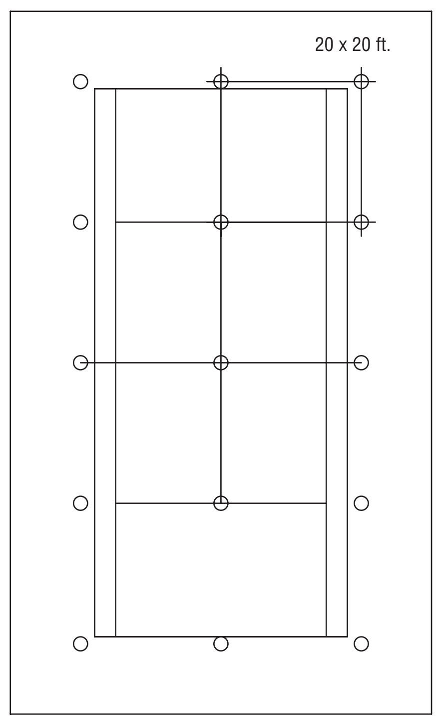

**Gymnasium**
94' x 50' court shown




**Soccer**
360' x 180' field shown

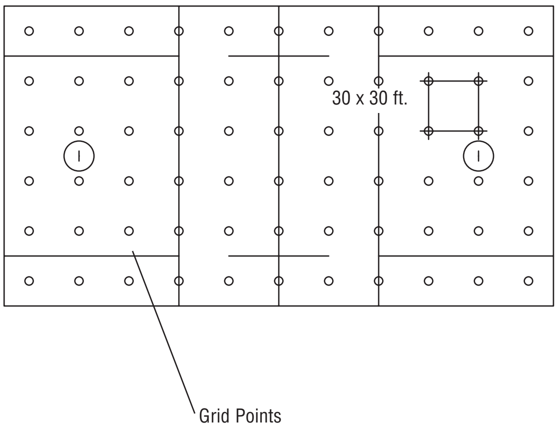



**Tennis**
78' x 36' court shown



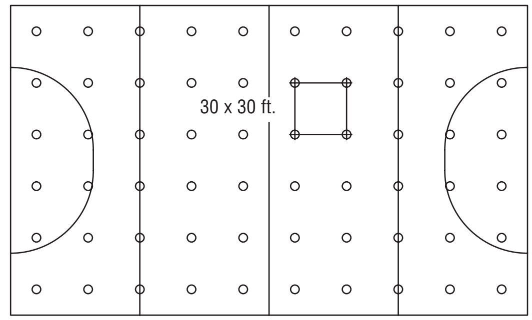
## Lacrosse

330' x 180' field shown



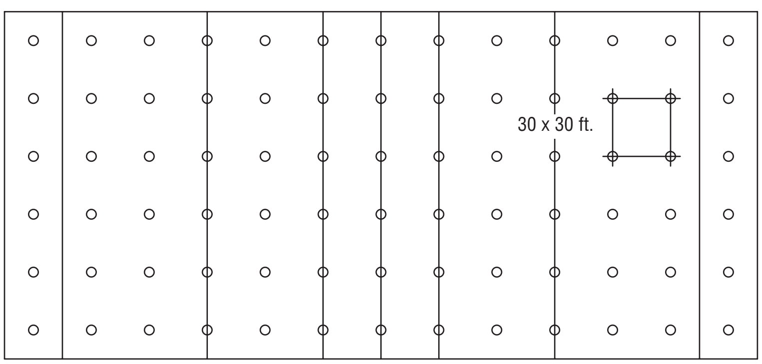

## Field Hockey

300' x 180' field shown



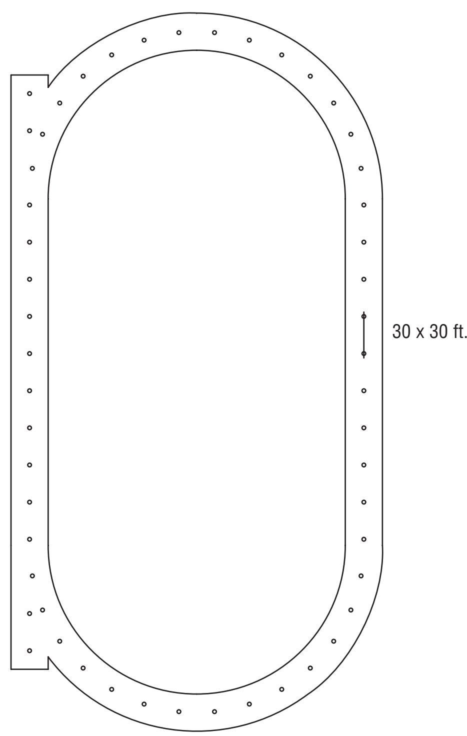

## Rugby

330' x 180' field shown (not including end zones)

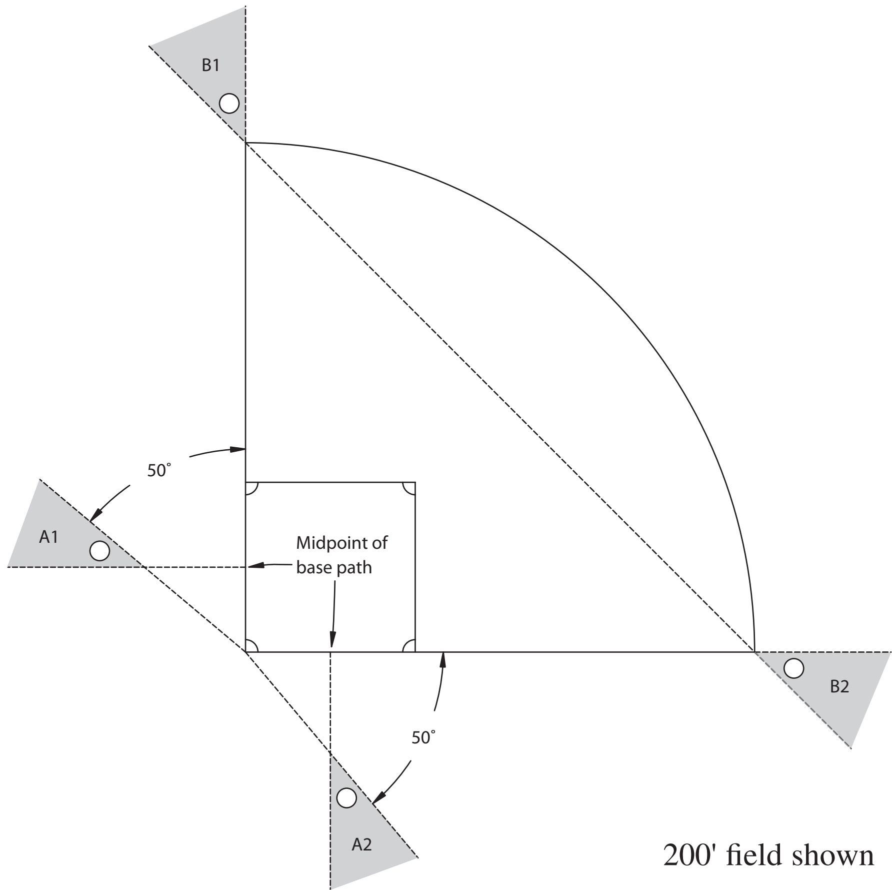



## Track

400 meter, 8 lane track shown



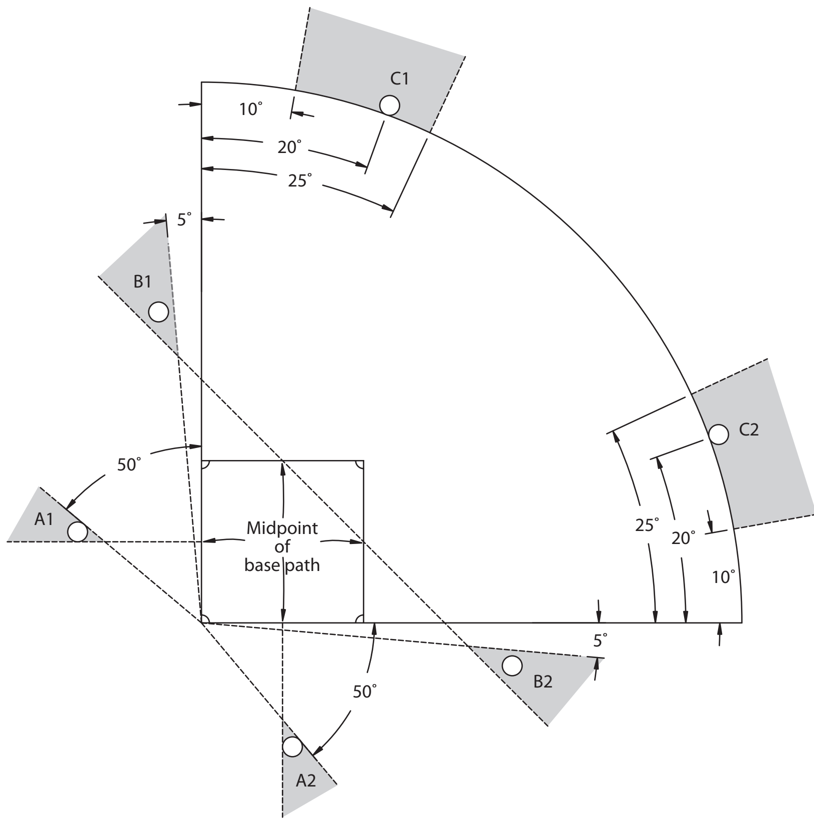
# Pole Location Diagrams




## 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.




300' field shown

## 6-Pole Baseball/Softball Field

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

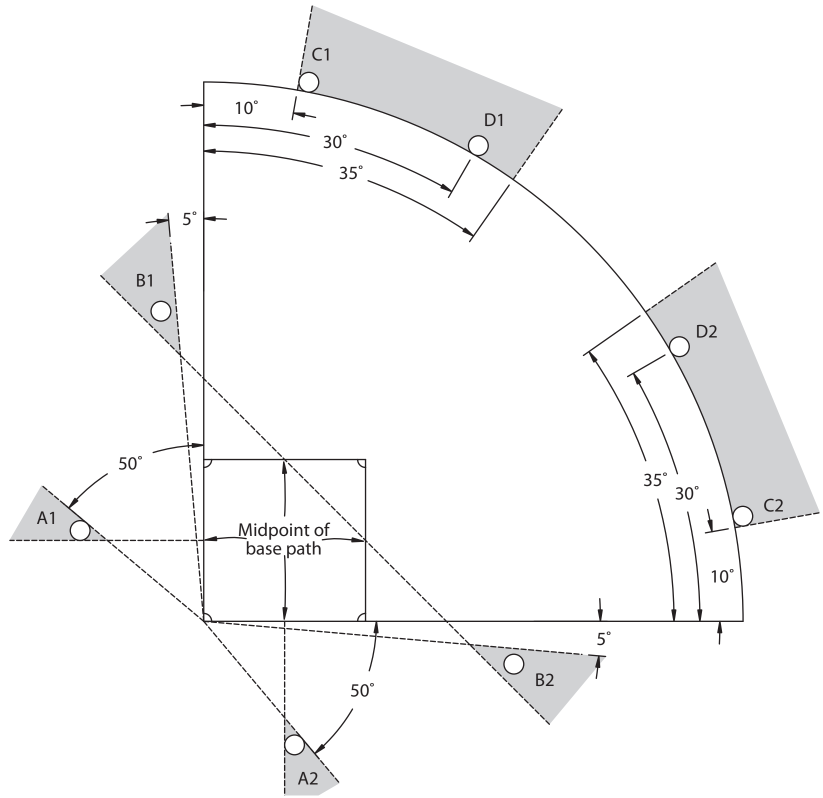
2. For fields with a radius of 320 feet or greater, an 8-pole design is recommended.

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.

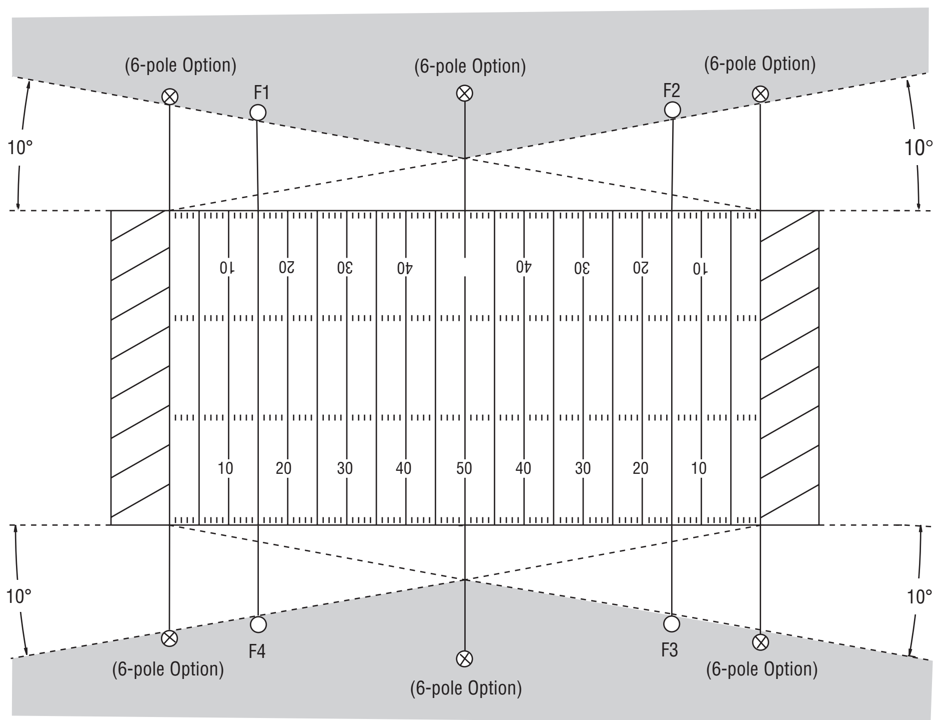
6. If the distance between home plate and the backstop is greater than 40 feet, an additional grid should be created to include 10 additional grid points. The average light level for this additional grid should meet or exceed the design criteria for the outfield points.




325' field shown

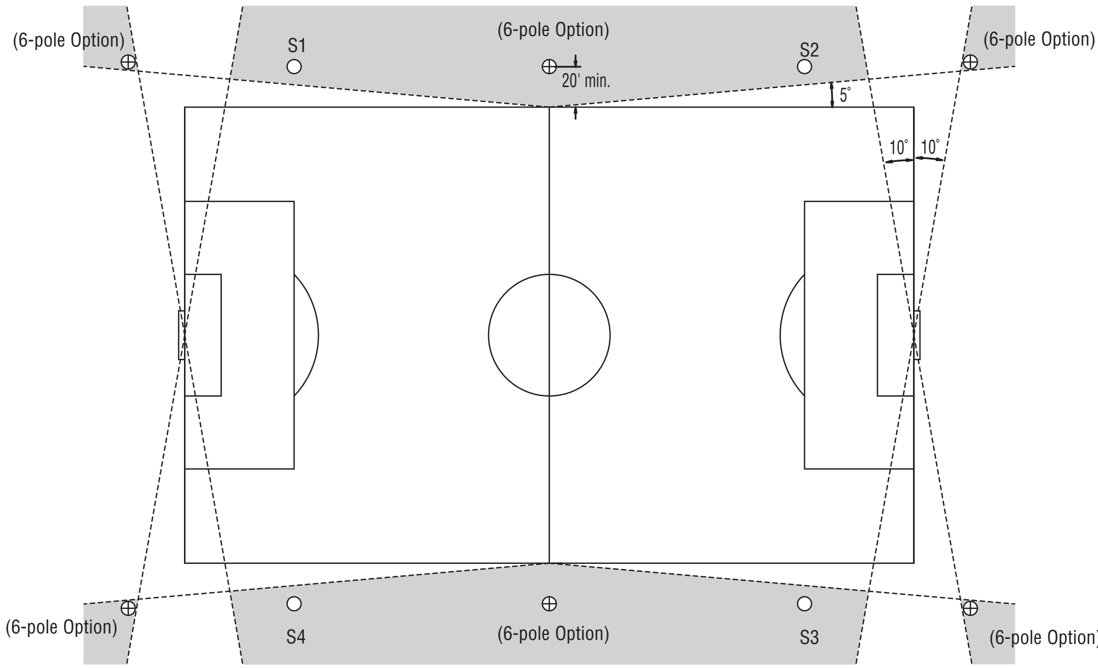
## 8-Pole Baseball/Softball Field

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 luminaire 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.



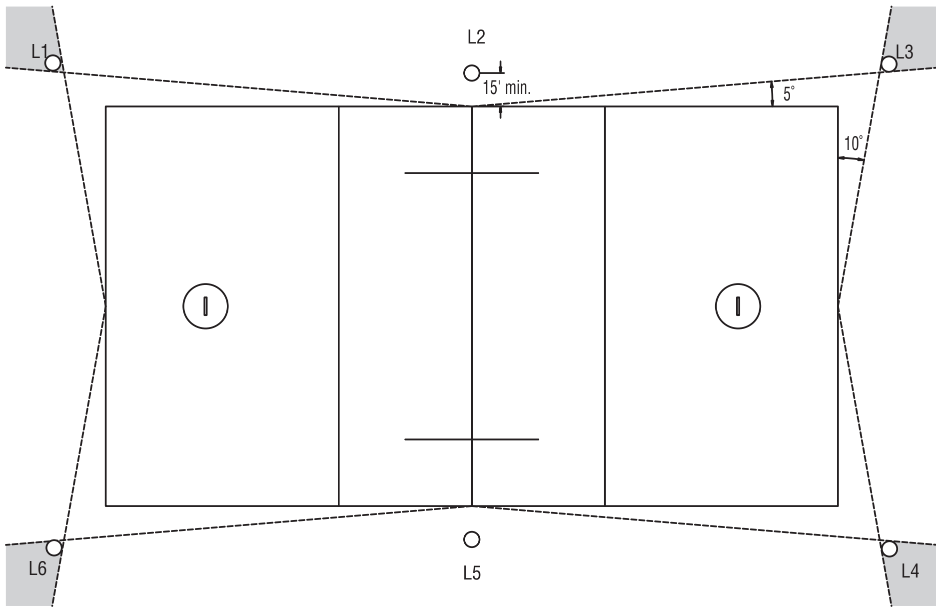

## Football Field

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.



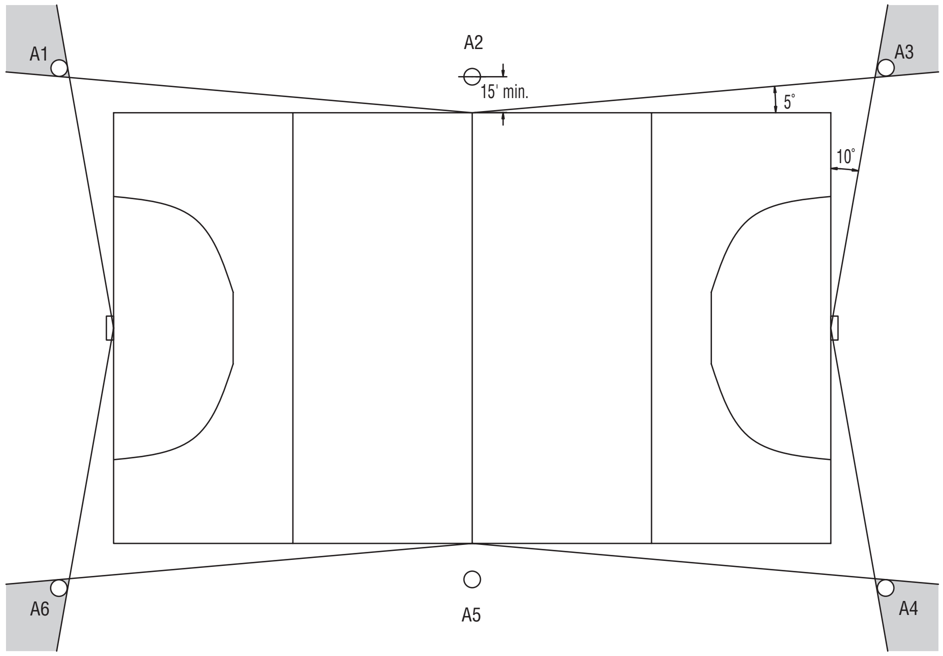

## Soccer Field

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. A corner kick is a specific visual task and general consideration should be given to facility design specifically for soccer.
   b. 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.

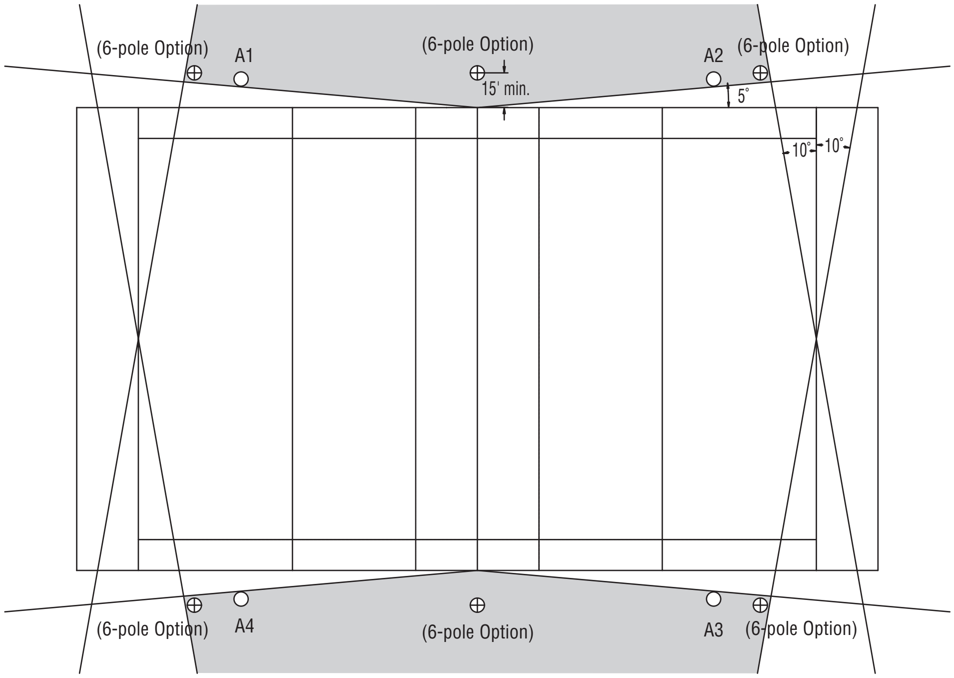



## Field Hockey Field

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.



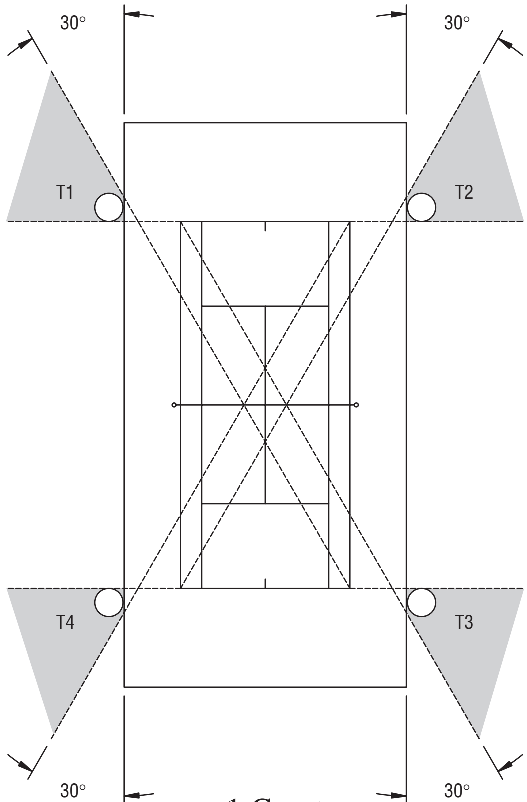

## Rugby Field

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. On a 4-pole design, the optimum pole locations are (.35 x field length) from center of field.

3. Poles should be positioned so as not to pose a potential injury hazard.

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



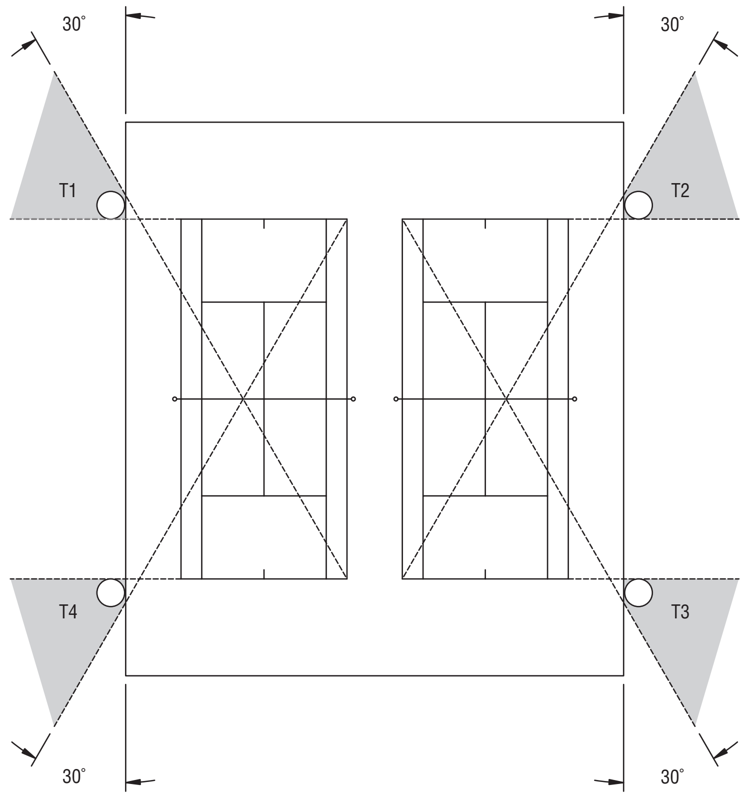
1 Court

## Tennis Courts

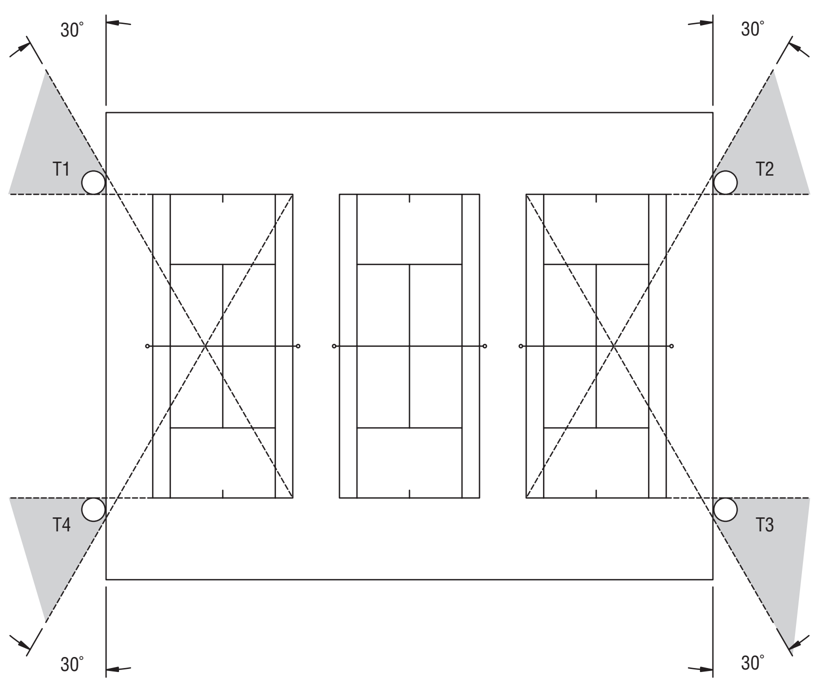
1. Poles are shown in optimal locations. Other permissible pole locations are indicated by the shaded areas.

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.

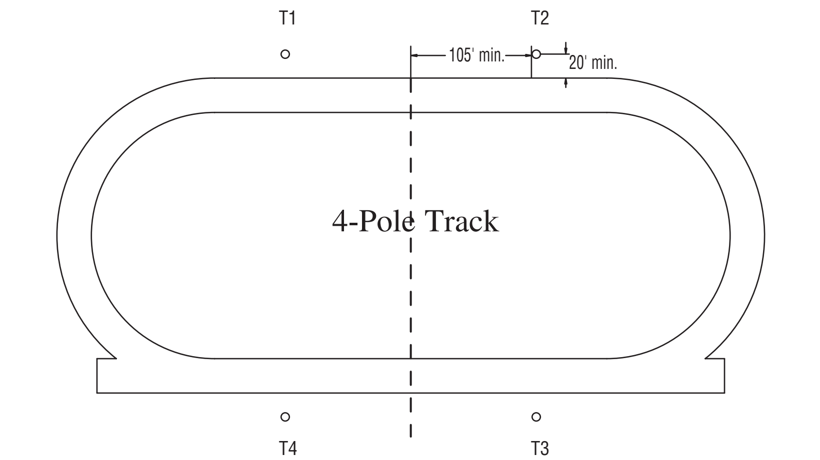
3. Vertical aiming angles should be 25 degrees minimum. The angles are measured from below a horizontal plane at luminaire height.

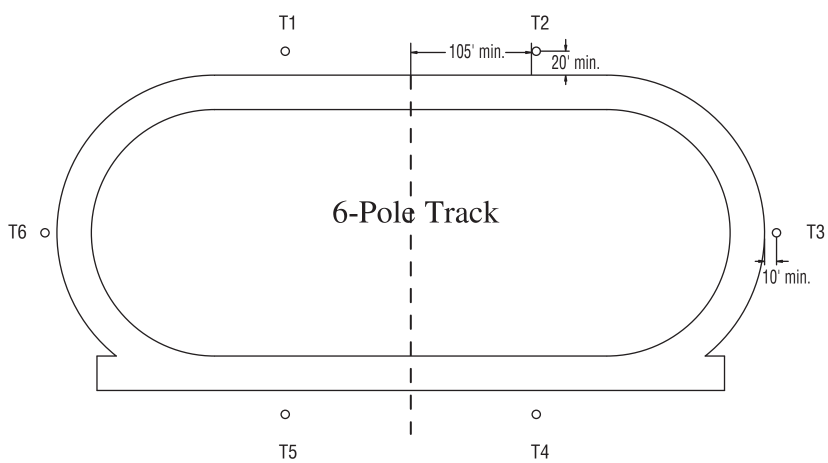



2 Courts




3 Courts




## 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 18) or soccer design (page 19).

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 | N/A | Notes |
|---|---|---|---|---|
| **Lighting Performance Testing** | | | | |
| Check with the AD and Staff to see if there are any concerns regarding field (pole, electrical or lighting) | | | | |
| Average maintained foot-candles meet guidelines | | | | |
| Uniformities meet guidelines | | | | |
| **Service Entrance & Pole Distribution Boxes** | | | | |
| Warning Stickers, wiring diagrams, circuit labels should be posted and legible | | | | |
| Snap all breakers on and off several times to ensure firm contact | | | | |
| If fuses are used at main service, check continuity | | | | |
| Insulation around wiring should show no signs of deterioration | | | | |
| Wiring should show no heat discoloration. | | | | |
| Signs of wear should be replaced on taped connections | | | | |
| Bare wires and exposed connections should be wrapped with insulated covering | | | | |
| Are the panels appropriately locked or access minimized from the public | | | | |
| Check all grounding connections at service entrance and at poles | | | | |
| **Pole Structures** | | | | |
| Wood poles checked for leaning and resulting misalignment of luminaires | | | | |
| Wood poles checked for twisting and resulting misalignment of luminaires | | | | |
| Wood poles checked for decay. Just below ground level, woodpecker holes etc. | | | | |
| Steel anchor bolt poles checked for signs of corrosion | | | | |
| Steel anchor bolt poles checked for proper drainage in grout at base | | | | |
| Direct burial steel poles checked for proper mastic covering above/below grade at base | | | | |
| Direct burial steel poles checked for water/moisture inside pole and corrosion around base of pole | | | | |
| Direct burial steel poles checked for proper mastic covering inside the pole | | | | |
| Pull on conduits in hand holes to check for looseness | | | | |
| Check for all pole electrical access covers in place | | | | |
| Check for all external cable conduit to be in good shape, not cracked or missing | | | | |
| Check for other visible signs of deterioration? Specify | | | | |
| Check any pole climbing equipment for proper attachment, alignment and decay or corrosion | | | | |
| Check to make sure trees are not encroaching on the pole structures or overhead wires | | | | |
| **Luminaires** | | | | |
| Check for signs of out-gassing, leaking or water damage | | | | |
| Check for broken or missing lens covers, replace if needed | | | | |
| Check for luminaires not operating. Trouble shoot and repair | | | | |
| Visually inspect ballast/drivers at 10' above grade or with binoculars for integral ballasts/drivers for signs of deterioration | | | | |
| Check to make sure capacitors are not bulging | | | | |
| Do any of the luminaires need realignment (visual and light level testing) | | | | |
| 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 halide) | | | | |
| Check that capacitors aren't bulging. (metal halide) | | | | |
| Check aiming alignment of all luminaires.<br>On wooden poles, see if cross-arms are still aligned with the field and horizontal. | | | | |

# Lighting Performance Testing

To verify that your field meets the NCHSAA 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

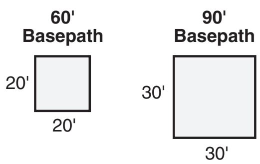
Outfield = Total of outfield readings ÷ number of readings.

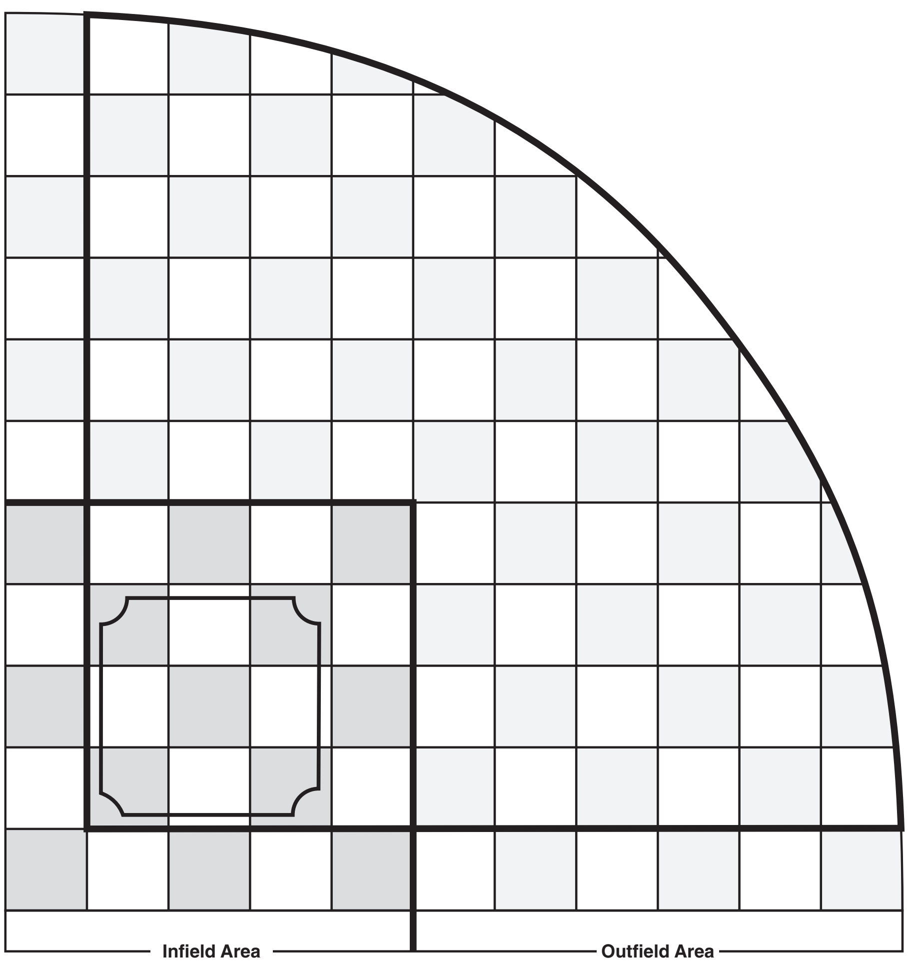
### To obtain uniformity ratio for infield or outfield:

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

### For example:

61 footcandles ÷ 31 footcandles = 2.1



# Football

## To obtain average footcandle value:

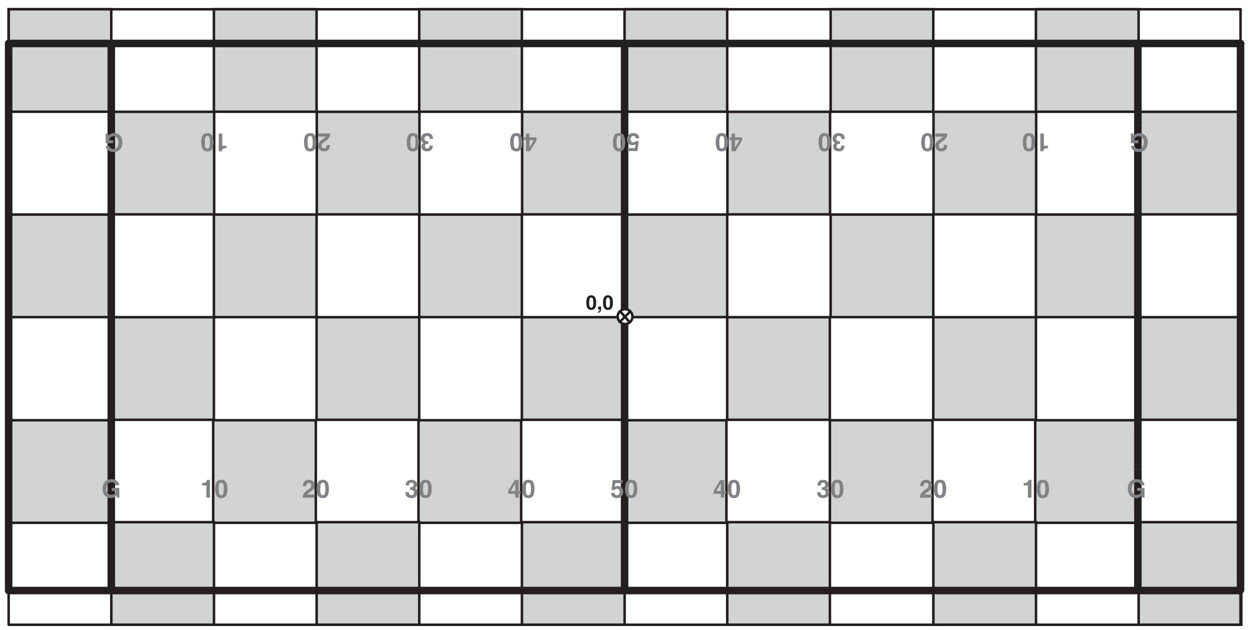
Record light readings within each square.

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.

**30’ x 30’ grid**



# Soccer

## To obtain average footcandle value:

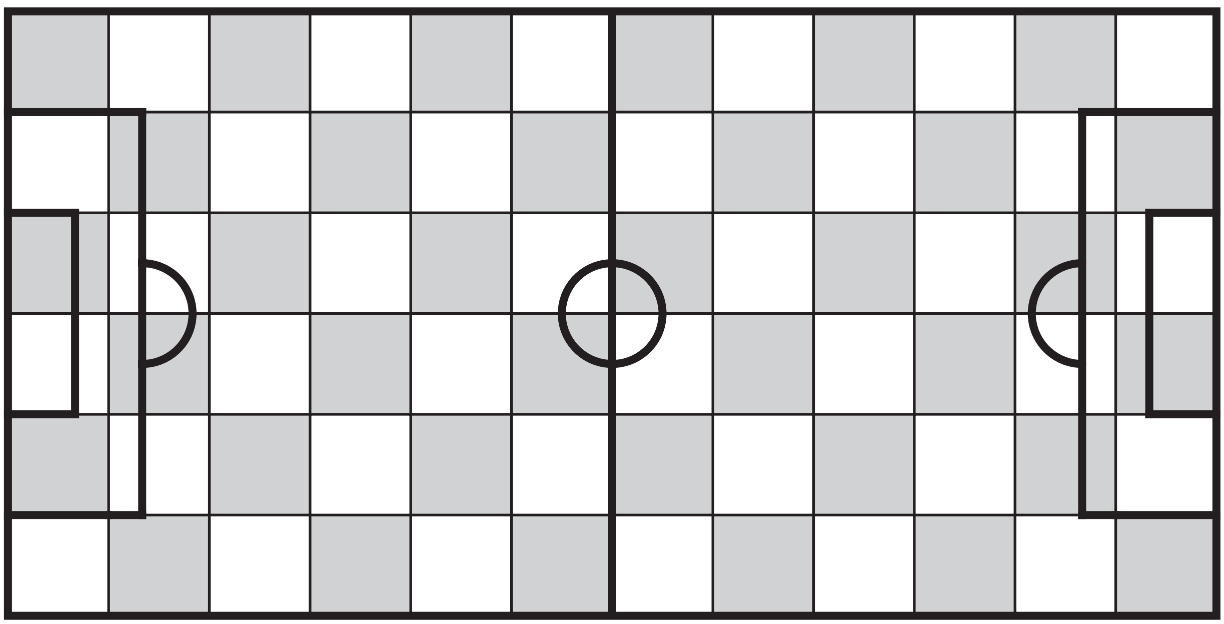
Record light readings within each square.

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.

**30' x 30' grid**



# Lacrosse

## To obtain average footcandle value:

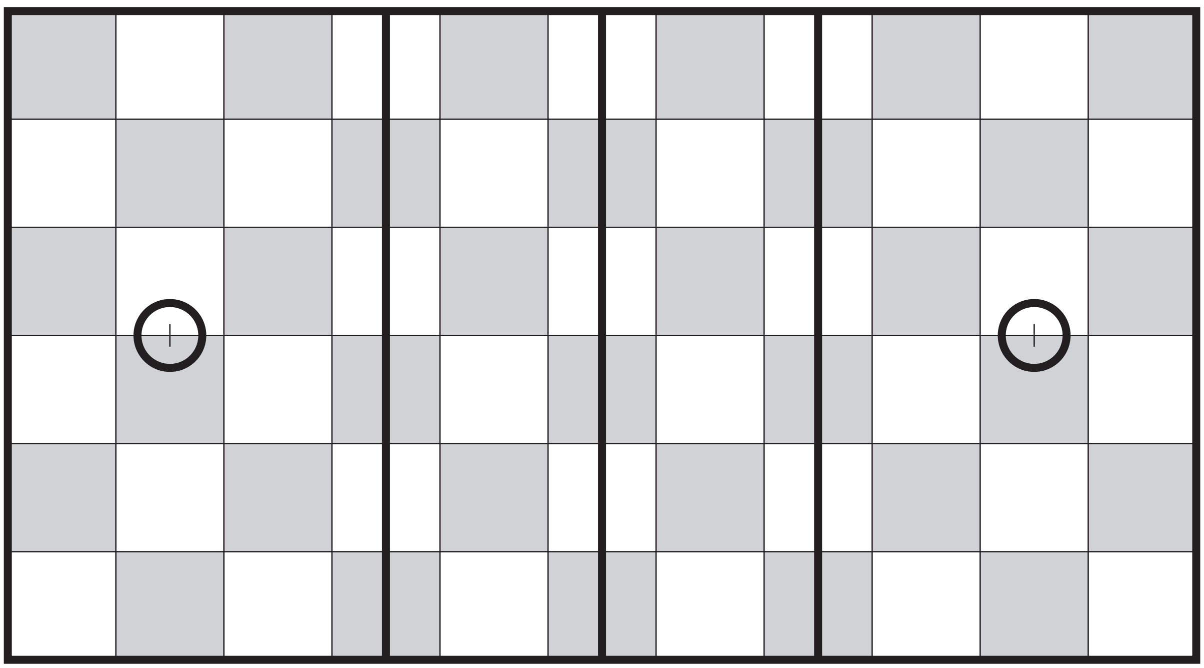
Record light readings within each square.

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.

**30' x 30' grid**



# Field Hockey

## To obtain average footcandle value:

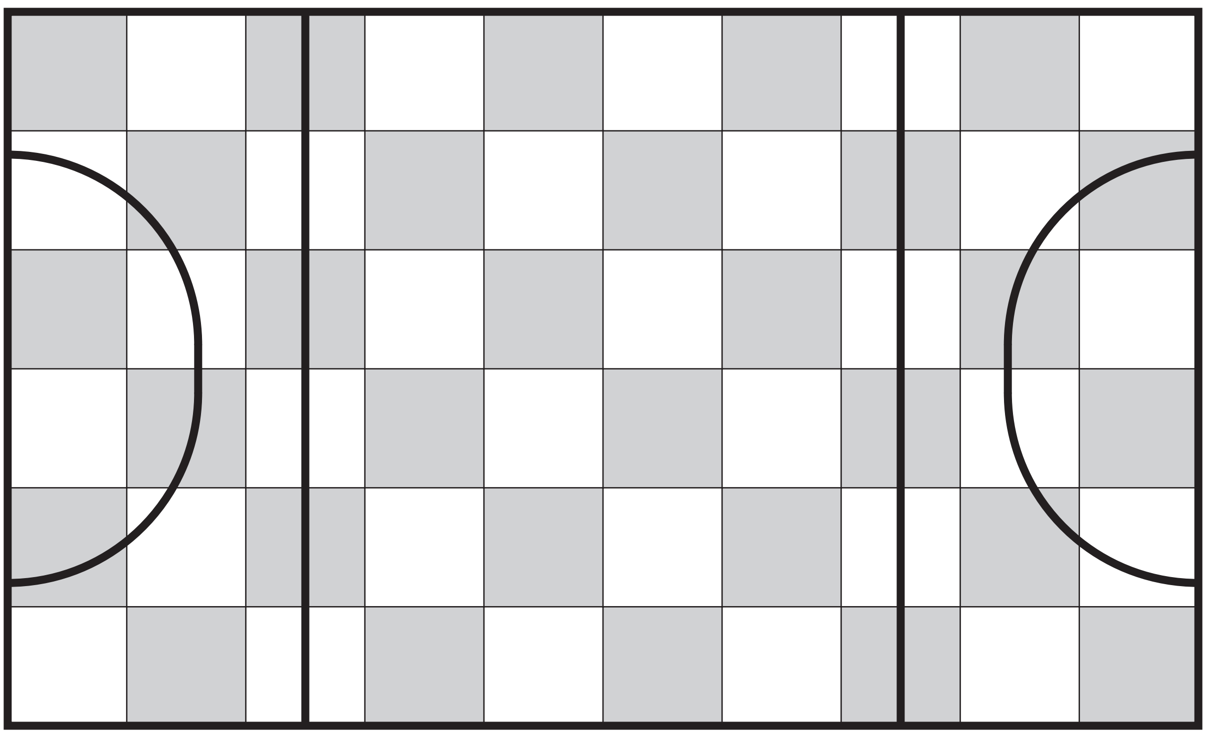
Record light readings within each square.

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.

**30’ x 30’ grid**



# Basketball

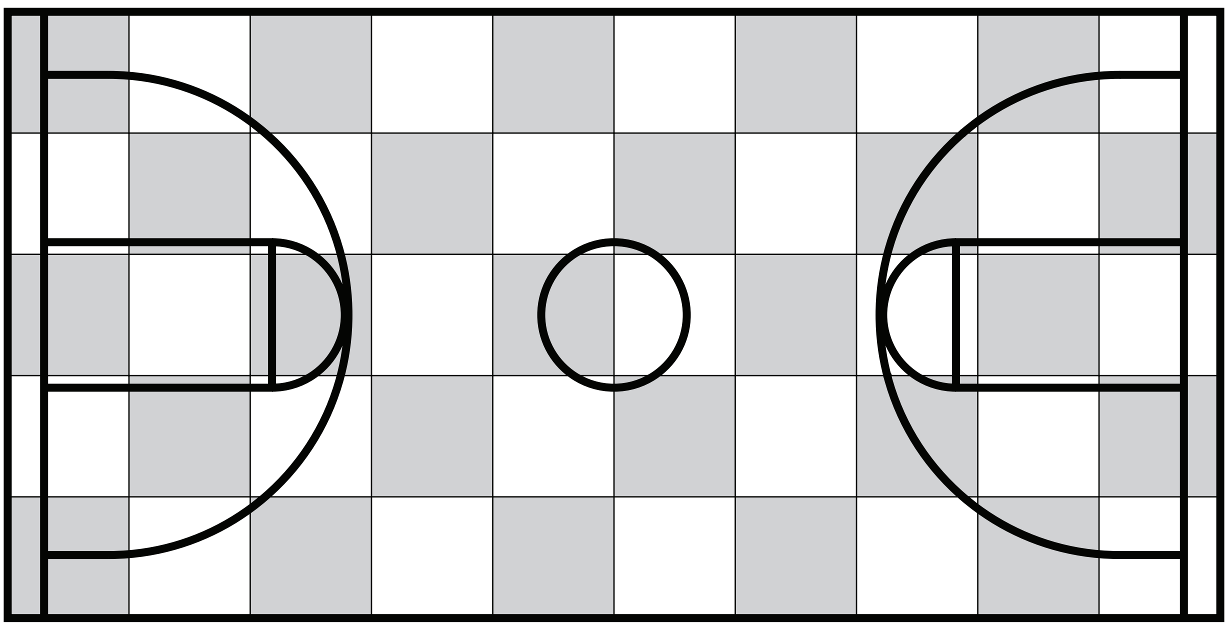
## To obtain average footcandle value:

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.

**10’ x 10’ grid**



## Tennis

### To obtain average footcandle value:

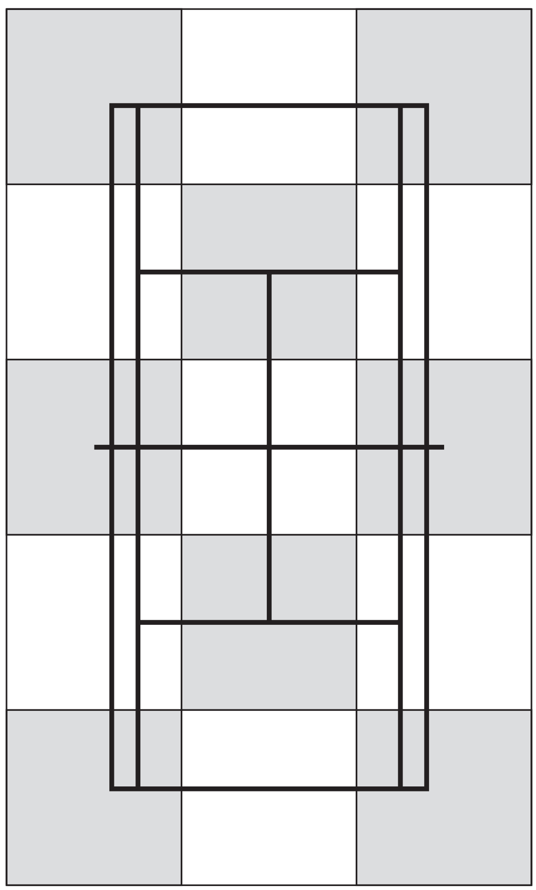
Record light readings within each square.

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.

**20’ x 20’ grid**



## Rugby

### To obtain average footcandle value:

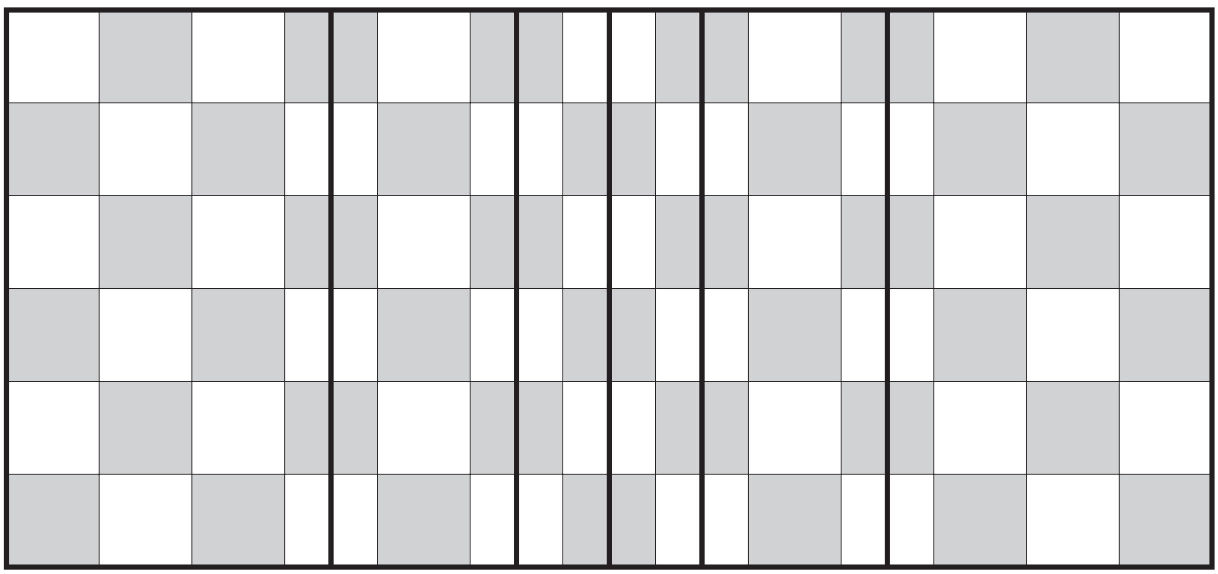
Record light readings within each square.

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.

**30’ x 30’ grid**



# Track

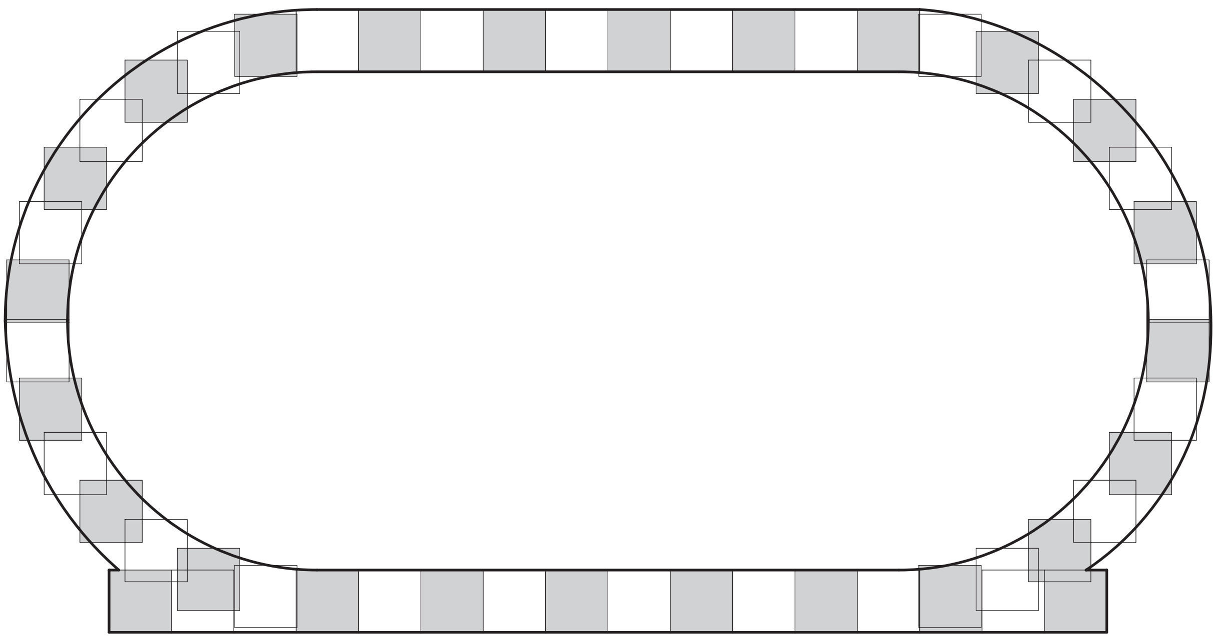
## To obtain average footcandle value:

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.



## GLOSSARY

**Ballast** A transformer that delivers the proper operating voltage for high intensity discharge type lamps including metal halide lamps.

**Candlepower (CP)** Measurement of light intensity expressed in candelas. The directional characteristic of a light source is described by the candlepower in specific directions.

**Coefficient of Variation (CV)** A measurement of illuminance uniformity. The standard deviation of a set of grid values divided by the average.

**Constant Light Levels** The amount of light you can expect on the field at any given time over the extended life of the system.

**Driver** The device used to power the LEDs. It provides sufficient current to light the LEDs to the required brightness and also limits the current to prevent damage to the LEDs.

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

**Glare** The sensation we experience when looking into an excessively bright light source that causes discomfort or a reduction in the ability to see. Glare can reduce the participant's ability to perform at their optimal level and/or cause discomfort to the spectators or surrounding neighbors.

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

**Initial Light Levels** The average light levels when your lamps are new. Measuring initial light levels assures that you receive a system that meets your specifications. Your designer should provide scans showing what these levels will be.

**LED (Light Emitting Diode)** Small semiconductor device that creates light when electricity passes through it.

**Light Loss Factor (LLF)** Formerly called maintenance factor, Light Loss Factor is a factor used in calculating illuminance over a given period of time and under given conditions. It accounts for light loss due to temperature and voltage variations, dirt accumulation on luminaire, lamp depreciation, maintenance procedures and atmosphere conditions. Light loss factors are divided into two groups, "Recoverable" and "Non-Recoverable." Recoverable light loss factors, such as lamp lumen depreciation, can be recovered by relamping, and Non-Recoverable light loss factors, such as tilt factor, cannot be recovered by the general maintenance processes.

**Lumen** A quantity measurement of light, used mostly in measuring the amount of light a lamp produces.

**Maintained Light Levels** The average illuminance below which the light level is not supposed to fall throughout system life. Actual values are calculated from measurements taken on the specified surface at the time maintenance is to be carried out. This process would typically use a lamp lumen value at 70 percent of rated lamp life). In order to achieve the desired "maintained" light level as the system ages, the maintenance interval must become shorter and shorter due to non-recoverable light loss factors. This maintenance interval is dependent on local environmental conditions and the installation's operational characteristics.

**Max. to Min. Uniformity Ratio** A design criteria to assure that light is distributed evenly across the entire field. A max/min uniformity ratio of 2:1 means that the brightest point is no more than double any other point.

**Metal Halide Lamp** A lamp that generates light by passing electrical current through metallic gases. The first choice for sports facilities because of efficiency and color.

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

**NEMA Type** A classification of reflectors. For example, a NEMA 2 reflector directs 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.

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

**Reflector** Key element of lighting optics. It surrounds the lamp and directs light to the field. The efficiency of the reflector determines how many light luminaires you have to buy and maintain.

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

**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 average illuminance below which the light level is not supposed to fail throughout system life.

**Tilt Factor** This factor is a function of the lamp position for each luminaire and directly affects the lamp performance in that specific floodlight. It is part of the non-recoverable light loss factor. The lamp tilt factor should be used in computer calculations and appear on any output documentation. A tilt factor of 1.0 should not be used, unless the lamp data provided shows testing in the installed position.

**Underwriters Laboratories (UL)** Independent, not-for-profit product safety testing and certification organization. Visit www.ul.org for additional information.

**Uniformity Gradient (UG)** Rate of change of illuminance between adjacent (grid) values.

**Vertical Aiming Angles** 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.

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