Recommended Practice for
Sports and Recreational Area Lighting
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1.0 INTRODUCTION

1.1 Purpose and Scope

As the population of North America has grown and prospered, the amount of leisure time devoted to recreation has increased. An important consequence has been growth in the demand for lighted stadiums to accommodate the large numbers of people who want to participate in sporting events. From the 1980s and continuing through the 1990s, light source efficacies have improved. This has allowed for improved lighting quantity and quality without additional electrical energy consumption. Lighted ball fields and other sports facilities are now quite common, and new construction continues. Sports lighting has become a very significant industry that serves a large, growing audience seeking desirable leisure time activities that are healthy and fun.

The use of computers helps experienced lighting designers improve their designs. A computer will not help the inexperienced designer produce better designs, nor will it suggest modifications to improper designs. Therefore, lighting designers need a thorough understanding of illuminating engineering principles and the associated calculation software.

The purpose of this Recommended Practice is to provide design criteria for new lighting systems and for the evaluation of existing installations. This Practice includes illuminance recommendations for major sports, such as baseball, tennis, basketball, and football as well as for recreational and social activities such as horseshoe pitching and croquet. Recommendations are also given for lighting general purpose facilities and multi-sport stadiums. This Practice revises and replaces the previous edition last published in 1988.¹

This Practice consists of several major sections. They include: fundamentals of good illumination, equipment and design factors, power and wiring, illumination recommendations for indoor and outdoor sports, and five Annexes. The Annexes cover illuminance calculations, field measurements, floodlight aiming, maintenance of light levels, and lighting economics. There is also an extensive glossary of lighting terms and a reference list that pertains to sports lighting design.

1.2 Class of Play and Facilities

The traditional way of classifying sports as amateur and professional is no longer meaningful. Modern practices frequently allow amateurs and professionals to compete against each other, such as in golf tournaments and tennis matches. Furthermore, "amateur" basketball and football are now played in the same facilities and at practically the same skill level as professional sports.

In general, as the skill level is elevated, players and spectators require a better and more sophisticated luminous environment. A correlation exists between the size of a facility and the level of play, e.g., a higher skill level attracts a greater number of spectators. As the number of spectators increases their distance from the playing surface increases and their need for increased illuminance to see players and tasks requires the values to increase. Accordingly, facilities should be designed to satisfy the most talented players and accommodate the greatest potential spectator capacity. In large facilities which seat over 10,000 spectators the lighting criteria is usually governed by the needs of television, which will be covered by a future Design Guide. To determine illumination criteria, this Practice groups facilities into four classes based on the skill levels of the players and the anticipated number of spectators (see Table 1):

- **Class I** - Competition play before a large group (5000 or more spectators). However, for the purpose of this Practice, illumination criteria for individual sports are limited to a spectator capacity of 10,000 or less (see Figure 1). Lighting criteria for major stadiums and arenas require special design considerations such as vertical and horizontal illuminance values not covered by this Practice, which may be defined by individual sports and/or broadcasting organizations.

- **Class II** - Competition play with facilities for up to 5000 spectators (see Figure 2 in color insert).

- **Class III** - Competition play with some spectator facilities.

- **Class IV** - Competition or recreational play only (no provision for spectators).

![Figure 1. This racetrack is lighted by clustered banks on individual structural towers to provide the lighting needs of both contestants and a large number of spectators.](image-url)
Table 1: Class of Play and Facilities

<table>
<thead>
<tr>
<th>FACILITY</th>
<th>CLASS</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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</thead>
<tbody>
<tr>
<td>Professional</td>
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<tr>
<td>College</td>
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<td>Semi-Professional</td>
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<td>Sport Clubs</td>
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<td>Amateur Leagues</td>
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<td>X</td>
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<td>High Schools</td>
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<td>X</td>
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<td>Training Facilities</td>
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<td>X</td>
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<tr>
<td>Elementary Schools</td>
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<tr>
<td>Recreational Events</td>
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<tr>
<td>Social Events</td>
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<td>X</td>
</tr>
</tbody>
</table>

Class I - Facilities with spectator capacity over 5,000
Class II - Facilities with spectator capacity under 5,000
Class III - Facilities with some provision for spectators
Class IV - Facilities with no provision for spectators

There is, of course, an overlap between illumination criteria for the various skill levels and for facility size. The general correlation is presented in Table 1.

1.3 Types of Sports

Based on illumination requirements, all sports may be considered either aerial sports or ground-level sports. Within each of these two groups, all activities can be further divided into multi-directional sports and uni-directional sports.

1.3.1 Aerial Sports. These sports involve playing with an object (such as a ball) that is in the air at least part of the time. The major subcategories are:

- **Multi-Directional Aerial Sports** are sports where the players and spectators view the playing object from multiple positions and viewing angles. These sports demand critical vertical illuminance over the height of the entire playing area as well as horizontal illuminance at ground level. It is important to control direct glare by locating the luminaires away from the most frequent viewing directions of players and spectators. Typical multi-directional aerial sports include badminton, baseball, basketball, football, handball, jai alai, ski jumping, soccer, squash, tennis, and volleyball.

- **Uni-Directional Aerial Sports** are sports where the playing object is viewed in the air from a fixed position on the ground. General horizontal illuminance is required where the playing object is launched (start) and vertical illuminance is required where the playing object lands or is intercepted (finish). This is normally achieved by aiming some luminaires downward at the start and aiming other luminaires at high angles toward the finish. All luminaires must be shielded from the player's field of view. Typical uni-directional sports include golf at a driving range, skeet shooting, and trap shooting.

1.3.2 Ground Level Sports. These sports are played on the ground or a short distance above the ground. In the normal course of play, players and spectators do not look upward. The major subcategories are:

- **Multi-Directional Ground Level Sports** where the players and spectators view the playing object from multiple positions, normally looking downward, horizontally, and occasionally upward. These sports require well-distributed horizontal illuminance, although vertical illuminance should be considered. Typical multi-directional ground level sports include boxing, curling, field hockey, ice hockey, skating, swimming (excluding high board diving), and wrestling.

- **Uni-Directional Ground Level Sports** where the playing object is aimed at a fixed target near ground level (usually the target is in a vertical position). Vertical illuminance is critical at the target. It is normally provided by aiming luminaires (shielded from the players and spectators field of view) toward the target. Typical uni-directional ground level sports include archery, bowling, skiing, and target shooting.

1.4 Power and Energy

The wise use of electrical energy continues to be an important consideration in sports lighting systems. The first and most important criterion is to select the proper illuminance. Utilizing a design criterion in excess of that actually needed increases construction, operation, and maintenance costs and wastes energy.

Since most sports involve the critical viewing of a fast moving target (baseball, hockey puck), sports facilities normally require illuminances from 350 lux to 1600 lux (35 fc to 160 fc). This may involve high unit power densities (watts per square meter [square foot]), large power demand (one thousand watts expressed as kW), and significant energy consumption (one thousand watt-hours expressed as kWh). Note that very little energy is consumed at high power demand if the usage...
6.24.2 Design Considerations. Five factors are of particular importance to ski area lighting design:

- **Illuminance Uniformity** - It is not essential that all surfaces receive uniform illuminance. In fact, the terrain will be made more visible by the directionality of the light and its non-uniformity within the illuminance criteria parameters of Section 6.24.1. Semi-directional illumination provides shading and modeling, which aids in seeing the ski slope.

- **Weather** - At ski areas where foggy conditions are common, it may be desirable to increase the minimum vertical illuminance to 3 lux (0.3 fc). This will compensate for snowy or foggy atmospheric conditions.

- **Field Measurements** - Field verification should be done with a normal amount of snow on the slope, and readings should be taken only during clear weather.

- **Luminaire Aiming** - Generally a function of ski slope width, curvature, and gradient, luminaire aiming should be in the general downhill direction (the skier's direction of travel — see Figure 78). Certain slope conditions and layouts may require aiming some luminaires in other than downhill directions. Care should always be used to minimize white-out and glare opportunities.

- **Effective Pole Height** - The effective pole height is used to determine longitudinal pole spacing and should be as illustrated in Figure 79. On slopes, the effective pole height includes the pole height above snow, the snow depth, and the vertical differential between poles.

![Figure 78. Pole location and luminaire aiming for selected ski slopes](image1)

![Figure 79. Effective pole height used for skiing.](image2)

Net pole heights should be determined from coverage requirements, beam spread, terrain, and other conditions peculiar to the slope being lighted. In general, pole heights should be at least 7.6 meters (25 feet) above the snow surface.

6.25 Soccer

Soccer is a multi-directional ground level sport. However, the ball is frequently kicked high into the air. The following lighting criteria is for college, high school, and recreational play. Major national and international soccer competitions are generally held in large stadiums with specially designed lighting systems (see Figure 51).
6.25.1 Illuminance Criteria. Recommended illuminance levels are: (See Figure 80.)

Class I - Horizontal illuminance: 750 lux (75 fc)
\[ CV = 0.13 \text{ or less.} \quad \left( \frac{E_{max}}{E_{min}} = 1.7:1 \text{ or less} \right) \]

Class II - Horizontal illuminance: 500 lux (50 fc)
\[ CV = 0.21 \text{ or less.} \quad \left( \frac{E_{max}}{E_{min}} = 2.5:1 \text{ or less} \right) \]

Class III - Horizontal illuminance: 300 lux (30 fc)
\[ CV = 0.25 \text{ or less.} \quad \left( \frac{E_{max}}{E_{min}} = 3:1 \text{ or less} \right) \]

Class IV - Horizontal illuminance: 200 lux (20 fc)
\[ CV = 0.30 \text{ or less.} \quad \left( \frac{E_{max}}{E_{min}} = 4:1 \text{ or less} \right) \]

Illuminance readings should be taken at a 1-meter (3-foot) elevation.

6.25.2 Design Considerations. Refer to Figure 81 for recommended pole locations. Regulation soccer field size varies. Width can be 59.5 to 68.6 meters (195 to 225 feet) and length can be 100.6 to 109.8 meters (330 to 360 feet).

6.26 Softball

Softball is a multi-directional aerial sport similar to baseball. However, softball is played with a larger diameter ball on a smaller field.

Softball field dimensions (for either fast-pitch or slow-pitch play) vary with the league. The baselines are generally between 18.3 and 19.8 meters (60 to 65 feet) and the outfield between 61.0 and 94.5 meters (200 to 310 feet).

6.26.1 Illuminance Criteria. The illuminance criteria for softball are similar to those for baseball. See Section 6.5 and Figure 8.

6.26.2 Design Considerations. The minimum luminaire mounting height and corresponding pole setback should be determined as illustrated in Figure 16. Refer to Figure 53 for guidelines for locating luminaires.

6.27 Swimming

See Section 5.17.

6.28 Tennis

See Section 5.18 for a general description of tennis, classification of the sport's play/facilities, definition of playing areas, and recommended reflectance values of surfaces.