

Site Lighting: **Optical Systems Design** and Application Guide for **Site and Roadways**



Photo Courtesy Kim Lighting

Selecting the right type of site lighting enhances building design, efficiency, and safety

Provided by Kim Lighting

Architecture and light: The two are intertwined in good design of all buildings, but the same is true of building sites. Outdoor spaces frame and enhance any building design. Depending on the lighting used, these outdoor spaces can create settings that might be attractive or mysterious, inviting, or secluded, secure-feeling or foreboding. With buildings and spaces being used during more hours of the day and night, good site lighting design becomes as important as good building lighting design.

Outdoor lighting, like all artificial illumination, is based on an understanding of light principles and the specification of luminaires that meet one's objectives. A luminaire is defined by the Illuminating Engineering Society of North America (IESNA) as "a device to produce, control, and distribute light. (It is) a complete lighting unit consisting of the following components: one or more lamps, optical devices designed to distribute light, sockets to position and connect the lamps to a supply of electric power, and the mechanical components required to support or suspend the housing above grade."

CONTINUING EDUCATION



Use the learning objectives below to focus your study as you read **Site Lighting: Optical Systems Design and Application Guide for Site and Roadways**. To earn one AIA/CES Learning Unit, including one hour of health, safety, welfare credit, answer the questions on page 268, then follow the reporting instructions on page 347 or go to the Continuing Education section on archrecord.construction.com and follow the reporting instructions.

LEARNING OBJECTIVES

After reading this article, you should be able to:

- Identify the lighting requirements in each area of site lighting
- Describe different methods to direct light toward intended areas or away from areas not to be illuminated
- Describe lighting distribution types and how they are best suited for lighting outdoor environments
- Explain how isofootcandle plots are used to design site lighting

From a pure lighting standpoint, the main items that differentiate luminaires are the internal optical system and the lamp (bulb) unit. The function of an optical system is to direct light energy emitted by the lamp into desirable areas. This function can be accomplished through reflection, diffusion, baffling, refraction, or transmission through a lens. Lamp placement within the luminaire also plays a significant role in determining optical system performance. Using the lamp's natural distribution pattern to its greatest advantage produces the most effective optical designs. For example, a horizontal lamp orientation produces asymmetric light distribution patterns, while vertical lamp orientation produces a strong symmetric pattern. Reflector and lens designs that enhance these characteristics produce the most efficient results.

IESNA also identifies performance and design considerations as follows, "Luminaire performance can be considered a combination of photometric, electrical, and mechanical performance. Photometric performance of a luminaire describes the efficiency and effectiveness with which it delivers the light produced by the lamp to the intended target." Luminaire manufacturers need to consider a wide variety of factors in designing and producing their products. Architects and other design professionals need to be aware of fundamental criteria in designing lighting layouts and specifying luminaires for use on their projects.

I. SITE LIGHTING AREAS AND DESIGN INTEGRATION

Any given building site usually has differing uses and conditions—each has differing lighting requirements as well. Therefore, meeting the diverse needs of site illumination requires a variety of different solutions that can be coordinated and integrated to complement the building design. Such an integrated site lighting design begins with first identifying the specific lighting requirements for each portion of the site, then selecting luminaires that combine appropriate aesthetic design with relevant lighting performance features.

Conceptually, project sites can be classified into four basic lighting areas; roadways, open areas, pedestrian areas, and the site perimeter, each representing a unique set of lighting circumstances, as described below and shown in Figure 1.

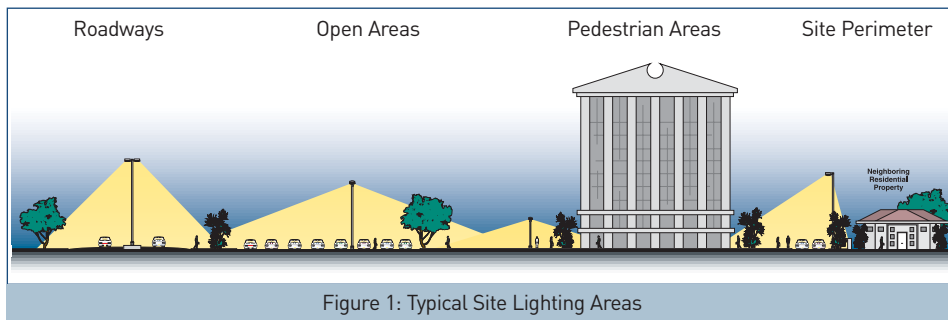


Figure 1: Typical Site Lighting Areas

1. Roadways

Lighting for roadways, including private drive lanes, usually requires uniform light distribution and glare control with wide pole spacings to minimize the total number of luminaires needed. Luminaire selection criteria include overall performance, consideration of maintenance, lamp choices influenced by utility or owner interests, and the ability to remain in service for long periods with minimal attention. Reflectors and optical designs within the luminaires include an array of possible light distribution patterns in order to illuminate varied roadway widths and traffic patterns with narrow perpendicular and wide lateral beam spreads.

2. Open Areas

Lighting of open areas requires careful consideration of illumination requirements, uniformity, and brightness control. These areas are usually subject to scrutiny relevant to the safety and security of site occupants and the interaction between vehicle and pedestrian traffic. Parking areas and connecting walkways, in particular, are a potential source of litigation and liability for the project owner, requiring accurate prediction of illumination levels and dependable performance. In order to optimize visibility for all users, it is important to control illumination levels, uniformity of light distribution, and glare. At the same time, an economical layout will be based on maximizing the spacing of luminaires.

3. Pedestrian Areas

The transition between the surrounding site and the building itself defines the pedestrian area, including plazas, courtyards, and pathways. These spaces require the widest range of lighting solutions since they combine the concerns of open areas and the integration of luminaire appearance

with the building's architectural design. Luminaires in this area are usually highly visible, requiring attention to finish quality and detail. Illumination of irregularly shaped spaces, and a need to control stray light, requires optical diversity, particularly since fixture placement may be influenced by aesthetic concerns. Ideally, if the appearance and design components of the luminaires specified in these areas are shared with other site luminaires, the integration of the lighting system for the entire site is enhanced.

4. Site Perimeter

Lighting the site perimeter includes requirements to control or eliminate illumination from "trespassing" onto adjacent properties.

Light trespass ordinances, and courtesy to neighboring property occupants, require tight control of light emitted behind the luminaire. Efficient design satisfies some of this demand, while optics inside the luminaire that cut off light distribution in certain areas provide an additional level of control. House-side shields may also be required to provide even tighter control by trimming the distribution pattern. These concerns must be satisfied, of course, without affecting overall system performance.

Any given building site usually has differing uses and conditions—each has differing lighting requirements as well.

II. PHOTOMETRY INFORMATION

The design of site lighting requires an understanding of the unique information used to represent elements of optical performance. Photometry, or the measurement of light intensity and relative illuminating power, is the foundation on which any evaluation of luminaire performance is based. Use of independent testing labs to conduct the measurements and compile the information ensures that the photometry information is accurate and reliable.

Basic Language and Presentation

In order to properly select luminaires appropriate to the specific locations and requirements of a building site, an understanding of some of the basic language and ways that information is presented is required.

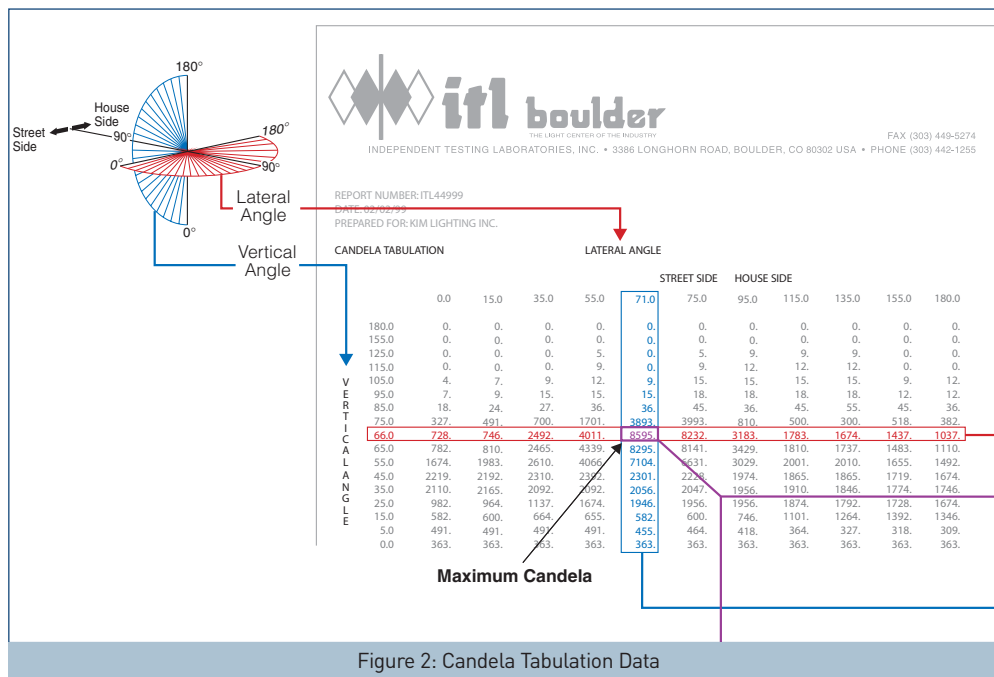


Figure 2: Candela Tabulation Data

Candela Tabulation

One of the fundamental units of measurement is the candela, which in 1979 became the international standard to define luminous intensity. Figure 2 shows a typical candela tabulation data sheet prepared by an independent lab with a luminaire orientation diagram for reference.

The Candela Tabulation Data Sheet presents the raw data used for all illuminance calculations and is tabulated with the vertical angles in rows and lateral angles in columns. As the diagram indicates, lateral values from 0° to 90° are in front of the luminaire and referenced as “Street Side.” Lateral values from 90° to 180° are behind the luminaire and referenced as “House Side.”

Vertical values from 0° to 90° are below the fixture, while values 90° to 180° are at the fixture level and above. As we will see, candela data is also used to define a luminaire’s light distribution type and cutoff characteristics.

Footcandle Calculations

The data provided in Candela Tabulation Data Sheets is used to calculate footcandle levels within a proposed lighting design. Generally, this is accomplished by using computers to make calculations, which are, in turn, dependent upon the accuracy of the data. Figure 3 illustrates the relationship of the calculated illumination at a single point to the information provided in the candela tabulation. (See Figure 7 later in this article for the correlating location on an isofootcandle plot.)

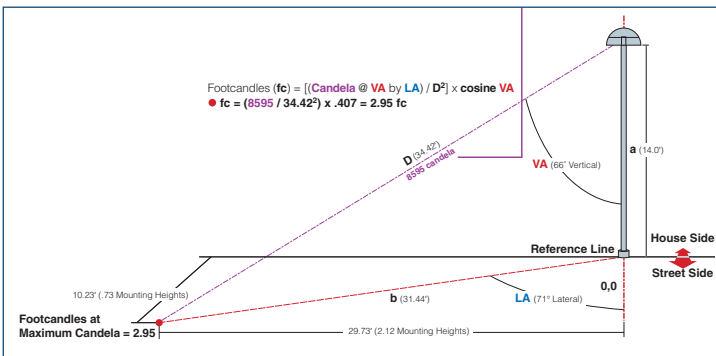


Figure 3: Footcandle representation based on Candela Tabulation Data

Candela Plots

Candela plots are graphical representations of candela tabulation data (figure 2). Outdoor lighting produces unique light patterns which are difficult to represent in a flat two-dimensional plane. Therefore, to create distribution plots that illustrate luminaire performance, curves are plotted with a three-dimensional dynamic. An example, based on the candela tabulation data above, is presented in the charts shown in Figure 4.

Using the tabulated maximum candela value, which in this example is 8595, two planes are identified: a lateral angle of 71°, and a vertical angle of 66°. The vertical angle is used to create a cone, with its slope equal to the vertical angle of maximum candela (66°). On this cone, all lateral candela distribution values from the tabulated data row at 66° are plotted. The result is shown on the right side of the cone chart. The two-dimensional view looks down at the top of the constructed cone.

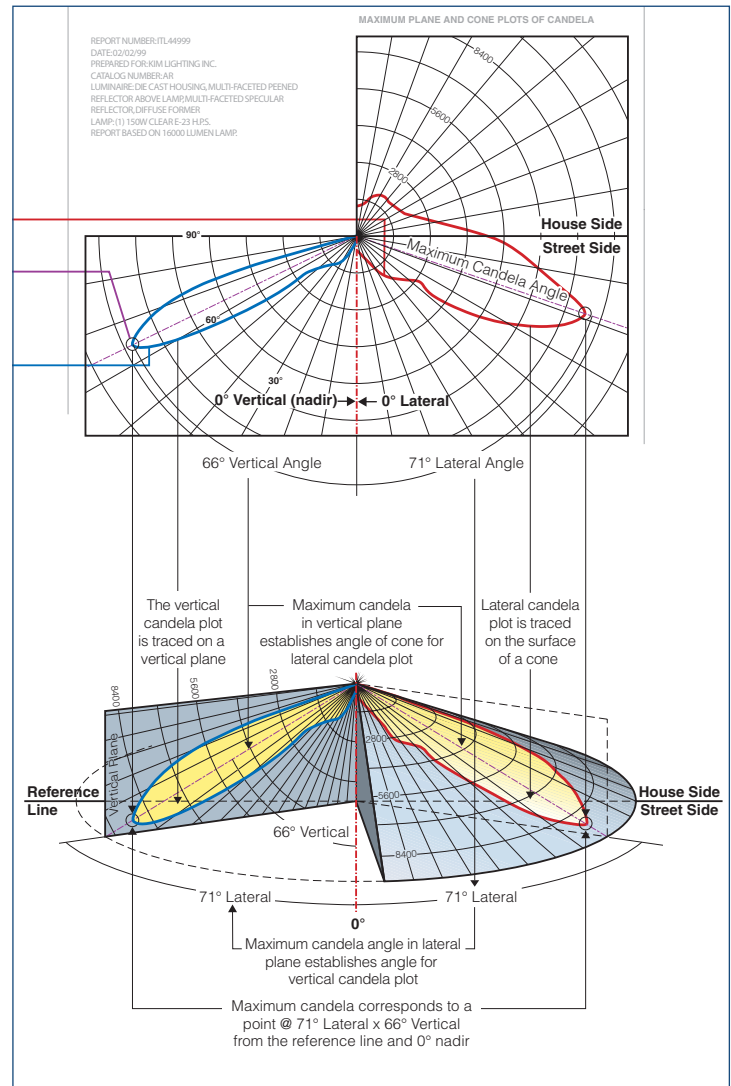


Figure 4: Maximum Plane and Cone Plots of Candela

The second value, the lateral angle of 71°, is used to construct a vertical plane off the lateral baseline. The result is shown on the left side of the cone chart. On this surface, all vertical candela distribution values from the tabulated data column at 71° are plotted. For purposes of presenting the plot, the vertical plane is flattened, or laid back 90°, to show it in the same plane as the right side plot.

The chart is also shown in a perspective view, to help visualize the relationship between the two plotted curves. The combination of the two curves represents luminaire performance in three dimensions.

III. LIGHT DISTRIBUTION PATTERNS

Outdoor luminaires produce lighting patterns that can be identified first by their reach in front of a single fixture location and second by their reach on each side of that location. “Distribution types” describe the reach of the luminaire’s light pattern forward of each fixture, while “distribution ranges” define the reach to either side.

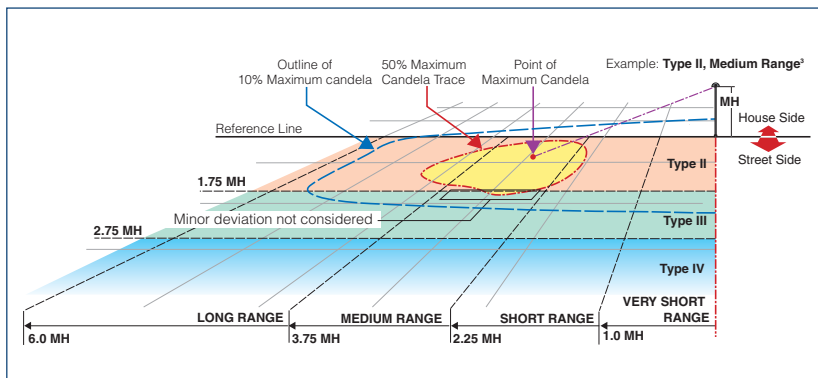


Figure 5: Grid and light patterns to determine Distribution Type

Distribution Types

(Refer online for example illustrations of each Distribution Type).

The term "distribution type" defines how far forward of the luminaire (i.e., on the street side) the effective output reaches. The specific classification of distribution types is based on locating the luminaire's effective major output pattern on a grid representing distances in units of Mounting Height (MH) from the luminaire. This pattern is defined by tracing an area representing light distribution at 50% of maximum candela. By measuring where the bulk of this pattern falls on the grid, a luminaire can be classified as follows and as shown in Figure 5. Refer to illustrations of definitions online. (Note that in some cases, minor deviations in a beam pattern may cross the boundary from one type into another. While this has a nominal effect on applied performance, it should not be considered for classification purposes.):

- **Type II** defines shallow reaches, when the 50% maximum candela trace lies within 1.75 MH on the street side of the reference line.⁴
- **Type III** is a mid-range, when the 50% maximum candela trace lies within 2.75 MH on the street side of the reference line.⁴
- **Type IV** identifies luminaires with a definite forward-throw distribution, when the 50% maximum candela trace lies beyond 2.75 MH on the street side of the reference line.⁴
- Distribution is classified as **Type V Square** for horizontal lamp luminaires when the 50% maximum candela trace is symmetric in four quadrants. This distribution is characterized by four candela peaks, diagonal to the reference line.
- **Asymmetric^{5,6} Distribution** (similar to Type III): This distribution is for vertical lamp luminaires when the 50% maximum candela trace lies beyond 1.0 MH on the street side of the reference line, and inside 1.0 MH on the house side of the reference line. Narrow range distribution is identified when the point of maximum candela falls inside of 2.25 MH; wide range is identified when the point of maximum candela falls beyond 2.25 MH.
- **Symmetric^{5,6} Square Distribution** (similar to Type V Square): Distribution is classified as symmetric square for vertical lamp luminaires when the 50% maximum candela trace is symmetric in four quadrants on both street and house side of the reference line. Narrow range distribution is identified when the candela peaks fall inside of 2.25 MH along the reference line; wide range is identified when the candela peaks fall beyond 2.25 MH.

Distribution Range

Distribution range defines how far the distribution pattern reaches laterally, perpendicular to the axis used to identify general type. The ranges used are defined as follows and indicated graphically in Figure 5.

Long Range: A distribution is identified as long range when the point of maximum candela lies from 3.75 to 6.0 MH from the luminaire's centerline, along the reference line.

Medium Range: A distribution is identified as medium range when the point of maximum candela lies from 2.25 to 3.75 MH from the luminaire's centerline, along the reference line.

Short Range: A distribution is identified as short range when the point of maximum candela lies from 1.0 to 2.25 MH from the luminaire's centerline, along the reference line.

Very Short Range²: A distribution is identified as very short range when the point of maximum candela lies from 0 to 1.0 MH along the reference line.

Distribution types only generally describe a distribution pattern. To establish the suitability of a luminaire for a specific application, an evaluation must be completed using actual photometric data for the specific fixture and lamp combination being considered.

IV. CUTOFF

Beyond distribution and range, luminaires are defined by how well they control or cut off light at selected vertical angles. Typically this reference point is referred to as zero degrees vertical or "nadir". Designs without significant cutoff characteristics distribute light in zones unlikely to contribute to useful visibility, contribute to light pollution, and are inefficient.

"Distribution types" describe the reach of the luminaire's light pattern forward of each fixture, while "distribution ranges" define the reach to either side.

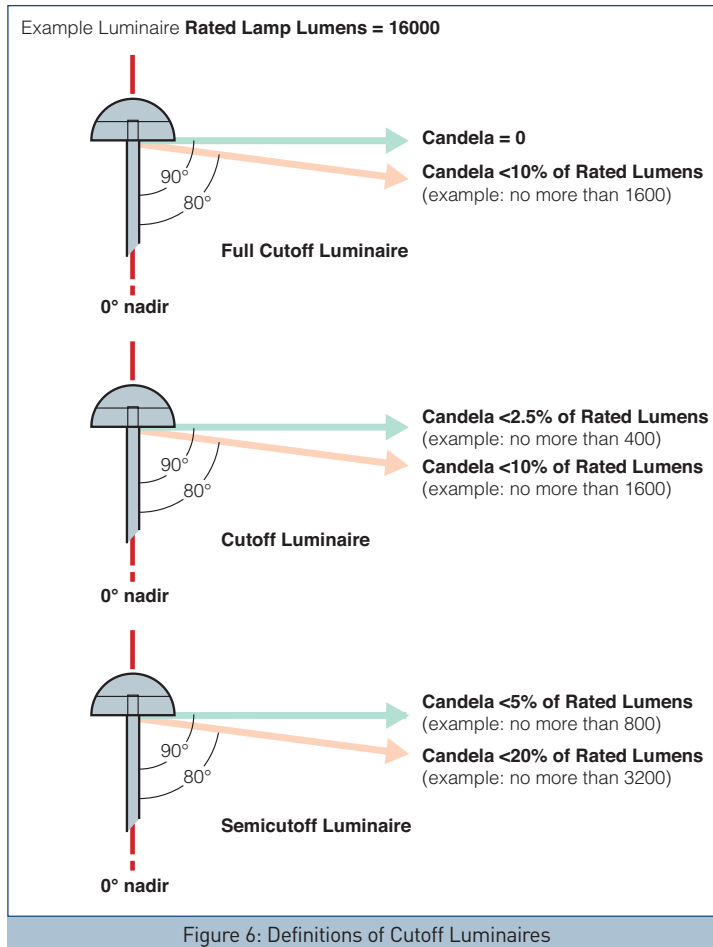


Figure 6: Definitions of Cutoff Luminaires

...Cutoff is based on what proportion of a luminaire's output is being distributed at 80° and 90° above nadir.

Definitions

The definition of **cutoff** is based on what proportion of a luminaire's output is being distributed at 80° and 90° above nadir. See figure 6 for graphic examples of some of the luminaire cutoff types defined below. (Extracted from IES Publication RP33-99 (2/99))

Noncutoff

A luminaire's light distribution is designated as noncutoff when there is no limitation of illumination in any zone.

Full Cutoff

A luminaire's light distribution is designated as full cutoff when the candela at 90° above nadir is 0 and less than 10% of rated lamp lumens at 80° above nadir.

Cutoff

A luminaire's light distribution is designated as cutoff when the candela at 90° above nadir is less than 2.5% of rated lamp lumens, and less than 10% of rated lamp lumens at 80° above nadir.

Semicutoff

A luminaire's light distribution is designated as semicutoff when the candela at 90° above nadir is less than 5% of rated lamp lumens, and less than 20% of rated lamp lumens at 80° above nadir.

Example:

A luminaire with tested data showing a total of 16,000 Rated Lamp Lumens has a candela tabulation that produces 18 candela at 90° (<2.5% of Rated Lumens) and 55 candela at 80° (<10% of Rated Lumens). These values fall within the defined ranges shown in Figure 6, classifying this as a cutoff luminaire.

VI. ISOFOOTCANDLE PLOTS

Isofootcandle plots are a common tool for evaluating and comparing different luminaires for a given application. These plots are often provided by luminaire manufacturers for architects and engineers to use in selecting and specifying appropriate lighting products. An example is shown in Figure 7.

Usage

Isofootcandle plots graphically represent a particular luminaire's lighting pattern, in illuminance, as the light strikes a horizontal surface. These plots are scalable as they are represented in mounting height increments. An approximation of pole spacings required to attain a desired light level can easily be determined from the information provided. These plots also provide a productive tool for the comparison of various luminaires. The easily read visual reference indicates beam patterns graphically, where other information (such as candela tabulations and isocandela curves) may be less clear.

Conventions

Isofootcandle plots include footcandle calculations shown with the luminaire at various mounting heights. Contour lines are drawn through illuminance values. Each contour, from the center out, represents approximately 50% of the value of the previous contour. The plot of contours is placed over a grid indicating mounting height divisions to demonstrate the luminaire's applied performance.

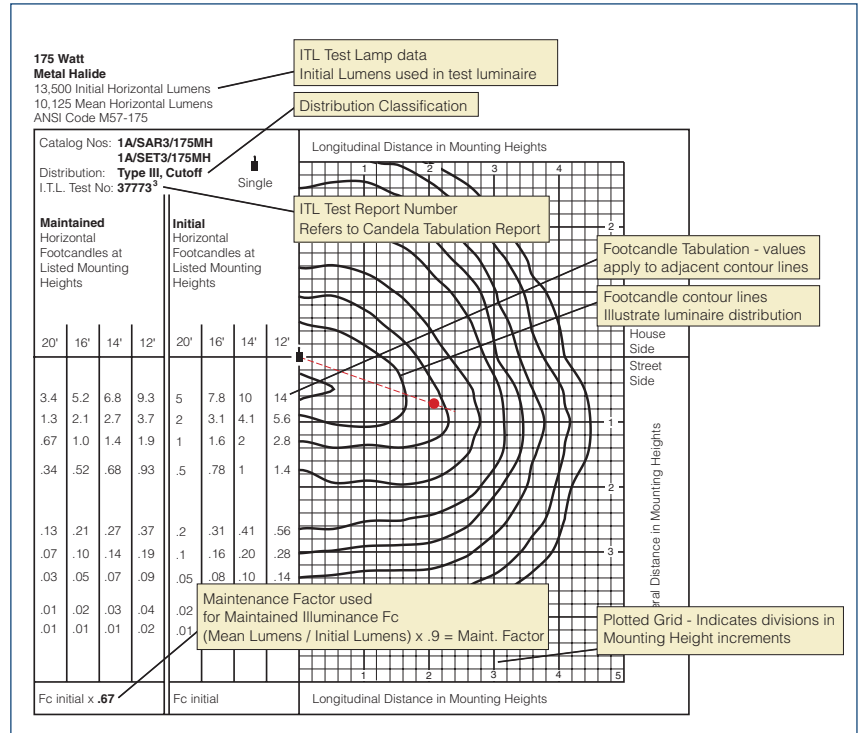


Figure 7: Elements of a typical Isofootcandle plot

Estimated Spacing and Uniformity

As early as the schematic design phase of a project, isofootcandle plots can be used for rough luminaire layouts for site lighting.

EXAMPLE: Refer to the isofootcandle plot in Figure 8 and assume a desired minimum initial illuminance of 2.0fc, using luminaires mounted on 14' poles. To estimate a fixture layout, start from the perimeter, where the 2.0fc isofootcandle trace crosses the reference line, to establish the maximum single fixture distance to the site perimeter (1.6 MH). In order to attain the minimum illuminance (2.0fc) between fixtures, the 1.0fc traces of two fixtures must intersect at the site perimeter and interior. Therefore, lateral spacing is determined where the 1.0fc trace intersects the reference line (2.2 MH), and maximum forward spacing is identified where the lateral spacing line intersects the 1.0fc trace on the street side of the luminaire (1.8 MH). These two dimensions indicate the mid-points between luminaires, in mounting heights. Multiplying these mounting height (MH) dimensions by the pole height (14') defines the maximum luminaire spacings in both directions. In this example, 60' (4.4 MH x 14') x 50.4' (3.6 MH x 14').

Approximate Illuminances and Uniformity

By overlaying isofootcandle plots, a rough idea of illuminances can be determined by adding the values of each contour where they intersect as shown in the lower portion of the example in Figure 8. Through observation of the overlapping of the isofootcandle plots, approximate uniformity can also be estimated. More accurate calculations (computer generated evaluations) will generally return levels higher than those achieved using this method, as smaller contributions from every adjacent luminaire would be included.

VII. APPLICATION IN DESIGN

Distribution Pattern Uses

Ideally, all light energy produced would be focused into desired lighted zones with

no wasted energy being directed elsewhere. This would require an infinite array of distributions, and the ability to tune them to every site condition. While this is not realistic, the combination of careful luminaire selection, mounting height, and luminaire placement can produce very efficient designs, using just four basic distribution patterns, as shown in

Figure 9. For each of the basic distributions, variations such as range and the characteristics of horizontal vs. vertical lamp optics produce additional choices. Further fine tuning can be attained with house-side shields and reflector orientation. ■

CLICK FOR ADDITIONAL REQUIRED READING

The article continues online at <http://archrecord.construction.com/resources/conteduc/archives/0512kim-1.asp>

To receive AIA/CES credit, you are required to read this additional text. For a faxed copy of the material, contact: MJ Paul (626) 968-5666 or email: mjpaul@kimlighting.com


 AIA/ARCHITECTURAL RECORD
CONTINUING EDUCATION Series

LEARNING OBJECTIVES

After reading this article, you should be able to:

- Identify the lighting requirements in each area of site lighting
- Describe different methods to direct light toward intended areas or away from areas not to be illuminated
- Describe lighting distribution types and how they are best suited for lighting outdoor environments
- Explain how isofootcandle plots are used to design site lighting

INSTRUCTIONS

Refer to the learning objectives above. Complete the questions below. Go to the self report form on page 347. Follow the reporting instructions, answer the test questions and submit the form. Or use the Continuing Education self report form on *Record's* web site—archrecord.construction.com—to receive one AIA/CES Learning Unit including one hour of health, safety, welfare credit.

QUESTIONS

1. Site lighting is classified into what four basic areas?
 - a. Long, medium, short, and very short
 - b. Building areas, shopping centers, courtyards, and path areas
 - c. Roadways, open areas, pedestrian areas, and site perimeter
 - d. Type II, Type III, Type IV, and Type V areas
2. Candela data is used:
 - a. to define a luminaire's distribution type
 - b. to define cutoff characteristics
 - c. for all illuminance calculations
 - d. all of the above
3. _____ areas require careful consideration of illuminance requirements, uniformity, and brightness control.
 - a. Heavy traffic areas
 - b. Wide areas
 - c. Open areas
 - d. Walk areas
4. What do distribution types describe?
 - a. the reach of the luminaire's light pattern forward of each fixture
 - b. the reach of the luminaire's light pattern behind each fixture
 - c. the reach of the luminaire's light diagonal to the reference line
 - d. the reach of the luminaire's light centerline, along the reference line
5. Type II Distribution is when the 50% maximum candela trace lies within _____ MH (Mounting Height) on the street side of the reference line.
 - a. 1.75 MH
 - b. 2.25 MH
 - c. 2.75 MH
 - d. 3.75 MH
6. What does distribution range describe?
 - a. how well luminaires control light at angles above 80° from nadir
 - b. how far the distribution patterns provide maximum pole spacing in both lateral and longitudinal directions
 - c. how distributions are well suited for site / area perimeters, wide roadways, and open areas
 - d. how far the distribution pattern reaches laterally, perpendicular to the axis used to identify general type
7. When is a distribution identified as Very Short Range?
 - a. When the point of maximum candela lies from 3.75 to 6.0 MH from the luminaire's centerline, along the reference line
 - b. When the point of maximum candela lies from 2.25 to 3.75 MH from the luminaire's centerline, along the reference line
 - c. When the point of maximum candela lies from 1.0 to 2.25 MH from the luminaire's centerline, along the reference line
 - d. When the point of maximum candela lies from 0 to 1.0 MH along the reference line
8. What is cutoff based on?
 - a. the proportion of a luminaire's output distributed at 90° and 90° above nadir
 - b. the proportion of a luminaire's output distributed at 80° and 90° above nadir
 - c. the proportion of a luminaire's output distributed at 80° and 80° above nadir
 - d. the proportion of a luminaire's output distributed at 90° and 80° above nadir
9. When is a light distribution designated as cutoff?
 - a. When the candela at 90° above nadir is less than 2.5% of rated lamp lumens, and less than 10% of rated lamp lumens at 80° above nadir
 - b. When there is no luminous limitation in any zone
 - c. When the candela at 90° above nadir is less than 5% of rated lamp lumens, and less than 20% of rated lamp lumens at 80° above nadir
 - d. When the candela at 90° above nadir is 0 and less than 10% of rated lamp lumens at 80° above nadir
10. What do isofootcandle plots represent graphically?
 - a. the luminaire's lighting pattern at various mounting heights
 - b. the luminaire's lighting footcandle levels within a proposed lighting design
 - c. the luminaire's requirements to control illumination onto adjacent properties
 - d. the luminaire's lighting pattern as it hits a horizontal surface



For the past 70 years, Kim Lighting has produced innovative, architecturally relevant, performance oriented lighting products designed for the outdoor environment. Kim combines high performance optical systems, the highest quality materials, the latest manufacturing technologies and practices to complement the architecture in a variety of applications. Kim Lighting is the recognized industry leader in outdoor lighting products that include roadway, area, site, pedestrian area, pathway landscape, building mounted, and parking garage lighting applications.

CIRCLE 86 ON READER SERVICE CARD OR GO
TO ARCHRECORD.CONSTRUCTION.COM/PRODUCTS/

The sample site plan in Figure 10 shows how the combination of these four basic distribution patterns are used to direct light energy into the lighted zones.

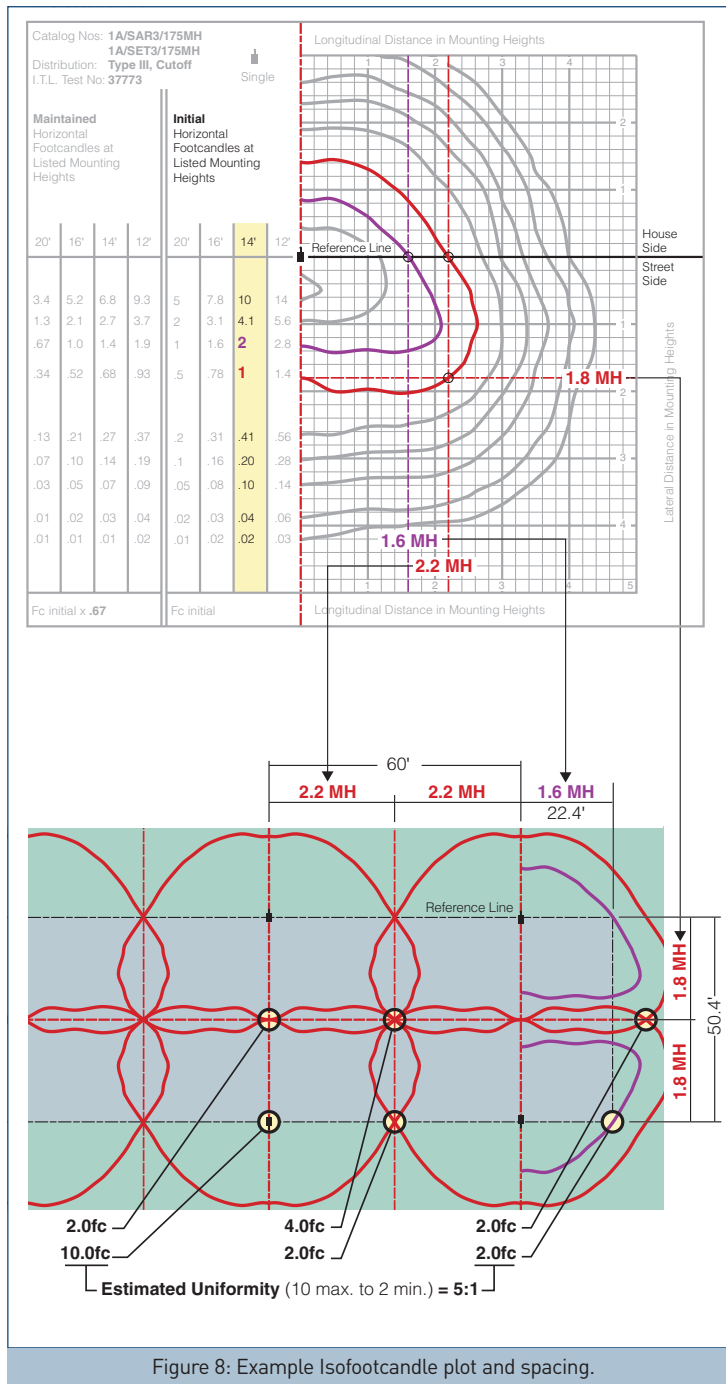


Figure 8: Example Isofootcandle plot and spacing.

Important Features for Fine-Tuning Designs

Lamp Orientation: Horizontal lamp orientation provides the greatest control over lateral distribution. The normal lamp distribution is very well suited for asymmetric as well as square symmetric distribution. Horizontal lamp orientation produces relatively small arc tube exposure to high distribution angles. This produces a superior cutoff characteristic.

Vertical lamp orientation subjects the greatest portion of the lamp's output to control by the reflector system, producing optimal vertical distribution control. This orientation

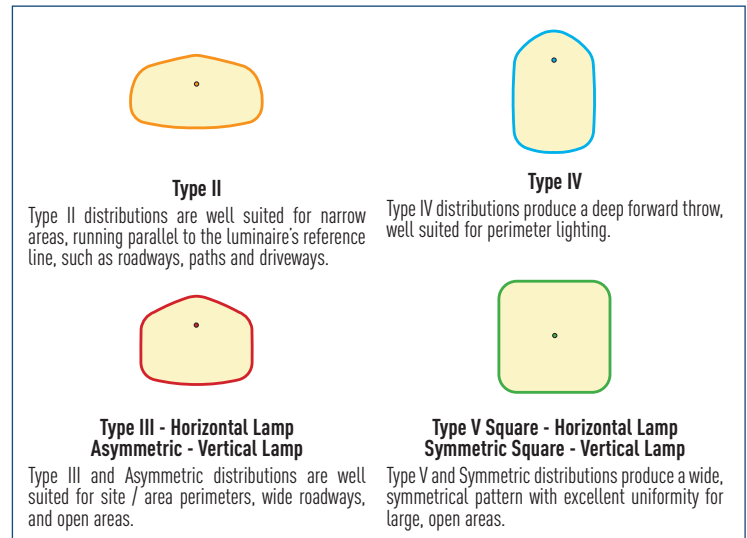


Figure 9: Four basic distribution patterns.

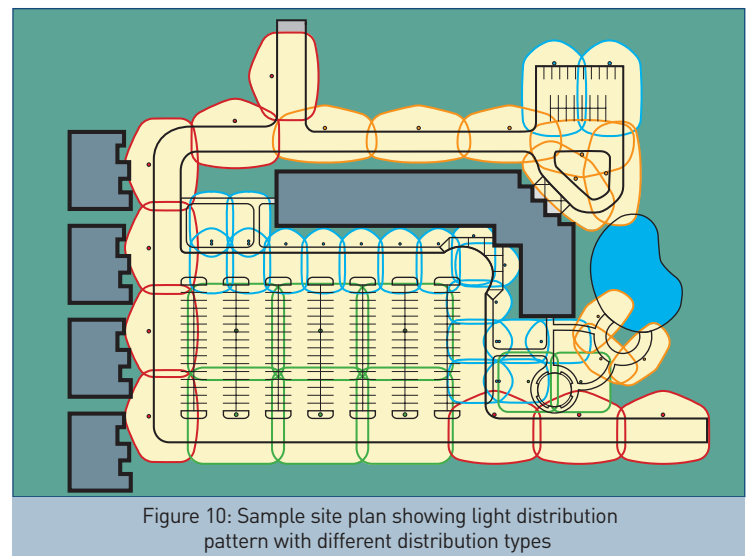


Figure 10: Sample site plan showing light distribution pattern with different distribution types

provides less control over lateral output, favoring symmetric distribution patterns. Vertical lamp orientation also takes advantage of the higher lumen output produced by a vertical arc tube positioning.

Square vs. Round Distribution: For large areas, symmetric distributions provide maximum pole spacing in both lateral and longitudinal directions. Round distributions, however, do not reach well diagonally between pole locations, reducing uniformity and requiring shorter distances between luminaires. Square distribution patterns are specifically engineered to maximize pole spacing by improving uniformity diagonally between fixture locations. As shown in Figure 11, a typical round pattern produces poor diagonal overlap, requiring tighter pole spacing to maintain acceptable uniformity. A Type V Square Pattern provides improved diagonal overlap allowing wider pole spacing while maintaining excellent uniformity.

House-Side Shields: When luminaires are located close to structures, or areas where the illumination emitted on the house-side of the reference line is objectionable, house-side shields offer additional cutoff control. These devices essentially trim light emitted by the lamp, as well as light reflected from within the optical system. These are applied to Type II, Type III and Type IV (horizontal lamp) and Asymmetric (vertical lamp) optical systems

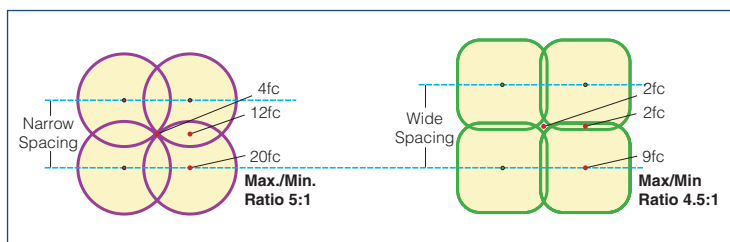


Figure 11: Typical Round vs. Square Overlap patterns

only as shown in Figure 12. House-side shields are not applied to Type V or Symmetric optical systems, as the shields will not function properly in these systems.

It should be noted that the effects of lamp orientation and lens configuration on house-side shields are dramatic. Main reflector distribution, street-side reflector brightness, and direct lamp visibility are factors that determine the effectiveness of house-side shields in reducing unwanted brightness on the house-side of the optical system. Horizontal lamp orientation presents the greatest challenge in designing effective shielding. Convex lenses allow more effective control, as the shielding device is able to better control direct arc tube brightness. Vertical lamp orientation provides even greater control, as the arc tube is already deeper in the optical system.

Reflector Orientation/Rotatable Optics

Orientation of luminaires is often controlled by available pole locations and a product's aesthetic design. The luminaire's head, arm, or yoke, however, may dictate an orientation that varies from the desired optical orientation. The ability to rotate optical systems provides a high degree of flexibility to tailor luminaire performance to specific applications,

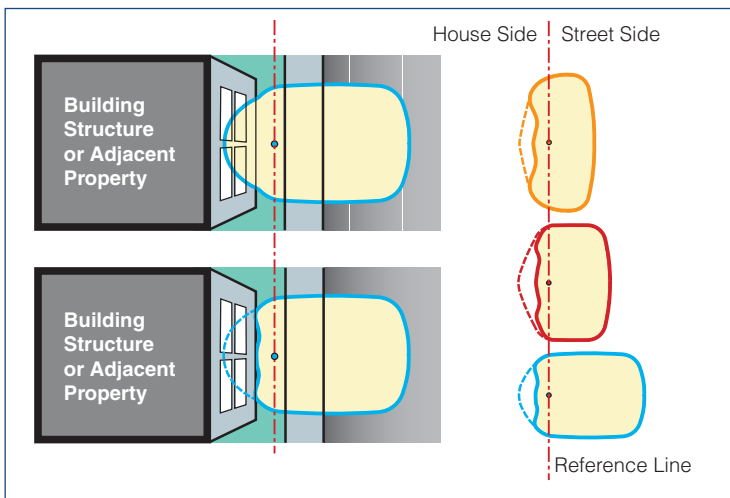


Figure 12: House-side shields for cutoff and light control for different types of luminaires

while maintaining the aesthetic continuity of the luminaires used. The combination of optical distributions in multiple luminaire applications produces additional unique "footprints," creating customized performance and/or increased illumination levels to suit a very wide range of needs. Figure 13 shows just a few examples based on a simple twin mounting arrangement.

Footnotes:

1. ITL Reports using IES guidelines consider any crossing of the identified boundaries as definition of overall type, regardless of its impact or significance to applied performance. Classifications indicated do not consider minor deviations in classification of type shown.

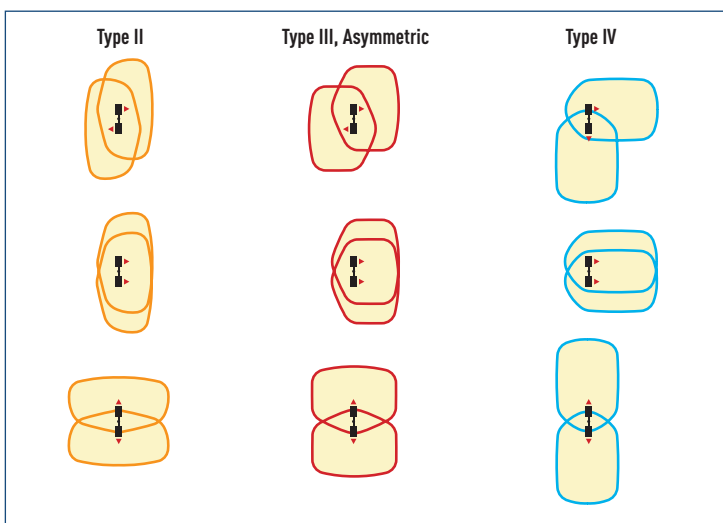


Figure 13: Examples of optics that can be rotated within luminaires

2. The "Very Short Range" identification is not an IES standard definition, but is used by ITL to identify distributions with ranges inside the 1.0 MH allowed in the "Short Range" definition established.
3. Information shown is for illustrative purposes only and does not represent a specific luminaire's performance.
4. Definition is extracted from IES Lighting Handbook, 8th edition.
5. Definition has not been identified by the IES at this time. Definition shown is based on Kim Lighting research and development efforts and engineering of optical systems to improve applied performance.
6. Distribution may be classified by ITL, using IES standard practices, as a Type IV distribution, due to a small portion of the 50% isocandela trace falling beyond the 2.75 MH line. This aberration in classification methodology conflicts with luminaire applied performance. Classification indicated more accurately represents actual luminaire usage.

CASE STUDY

The expansion and beautification of the Minneapolis Community & Technical College (MCTC) parking ramp.

Bentz/Thompson/Rietow (BTR), Architects-of-Record

The Minnesota State Colleges and Universities system (MnSCU) gained control of the MCTC and its associated power plant and parking ramp. However, the parking ramp, having had no true upgrades to its exterior and having had a less than urban-friendly original design, became known as a blight on the area, poorly representing the college and the site's importance. The original ramp, built in 1978 for the Minneapolis Public School system, was one of the first major public design/build projects. The original design, while inventive in the use of long-span precast concrete wall panels, did little to harmonize with its surroundings and little to respond to the importance of the site, which is truly a spectacular location. The ramp is located on the major public thoroughfare through downtown, Hennepin Avenue. This roadway has historically been one of the storied streets in the city; it is the gateway to the city from the west and crosses the Mississippi River to the east, and is known as the entertainment avenue for the city. After a decline in the area that lasted several decades, this downtown street has once again established itself as a major theater district with numerous eating establishments, clubs, bars, and plenty of nightlife.

Early on, the design team resolved that the project needed to reinforce the urban edge. The team also posited that the ramp should have a dynamic façade response that could change from night to day and could respond to differing light and climate conditions. In order to balance the need for an increased height/mass of the façades with the budget, the team

began working with the concept of light structures that would provide a layering effect and serve as a theatrical scrim. The material had to be light yet strong, beautiful yet inexpensive, durable yet open enough to provide a safe environment for patrons. Heavily anodized, swaged aluminum floor grating was used because it met all of the design criteria. This material was used in a vertical application for the light columns that march down Hennepin Avenue. The same material was used in horizontal application to serve as the background scrim for the façades. Mullionless channel glass was used at the main stair towers to provide natural light into the stairs and to serve as urban-sized lanterns along the façade.

The design drastically improves the image of the structure during the day and, by using materials similar to ones used on the adjacent campus, finally makes the structure seem to be part of the same institution. The gentle curves at the cornice of the scrim and the bay spacing/proportions of the light columns recall heights, proportions, and details of an adjacent basilica. The ramp takes a background role to the basilica during the day. At night, the ramp takes on a special presence; it becomes a glowing, theatrical piece that calls attention to the campus and serves as a distinct gateway to city and the entertainment district.

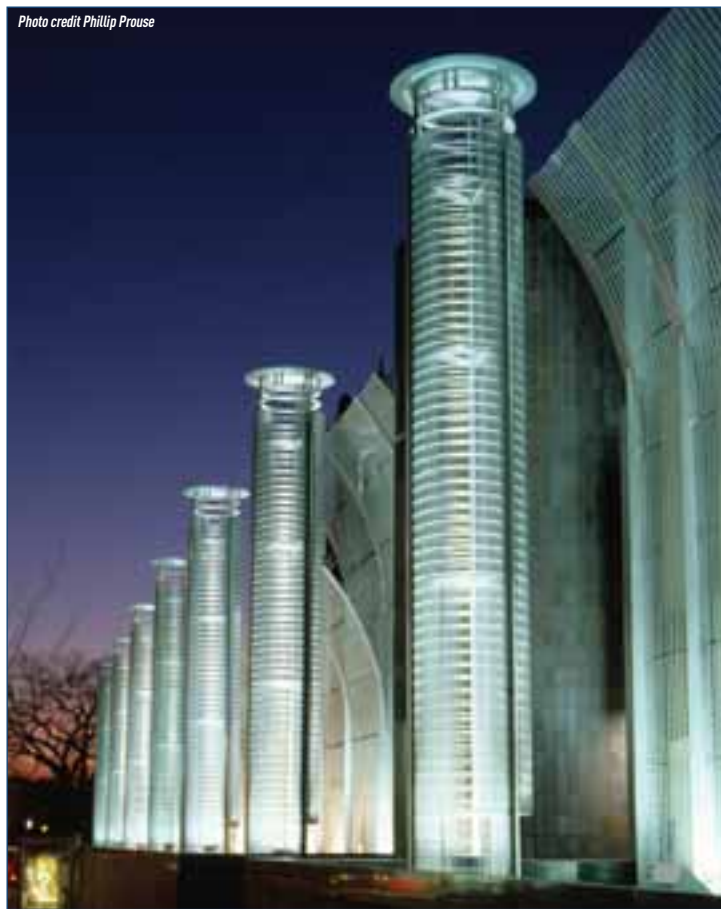


Photo credit Phillip Prouse

Figure 14: Photo of MCTC Parking ramp lit at night.

Exterior lighting design was crucial to the success of the project. The team realized that lighting and material had to be synthesized in such a manner that would leverage the design intent without incurring large construction costs. Because the existing ramp had drastically different perimeter conditions in relationship to the scrim motif, the team needed fixtures that could be mounted in a variety of conditions while still having the same photometric distribution on the scrim. The result of this creative and collaborative design can be seen in Figure 14 (Photo credit Phillip Prouse).

According to Gary F. Milne Rojek, AIA Principal at BTR, "Designers need to understand what surfaces are going to be lit, what level of illumination is desirable, what amount of spread and control is required, and how to coordinate with other lighting on the project. On our ramp project, it was extremely important for us to illuminate the horizontally oriented grating in a very uniform and white light. The uplighting that was used had a very wide and uniform distribution that evenly illuminated the horizontal bars yielding the design intent of a theatrical scrim. The curvature of the grating at the top of the bands provides a subtle variation in reflectance. On the vertically oriented column grating, much narrower spread fixtures were used in order to emphasize the column elements in front of the scrim. Both of these design concepts had to be balanced with the distribution and color range of the standard ramp downlights."

The building owner has high praise for the results. Sally Grans, AIA, Director of Facilities Planning and Programming at MnSCU notes, "Other people need to see just how plain beautiful this once-ugly duckling parking ramp has now become a jewel! It is rare to see lighting as a work of art and this parking ramp is now truly artful. My only concern is that people don't get into car accidents as they slow down to look at it!"

Security Commentary

Security and site lighting often go hand in hand. There are some specific details that can help to ensure increased levels of security (and the perception of security).

Martha J. Droge, an Associate at Ayers/Saint/Gross in Baltimore, was a police officer before becoming a landscape architect. She writes and speaks often about site security and offers the following points:

- Metal halide lights render the vertical plane visible at a nearer distance than sodium lamps. This is important from a security perspective because the vertical plane is where the human face and hands are revealed as one approaches a person. Seeing the face and hands as soon as possible increases a pedestrian's sense of safety and aids security personnel when patrolling an area.
- Depending on the technology, CCTV cameras and/or night vision aids can be thrown off by bright lighting. Obviously, the lighting plan and the security technology/perimeter surveillance plan should be well-coordinated.
- A lighting plan for a large complex of buildings or campus should designate certain routes as primary pedestrian routes after dark. Depending upon the circumstances, the primary routes might be the most direct paths between major spaces or parking lots, or the paths that keep pedestrians near safe, after-dark activity areas (buildings with people coming and going, security patrols, positive night life activities, etc.). Primary paths should receive excellent comprehensive lighting and welcoming landscapes as cues to pedestrians to take those paths after dark. Secondary after-hours routes may have lighting for basic safety, but pedestrians should be directed to the primary routes after dark through coordination with campus maps and directions from campus representatives.

Keeping some of these points in mind when preparing an overall site lighting plan and layout can go a long way toward improved security conditions in outdoor settings.

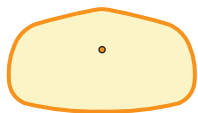
Peter J. Arsenault, AIA, NCARB, LEED-AP is an architect and consultant focused on green building and sustainable community planning, based near Syracuse, NY.

About the article sponsor: **Kim Lighting** is known throughout the world as the premier designer and manufacturer of quality, high performance, architecturally relevant, outdoor lighting solutions. Kim has designed and manufactured outdoor lighting products for over seven decades and now occupies more than 400,000-square feet of factory space in the

City of Industry, Ontario, and La Mirada, California employing over 600 people. Kim owes a great deal of its success to the core values established by its founder, F.B. Nightingale;

innovate, educate, and never compromise quality. Kim Lighting, "The Ultimate in Architecturally Relevant Outdoor Lighting." Learn more at www.kimlighting.com.

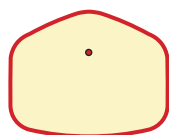
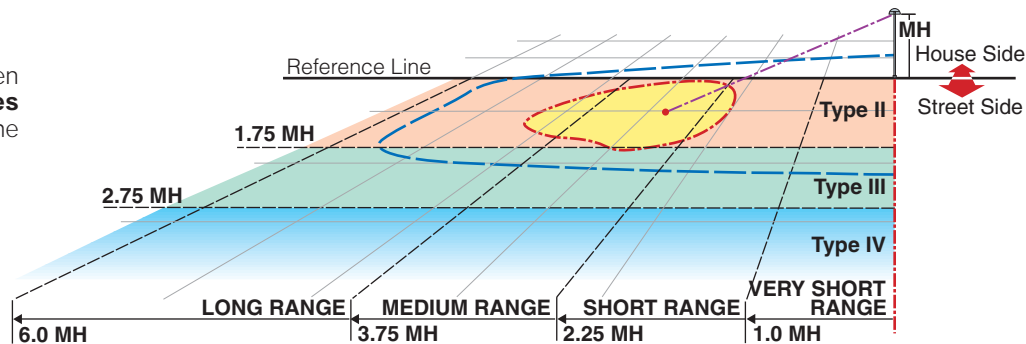
Distribution Types Definitions



**Type II
Horizontal Lamp**

A distribution is classified as **Type II** when the **50% maximum candela trace lies within 1.75 MH** on the street side of the reference line.⁴

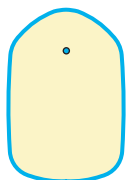
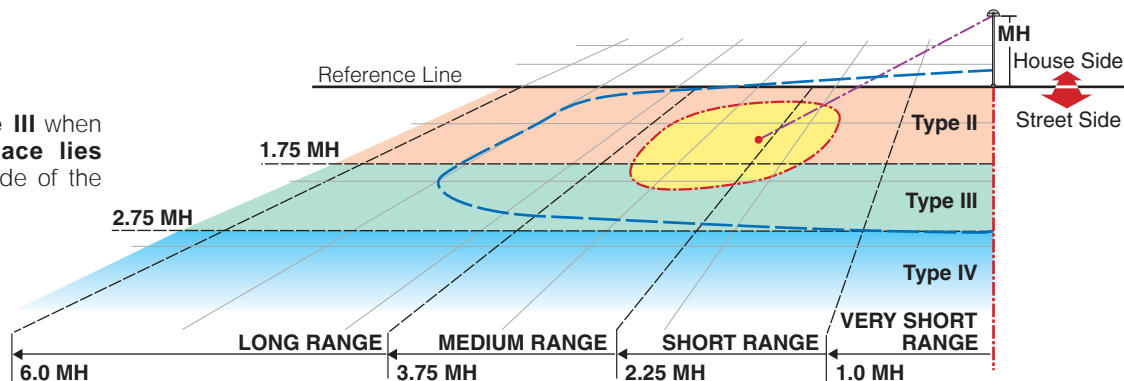
Example: **Type II, Medium Range³**



**Type III
Horizontal Lamp**

A distribution is classified as **Type III** when the **50% maximum candela trace lies within 2.75 MH** on the street side of the reference line.⁴

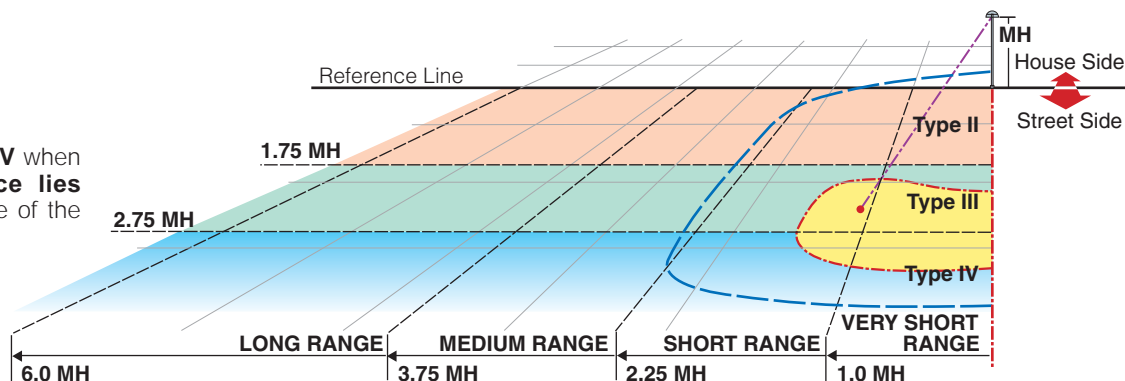
Example: **Type III, Medium Range³**

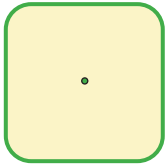


**Type IV
Horizontal Lamp**

A distribution is classified as **Type IV** when the **50% maximum candela trace lies beyond 2.75 MH** on the street side of the reference line.⁴

Example: **Type IV, Short Range³**

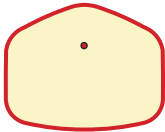
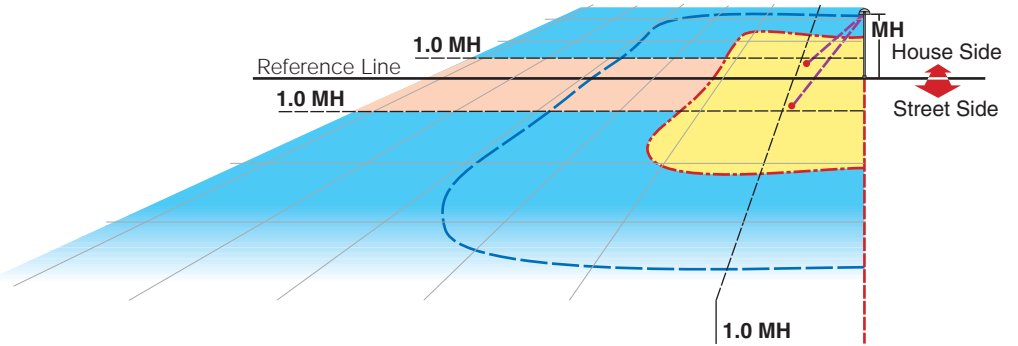




Type V Square⁵
Horizontal Lamp

Distribution is classified as Type V Square for horizontal lamp luminaires when the **50% maximum candela trace is symmetric in four quadrants**. This distribution is characterized by four candela peaks, diagonal to the reference line.

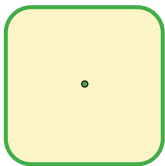
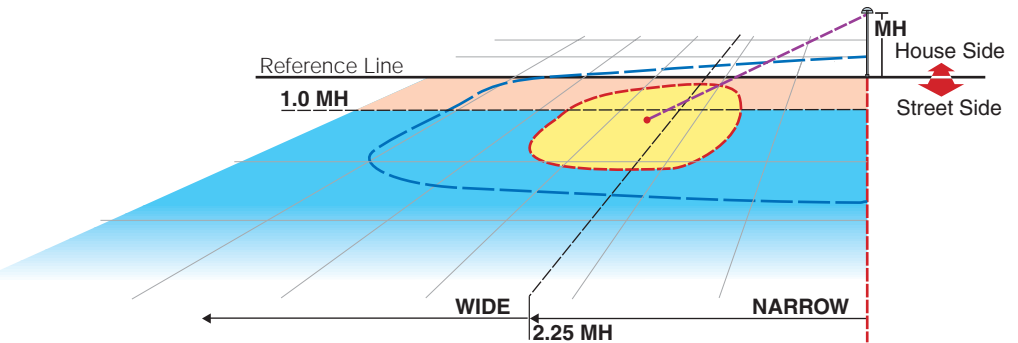
Example: **Type V Square³**



Asymmetric^{5,6}
Vertical Lamp

General pattern appearance is similar to Type III. Distribution is classified as Asymmetric for vertical lamp luminaires when the **50% maximum candela trace lies beyond 1.0 MH on the street side of the reference line, and inside 1.0 MH on the house side of the reference line**. **Narrow Range** distribution is identified when the **point of maximum candela falls inside of 2.25 MH**, **Wide Range** is identified when the **point of maximum candela falls beyond 2.25 MH**.

Example: **Asymmetric, Wide³**



Symmetric Square^{5,6}
Vertical Lamp

General pattern appearance is similar to horizontal lamp Type V Square. Distribution is classified as Symmetric Square for vertical lamp luminaires when the **50% maximum candela trace is symmetric in four quadrants on both street and house side of the reference line**. **Narrow Range** distribution is identified when the **candela peaks fall inside of 2.25 MH along the reference line**, **Wide Range** is identified

Example: **Symmetric Square, Narrow³**

