DESIGN STANDARDS FOR: ATHLETIC FIELD LIGHTING

SECTION I: Introduction:

Seattle is one of the mostly densely populated areas on the West Coast, therefore, Seattle Parks and Recreation (SPR) is committed to supporting growth management and comprehensive planning goals by providing an inventory of athletic facilities within Seattle that are safe, high quality fields. Due to the City of Seattle's geographic location and environmental conditions, the use of synthetic surfaces and field lighting greatly increases the Park system's scheduling capacity. The decision to light athletic fields comes with impacts to the immediate residents and area neighbors, even when utilizing the latest technologies. The Joint Athletic Facilities Development Program (JAFDP) and these lighting design standards reflect the commitment to both providing safe, high quality facilities and the recognition that these facilities impact the communities in which they are located.

Within this context, this document outlines the issues requiring consideration during the design phase of an athletic field lighting project. It also outlines design standards on technical issues such as levels of field lighting, addresses obtrusive light and establishes design parameters for materials, all while allowing flexibility with regard to emerging technologies.

SECTION II: Definitions:

Common Lighting Systems: The key technical issues to consider when selecting a preferred lighting system include: Illumination Levels, Uniformity, Obtrusive Light Levels, Daylight Appearance (pole number, fixture density), Lamp Type (affects color rendition), Initial Capital Investment and Operating and Maintenance Costs.

- **Full Cut-off -** "Full Cut-off" Lighting Systems incorporate a downward aiming array of fixtures set close to the supporting pole, arrayed around the field-side of the pole at various heights. Individual fixtures are composed of a reflector enclosed within an essentially open-bottomed, box-like structure. "Full cut-off" refers to the fact that the lamp placement inside the box and above the plane of the bottom opening eliminates, or cuts off, all direct light above the plane of the fixture opening. "Full Cut-off" system designs may incorporate both metal halide and high-pressure sodium lamps of 1000 watts each.
- **Pros** (compared to "Shielded Aimable"): No glare above the plane of the fixture. Minimal sky glow (some glow is produced by reflected light, which varies by field surface). Visually unobtrusive at the mounting point (fewer fixtures, mounted close in), in daylight.
- **Cons** (compared to "Shielded Aimable"): Uniformity on larger surfaces is more difficult to achieve. More spill light behind the pole. Difficult to adjust. Does not allow for a reduction in pole quantities. Typically higher initial capital outlay. Poles must be close to the playing surface.

- **Shielded Aimable -** "Shielded Aimable" Lighting Systems incorporate a parabolic (somewhat dome-shaped) metal reflector around the lamp that results in a controlled beam spreads. Fixtures are arrayed on supporting cross-arms extending outward from the pole. The term "shielded" refers to two typical components- the parabolic reflector, which to some degree shields the lamp as viewed from off-site and separate visors and shutters that, can be bent or hinged to tighten the beam spread and further shield the lamp. The term "aimable" refers to the fact that the individual fixtures are mounted on an armature such that they can be specifically targeted at a pre-determined point on the surface to be lighted. Although high-lift equipment is required to do so, each fixture can be re-aimed or have its individual visors and/or shutters adjusted, added to, or removed, if necessary. "Shielded Aimable" systems are produced almost exclusively with metal halide lamps with either a 1000 or 1500 watt power output.
- **Pros** (compared to "Full Cut-off"): High degree of uniformity regardless of field size or shape. High degree of control of spill light behind the pole. Adjustability of "problem" fixtures (on-field or off). Typically lower number of poles required. Typically lower initial capital outlay.
- **Cons** (compared to "Full Cut-off"): Higher glare below the plane of the fixture. Moderate glare above the plane of the fixture. High resultant sky glow from direct and reflected sources. Visually dense at mounting point (numerous fixtures arrayed on cross-arms), in daylight.

Environmental Zones (defined by the Illuminating Engineering Society of North America, IESNA):

Zone	Description	Light trespass (maximum levels at the residential property line)* Initial/Maintained
E1	Areas with intrinsically dark landscapes such as national parks and areas of outstanding beauty.	0.14 fc / 0.1 fc
E2	Areas of low ambient lighting such as suburban or rural residential areas.	0.42 fc / 0.3 fc
E3	Areas of medium ambient brightness such as urban residential areas.	1.1 fc / 0.8 fc
E4	Areas of high ambient brightness such as dense urban areas with mixed residential and commercial uses.	2.1 fc / 1.5 fc

*As a comparison, a 30 foot street lamp located 10 feet from a residential property line would have a vertical illumination level, at 6 feet above grade, of 1.3 fc at the residential property line (Reference page 2-17).

Illuminance: The density of the flow of light falling on a surface. This document refers to illuminance as measured in foot-candles (fc), which is defined as one lumen uniformly distributed over an area of one square foot.

- **Horizontal** illuminance is the normal design criteria used for design calculations and measuring field lighting levels for athletic field lighting projects. It is calculated by measuring the amount of light falling on the horizontal plane 36 inches above the surface.
- **Vertical** illuminance is critical for sports where the ball spends most of the time in the air (such as baseball, football and softball). Vertical levels are typically calculated in four

directions and at various heights above the playing field. It is also used to calculate spill light levels.

- **Initial** illuminance is the measurable output of the fixture with a new arc tube (light source) installed.
- **Maintained** illuminance is the average output of the fixture following an initial burn-in period. The initial burn-in period is approximately 100 hours. (reference page 2-20)

Illumination – Off Site:

- **Ambient Light** describes the existing light levels in a neighborhood given off from streetlights, building lights, etc.
- **Spill light** is the light that falls beyond the athletic field being illuminated. Spill light is expressed in foot-candles (fc) and is normally measured in the vertical plane.
- **Glare** is light that hinders or bothers the human eye due to the eye's difficulty in adjusting to different levels of light. Direct glare from a light source is typically an important issue in the design and operation of athletic field lighting installations, both in terms of players and nearby populations. Topography and vegetation can change the impacts of glare. There is no industry standard for measuring glare once a project is completed. However, there may be design steps that may mitigate the effects of glare such as increased pole height.
- **Sky glow** is the haze or glow of light emitted above the lighting installation and reduces the ability to view the darkened nighttime sky. This is a combination of light emitted directly from the light source and reflected light that casts upward from the surface being illuminated. The level of sky glow is also impacted by atmospheric conditions; clouds and moisture increase the effects of sky glow.

Levels of Play Classifications - IESNA set forth four illumination classifications based on the level of play being accommodated on a lighted athletic field. Recommended levels for social or recreational sports range from 20 to 50 foot-candles; levels for professional play with large spectator attendance and television coverage can reach 300 foot-candles. Field illumination for SPR athletic fields will conform to either Level III or Level IV standards, depending on the anticipated use of the field.

- **Level I** illumination is for competition play before a large group of spectators' attendance (approximately between 5,000 and 10,000 spectators).
- **Level II** illumination is for competition play with up to 5,000 spectators.
- **Level III** illumination is for competition play with some provision for spectators, such as permanent bleachers for 50 – 100 spectators.
- **Level IV** illumination is for competition or recreational play only with no provision for spectators.

Uniformity: Uniformity measures the relationship between the brightest area on the field and the darkest area on the field. Allowable variations are set to ensure player safety and are established based on the level of play classification determined for the field.

SECTION III: Design Considerations

Site Considerations

1. **Light Levels -** Meeting illumination levels for safe play on the field while minimizing lighting impacts off site is the priority design consideration for athletic field lighting projects.
   - On field light levels: Projects will be designed to meet field surface illumination levels necessary for the safe play of the sports that will be played at the project site.
   - Off site light levels: Project design will include analyses of spill light, glare and sky glow.
2. **Park Amenities -** Replacement and new lighting projects may present an opportunity to consider additional park amenities which might be appropriate for the site, such as comfort stations, drinking fountains, security lighting, seating and ADA access.
3. **Topography -** The surrounding topography will be considered when selecting a project's lighting system in an effort to minimize impacts of obtrusive light as well as for aesthetic considerations such as impact to views.
4. **Traffic and Parking -** Increased scheduling of a athletic field may cause periodic traffic congestion and constrain available parking. These issues will be considered during a project design through the public involvement process and/or State Environmental Policy Act (SEPA) analysis. Additionally, the Department will work with sports organizations, field users, and community organizations to provide site-specific information as to preferred traffic routes and parking areas.
5. **Vegetative Screens -** Tall shrubs and trees may be considered as screens to reduce glare and spill light.
6. **Wildlife -** Potential impacts of lights on wildlife varies for each proposed site. Analysis of these potential impacts is performed as part of any required SEPA process.

Programming Considerations

1. **Capacity -** All SPR athletic fields where lights exist or will be installed should be evaluated and monitored with respect to the type of sports, age group, field dimensions, type of surface, etc. by the scheduling staff to maximize the opportunities and improve the management of the entire system.
2. **Noise -** In order to practice a "Good Neighbor" policy in and around parks where lights exist or will be installed every precaution should be taken to minimize the type and amount of noise a surrounding neighbor may be exposed to. Therefore, the Department will work closely with user groups and encourage them to practice being the best neighbor possible while using park facilities.
3. **Programming -** While recognizing that user needs vary, the Department will attempt to balance the needs of users with the impacts to and needs of the neighboring community. Hours of operation for lighted athletic fields are addressed in the Department's Scheduling and Use Policy.

Maintenance and Operational Considerations

1. **Energy Costs -** The cost of energy will be an ongoing challenge and therefore the type of lighting systems installed at each athletic field site should be analyzed for short and long-term energy consumption needs. Current data regarding use patterns, alternative uses, types of lamps used and the level of lighting to accommodate the users at a given location are all considerations.
2. **Safety of Users and Neighbors -** On and off field safety will be considered in the design and development of athletic fields. Close coordination with user groups and good

communication with neighbors to address issues and concerns should be on-going. Attention should also be given to ensure user safety after field lights are turned out.

3. **Maintenance & Utility Impact Report**: Shall be submitted in conjunction with the Illumination Concept Plan, a detailed analysis to determine the anticipated operation and maintenance costs associated with implementation of the proposed Illumination Concept Plan. This analysis shall be presented in a format and level of detail such that the analysis can be easily reviewed by an SPR analyst to verify that all assumptions are reasonable, calculations are complete and correct, and that all elements of the lighting plan have been incorporated.
4. **Maintenance -** A maintenance plan outlining on-going services and upkeep will be a critical part of the lighting program and therefore project design should consider issues related to future maintenance. In addition, a well-organized inspection program to monitor and evaluate the efficiency and effectiveness of each lighting system should be developed for each site.

SECTION IV: References

- These Lighting Design Standards are based on the *2001 Ballfield Lighting Study*, and the various technical references therein, (The Study) prepared by McGowan Bros. Engineers for SPR.

SECTION V: Standards for Illumination Levels

Illumination levels are determined based on the level of play being accommodated at the project site. The lighting consulting engineer shall verify the level of play with SPR prior to initiating design. The athletic field lighting project must conform to the following standards for illuminance levels, uniformities and light loss factors.

In general, SPR facilities will be built to Level IV illumination standards. Certain baseball/softball athletic fields that can accommodate tournament play with spectator attendance will be built to Level III illumination standards, such as Lower Woodland.

Criteria	Level III Baseball/Softball	Level IV Baseball/Softball	Level III Soccer/Football	Level IV Soccer/Football
Minimum Maintained Average Horizontal Illuminance	50 fc (infield) 30 fc (outfield)	30 fc (infield) 20 fc (outfield)	30 fc	20 fc
Horizontal Uniformity (max: min)	2.5:1 or <	3:1 or <	2:1 or <	4:1 or <
Horizontal Uniformity (CV)	0.21 or <	0.25 or <	0.25 or <	0.3 or <

SECTION VI: Standards for Addressing Obtrusive Light

Spill Light: The adopted Environmental Zone for City of Seattle projects is E3. Only the pre-curfew limitations will be considered, in accordance with the lighting study. Therefore, projects at newly lighted sites shall conform to a maximum maintained vertical illuminance level for spill light that does not exceed 0.8fc (initial 1.1fc) at the residential property line. The lighting designer shall undertake initial vertical illuminance calculations on a line along the edge of the properties and roadways as defined by the City to establish compliance with the 0.8fc level. The levels shall be calculated vertically at five feet above grade. At sites with existing lighting systems, every effort will be made during the design of replacement system to meet this standard. However, in order to encourage an expeditious replacement of these out of date systems, projects may deviate from this spill light level.

Glare Analysis: Although glare is very subjective and difficult to measure in the field, it can be analyzed during the design phase. Therefore, as part of the luminaire and mounting height selection process, the lighting designer will review candlepower curves and determine the appropriate luminaire mounting height and optical system so that no greater than 12,000 candlepower from any given luminaire is visible from the residential property line. [This analysis is outlined in The Study, page 2-40].

Sky Glow Assessment: As it is nearly impossible to measure sky glow in the field, it shall be assessed during the design stage to ensure that the calculated maintained average lighting level on a horizontal plane above the lights shall not exceed five percent of the maintained calculated average lighting level on the field surface. We recognize, however, that this method does not account for the reflected light from the field surface or the atmospheric conditions.

SECTION VII: Standards for Materials

Improvements in technology will be considered when choosing appropriate materials.

- **Lighting System:** Full Cutoff, Shielded Aimable, or a hybrid of these two systems will be used for all SPR athletic field lighting projects.
- **Lamp wattage:** SPR athletic field lighting projects will consider both 1000 watt and 1500 watt lamp systems, and choose the optimal system based on the design considerations list in SECTION III.
- **Pole Material:** SPR athletic field lighting projects will consider galvanized steel and concrete poles, and choose the optimal material based on the design considerations list in SECTION III. Wooden poles are not acceptable due to the susceptibility to twisting and rotting.
- **Safety lighting:** All lighted facilities shall provide pedestrian-scale lighting of sufficient intensity and duration to allow all participants to exit the site safely at the conclusion of any scheduled evening use. Consideration will be made regarding ADA compliant routes of travel and common points of pedestrian and emergency access and egress from the site. The pedestrian lighting should be designed to incorporate "full cut-off" type fixtures at heights that discourage vandalism but are within the height restriction of land use development standards for the site. Cost effectiveness shall be maximized by utilizing the athletic field lighting poles where possible, and by designing fixture heights that minimize the number of additional poles necessary to achieve the intent.

- **Control System:** All SPR athletic field lighting projects will include an on-site switch that can allow lights to be operated at the site. Projects will also be designed to allow individual fields to be lighted separately so that all facility lights are not required to be on when a limited number of fields are in use.

SECTION VIII: Project Design

Lighting Design: Lighting design shall be based on the performance criteria defined by the City. It is the responsibility of the lighting designer to meet the required lighting criteria. The City takes no responsibility for any misinterpretation of these standards. The performance of the installed athletic field lighting system will be field measured as described in SECTION IX.

Project Design Team: A City approved Consultant Electrical Engineering firm with thorough knowledge of sports lighting systems, power distribution and controls systems shall undertake all athletic field lighting projects. The electrical engineer shall be registered in the State of Washington. The electrical engineer shall be responsible for the preparation of the construction design drawings(s), technical specifications and the review of the supplier's pole and lighting submittals.

The design team shall design foundations to suit the local soil conditions present. An independent geotechnical engineer registered in the State of Washington shall approve the foundation designs. The City may supply a soil report. Where geotechnical information is not provided, the design team shall confirm the soil conditions.

Codes and Standards: All electrical design shall be performed in accordance with the latest edition of the National Electrical Code (NEC) and any applicable Washington State or local codes and amendments. All engineering shall follow the latest edition of standards and codes, and shall be performed under the direction of engineers competent to practice in those fields. Although the Non-Residential Energy Code (NREC) does not directly apply to athletic fields, energy consumption and energy efficiency shall be given the utmost importance in design.

Design Process: A standard design process has been established to minimize confusion and streamline the design.

1. The City selects a qualified electrical engineering firm for the specific sports lighting project.
2. The Consultant Engineering firm's project team meets with the City to discuss the project specifics and criteria to be followed.
3. A project schedule is developed after the engineer records all discussions and key issues. The Consultant Engineer submits notes (i.e., memorandum of understanding) to all key persons involved in the project.
4. The Consultant Engineer determines the specific lighting electrical loads.
5. The Consultant Engineer meets with the local utility company to establish either a new or upgraded service including supply voltage and service location.
6. The Consultant Engineer develops the electrical design drawings, specifications and cost estimates.
7. The drawings, specifications and cost estimate are reviewed with the City, Revisions are made as required and a reproducible set of drawings and digital set of specifications are

issued to the City for their bid process. The drawings shall be signed and sealed by the engineer.

8. The Consultant Engineer provides bidding assistance and shall be available to respond to any questions from bidders. The engineer shall issue addendum as required.
9. After award, the Consultant Engineer shall review and comment on vendor lighting and technical information submitted.
10. The engineer shall provide construction administration services.
11. Following construction, the engineer shall measure and record all illumination levels in accordance with IESNA LM-5 (Refer to the SECTION on Performance Verification later in this memorandum). This document shall become a part of the project's permanent record.

Drawings and Specifications: Drawings detailing the entire sports lighting installation shall be produced for each installation. At a minimum, the consultant shall supply the following items. [Supplemental specifications may be produced for each contract to compliment these Lighting Design Standards.]

- **Site Plan –** Showing the fields, pole locations, conduit, wiring, pull boxes, service locations, lighting control cabinet and other features necessary to properly construct the facility.
- **Details –** One-line diagram, lighting control schematic, panel schedules, pull box details, conduit trench detail, control cabinet details, equipment elevations and other detail needed to properly construct the facility.
- **Drawings** - Drawings shall be prepared in AutoCAD format and shall include the following information:
- **Initial and Maintained Illuminance Designs:** The sports field being illuminated shall be presented at a 1:30 scale, or larger showing all illuminance levels at a grid spacing of 10 feet. Grid points shall be calculated at three feet above grade. Grid points shall extend to the edge of the primary play area (PPA) as defined by the City.
- **Summary Table:** A summary table shall be included on the drawing showing the number of grid points, the design average illuminance levels and uniformities achieved (as noted in Table 1), luminaire model number(s) and types, lamp types(s), wattage and lumen output, light loss factors, tilt factors and other information as deemed necessary.
- **Pole Location:** Pole locations and luminaire mounting heights and total number of luminaries on each pole shall be presented on the drawings. Pole locations shall be dimensioned to key control points.
- **Spill Light Levels:** Off-site vertical illumination (light trespass) levels at 20-foot intervals on the boundary lines defined by the City shall be shown on the drawing. Levels shall be shown in vertical foot-candles calculated at five feet above grade with the meter oriented in the vertical position facing the lights.
- **Glare Levels:** The field being illuminated shall be shown to match the appropriate Maintained and Initial Designs and 12,000 candle power points (as shown in The Study, page 2-40). All luminaire aiming points, pole locations, and number of fixtures on each pole, fixture types and NEMA beam patterns shall also be shown.
- **Candlepower cut sheets:** The lighting supplier shall provide luminaire candlepower cut sheets showing the vertical and horizontal axial candlepower at five-degree increments. These candlepower curves shall be supplied for each luminaire used. An independent testing company shall verify and supply the vendor's candlepower cut sheets.
- **Consultant Information:** Lighting supplier's name, lighting designer's name, phone number, date of design, project title and location, and bar scale shall be included on each drawing.

SECTION IX: Performance Verification

Lighting:

- The Consultant Engineer shall field measure illuminance levels and document findings in accordance with LM-5. Spill light levels shall also be measured and documented and nighttime digital pictures taken at key points along the residential boundary.
- Where the lighting installation does not meet the required performance levels the Consultant Engineer shall coordinate re-aiming by the supplier. Re-testing will be required where fixtures are re-aimed. Illumination level measurements shall take place after the lights have been in operation for a period of 50 to 100 hours of operations.
- The engineer shall inspect the installation of the sports lighting equipment for general conformance to the performance requirements. Upon completion, the Consultant Engineer shall submit a drawing showing the final measured illumination levels, uniformities and spill light levels along with properly labeled nighttime digital pictures from the residential boundary looking at the lights. A letter of compliance shall accompany the measured levels.

Electrical Systems:

- The entire electrical installation shall be inspected by the engineer of record or his designated representative for general conformance to the design. Deficiencies shall be listed in writing and submitted to the contractor for correction. Upon correction of deficiencies. The Consultant Engineer shall submit notification of substantial completion to the City.
- After completion of the installation, the engineer shall prepare a final set of record drawings commonly referred to as “as-builts: that shall take into account all changes through construction. The record drawings shall be incorporated into an Operation and Maintenance (O&M) manual, which shall include all pertinent information, shop drawing product information, and other salient data deemed necessary to document the installation.

Geotechnical:

- All foundation installations shall be inspected and approved by a geotechnical engineer. The Consultant Geotechnical Engineer shall provide a copy of the foundation design and backfill attached to a letter approving the installation.

END OF SECTION