# Lighting Standards

# of the

# US Soccer Foundation

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Thanks to Musco Lighting for assisting in the development of these guidelines.

# Lighting Guidelines

The following standards have been created for the United States Soccer Foundation by Musco Lighting. These standards apply to the lighting of soccer fields funded through the Foundation Grants Program and are strongly recommended as a reference for projects using the Resource Center as a guide.

Lighting athletic fields provides more opportunities for participants and allows increased family and community attendance at evening events. These standards incorporate the most current data available regarding the desired performance, lighting, electrical and structural issues that apply to installation of a safe, effective lighting system. Lighting technologies currently available vary greatly in efficiency, with the most effective providing life cycle savings equal to or greater than the initial cost of the system, depending on hours of usage.

The standards are divided into recommended minimums and desirable features. The minimums establish criteria important to safe conduct of soccer 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 your facility's needs.

**With ever increasing pressure on operating budgets, leagues are encouraged to clearly establish the performance criteria they expect and to evaluate the life cycle operating cost of the sports lighting system.**

## I. Recommended Minimum Standards

These minimum standards are recommended for all lighting installations after the date of adoptions 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. **Note:** The highest level of use for each facility shall determine the level of lighting required.

### PART 1 – GENERAL

#### 1.1 LIGHTING PERFORMANCE

The quantity of equipment needed is determined by the efficiency of the lighting system. Newest technology is capable of delivering equal or better results with up to half the amount of equipment than prior technology systems. There are two acceptable methods of determining the amount of equipment needed.

**A. Preferred technology**

By utilizing a series of timed 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 large reductions in the quantities of luminaires needed to meet design targets.

**B. Prior technology**

Computer designs are done using two sets of values. One predicts "initial light levels" when lamps are new. The other predicts "maintained light levels" after the lamps have passed through a depreciation in light output. It is important to have the lighting designer use a maintenance factor adequate to account for this depreciation in light output throughout the life of the lamp. A value no greater than .70 shall be applied to initial light levels to predict these maintained values. Quality manufacturers are willing to provide guarantees of lighting performance.

**C. Performance Requirements**

Playing surfaces shall be lit to an average constant or target light level and uniformity as specified in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Measured average illumination level shall be +/- 10% of predicted mean in accordance with IESNA RP-6-01, and measured at the first 100 hours of operation.

| Level of Play/Description | Average Constant or Target Light Levels (Horizontal) | Maximum to Minimum Uniformity Ratio |
|---|---|---|
| Standard — Competition<br>No special spectator considerations | 30 footcandles | 2:1 |
| Premium — Tournaments<br>Up to 5,000 Spectators | 50 footcandles | 2:1 |
| Professional — Stadiums*<br>Special considerations | 75+ footcandles | 1.5:1 or better |

* Professional facilities involve large spectator seating and/or televised events

**D. Glare for Participants**

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

## 1.2 ENVIRONMENTAL LIGHT CONTROL

Many facilities are located near residential properties, 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 can assist in assessing this issue and provide drawings showing maximum footcandles at any points 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.

## 1.3 LIFE CYCLE COSTS

Facilities continue to struggle with operating budgets. Because the efficiency of lighting systems currently available can vary greatly, a life cycle operating cost analysis should be completed 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.

## 1.4 WARRANTY AND GUARANTEE

Product warranties are a good gauge of a manufacturer's confidence in their products. Prior generation equipment can range from 5 years to 10 years, and details of covered items and conditions vary greatly. New generation technology comes with warranty periods of up to 25 years and includes guaranteed light levels, parts, labor, lamp replacements, energy usage, monitoring and control services, spill light control and structural integrity. The manufacturer should provide specially-funded reserves to assure fulfillment of the warranty for the full term. It is highly recommended you insist on these all inclusive warranties to limit your league's future exposure to escalating costs and maintenance hassle.

## 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 or direct burial steel poles are not recommended.

2. Pre-stressed concrete base embedded in concrete backfill or a poured-in-place foundation containing reinforcing steel cured a minimum of 28 days before any stress load is applied.

3. All luminaires shall be constructed with a die-cast aluminum housing or external hail shroud to protect the luminaire reflector system.

4. All ballasts and supporting electrical equipment shall be mounted remotely in aluminum enclosures approximately 10’ above grade. The enclosures shall include ballast, capacitor and fusing for each luminaire. Safety disconnect per circuit for each pole structure will be located in the enclosure.

5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.

**B. Manufacturing Requirements**

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

**C. 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 shall be anodized, coated with a clear, high gloss, durable fluorocarbon, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All wiring shall be enclosed within the crossarms, conduit, pole or electrical components enclosure.

**D. Lightning Protection:**

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

**E. Safety**

All system components shall be UL Listed for the appropriate application.

**F. Maximum total voltage drop**

Voltage drop to the disconnect switch located on the poles should not exceed three (3) percent of the rated voltage per IESNA RP-6-01.

### 2.2 STRUCTURAL PARAMETERS

**A. Location**

Poles shall 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 licensed structural engineer illustrating that the foundation design is adequate to withstand the forces imposed from the pole, fixtures and other attachments to prevent the structure from leaning.

**C. Support Structure Wind Load Strength**
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 State Building Code. Luminaire, visor, and crossarm shall withstand 150 mph winds and maintain luminaire aiming alignment.

**D. Structural Design**
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.

**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 provided by the school, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2001 IBC, Table 1804.2-I-A.

## 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, School's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA RP-6-01, Appendix 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 fixtures 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 fixture maintenance and energy consumption costs created by the additional fixtures by reimbursing the Owner the amount of $1,000.00 (one thousand dollars) for each additional fixture required.

3. Manufacturer shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications.

### 3.2 ONGOING QUALITY ASSURANCE

**A.** Visual testing should be performed annually on lamps, lenses, conduit, poles, fuses, ballasts, grounding connections and breaker boxes to insure integrity and safety of system.

**B.** Full light and safety audits should be performed every other year. See Annual System Operation and Maintenance Checklist at the back of these standards.

# II. Desirable Features

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

### 4.1 TV Quality Lighting

Lighting for televised events involves additional considerations besides spectators and participants. It is recommended that leagues wishing to light facilities for television broadcasts use consultants and lighting manufacturers with experience and knowledge in that area.

### 4.2 Controls and Monitoring System

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

**A. Remote Monitoring**

System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The manufacturer shall notify the owner of outages within 24 hours, or the next business day. The controller shall determine switch position (Manual or Auto) and contactor status (open or closed).

**B. Remote Lighting Control**

System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall 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.

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

**C. Management Tools**

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

**D. Communication Costs**

Manufacturer shall include communication costs for operating the controls and monitoring system for a period of 25 years.

**E. Cabinet Construction**

Controls and Monitoring Cabinet shall be constructed of NEMA Type 4 aluminum. Cabinet shall 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 shall be provided.

### 4.3 Auxiliary Brackets

Sports lighting manufacturers can provide accommodations for mounting auxiliary equipment such as speakers on sport lighting poles. This ensures poles will be sized to accommodate the weight, dimensions and 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.

### 4.4 Scoreboards

Incorporating scoreboards onto the lighting poles can provide additional cost savings over installing separate structures. Lighting manufacturers can assist in providing a method for attaching a scoreboard appropriate for the sport.

### 4.5 Field Perimeter Lighting

The parking areas, major areas utilized 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.

## For additional information, contact the U.S. Soccer Foundation

**U.S. Soccer Foundation**
**1050 17th St. NW**
**Suite 210**
**Washington, D.C. 20036**
**Phone: 202/872-9277**

## 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** | + | |
| **C.** | **Spot relamping and maintenance over 25 years**<br>Assume ____ repairs at $ ____ each if not included | + | |
| **D.** | **Group relamps during 25 years**<br>____ annual usage hours x 25 years / lamp replacement hours x $125 lamp & labor x number of fixtures | + | |
| **E.** | **Extra energy used without control system**<br>____% x Energy Consumption in item A. | + | |
| **F.** | **Extra labor without control system**<br>$____ 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** | + | |
| **C.** | **Spot relamping and maintenance over 25 years**<br>Assume ____ repairs at $ ____ each if not included | + | |
| **D.** | **Group relamps during 25 years**<br>____ annual usage hours x 25 years / lamp replacement hours x $125 lamp & labor x number of fixtures | + | |
| **E.** | **Extra energy used without control system**<br>____% x Energy Consumption in item A. | + | |
| **F.** | **Extra labor without control system**<br>$____ 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 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, and other pertinent data<br>b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), or home plate for baseball/softball fields. Illuminance levels at grid spacing specified<br>c. Pole height, number of fixtures per pole, as well as luminaire information including wattage, lumens and optics<br>d. Height of 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 and 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 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-35-02. 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** | Luminaire Aiming Summary | Document showing each luminaire's aiming angle and the poles on which the luminaries are mounted. Each aiming point 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 Iowa. |
| | **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 Iowa. |
| | **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:** _____/_____/_____

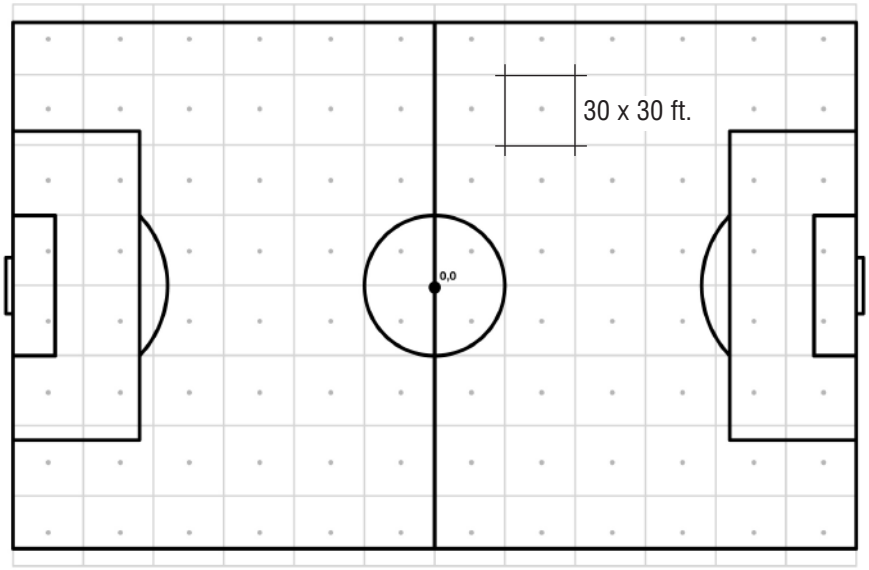
# APPENDIX

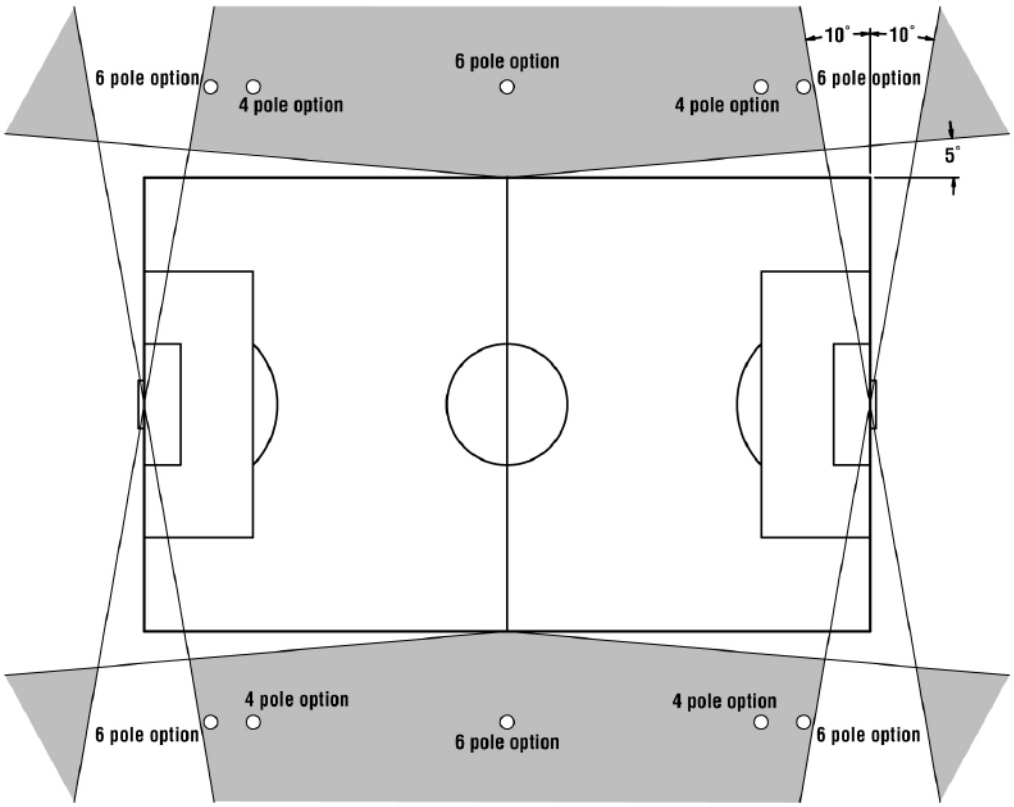
## Field-Measuring Grids of Typical Facilities

| Level of Play | Typical Facility Dimensions (ft2) | Horizontal Footcandles Constant/Maintained | Uniformity (Max to Min) | Typical Lighted Area Dimensions (ft) | Grid Size (feet) |
|---|---|---|---|---|---|
| Standard | 180 x 330 | 30 | 2.0:1 | 190 x 340 | 30 x 30 |
| Premium | 225 x 360 | 50 | 2.0:1 | 230 x 370 | 30 x 30 |
| Professional* | 225 x 360 | 75+ | 1.5:1 | 230 x 370 | 30 x 30 |

*Professional facilities may require special consideration in regard to television requirements and seating capacity.

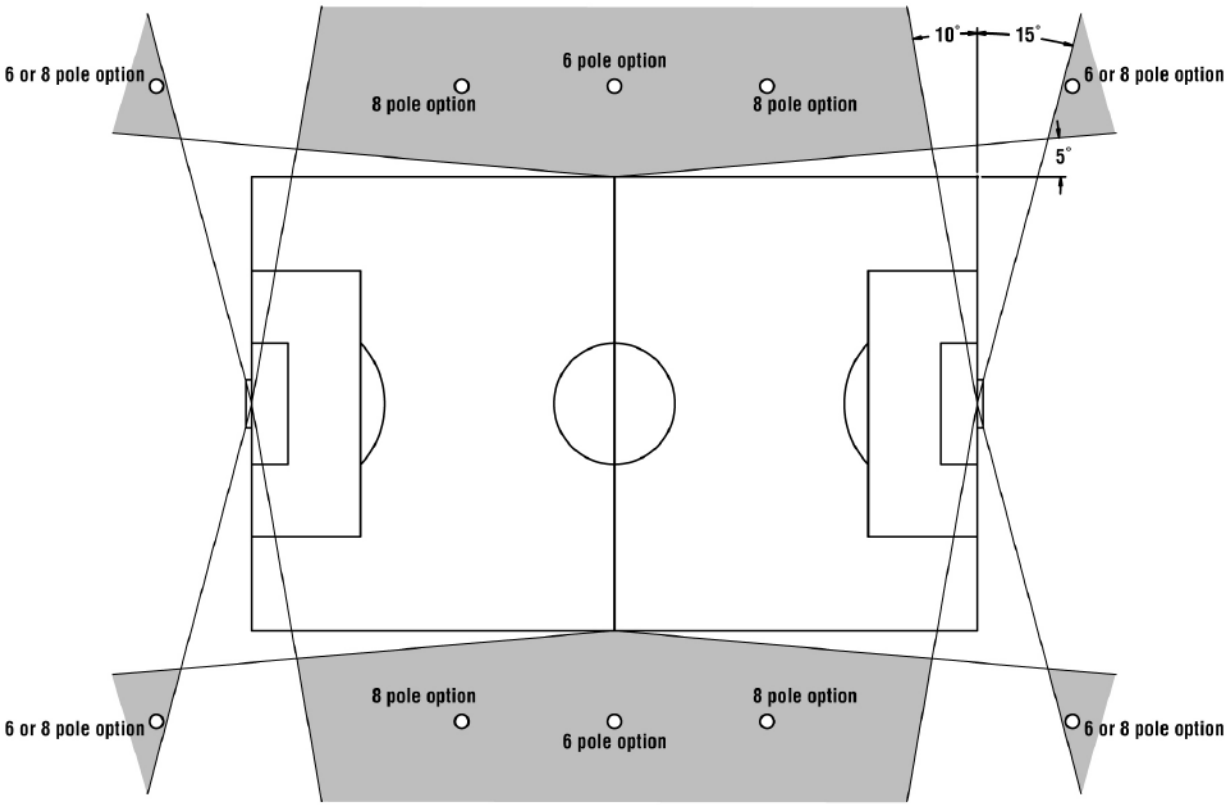
## Light Level Grid Point Layout






## 4 to 6 Pole Configuration

1. Special consideration for lighting placement is given to stadiums with customized roof mount potential.
2. Shaded areas indicate recommended pole location. All poles should be at least 20 feet from sideline.
3. On a 4-pole design, poles should be located between the penalty line and the goal line.
4. One a 6-pole design, setback of middle poles will depend on the presence of bleachers.
5. Pole placement and aiming angles shall be designed to minimize glare for players and spectators.
6. For new facilities or upgrades, it is recommended to consult a lighting professional for optimal pole placement.




## 6 to 8 Pole Configuration

1. Special consideration for lighting placement is given to stadiums with customized roof mount potential.
2. Shaded areas indicate recommended pole location. All poles should be at least 20 feet from sideline.
3. Setback of middle poles will depend on the presence of bleachers.
4. Outside poles should be located beyond end line. Optimum placement for TV is 15 degrees or greater off the end line for an end camera.
5. Pole placement and aiming angles shall be designed to minimize glare for players, spectators and television cameras.
6. The ratio of key light to backlight main camera levels should be between 1:1 and 1.5:1. A ratio of 1:1 is preferred.
7. For new facilities or upgrades, it is recommended to consult a lighting professional for optimal pole placement.

# ANNUAL SYSTEM OPERATION & MAINTENANCE CHECKLIST

**WARNING!! Turn off electricity at power source and at safety disconnect on the pole.**

| | 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 clearly legible. | | | |
| **Test reset action on all service breakers.** | | | |
| • Snap all breakers on and off several times to ensure firm contact. | | | |
| • If fuses are used at main service, check continuity.* | | | |
| **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** | | | |
| **Wood poles:** **Check to see that poles aren't leaning.** | | | |
| • Leaning poles may be unsafe and replacement or re-installation and/or re-aiming may be necessary. | | | |
| **Check for twisting.** | | | |
| • If poles have moved, re-aiming of the fixtures may be necessary. | | | |
| **Check for decay.** | | | |
| • Wood poles decay from the inside out. Core testing is the best method to determine the condition and safety of the pole. | | | |
| **Steel poles:** **Check baseplate for signs of deterioration.** | | | |
| • Check anchor bolt for signs of corrosion. | | | |
| • Check grouting under pole to make sure proper drainage exists. | | | |
| **Check for all pole access covers, replace missing covers.** | | | |
| **Cables and conduit:** | | | |
| • 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. | | | |
| **Luminaires** | | | |
| **Check fixture housings.** | | | |
| • Housings should show no sign of cracking and/or water leakage. | | | |
| **Check lenses.** | | | |
| • Clean lenses. | | | |
| • Replace broken lenses. | | | |
| **Replace burned-out lamps.** | | | |
| **Check luminaire fuses.** | | | |
| • Replace burned-out fuses. | | | |
| • Fuses should be the correct size. | | | |
| **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.** | | | |
| **Check that capacitors aren't bulging.** | | | |
| **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 feet from the electrical components. | | | |
| • Metal objects, such as bleachers, must have their own individual grounding system. | | | |

* These tests and/or repairs require the services of a qualified electrician.

# GLOSSARY

**Aiming Angles** The degrees below horizontal that light fixtures are aimed at the field. Angles are measured from a horizontal plane at fixture height. Critical in safe, playable lighting design.

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

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

**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.

**Initial Light Levels** The average light levels when your lamps are new. Manufacturers that do not provide constant illumination should provide scans showing what these levels will be.

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

**Maintained Light Levels** The lowest average amount of light for which a lighting system should operate over its extended life to ensure performance requirements. Maintained values should be no more than 70% of initial values to be sure that lamp depreciation has been accounted for in the design. You should receive scans showing what this level will be.

**Max. to Min. Ratio** 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.

**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 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.

**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. |
| **Reflector** | Key element of lighting optics. It surrounds the lamp (bulb) and directs light to the field. The efficiency of the reflector determines how many light fixtures 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 they can be serviced easily. |
| **Smoothness** | The change in light levels between measuring points. The less change between points the more even the lighting. |
| **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. |
| **Tilt Factor** | Most lamps generate fewer lumens when tilted off of either a horizontal or vertical position. Your design should show actual tilt factor used in your design. |
| **Underwriters Laboratories (UL)** | Independent, not for profit, product safety testing and certification organization. Visit www.ul.org for additional information. |