NLPIP
NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

Specifier Reports

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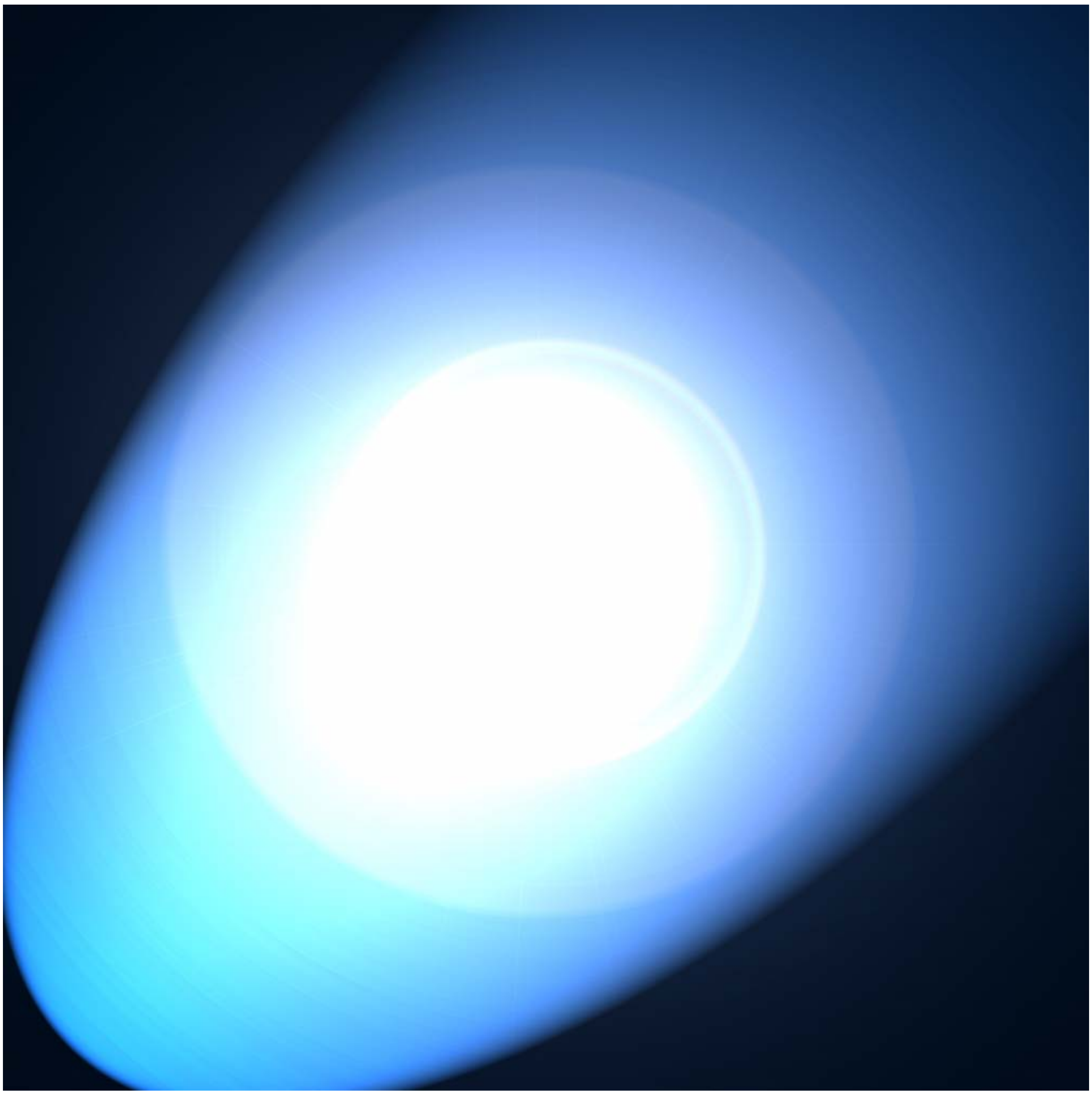
Parking Lot and Area Luminaires

Functional Luminaires using HPS and MH Lamps

Volume 9 Number 1, July 2004



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About NLPIP

The National Lighting Product Information Program (NLPIP) was established in 1990. NLPIP is administered by the Lighting Research Center (LRC), the world's leading university-based center devoted to lighting excellence.

NLPIP's mission is to help lighting specifiers and other lighting decision-makers choose wisely by providing the most complete, up-to-date, objective, manufacturer specific information available on energy-efficient lighting products. Priority is given to information not available or easily accessible from other sources. NLPIP tests lighting products according to accepted industry procedures or, if such procedures are not available or applicable, NLPIP develops interim tests that focus on performance issues important to specifiers or end users.

In 1998, NLPIP Online debuted at www.lrc.rpi.edu/programs/nlpip, making the information provided by NLPIP even more accessible to lighting specifiers and other interested people. NLPIP Online includes PDF files of *Specifier Reports, Lighting Answers,* and several searchable databases containing manufacturer-reported data and test results.

To ensure its continued objectivity, NLPIP does not accept funding from manufacturers.

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Contents

Introduction

A well-lighted parking lot or outdoor area is an important feature of a shopping center, urban park, apartment building, industrial park, or factory. Well-designed parking lot or area lighting can attract customers, facilitate traffic and pedestrian safety, increase economic development, deter crime and vandalism, and create a sense of personal security. Conversely, lighting that is poorly planned may waste energy, decrease vehicle and pedestrian safety, and may result in light pollution. As with any lighting design, specifying the appropriate luminaires in a parking lot or outdoor area is essential.

In January 1993, the National Lighting Product Information Program (NLPIP) published *Specifier Reports: Parking Lot and Area Luminaires*, which provided information about parking lot luminaires, summarized product information provided by manufacturers, and presented results of application analyses conducted by NLPIP. Since then, parking lot and area lighting luminaires have been examined in new ways. For example, the lighting industry currently is examining the optical efficiency and cutoff properties of these luminaires to determine if high-quality lighting can be achieved while reducing energy consumption, light pollution, and light trespass.

This issue of *Specifier Reports: Parking Lot and Area Luminaires* replaces the previous NLPIP publication by updating information on the critical performance and application issues for parking lot and area lighting luminaires, and identifying the information that a lighting specifier may request from a manufacturer when evaluating different products. This report focuses only on functional luminaires typically used in applications such as parking lots and area lighting, including: the cobra head luminaire, commonly used in roadway lighting but also used for lighting parking lots; the arm mount luminaire, currently the most common type used for parking lot lighting; and the post-top functional luminaire.

This report does not include decorative parking lot or area luminaires such as "teardrop", "pendant", or "lantern" style luminaires. It does not discuss high mast lighting systems with luminaires mounted at heights of 60 feet (18.3 meters) or higher because those systems have unique application criteria. This report also excludes wall-mounted or pole mounted "flood" type luminaires as well as ceiling-mounted luminaires used for covered parking. Finally, this report does not discuss indirect, landscape, or façade lighting luminaires.

This issue of Specifier Reports is not intended as a tutorial on parking lot or area lighting design. The Illuminating Engineering Society of North America (referred to as IESNA throughout this report), and parking lot and area lighting luminaire manufacturers offer reference materials that address lighting design considerations in detail. Resources are listed on page 44 of this publication.

NLPIP collected data from a variety of commercially available parking lot and area lighting luminaires. A summary of the products from 34 manufacturers, and their characteristics is found in Table 11. NLPIP also purchased 23 luminaires, independently evaluated and analyzed them and compared their performance in terms of luminaire efficiency, glare, light trespass, and sky glow. The selection of these luminaires was limited to luminaires that utilize 250-watt metal halide lamps and the same IES classification. Evaluation results and luminaire analyses are shown in the "Performance Evaluations" section beginning on page 21 and in Table 13a.

Background

Manufacturers of parking lot and area lighting luminaires offer a wide variety of options and accessories for their products aimed to address such issues as light distribution, energy consumption, light pollution, and light trespass, and often customize them for a specific project. Manufacturers can provide luminaires with a wide range of performance characteristics for use in parking lot and area lighting applications as well as other applications such as roadway lighting. The specifier often chooses a luminaire based upon the manufacturer's reputation for service and quality rather than upon the luminaire's individual performance characteristics. The information provided in this issue of *Specifier Reports* will aid in the process of decision-making beyond the manufacturer's reputation and clarify the issues related to the application of parking lot and area lighting luminaires.

Luminaire Types

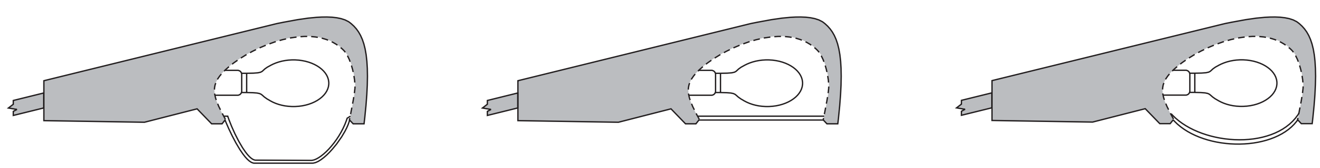
The selection of an appropriate luminaire for a particular application, and the ability to convey the reasons for this selection, require a working knowledge of the relevant luminaire types. This section describes the luminaire types commonly used for parking lot and area lighting applications.

Cobra Head Luminaires

The cobra head luminaire, most commonly used in roadway lighting, is also used for parking lot lighting. This luminaire's optical system typically consists of a horizontally mounted lamp, a reflector, and a lens (Figure 1). This luminaire is available for a wide variety of lamp wattages. Lamps of 250 watts or greater often are used in parking facilities at mounting heights of 20 feet or higher. These units can be mounted in single, twin, or quad configurations (see the sidebar "Mounting Configurations" on p. 6).

The cobra head luminaire is available in IESNA lateral light distribution classification Types I, II, III, and IV (see "Light Distribution" on p. 14). Manufacturers have adapted the optical system of these luminaires in order to limit the light intensity above 80° from nadir (straight down). As a result, the cobra head luminaire is also offered with a flat lens as well as a clear shallow lens to replace the refractor lens as shown in Figure 1. Cobra head luminaires with flat lenses typically cause less glare.

Figure 1. Cobra Head Luminaires



1a. Cobra head luminaire with drop lens

1b. Cobra head luminaire with flat lens

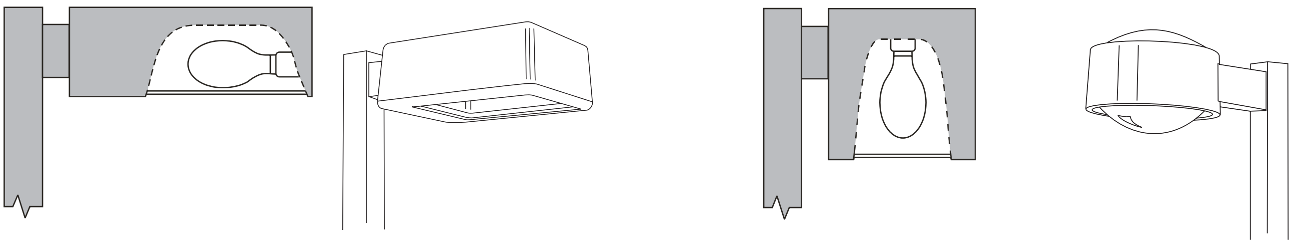
1c. Cobra head luminaire with sag or shallow lens

Arm Mount Luminaires

The arm mount luminaire is currently the most commonly used parking lot luminaire. This luminaire type has an optical system that usually consists of either a horizontally or vertically mounted lamp, a reflector, and a lens (Figure 2). Arm mount luminaires are available with various wattage lamps in different-sized housings. Smaller, low-wattage units (150 watts or less) can be mounted as low as 10 feet (3.0 meters); larger units (250 watts or greater) are mounted at typical parking lot pole heights of 20 to 40 feet (6.1 to 12.2 meters). An arm mount luminaire has a short, horizontal mounting arm, and these luminaires can be arranged in single, twin, or quad configurations. Originally designed with square or rectangular housings, arm mount luminaires are also available in round and domed shapes in a variety of colors and finishes.

Although the outward appearance of the horizontal-lamp luminaire and the vertical-lamp luminaire can be very similar, as shown in Figure 2, their primary functional difference is the light distribution they achieve.

Figure 2. Arm Mount Luminaires



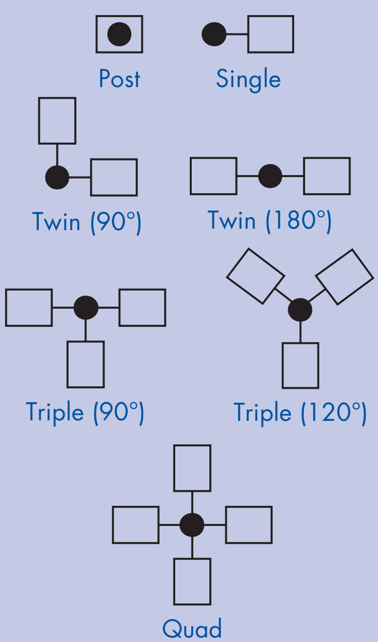
2a. Horizontal-lamp arm mount luminaire

2b. Vertical-lamp arm mount luminaire

Mounting Configurations

Parking lot and area luminaires are pole-mounted in seven different configurations as shown in Figure 4: post, single, twin (90°), twin (180°), triple (90°), triple (120°), and quad. Post-mounting and single-mounting refer to a single luminaire. A post-mounted luminaire is centered over the pole (such as a post-top luminaire); A single-mounted luminaire is positioned on an arm located to the side of the pole (such as an arm mount luminaire).

Figure 4. Luminaire Mounting Configurations



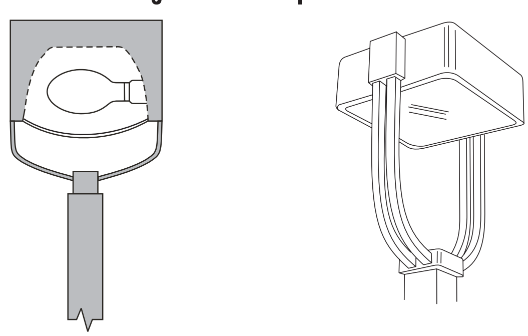
Arm mount luminaires may have full cutoff, semi-cutoff, or cutoff IESNA distributions depending on the lamp orientation, the optics of the reflector, and the optics of the lens. The horizontal-lamp arm mount luminaire, commonly referred to as a "shoebox" or "sharp cutoff" luminaire, provides light distribution Types I, II, III, IV, or V. The vertical lamp arm mount luminaire produces light distribution Types III, IV, or V and minimizes light directly below the unit, compared to luminaires with a horizontally mounted lamp. The vertical-lamp luminaire is usually available with a convex glass lens, although some manufacturers offer flat lens or prismatic refractor options.

Post-top Luminaires

The post-top luminaire is also used for parking lot lighting. This luminaire type has an optical system that usually consists of either a horizontally or vertically mounted lamp, a reflector, and a lens (Figure 3). Post-top luminaires are available with various wattage lamps in different-sized housings. Smaller, low-wattage units (150 watts or less) can be mounted as low as 10 feet (3.0 meters); larger units (250 watts or greater) are mounted at typical parking lot pole heights of 20 to 40 feet (6.1 to 12.2 meters). Because they are mounted on a yoke configuration at the top of a pole, these luminaires are most often used in single configurations.

Similar to the arm mount, the horizontal-lamp post-top luminaire provides light distribution Types I, II, III, IV, or V. The vertical lamp post-top luminaire produces light distribution Types III, IV, or V and minimizes light directly below the unit. The vertical lamp luminaire is usually available with a convex glass lens, although some manufacturers offer flat lens or prismatic refractor options.

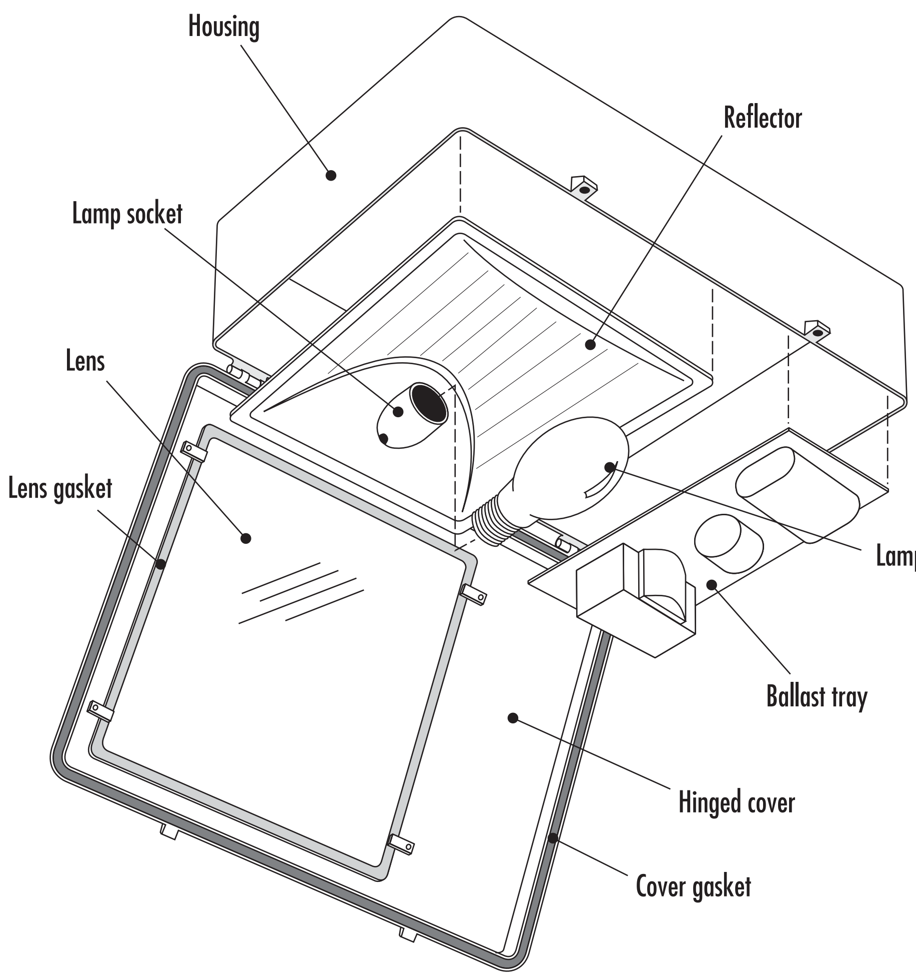
Figure 3. Post-top Luminaire



Luminaire Components

Although luminaire components can be analyzed individually, the overall construction and quality of a luminaire must be evaluated. For example, two luminaires may both be constructed with stainless steel housings, but one of the luminaires may allow water to infiltrate. Similarly, two luminaires may both utilize silicone gasketing, but the design of one of the gasketing systems may provide a better seal. Visual inspection of a product sample is one way to assess the overall quality of a luminaire. Samples usually are available through manufacturers' local representatives. Luminaire components are separated into three sections: optical system, mechanical system, and electrical system. An exploded view of typical luminaire components is given in Figure 5.

Figure 5. Exploded View of Typical Luminaire Components



Optical System

The purpose of an optical system is to produce visible light and redirect that light. A lamp serves as the light source. A reflector uses an opaque material that redirects the light by reflecting it. A refractor uses a transmissive material that redirects the incident light as it passes through it.

Lamps

The most commonly used lamps in parking lot and area lighting applications are high-intensity discharge (HID) lamps. These include high pressure sodium (HPS), metal halide (MH), and mercury vapor (MV). However MV lamps are not recommended by energy efficiency groups, because they are inefficient and their luminous flux output decreases over time to the point that they emit little useful light but still appear to be lighted. Although phosphor coated MH lamps are sometimes used for their improved color properties, the performance of a luminaire's optical system will suffer if a coated lamp is used because the larger, coated outer jacket (bulb) alters the optical size of the lamp.

Low pressure sodium (LPS) lamps are sometimes used for parking lot lighting. A few manufacturers offer parking lot and area lighting luminaires that use incandescent or fluorescent lamps. Among the fluorescent types of lamps is the induction lamp, a type of fluorescent technology that operates without the use of electrodes. This electrodeless lamp may become an important light source for parking lot and area lighting applications in the future because of its ruggedness, good color properties, and long life. With advancements in LED (light-emitting diode) technology, low wattage LED streetlights are also becoming available. As the efficacy of LEDs improve, it may also become an important light source for parking lot and area lighting.

Generally, MH and HPS lamps have greater efficacies and equivalent or longer life ratings than most incandescent and MV sources. The values shown in Table 1 for efficacy and life are for a 250-watt HPS lamp, a probe-start 250-watt MH lamp in vertical, horizontal, and universal mounting positions, a 250-watt MV lamp, and 180-watt and 135-watt LPS lamps. Table 1 provides both

Table 1. Performance Characteristics of Lamps Used in Parking Lot and Area Luminaires [a]

Standard Lamp		Lamp Efficacy (LPW) [b]	Lamp Wattage	Life (hours) [c]	Luminous Flux (lumens) Initial	Luminous Flux (lumens) Mean	Correlated Color Temperature (K)	Color Rendering Index (CRI)
HPS		104–116	250	24,000+	26,000–29,000	23,400–27,000	2,000–2,100	21–22
MH (probe-start)	Vertical pos.	70–92	250	10,000	17,500–23,000	11,300–17,000	3,200–4,000	65–70
	Horizontal pos.	69–92	250	10,000–15,000	17,200–23,000	9,400–15,000	3,200–4,300	65–70
	Universal pos.	66–88	250	6,000–10,000	16,600–22,000	10,600–17,500	3,000–5,000	65–75
MV		44–52	250	24,000+	11,000–13,000	8,250–10,800	3,700–6,700	15–50
LPS		167–178	180	16,000–18,000	30,000–32,000	32,000 [d]	1,700–1,800	0
		163–167	135	16,000–18,000	22,000–22,600	19,140–22,600	1,700–1,800	0

[a] Philips, GE Lighting, OSRAM SYLVANIA, and Venture Lighting lamp catalogs

[b] Efficacy values are for lamps only; ballasts also require power and reduce the efficacy of the lamp/ballast combination. Efficacy is calculated by dividing the initial lamp luminous flux by the lamp wattage.

[c] Life ratings are for 250-watt standard lamps, except where noted. These values may be higher for higher wattages or improved lamps.

[d] Data only available from one manufacturer

Lamp Efficacy

LPS lamps have the highest efficacy, which is desirable, but their large size limits the variety of available luminaire designs. This, together with poor color properties, limits the applications appropriate for these lamps. HPS and MH are greatly superior lamp choices. When choosing between HPS and MH lamps for parking lot and area lighting, consider efficacy, lamp life, and color quality. HPS lamps are higher in efficacy and have longer rated lives than MH lamps, but MH lamps have better color properties and may offer an advantage to off-axis vision.

initial and mean luminous flux. Mean luminous flux for HPS, MV, and LPS lamps is at 50% of rated life, while mean luminous flux for MH lamps is at 40% of rated life. MH lamps have lower initial luminous flux as well as mean luminous flux when compared to HPS lamps. Efficacy and life ratings vary for other wattages, with lower-wattage lamps generally providing lower efficacy. These values also vary with improved lamps such as pulse-start MH lamps or non-cycling HPS lamps, among others, which manufacturers offer in addition to the standard types of lamps. Lower wattage (<150 watts) mercury-free HPS lamps are also available. Choosing the "best" lamp requires careful consideration of energy, economic, design, operating, and aesthetic factors. This report is focused on HPS and MH lamp types. In this table, MV and LPS characteristics are provided for comparison.

The position in which metal halide (MH) lamps are installed makes a difference in the color variation and color shift of the lamps. It can also affect a lamp's life, as shown in Table 1. Installing MH lamps in a base-up position generally gives the best results both in terms of color stability and lamp life. Some lamps do equally well when installed base down, while other lamps should only be installed horizontally. The manufacturer's literature should always be consulted to determine the best installation position for a MH lamp. Most manufacturers' catalogs give the luminous flux output for lamps installed in specific burning positions. For more information on mid-range or mid-wattage MH lamps, refer to NLPIP publication, *Lighting Answers: Mid-wattage Metal Halide Lamps*, available online at www.lrc.rpi.edu/programs/nlpip/lightingAnswers/mwmhl/abstract.asp.

The choice of lamp wattage should be made on the basis of the illumination required, the lighting distribution from the luminaire, and the pole height and spacing. A common mistake in parking lot lighting is to install lamps that are too powerful for the mounting height. These lamps emit too much light for the mounting height used, resulting in glare and uneven light distribution.

Reflectors

The construction of the luminaire's reflector is a major distinguishing factor in its performance and cost. A reflector's optics should avoid redirecting the light back into the lamp, which would reduce the luminaire's efficiency. The goal is to maximize the amount of light coming out of the luminaire. Interchangeable optical systems allow luminaires with the same external housing to have very different optical systems. In some cases the same optical system can be used with lamps of different wattages. However, the position of the lamp's socket must be adjusted to ensure that the position of the lamp's arc tube is optimized with the reflector. Optical systems that can be rotated within the luminaire allow field adjustments to the optical system's orientation after installation.

Most reflectors used in parking lot luminaires are made from aluminum, although some luminaires use glass or plastic prismatic material for the reflector. Common outdoor luminaire reflectors are made of hydroformed aluminum. In this construction method the metal is formed around a male punch. Once the tooling for a particular optical system is complete, these one-piece reflectors can be manufactured economically, and they perform consistently. If a specular finish is required, these reflectors must be mechanically polished. Some manufacturers brighten their reflectors electrochemically in a process known as Alzak®. This results in a specular or semi-specular finish. Diffuse aluminum finishes are available for reflectors as well.

Spun reflectors are the least expensive type to produce. The spinning process shapes a sheet of metal into a reflector on a lathe while pressing it against a form. The finishes available for spun reflectors are the same as those available for hydroformed reflectors.

Segmented reflectors are fabricated from specially designed specular aluminum strips that are shaped and oriented specifically to provide the desired light distribution. Manufacturing costs for segmented reflectors are higher than costs for hydroformed or spun reflectors. Producing segmented reflectors with consistent photometric performance is more difficult than producing one-piece reflectors, but segmented reflectors offer more light distribution options, making it easier to control glare and to create uniform illuminance on the ground.

Lenses

Most luminaires have a glass or plastic lens mounted in the opening to allow light out of the fixture and to seal the luminaire housing to protect the luminaire components. This lens may be a refractor, flat lens, sag lens, or drop lens. A refractor is a type of lens and is often referred to as a prismatic lens. Prisms are designed to refract or spread the emitted light in a specific direction. Refractors are most often used in cobra head luminaires. Other types of lenses, such as clear lenses, can also redirect light, but their main function is to protect the lamp, contain debris when the lamp shatters, and in some cases block ultraviolet radiation. Lens materials used in parking lot and area lighting luminaires include tempered glass, clear glass, borosilicate glass, polycarbonate, and acrylic. Tempered glass lenses are extremely durable and do not deteriorate during their long life. Borosilicate glass is less durable but is able to survive thermal shocks. Polycarbonate is good for applications where vandalism is a problem, because it has extremely high impact resistance. It does become yellow and brittle over time when used in parking lot luminaires, but special ultraviolet inhibitors can slow this process. Acrylic and high-impact acrylic lenses have excellent resistance to ultraviolet radiation, but special, high-temperature acrylic must be used in many of the higher-wattage HID luminaires, which produce higher temperatures.

Mechanical System

The mechanical system provides the structure for a luminaire, including the housing, gasketing, and mounting brackets.

Housing

Luminaires used for parking lot and area lighting must be able to withstand adverse conditions such as solar radiation, saltwater spray, temperature extremes, wind-driven sand and debris, vehicle exhaust, rain and snow, vibration, rocks, and even bullets. Typical luminaire housings are constructed of aluminum, steel, or stainless steel, and non-metallic housings are also available. Aluminum housings endure most outdoor situations, including corrosive saltwater environments. Steel sheet housings are common in lower-cost equipment, but are susceptible to corrosion. Although a protective coating is often applied to the housing, some exposed edges may remain uncoated, or the coating may be scratched during installation and maintenance. More expensive luminaires use extruded aluminum or stainless steel housings. Stainless steel provides superior corrosion protection for extreme environmental conditions. Extruded aluminum housings are almost seamless and are durable in all environments.

A number of finishes are used for parking lot luminaire housings. Anodized aluminum, one of the most permanent finishes available, is only available in natural, bronze, or black, which are referred to as integral color class (ICC) colors. A less permanent and less expensive finish is the dye-anodized finish. An organic dye is used to produce the desired colors, but because the dyes used are organic, they will fade over time with exposure to solar radiation. Painted finishes, such as the polyester powder coat or baked-enamel finish, are available in

Additional System Components

Optical System Accessories
Internal and external louvers and shields are sometimes offered by manufacturers to minimize unwanted light. House-side shields are often used to minimize the light trespass from a luminaire onto a nearby building. Manufacturers also offer caps to stop direct uplight (see the section "Energy and Environmental Issues" on page 19). Retrofitting caps to existing luminaires is becoming a more common practice because it provides a convenient and inexpensive way to reduce unwanted uplight.

Mechanical System Accessories
Mechanical accessories include mounting hardware and various types and lengths of poles.

Electrical System Accessories
Some manufacturers offer photoelectric cells and photoelectric cell receptacles, which are discussed in the section on controls (page 16). Other accessories include quartz restrike and single and double fuses. A quartz restrike system uses quartz incandescent lamps to provide instantaneous light in the event of a power outage because HID sources may require several minutes to restart.

many colors. Painted finishes will also fade over time, and are more easily scratched than the anodized finishes. Some manufacturers offer a warranty on the housing finish.

Gasketing

A well-designed gasket system is essential to keep the luminaire's optical system clean. Poor gasketing can allow dirt or water to penetrate and result in reduced illuminances and increased maintenance or operating costs. When water leaks into a luminaire, the heat from the lamp and ballast causes the moisture to evaporate. The evaporated water may leave a stain on the lens, which reduces the luminaire's light output. Excessive moisture within the luminaire may corrode metal components and cause electrical malfunctions.

Commonly used gasketing materials include rubber (sponge neoprene, ethylene propylene rubber [EPDM, EPT, and Poron®]), polyester fabric such as Dacron® or felt, and silicone. Foam rubber gasketing is used occasionally, but is not as durable. Silicone gaskets are more expensive, but because silicone does not permanently deform with use these gaskets tend to maintain their effectiveness. With use, felt and neoprene materials can become deformed, creating gaps that allow water, insects, or dirt to penetrate. Stiff or non-compliant gasketing may make it difficult to close and clamp the lens frame to the luminaire housing.

Gasketing should be continuous and permanently attached to one surface so it will not fall off during luminaire maintenance. In some cases the optical system of a luminaire is attached to the housing with a molded silicone gasket to create an optical chamber that shelters the optical components from debris and sustains luminaire performance for extended periods of time. Since air will move in and out of the luminaire as it heats and cools during normal operation, some manufacturers allow the luminaire to "breathe" by providing a filter and gasketing system. This reduces substantially any dirt build-up on the lamp surface, interior reflectors, and lenses.

Electrical System

The electrical system includes lamp ballasts, supply wires, and connectors. Although lamps are part of the electrical system, they provide the light source and are included in the optical system section above.

Ballasts

Ballasts for HID lamps are classified by circuit type. Commonly used probe-start metal halide (MH) ballast systems for mid-wattage (175–400 watts) MH lamps include high-reactance autotransformer (HX-HPF), constant-wattage autotransformer (CWA), constant-wattage isolated transformer (CWI), and regulated lag (magnetically regulated) ballasts. CWA ballasts limit variations in wattage, and thus in light output, as voltage varies. CWA ballasts are high power factor ballasts, with power factors greater than 0.90. Another ballast type, HX-HPF, can be used in a wide variety of applications. Ballasts with high power factors draw less current than those with normal power factors, which allows the use of smaller conductors in the electrical distribution system. For more information on ballasts for mid-wattage MH lamps, refer to NLPIP publication, *Lighting Answers: Mid-wattage Metal Halide Lamps*, available online at www.lrc.rpi.edu/programs/nlpip/lightingAnswers/mwmhl/abstract.asp. For more information on HPS ballast systems refer to specific ballast manufacturer catalogs.

Pulse-start MH lamps require a different type of ballast than those described above. Pulse-start MH ballast systems include super constant-wattage autotransformer (SCWA), linear reactor, and regulated-lag ballasts. The latter is the most sophisticated of all three types and provides the highest power regulation to the lamp.

Most HID lamp ballasts are electromagnetic, but electronic ballasts are becoming available, especially for lower wattage lamp types. Electronic ballasts are only slightly more efficient but may offer features such as dimming, switching, and monitoring functions along with improved lamp performance.

Luminaire Classifications

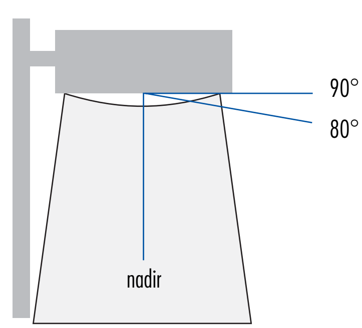
The IESNA classifies luminaires according to different types of cutoff and light distribution. Other classifications, although unofficial, such as by lamp type, lamp position, optical characteristics, or style are also prevalent in the industry. For aesthetic reasons, parking lot and area lighting luminaires can also be classified by their most obvious characteristics—shape and appearance. Unfortunately, decisions based solely on luminaire shape and appearance will tend to overlook issues such as light distribution, luminaire efficiency, energy efficiency, and light pollution.

Cutoff Classifications

Cutoff classifications were adopted by the IESNA as a means to describe and control glare from outdoor luminaires, especially for street lighting. Most planners try to use the fewest luminaires and poles for street lighting. To maximize spacing between luminaires without unacceptable nonuniformity, their luminous intensity at large angles above the nadir should be much higher than their luminous intensity near the nadir. However, such high luminous intensities could potentially cause glare to individuals when the luminaires are viewed from a distance. The cutoff classifications set limits on the luminous intensity permitted at large angles from nadir (such as 80°) and above. Limitations on the luminous intensity in the upward directions (above 90° from nadir) were later incorporated into cutoff classifications to control the amount of direct light going up into the sky.

The IESNA defines four outdoor luminaire cutoff classifications, each with different photometric criteria. For these classifications, two relevant zones are defined with respect to the nadir of a luminaire (Figure 6). One zone applies to angles at or above 80° from nadir; the other covers all angles at or above 90° from nadir . Light emitted in the 80° to 90° zone is more likely to contribute to glare, and light emitted above 90° is uplight.

Figure 6. Angles Referenced by the IESNA Cutoff Classifications



The definitions below are given in terms of *luminous intensity* (in candelas), but the values are made in reference to *luminous flux* (in lumens) of the light source. These values don't necessarily relate to the total amount of light in each zone.

- **Full cutoff**—The luminous intensity (in candelas) at or above an angle of 90° above nadir is zero, and the luminous intensity (in candelas) at or above a vertical angle of 80° above nadir does not exceed 10% of the luminous flux (in lumens) of the luminaire's lamp or lamps.
- **Cutoff**—The luminous intensity at or above an angle of 90° above nadir does not exceed 2.5% of the luminous flux of the lamp or lamps in the luminaire, and the luminous intensity at or above a vertical angle of 80° above nadir does not exceed 10% of the luminous flux of the luminaire's lamp or lamps.
- **Semicutoff**—The luminous intensity at or above an angle 90° above nadir does not exceed 5% of the luminous flux of the lamp or lamps in the luminaire, and the luminous intensity at or above a vertical angle of 80° above nadir does not exceed 20% of the luminous flux of the luminaire's lamp or lamps.
- **Noncutoff**—There is no luminous intensity limitation in the zone above maximum luminous intensity.

Casually skimming these definitions could lead to the assumption that for a cutoff luminaire, no more than 10% of the lamp luminous flux is emitted between 80° and 90° from nadir, or that no more than 2.5% of the lamp luminous flux is emitted above 90° from nadir. In fact, neither of these assumptions is correct.

Careful attention should be paid to the definitions of the various cutoff classifications (Bullough 2002). It is especially important to recognize that the definitions provide limits on *luminous intensity* from a luminaire. This value is expressed as a percentage of the *luminous flux* emitted by the lamp(s) inside the luminaire. For example, the semicutoff classification has an upward (90° and above) luminous intensity limit (in cd) equal to 5% of the lamp luminous flux (in lm). If the luminaire contains a 1000-lm lamp, the luminous intensity from the luminaire in any direction above 90° cannot exceed 50 cd. This differs from a common misinterpretation of the cutoff classifications, which might lead one to assume that the luminous flux from a semicutoff luminaire cannot exceed 5% of the lamp luminous flux. In fact, a semicutoff luminaire with a luminous intensity of 50 cd in every direction above 90° would emit 31% of the lamp luminous flux in the upward direction.

On the other hand, a luminaire (containing the same 1000-lm lamp) emitting no light above 90° would still be considered a semicutoff luminaire if its luminous intensity between 80° and 90° from nadir exceeded 100 cd in at least one direction but did not exceed 200 cd in any direction between 80° and 90°. Thus, a semicutoff luminaire could produce as much as 31% of the lamp luminous flux upward, or as little as 0%.

A luminaire that produces no direct light above 90° cannot automatically be classified as a full cutoff luminaire. To be considered full cutoff, the luminaire must also meet the required luminous intensity limitations between 80° and 90°. For this reason, many specifiers refer to luminaires with no upward luminous flux as *fully shielded* rather than full cutoff. Fully shielded luminaires can be classified as full cutoff, cutoff, semicutoff or even noncutoff luminaires, depending upon their luminous intensity characteristics between 80° and 90° from nadir.

Vertical Illuminance

Cutoff classifications are not useful for comparing the uplight from luminaires (as might be done to address sky glow), because the amount of uplight is not apparent from the cutoff classifications. Cutoff classifications may be useful for comparing the potential for glare, however, because it is possible to calculate the vertical illuminance at an individual's eyes as the individual moves toward a luminaire when the individual's eyes are at or beyond 80° from the nadir of a luminaire. Vertical illuminance at the eye is a useful metric for quantifying disability and discomfort glare (Rea 2000; Boyce 2003). Similarly, for comparing the potential for light trespass, cutoff classifications may be useful if adjacent property lines are located at or beyond 80° from the nadir of a luminaire, for a particular mounting height.

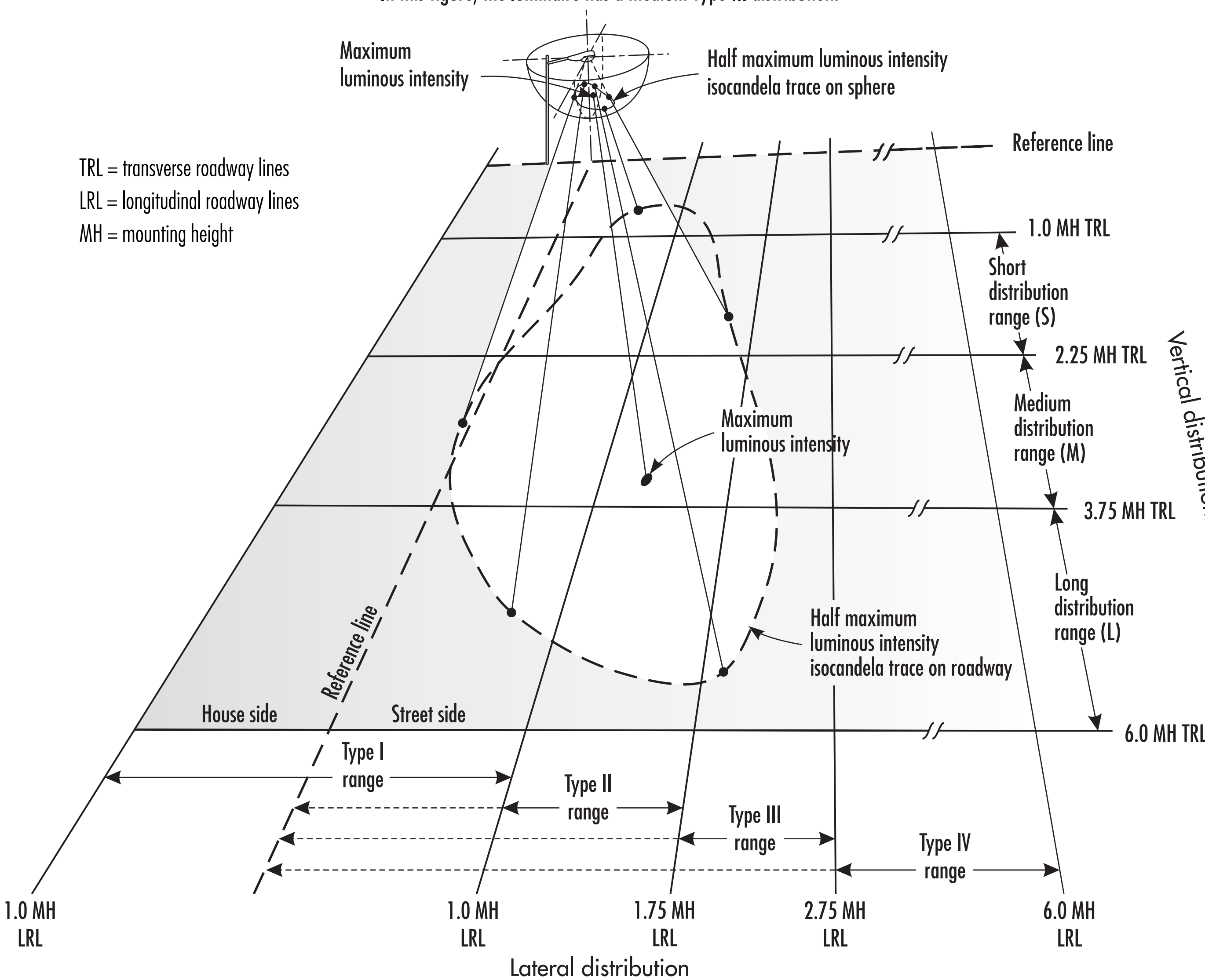
Light Distribution

Luminaire light distribution is defined in terms of vertical light distribution and lateral light distribution. Vertical light distributions are short, medium or long. Lateral light distributions include Types I, II, III, IV and V. Vertical light distributions fall between transverse roadway lines (TRL) and lateral light distributions fall between longitudinal roadway lines (LRL) as shown in Figure 7, based on the luminaire mounting height.

The vertical light distribution is determined based on the location of the maximum luminous intensity value in relation to the TRLs. In Figure 7, the maximum luminous intensity value falls in the medium distribution range from 2.25 to 3.75 mounting height TRL.

Figure 7. Diagram Showing Vertical and Lateral IESNA Distribution

In this figure, the luminaire has a medium Type III distribution.



Adapted from Rea 2000, Fig. 22-7.

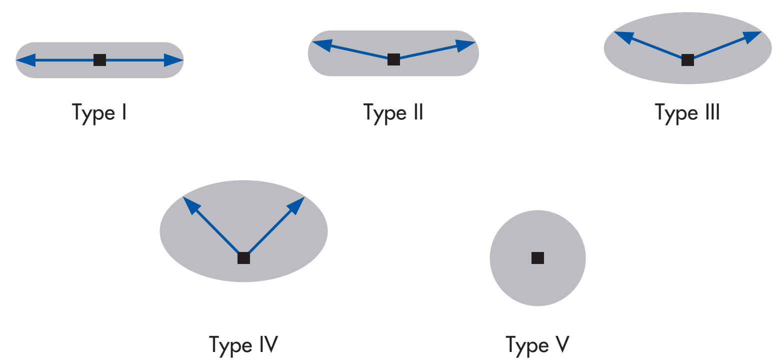
Non-Standard Classifications

While not part of the IESNA lateral light distribution classification, some manufacturers use terms such as *forward throw* to refer to the Type IV distribution, or *asymmetric* to refer to the Type III distribution. They also offer other light distribution patterns such as *square* or *rectangular*. These are identified as Type V-square and Type V-rectangular. While not part of the IESNA vertical light distribution classification, the lighting industry sometimes uses another category known as *very short*. Type III, IV, and V distributions are often used for parking lot and area lighting, while Type I, II, and III distributions are often used for roadway lighting.

Referring again to Figure 7, bounded by the TRLs of the vertical distribution, the lateral light distribution is then determined based on the highest LRL that the half maximum luminous intensity isocandela trace reaches. In this case, within the medium distribution range, the half maximum luminous intensity isocandela trace reaches the Type III range. Therefore, for this figure, the luminaire has a medium Type III distribution. The vertical distribution determines how far down the road the beam extends. The lateral distribution determines the width of the distribution.

The diagrams in Figure 8 further illustrate the lateral distributions of light cast by different types of luminaires. The luminaire is represented by a black square. Arrows show the direction of maximum intensity.

Figure 8. IESNA Lateral Light Distribution Classification Types



Luminaire Considerations

Luminaire Downward Efficiency

The total downward efficiency of a luminaire is expressed by the percentage of the lamp luminous flux that leaves the luminaire in a downward direction. A new luminaire's efficiency is governed by its optical performance. Luminaire efficiency changes over time due to deterioration of luminaire components. For most outdoor luminaires, initial downward efficiencies range from 60% to 90%. Overall performance of parking lot and area lighting systems depends on light distribution, pole layout and heights, and glare characteristics, so the luminaire efficiency value should not be used as the sole selection criteria.

Standards for Luminaires

ANSI (American National Standards Institute) standards exist that define quality levels for electrical materials. Different types of luminaires have multiple ANSI standards that apply. ANSI standards require a level of quality and interchangeability among manufacturers. NEC (National Electric Code) defines a standard for wiring installations performed by licensed electricians.

Maintenance

Maintenance costs for parking lot and area lighting systems can be high, because the mounting heights often require special equipment to access the luminaires. Easily replaced lamps, ballasts, and optical components help to minimize labor costs. Ease of maintenance, however, is also important for the safety of those maintaining the outdoor lighting systems. The less time a person spends replacing failed lamps, repairing faulty electrical components, or dealing with loose fasteners, the less risk there is for accidents to occur. Group relamping, rather than spot relamping, may also help to control maintenance costs (IESNA 2003, DG-4-03).

Dirt depreciation is an important maintenance issue. A clean luminaire is essential for best performance. Poor gasketing that allows dirt or water to penetrate can result in reduced illuminances and may increase maintenance or operating costs over the life of the system (refer to "Gasketing" on page 11).

Simplifying Service

Increasingly more manufacturers are offering products that are easier to service. The ballast and associated electrical parts can be mounted on a separate tray or compartment for easy removal and replacement. Tool-free access trays that hold the electrical components can be easily interchanged with minimum downtime. Electrical plug-in modules, also referred to as "quick disconnects," can minimize the potential for incorrectly reconnecting electrical circuits. Easy access to the lamp compartment eliminates the need for special tools or partial disassembly of the luminaire. Lens replacement should be simplified, because these components can be cracked or broken by extreme weather conditions, handling, or vandalism. Easy-to-find and operate latches, as well as sturdy hinge pins and hanger hooks that do not require tools, will make this process more convenient. Marking the luminaire with the wattage of the lamp required will help to prevent installing the wrong replacement lamp, which can result in short lamp life or other problems.

ANSI C136.15 outlines how a luminaire is to be marked for easy identification of the lamp type and wattage. Compliance with this specification will help prevent installation of the wrong replacement lamp, which could result in short lamp life or other problems.

Controls

Parking lot lighting systems are usually operated by a centralized control system that switches all of the luminaires in an installation as a group. This central system may be operated manually, by a photocell, or a time clock. Astronomical time clocks track the length of daytime throughout the year.

Alternatively, each luminaire can have a photoelectric receptacle for a plug-in photocell unit. The photocell controls the electrical power to the luminaire, so it operates only when the ambient light falls below a certain threshold. The luminaire operates from dusk to dawn and during low-light conditions such as a storm. Photoelectric receptacles are common in roadway, parking lot, and area lighting applications where the electric utility provides the lighting system.

Dusk-to-dawn lighting controls, commonly incorporating a photocell or time clock, ensure that the lighting system is shut off during daylight hours. When luminaires are used in a twin or quad mounting configuration, some of the luminaires may be switched off with a time clock during hours when the parking lot is not expected to be used. This strategy saves energy while maintaining a minimal illuminance for security purposes. A similar control strategy uses a bi-level dimming system, which reduces the power to the lamps by 50% during non-usage hours.

Some manufacturers offer instruments to diagnose the causes of control malfunctioning from the ground, eliminating the need to go up the pole to check the control. In addition, new technology allows wireless communication between poles for maintenance issues to determine which luminaire components require replacement and to monitor lamp life for group relamping.

Safety

Underwriters Laboratories, Inc. (UL) and the Canadian Standards Association (CSA) publish standards for luminaires that address safety issues. Manufacturers that elect to have their products listed by these organizations submit sample products for testing. Electrical or building codes usually require a UL- or CSA-listed luminaire. Luminaires may be listed either as a complete assembly or as being constructed of listed components; the assembly listing is the most comprehensive for the intended use. UL- or CSA-listed luminaires must meet mechanical, electrical, and temperature specifications under stated laboratory test conditions. The listing ensures that a product meets a published operating performance standard. A luminaire that contains listed components, but is not listed as a complete unit, does not necessarily offer this same assurance.

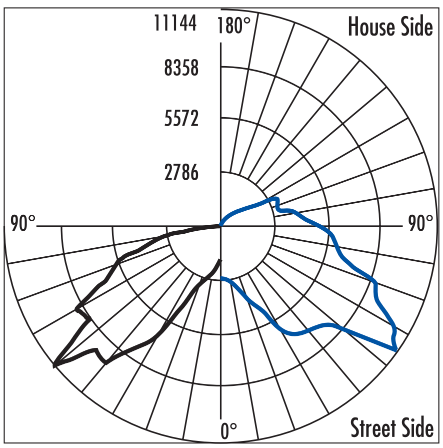
Luminaire Photometry

A photometric report describes the light distribution characteristics of a luminaire. Photometric data are used in computer predictions of illuminances and potential glare. The photometric report should be based on tests performed in accordance with IESNA testing procedures (relevant IESNA publications are listed at the end of this report.) A complete photometric report includes tabulated luminous intensity and luminaire efficiency data, an isointensity or isocandela plot, and a horizontal isoilluminance plot. These data usually are available in an IESNA-approved electronic format known as photometric files or IES files for use in computer calculation programs. Current industry practice is to photometer only the lower hemisphere of roadway, parking lot, and area luminaires, so data on light emissions above 90° from nadir may be difficult to find. These data are becoming more important for light trespass and light pollution calculations, however, so a full photometric report should be requested from the luminaire manufacturer.

Luminous Intensity Distribution Plots

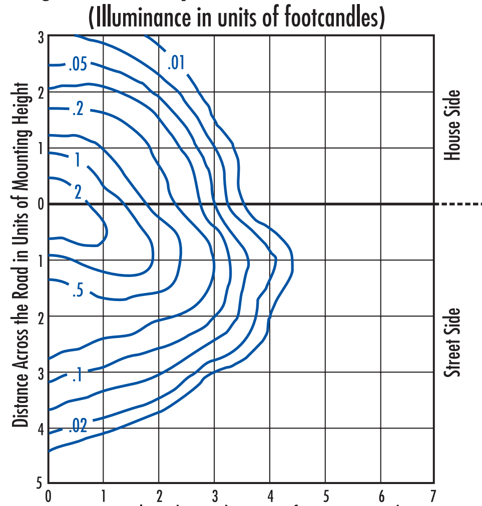
An intensity plot provides details of the luminous intensity produced by the luminaire at various angles within vertical and horizontal planes. In other words, it provides vertical and horizontal "slices" of data. Vertical intensity plots represent measurements made at various angles of elevation in a vertical plane through the light center. The light center is the position chosen for the luminaire to represent the center of the light source. Horizontal intensity plots represent measurements made at various angles in a horizontal plane through the light center. The intensity curves shown in Figure 9 are examples of luminous intensity distributions. The blue curve represents the horizontal luminous intensity distribution for one selected vertical angle. The black curve represents the vertical luminous intensity distribution for one selected horizontal angle. The lighting specifier should use both vertical and horizontal intensity plots to determine the luminaire's light distribution and its potential for light pollution.

Figure 9. Example of Luminous Intensity Plot
(Intensity in units of candelas)



Black indicates vertical angles; blue indicates horizontal angles

Figure 10. Example of an Isoilluminance Plot
(Illuminance in units of footcandles)



Illuminance Distribution Plots

An isoilluminance plot provides the estimated illuminances for a given lighting installation. For outdoor luminaires, the values are given in footcandles or lux on the ground. Illuminances for any given luminaire will depend on the luminaire's mounting height, lamp wattage, and the horizontal distance at ground level from the luminaire.

In an isoilluminance plot, lines of equal illuminance produce a series of contours much like a topographical map. Manufacturers use two methods to format these plots so that all combinations of mounting height, distance from luminaire, and luminaire type are covered. The distance from the luminaire is normalized with respect to mounting height as shown in Figure 10. The isoilluminance plot in Figure 10 assumes a luminaire light loss factor of 1.0, appropriate for a new luminaire. In another format (not shown), each chart represents a specific application and allows illuminances to be read directly from the graph. Both formats provide a method to determine easily the minimum and maximum illuminances. Required luminaire distribution types and locations can be determined by overlaying isoilluminance curves on a scaled plan of the parking lot. Illuminance is additive; illuminance contributions at a single point from two luminaires can be added together to get the resultant total illuminance.

Application Considerations

A number of issues can arise in parking lot and area lighting applications when critical luminaire performance characteristics, such as light loss, light distribution, and cutoff, and spectrum are misunderstood or applied incorrectly.

Light Loss

The efficiency of a new luminaire is governed by the luminaire's optical performance and its ballast. When choosing a luminaire, the luminaire downward efficiency may govern how many luminaires are needed to meet the lighting objectives. Light output of all luminaires decreases in various ways over time. Inevitably, light losses occur due to lamp depreciation and the normal wear of luminaire components. However, light losses can also occur when external elements such as dirt and moisture leak into the housing and accumulate on surfaces. This may absorb or block light within the luminaire, and it may affect the luminaire's electrical components. Regardless of the cause, decreased light output will lead to lower light levels.

Light Distribution

A luminaire's vertical and lateral light distribution can affect the quality of the lighting installation in terms of illuminance, uniformity, comfort, and safety. Excessive vertical illuminances, for example, can produce visual discomfort or disability and may increase light trespass. Horizontal and vertical illuminances that fall below recommended practices may impair visibility by reducing one's ability to see approaching vehicles or pedestrians.

Horizontal illuminance uniformity is important in parking lot and area lighting applications for both comfort and safety reasons. Selection of the appropriate luminaire is based on the required illuminance and illuminance uniformity on the ground. The manufacturer-supplied photometrics for a luminaire must be accurate to design the lighting installation. If the manufacturer's photometrics of the luminaire do not match the actual photometrics, the illuminance and the illuminance uniformity may not meet the lighting objectives. Discrepancies between manufacturer-supplied photometrics and the actual photometrics of the luminaire may lead to inappropriate selection of lamp wattages, luminaire mounting heights, number of luminaires, and spacing between luminaires.

Cutoff

The cutoff system restricts the intensity values above 90° and also restricts the intensity values for the vertical angles from 80° to 90° (refer to "Luminaire Classifications" on page 12). If glare is a concern, be aware that there is considerable variation in the amount of glare that cutoff and full cutoff luminaires can produce (see "Results" on page 25). Since both cutoff and full cutoff luminaires have the same maximum intensity above 80° measured from nadir, the lighting specifier should consider the glare zone luminous intensity values and the glare zone luminous flux leaving the luminaire in the zone between 80° and 90° when comparing different luminaires. For more information on cutoff application issues refer to the NLPIP publication *Lighting Answers: Light Pollution*, available online at www.lrc.rpi.edu/programs/nlpip/lightingAnswers/lightpollution/abstract.asp.

Regulations and Ordinances

Many state regulations and local ordinances require full cutoff luminaires or luminaires with no direct uplight. To avoid noncompliance, lighting designers and specifiers must be familiar with the state and local lighting laws and the definitions used by various authorities to define cutoff. Definitions used in regulations and ordinances are generally intended to limit the use of luminaires and do not correspond with IESNA cutoff classifications.

Spectrum

The spectral (color) content of a light source affects visibility at night. At daytime levels, only the cone photoreceptors in the eye contribute directly to seeing. This is known as *photopic* vision. At very low levels close to complete darkness, only rods contribute to seeing (*scotopic* vision). At light levels typically selected for outdoor area and street lighting (IESNA 2000, RP-8-00; IESNA 1998, RP-20-98), however, both rods and cones contribute to seeing (*mesopic* vision). The rods are more sensitive to shorter (blue-green) wavelengths of light than the combined response of the cones, so as light levels decrease, the visual system's spectral sensitivity shifts toward the shorter wavelengths.

As a consequence, all light measurements based on the photopic (cone) spectral response do not accurately characterize light at low, mesopic light levels. At these levels, lamps with a greater proportion of output in the blue-green region of the spectrum result in increased peripheral (off-axis) visibility (e.g., object detection) compared to lamps with little output in this spectral region (He et al. 1997; Bullough and Rea 2004). This is true even when they produce equal photopic light levels. However, this applies only to off-axis vision, because there are no rods located in the central part of the retina, which provides on-axis vision. For on-axis visual tasks such as steering a vehicle into a parking space or reading a sign, photopic light quantities are an accurate specification of objects in the lighted environment.

If two installations (one using HPS lamps and one using MH lamps) provide equal (photopic) light levels at night, one's ability to detect peripheral (off-axis) objects would be better under the MH lamp, but one's ability to read signs (an on-axis visual task) would be equal under each lamp. Although HPS lamps are rated slightly more energy efficient than MH lamps, MH lamps might be more energy efficient at providing off-axis visibility. However, HPS lamps will always be more energy efficient than MH lamps for providing on-axis visibility.

Energy and Environmental Issues

Energy Use

The energy used by a parking lot or area lighting system depends on the lamp type, the ballast, the luminaire, the number of luminaires required, and the control strategy. Older installations that utilize incandescent or MV lamps can be replaced with the more efficient HPS, LPS, or MH lamps, which can provide a given illuminance using lower wattages.

Because average illuminance and illuminance uniformity are important performance criteria for parking lot and area lighting applications, both the luminaire efficiency and the luminaire's light distribution affect energy use. A highly efficient luminaire requires less wattage to produce a certain illuminance than a less efficient luminaire. However, if highly efficient luminaires have a narrow light distribution, they may need to be spaced more closely together to satisfy the illuminance uniformity criteria. This could result in a greater connected load for the system with the more efficient luminaires. Light distribution can determine the amount of light (and thus energy) that is wasted by being delivered to areas other than where it is required.

Light Pollution

Light pollution is a by-product of lighting at night, especially when lighting is excessive. It includes such effects as sky glow, light trespass, and glare. Minimizing light pollution and wasted energy begins by lighting to the minimum light levels needed, choosing efficient luminaires and lamps, and turning the lights off when not needed.

Uplight

Uplight is light directed upward at angles greater than 90° from nadir (Figure 6). The source of uplight can be from direct uplight from a luminaire, reflected light from the ground and other surfaces, or a combination of the two. Uplight causes sky glow.

Sky Glow

Sky glow occurs from both natural and human-made sources. Natural sky glow is well-quantified, but electric lighting also increases night sky brightness. Light that is either emitted directly upward by luminaires or reflected from the ground is scattered by dust and gas molecules in the atmosphere, producing a luminous background. It can reduce one's ability to view the stars. Sky glow is highly variable depending on immediate weather conditions, the quantity of dust and gas in the atmosphere, the amount of light directed skyward, and the direction from which it is viewed. In poor weather conditions, more particles are present in the atmosphere to scatter the upward-bound light, so sky glow becomes a highly visible effect of wasted light and wasted energy.

For more information on how light pollution is currently being addressed, refer to the NLPIP publication *Lighting Answers: Light Pollution*, available online at www.lrc.rpi.edu/programs/nlpip/lightinganswers/lightpollution/abstract.asp.

Trespass Measurement

A simple method to evaluate light trespass in the field is to measure the vertical illuminance (the light on a vertical plane) at the lighting installation's property boundary using an illuminance meter facing the site. Then, turn the illuminance meter around and measure the vertical illuminance facing away from the site. If the vertical illuminance with the meter facing the site is greater than with the meter facing away from the site, light trespass onto the neighboring property may be occurring. However, there is no officially recognized method for determining which ratios are acceptable for different situations.

Light Trespass

Light trespass occurs when spill light is cast where it is not wanted, but since it is difficult to define when, where, and how much light is unwanted, light trespass is somewhat subjective. An example of light trespass is when spill light from a streetlight or floodlight enters a window and illuminates an indoor area. Some luminaire manufacturers offer luminaires that tailor their light distribution for the edge of the parking lot to minimize light trespass on property behind the luminaire. Accessories such as a house-side shield can also be used.

The Institution of Lighting Engineers (ILE) *Guidance Notes for the Reduction of Light Pollution* (ILE 2000) specifies the maximum illuminance allowed to fall on the windows of property adjacent to the lighted site in different outdoor lighting zones. A similar approach has been adopted for property boundaries in the *IESNA Guideline for Security Lighting for People, Property, and Public Spaces* (2003).

Glare

Glare is a visual sensation caused by excessive and uncontrolled brightness. It can be disabling or simply uncomfortable. Disability glare is the reduction in visibility caused by intense light sources in the field of view; discomfort glare is the sensation of annoyance or pain induced by overly bright sources (Rea 2000).

Reducing glare is an effective way to improve lighting. IESNA cutoff classifications, described on page 12, provide a means for evaluating glare. Another common method to evaluate glare is to calculate the luminous flux (as a percentage of lamp luminous flux) leaving the luminaire in the zone between 80° and 90° measured from the nadir, or vertical axis (Figure 6). This zone between 80° and 90° measured from the nadir represents the *glare zone*.

The luminous area of the luminaire and the lamp spectral power distribution also impact glare. For example, a clear lens that allows a direct view of a high-luminance lamp arc could increase discomfort relative to a refractor lens having a much lower luminance. And while the reduction in visibility from a glare source does not appear to depend on spectral power distribution, the sensation of discomfort tends to increase from sources with a greater proportion of short-wavelength (blue) light.

Yet another consideration in evaluating the glare of a luminaire is the mounting height and the visually adjacent luminances produced by the lighting system.

Luminous intensity data alone cannot be used to predict the effects of glare, because these effects also depend upon the viewer's visual adaptation level. A luminaire operating during daytime would not be considered a source of glare, but the same luminaire operating in a dark location at night might be. Because dark, nighttime viewing conditions serve as a worst-case scenario for glare, much of the discussion of glare in this report addresses glare under these conditions. Under conditions of high ambient lighting, glare from area and parking lot luminaires will be less problematic, even for the same luminous intensity.

Performance Evaluations

This NLPIP report presents data from a variety of commercially available parking lot and area lighting luminaires. Some of these luminaires are also used for roadway lighting. NLPIP collected data from 34 parking lot and area lighting luminaire manufacturers. Table 11, beginning on page 33, is a collection of information reported by manufacturers in their web sites and catalogs.

NLPIP also tested 23 luminaires typically used in parking lot and area lighting applications. These are designated by the ✓ symbol. The goal of this testing was to spot check manufacturer-supplied data and to gather information for accurate calculation of new metrics. The desired information includes intensity data measured above 90° from nadir for luminaires and a larger sampling of intensity data for vertical and horizontal angles, especially between the vertical angles of 80° and 90°, referred to as the glare zone. The testing also compared the performance of the 23 luminaires in terms of luminaire efficiency, glare, light trespass, and uplight as a function of luminaire type, lamp orientation, and cutoff classification.

NLPIP limited its selection to cobra head, arm mount, and post-top luminaires that use 250 W MH lamps with a Type III light distribution. MH lamps were chosen over HPS lamps since, according to the specifiers polled, they are becoming more commonly used in many new parking lots and area lighting applications due to their white light characteristics. For the same wattage lamp, a luminaire with a MH lamp will emit less light than the same luminaire with a HPS lamp, as seen in Table 1. Within each luminaire type, NLPIP selected full cutoff, cutoff, and semicutoff luminaires as well as horizontal and vertical lamp orientations. Wherever possible, NLPIP included in each category the luminaires identified as commonly used by specifiers and lighting representatives. The tested luminaires were purchased through local distribution channels. Testing results are shown in Table 13a.

Evaluation Methods

Survey

Before collecting data, NLPIP interviewed 13 specifiers and lighting representatives throughout the U.S. for advice about which parking lot luminaire models are most commonly used. NLPIP also contacted 25 members of the IESNA Street and Area Lighting Committee, who also contributed to the product recommendations. NLPIP used these product recommendations, along with the product information gathered from manufacturers listed in Table 12, to select the luminaires for testing,

Selection

The luminaires selected for testing were chosen to obtain an equal representation in terms of luminaire type, cutoff classification, and lamp orientation. NLPIP attempted to avoid using more than two products from any one manufacturer. However, there were limited selections for the cobra head luminaire, which resulted in testing three products from one manufacturer. In addition, due to a disparity between the luminaires NLPIP ordered and the luminaires shipped by manufacturers, two of the luminaires were removed from the analysis. A total of 23 luminaires were measured by an independent testing laboratory (see "Photometric Measurement Procedure" below).

Luminaire Product Identification

NLPIP tracked the product numbers for all 23 luminaires; each matched with the box in which it was shipped and the packing slip. The test results for these luminaires are presented in Table 13a. For the 23 tested luminaires, the specific product information is presented in Table 13b. Type III luminaires with 250-watt MH lamps were selected for testing. In most cases the wattage and the distribution (type) was specified in the order number of the luminaire. In two cases, the cut sheets did not specify the distribution in terms of type, but rather the distribution was specified as asymmetric. For both of these cases, the manufacturer's photometric files were used to calculate the distribution to ensure a Type III distribution.

NLPIP found that some luminaires did not have an identifying product number on the luminaire itself. NLPIP also found that some luminaires did not have identifying product information on the box in which the luminaire was shipped. Still other luminaires had incomplete product information on the luminaire as well as on the box. For these luminaires, packing slips were used to determine the product information. Some luminaires did not include the model number, some did not include the lamp type or wattage, and others did not include the name of the manufacturer or product family of the luminaire.

Labeling Problems

Poor labeling may lead to a number of problems for a specifier, including difficulty in:

- verifying that they received the luminaires they ordered
- accurately representing inventory
- selecting luminaires from inventory
- matching lamp type and lamp wattage with the luminaire
- selecting the luminaire with a desired light distribution

It can also create problems for maintenance personnel when they replace lamps, ballasts, or luminaires.

Poor labeling and the resulting difficulties may be eliminated by requiring the selected luminaire to comply with ANSI C136.22, which requires the manufacturer to provide the manufacturer's name and luminaire catalog number, input voltage, maximum line current, ballast type, lamp type and wattage, wiring diagram, and date of manufacture on the luminaire.

Photometric Measurement Procedure

Luminaire testing was conducted by NLPIP from September 2003 through January 2004 at Luminaire Testing Laboratory (LTL), Inc., in Allentown, PA. The testing and reporting was based on the *IESNA Approved Method for Photometric Testing of Roadway Luminaires* (LM-31-95) and other pertinent IESNA procedures.

Relative measurements were taken with a calibrated photometer and were performed on the luminaires using reference MH lamps that were seasoned for 100 hours. The luminous intensity distribution of the lamp was measured and used to rate the luminaire luminous intensity distribution to the lamp's total luminous flux. All were tested using a multitap ballast programmed at 240 volts.

Luminaire Testing Issues

Two issues related to luminaire testing should be noted.

1. The certainty of the goniometric center's location is critical to luminaire measurement. It is often difficult to determine where the goniometric center should be located. The choice may be different depending on the interpretation of LM-31-95.
2. The requirement of the cutoff classification for zero luminous intensity at or above 90° from nadir and the limit on the luminous intensity at or above 80° from nadir provides no tolerance for measurement uncertainties.

Full 360° goniometric measurements were performed on the luminaires. These measurements were taken in increments of 10° from 0° to 360° horizontally and in increments of 0.5° from 0° to 180° vertically. The horizontal information reported in the photometric files was averaged to balance out abnormalities due to the positioning of the arc tube and the data were reported from 0° to 180°.

The goniometric center was selected based on LM-31-95 guidelines. For a flat lens luminaire or a clear drop lens luminaire, the center position was located at the center of the opening in the reflector. For a luminaire with a refractor, such as a cobra head, the center position was located at the center of the refractor, both vertically and horizontally.

The resulting photometric data were used to calculate luminaire downward efficiency, glare, light trespass, and uplight.

Determination of Luminaire Downward Efficiency

NLPIP obtained luminaire downward efficiency values directly from the luminaire testing reports using the data from vertical angles of 0° to 90°. The luminaire downward efficiency was evaluated in terms of luminaire type, lamp orientation, and cutoff classification.

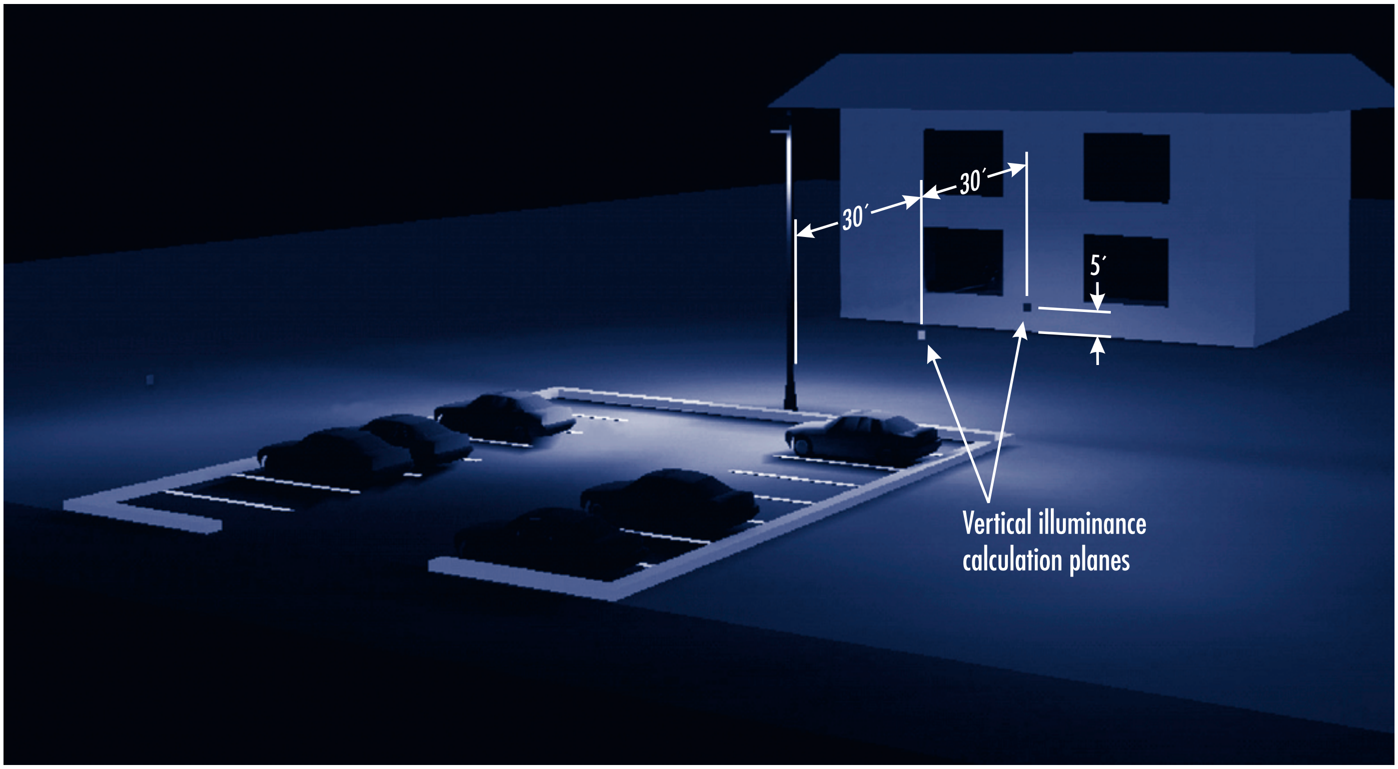
Determination of Glare Potential

NLPIP analyzed the photometric files from the luminaire testing to evaluate the potential for glare in two ways: the maximum intensity as a percentage of the lamp's luminous flux in the glare zone; and the luminous flux (as a percentage of lamp luminous flux) in the glare zone. Consideration of luminous flux in the glare zone is appropriate when comparing luminaires that have the same distribution and lamp source. However, this comparison would not be appropriate when comparing luminaires with different distributions, because the same quantity of glare zone luminous flux may be distributed differently for different luminaire distributions.

Determination of Light Trespass Potential

NLPIP analyzed all of the tested luminaires for light trespass through virtual simulations created using a rendering software package by Autodesk®, known as Lightscape. The purpose of these simulations was to determine whether luminaire type, lamp orientation, or cutoff classification indicated light trespass values. The luminaires were grouped in this way because specifiers and designers often select luminaires based on these characteristics. However, when considering light trespass it may be more appropriate to consider the lens type, the housing's shape, and the mounting method. The simulation illustrated in Figure 11 represents a parking lot with a luminaire located on the perimeter. Light trespass was determined by calculating the illuminance on a vertical plane at a distance of 30 feet (9.1 meters), or one mounting height behind the luminaire. The illuminance reading on the plane was centered at a height of 5 feet (1.5 meters). The vertical illuminance was also calculated at a distance of 60 feet (18.3 meters), or two mounting heights behind the luminaire at 5 feet (1.5 meters).

Figure 11. Light Trespass Simulation



Determination of Sky Glow Potential

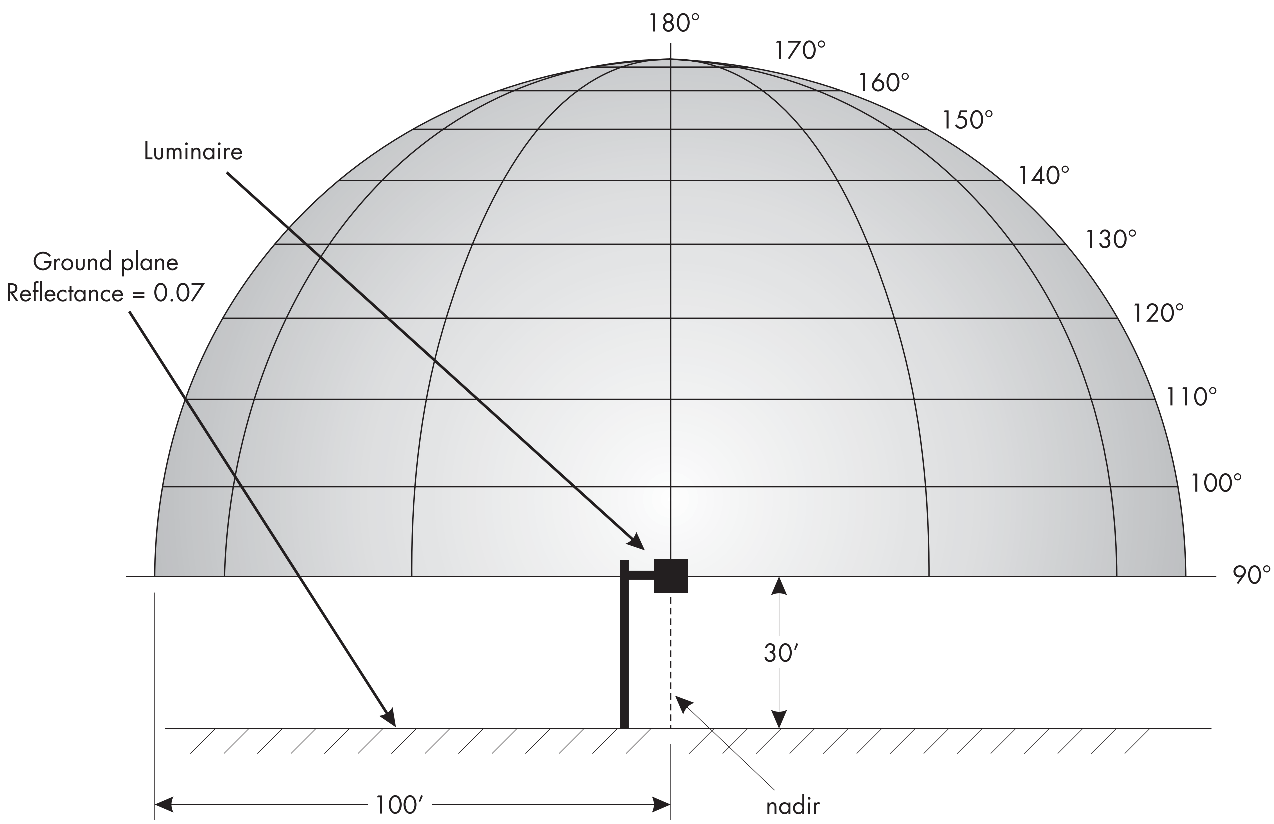
Direct Uplight

The percentage of direct uplight of the tested luminaires in terms of the lamp luminous flux was determined from the upward flux values in the photometric testing reports.

Uplight Dome Metric

NLPIP analyzed all of the tested luminaires for uplight through virtual simulations created using a rendering software package from Lighting Analysts, Inc. known as AGI32. The purpose of the analysis was to determine whether luminaire type, lamp orientation, or cutoff classification indicated uplight values. NLPIP created a half-dome calculation sphere around the pole-mounted luminaire to analyze uplight (Figure 12). Analysis results include both direct and reflected uplight. The luminaire mounting height was maintained at 30 feet (9.1 meters) and the radius of the half-dome at 100 feet (30.5 meters). In each case, the luminaire was placed at the center of the half-dome so the direct light from the luminaire traveled an equal distance in all directions before it reached the surface of the calculation dome. A lambertian ground plane was created with a reflectance of 0.07, which is the approximate reflectance value of typical dry asphalt after several months of use (U.S. Government and NASA 2004). However, most parking lots are surrounded by grass, have white parking space markings, cars, and nearby trees and buildings that would result in a higher overall reflectance value. Therefore, in this simulation, the reflectance value used is at the lowest end of the range of reflectances that would represent a parking lot. The data from the tested photometric files were used in the calculation. Figure 12 shows the half-dome surface on which the illuminance was calculated. The half dome was centered around one of the luminaires (the light meter sensor points inwards toward the luminaire), as represented and calculated in the computer simulation. The uplight values are considered on the shaded half-dome only.

Figure 12. Uplight Dome Metric



Results

NLPIP conducted analyses of downward efficiency and the potential for glare, light trespass, and uplight to determine whether any correlations exist when the results are sorted by luminaire style, lamp orientation, and cutoff classification. A calculation of analysis of variance (ANOVA) was performed for each analysis.

Luminaire Downward Efficiency

NLPIP calculated the downward efficiency of each of the luminaires (Table 13a). Based on the tested photometric files, downward efficiencies ranged from 54.8% to 88.7% with an average of 75.3%.

The downward efficiency was analyzed in terms of the three luminaire types: cobra head, arm mount, and post-top. As shown in Table 2, cobra head luminaires have a higher downward efficiency than arm mount and post-top luminaires, which is statistically significant. There was no significant difference between the downward efficiency of the arm mount and post-top luminaires.

Table 2. Average Downward Efficiency (by luminaire type)

Luminaire Type	Average Downward Efficiency (% of lamp luminous flux)	Range of Downward Efficiency (% of lamp luminous flux)
Cobra Head	85	80–89
Arm Mount	75	55–89
Post-top	71	61–83

The downward efficiency was analyzed in terms of the horizontal and vertical lamp orientation. As shown in Table 3, luminaires with lamps oriented horizontally have a higher downward efficiency than luminaires with lamps oriented vertically, which is statistically significant.

Table 3. Average Downward Efficiency (by lamp orientation)

Lamp Orientation	Average Downward Efficiency (% of lamp luminous flux)	Range of Downward Efficiency (% of lamp luminous flux)
Horizontal	80	70–89
Vertical	68	55–76

The downward efficiency was analyzed in terms of the three cutoff classifications: semicutoff, cutoff, and full cutoff. NLPIP found similar average downward efficiency values and a wide variation of downward efficiency for each cutoff classification. Therefore, there were no significant differences among cutoff classifications in terms of downward efficiency.

Glare Potential

NLPIP calculated the luminous flux in the glare zone (80° to 90°) as a percentage of lamp luminous flux for each luminaire (Table 13a). The glare zone luminous flux was equal to or less than 0.5% of the lamp luminous flux for 15 luminaires. These same luminaires were evaluated in terms of maximum luminous intensity, the calculation to determine the IESNA cutoff classification. For this very small glare zone luminous flux, the maximum luminous intensity values (as a percentage of the lamp luminous flux) ranged widely from 1.1% to 10.5%. For the cutoff classification, this ranges from full cutoff to semicutoff.

The glare zone luminous flux for the luminaires shown in Table 13a was analyzed. NLPIP found a wide variation for each analysis and no significant differences among values with regard to luminaire type, lamp orientation, or cutoff classification calculated from manufacturer photometric files. However, based on the tested cutoff classification, as shown in Table 4, semicutoff and cutoff luminaires have a higher average glare zone luminous flux than full cutoff luminaires, which is statistically significant. There was no significant difference between glare zone luminous flux for semicutoff and cutoff luminaires.

Table 4. Glare Zone Luminous Flux		
Tested Cutoff Classification	**Avg. Glare Zone Luminous Flux, 80°-90° (% of lamp luminous flux)**	**Range of Glare Zone Luminous Flux, 80°- 90° (% of lamp luminous flux)**
Semicutoff	1.0	0.4–2.1
Cutoff	1.5	0.4–2.7
Full Cutoff	0.3	0.0–1.3

The luminaires shown in Table 13a were analyzed in terms of glare with respect to the glare zone maximum luminous intensity as a percentage of the lamp luminous flux. NLPIP found a wide variation for each analysis and no significant differences among glare values with regard to luminaire type, lamp orientation, or cutoff classification calculated from manufacturer photometric files. However, based on the tested cutoff classification, shown in Table 5, semicutoff luminaires have higher average glare values than cutoff and full cutoff luminaires, which is statistically significant. There was no significant difference, however, between glare values for cutoff and full cutoff luminaires.

Table 5. Glare Zone Maximum Luminous Intensity		
Tested Cutoff Classification	**Avg. Max. Luminous Intensity, 80°-90° (% of lamp luminous flux)**	**Range of Max. Luminous Intensity, 80°- 90° (% of lamp luminous flux)**
Semicutoff	11.6	10.1–15.0
Cutoff	4.2	2.1–6.4
Full Cutoff	3.4	1.1–9.3

Light Trespass Potential

The luminaires shown in Table 13a were analyzed in terms of light trespass. As described in the "Evaluation Methods" section (page 22), a simulation was performed using the photometric files of the tested fixtures to determine the vertical illuminance at a height of 5 feet above the ground at a distance of 30 feet and 60 feet behind the luminaire. The average values for all luminaires, as well as the range, is provided in Table 6.

Table 6. Vertical Illuminance Behind a Luminaire That May Indicate Light Trespass		
Distance Behind Luminaire	**Average Vertical Illuminance, 5′ above the ground (lux)**	**Range of Vertical Illuminance, 5′ above the ground (lux)**
30′ or 1 MH	8.5	3.6–13.4
60′ or 2 MH	2.9	0.4–10.0

NLPIP found a wide variation for each analysis and no significant differences among light trespass values with regard to luminaire type, lamp orientation, or cutoff classification. When attempting to limit light trespass, the specifier should consider the characteristics of parking lot and area lighting luminaires individually. It is also important to realize that light trespass is highly dependent on factors such as mounting height, orientation, location, and site topography.

Sky Glow Potential

As described in the Evaluation Methods section, NLPIP testing provided two methods to evaluate the potential to contribute to sky glow: the direct uplight from the luminaire, and the uplight dome metric.

Direct uplight was considered in two manners. First, similar to the calculation to determine IESNA cutoff classification, the maximum luminous intensity value as a percentage of the lamp luminous flux was calculated from the tested photometric files. For all of the luminaires, the maximum luminous intensity above 90° in terms of the percentage of lamp luminous flux was 2.1%. Therefore, all tested luminaires met or exceeded the cutoff classification for angles above 90°.

Direct uplight, quantified as the luminous flux emitted above 90° by the luminaire as a percentage of the lamp luminous flux ranges from 0.0% to 3.1% with an average of 0.4% (see the upward efficiency column, Up (%), in Table 13a). The luminaires shown were analyzed in terms of direct uplight sorted by luminaire type, lamp orientation and cutoff classification. NLPIP found a wide variation and no significant differences for the direct uplight analysis with regard to luminaire type, lamp orientation, or cutoff classification calculated from manufacturer photometric files. However, based on the tested cutoff classification, as shown in Table 7, cutoff luminaires have higher average direct uplight values than semicutoff luminaires, which is statistically significant. Because full cutoff luminaires by definition emit no light above 90°, they were not considered in the statistical analysis.

Table 7. Direct Uplight as a Function of Tested Cutoff Classification

Tested Cutoff Classification	Average Direct Uplight Luminous Flux (% of lamp luminous flux)	Range of Direct Uplight Luminous Flux (% of lamp luminous flux)
Semicutoff	0.5	0.0–2.0
Cutoff	1.7	0.4–3.1
Full Cutoff	0.0	0.0

NLPIP also analyzed the same luminaires in terms of direct and reflected uplight. For this analysis, the uplight dome metric, as described in the "Evaluation Methods" section (page 22), was used. Uplight was calculated based on the tested photometric files and was analyzed in terms of luminaire type, lamp orientation, and cutoff classification. For each calculation, the percentage of uplight luminous flux for each luminaire is given as a percentage of the lamp luminous flux.

Uplight was evaluated in terms of the three luminaire types: cobra head, arm mount, and post-top. As shown in Table 8, cobra head luminaires have higher average uplight values compared with arm mount and post-top luminaires, which is statistically significant. There was no significant difference between the uplight of the arm mount and post-top luminaires.

Table 8. Average Uplight Values as a Function of Luminaire Type

Luminaire Type	Total Uplight Luminous Flux (% of lamp luminous flux)	Range of Total Uplight Luminous Flux (% of lamp luminous flux)
Cobra Head	6.3	4.9–8.4
Arm Mount	4.0	2.8–5.0
Post-top	3.8	3.1–4.7

Determining Uplight Values

While this report focuses on individual luminaires rather than lighting systems, these uplight percentage values provide a simple way to determine the amount of uplight to expect for a lighting installation. For example, to compare the amount of uplight for a parking lot using cobra heads versus a parking lot using arm mount luminaires, specifiers would design the parking lot using their chosen luminaire to determine how many luminaires are required to meet the lighting objectives. The number of luminaires multiplied by the lamp luminous flux for each luminaire multiplied by the total uplight for each luminaire would provide an expected uplight value for that installation.

Uplight was evaluated in terms of luminaire horizontal and vertical lamp orientation. As shown in Table 9, luminaires with horizontal lamp orientation have higher uplight than that from luminaires with vertical lamp orientation, which is statistically significant.

Table 9. Average Uplight Values as a Function of Lamp Orientation

Lamp Orientation	Total Uplight Luminous Flux (% of lamp luminous flux)	Range of Total Uplight Luminous Flux (% of lamp luminous flux)
Horizontal	4.9	3.8–8.4
Vertical	3.4	2.8–8.1

Uplight was evaluated in terms of the cutoff classification of the luminaires as measured in independent testing (Table 10). The only significant difference found among the cutoff classifications from the tested photometric files was that cutoff luminaires have higher total uplight values than full cutoff luminaires. There was no significant difference between uplight values for full cutoff and semicutoff luminaires, or between cutoff and semicutoff luminaires.

Table 10. Average Uplight Values as a Function of Tested Cutoff Classification

Tested Cutoff Classification	Total Uplight Luminous Flux (% of lamp luminous flux)	Range of Total Uplight Luminous Flux (% of lamp luminous flux)
Semicutoff	4.3	3.2–6.7
Cutoff	6.6	4.7–8.4
Full Cutoff	4.1	2.8–5.0

It is important to note that the reflected component of uplight is a larger portion of the total uplight when the direct contribution of uplight (Table 7) and the uplight calculated from the dome metric (Tables 8–10) are compared.

Comparisons with Manufacturer-Reported Data

NLPIP noted several important discrepancies when comparing manufacturer-reported data with the independent laboratory testing results.

Luminaire Downward Efficiency

When NLPIP compared photometric data provided by the manufacturers and the testing laboratory, it found close agreement between the two sets in only 14 of the 23 tested luminaires. This indicates that manufacturer-reported data are not always a reliable source of information for comparing luminaires for downward efficiency.

Cutoff Classification

NLPIP found several differences among the three methods of determining cutoff classification: manufacturer's claim; manufacturer's photometric files; and the independent test report. These discrepancies are noted in Table 13a. All three values agreed for only four luminaires. The manufacturer photometric files and independent test reports agreed for 13 luminaires. And eight luminaires met a more stringent cutoff classification than the one claimed by either the manufacturers' literature or photometric files.

The cutoff classification entries in Tables 11 and 13a are one of the four IESNA cutoff classifications (FC, C, SC, NC), plus an asterisk (*), or a dash (–). If the

IESNA cutoff classification could be determined from the data sheets or the photometric information on the manufacturer's web site, the specific IESNA cutoff classification was entered. An asterisk indicates that the term "cutoff" was used on the data sheet, but it was not apparent whether the term was used to represent the IESNA cutoff classification or whether it was being used as a broader descriptive term. The dash indicates that there was no mention of cutoff on the data sheet.

One possible reason for the discrepancy between the cutoff classification taken from the independent test reports and the cutoff classification determined from manufacturers' photometric files is that for a number of the luminaires (Table 13a), a photometric file for a 250-watt MH lamp luminaire was not available. When manufacturers were contacted, they provided photometric files with a higher or lower wattage, and in one instance a different lamp type. Discrepancies may result when using photometric files that do not accurately represent the characteristics of the luminaire. This may also be the reason for the difference between the manufacturer-claimed cutoff classification and the cutoff classification determined from manufacturers' photometric files. If the manufacturer tested the luminaire to be a certain cutoff classification but provided a photometric file for a different luminaire, this may result in discrepancies.

The discrepancy for two of the luminaires where the manufacturer claimed a stricter cutoff classification than the test bore out may be due to the uncertainty in the testing procedure. Both luminaires had slightly higher values for the maximum intensity at or above 80°, as seen in Table 13a. These luminaires were 1% and 5% over the limit, which most likely is within the uncertainty in the measurement system. This discrepancy is noted on the table. Unfortunately, the cutoff classification alone provides no information to indicate whether a cutoff luminaire, for example, falls in the middle of the range or at the edge.

Light Distribution Type

Of the 23 luminaires tested, NLPIP found that 14 luminaires displayed the expected Type III distribution. The remaining nine luminaires had distributions other than Type III, ranging from Type I to Type IV. Only three products, all from one manufacturer, specified vertical classification in their literature. Of those three, one luminaire had a discrepancy between the manufacturer's claimed vertical distribution and the tested vertical distribution. Through testing, NLPIP found that 16 luminaires had a short vertical distribution, while the remaining seven had a medium vertical distribution (Table 13a).

The uncertainty of the IESNA lateral distribution is noted in Table 13a. For two of these luminaires, the location of the half-maximum isointensity trace lies on the boundary with another distribution. Uncertainty in the testing procedure to measure the luminous intensity distribution of the luminaires calls into question the distribution listed in Table 13a. For the remaining two luminaires, the IESNA classification would change if the vertical classification *very short* were used. Unfortunately, the IESNA light distribution classification alone provides no information to indicate whether a Type III, for example, falls in the middle of the range or at the edge. It also provides no information about the vertical distribution used to make the determination.

Conclusions

In general, there is a larger variability among the luminaires in relation to the claim of manufacturers about cutoff classification and IESNA classification. Meanwhile the standards used to classify the fixtures have a tight tolerance and are not always representative in terms of uplight and possibly glare. This is seen in Table 13a when comparing the intensity above 90° with the upward efficiency and when comparing the glare zone intensity with the glare zone luminous flux.

The analyses presented in this report emphasize several important considerations. Specifiers should be aware that manufacturer-reported photometric data may be different from the results of independent photometric testing on a particular luminaire. In some cases, manufacturer-reported data may contradict information contained in its own product literature. Specifiers should utilize independent-laboratory test results such as those published in this report. When such data are not available, the specifier should use manufacturer-provided data but allow for the possibility of deviations in analyses and calculations. When possible, visit an installation using the specific luminaire under consideration, or arrange with manufacturers' representatives to conduct a mockup.

Luminaire downward efficiency may be a useful initial quantity when considering the number of luminaires, poles, and other hardware needed to provide a particular illuminance in a particular location. It is important to consider uniformity and other criteria as well. There are many ways to group luminaires. While there is significant overlap among different groups, independent laboratory photometric data evaluated by NLPIP suggest that differences can exist among luminaire types when compared for their outward appearances. The cobra head luminaires tested, for example, were slightly more efficient than the arm mounted and post-top luminaires. Similarly, the luminaires with horizontally oriented lamps were somewhat more efficient than those with vertical lamps. However, there were no differences among the luminaires in terms of cutoff classification.

Regarding the potential for glare or for light trespass, different groups of luminaires do not appear to perform differently overall. Rather, these characteristics are dependent upon the specific installation layout, geometry, and ambient conditions. Specifiers should consult manufacturer-provided photometric data to plan for avoiding glare and light trespass. These data may not provide an accurate description of an individual luminaire's performance, but it should provide specifiers with an estimate of when these issues are likely to be important for a particular installation.

With respect to the potential for sky glow, a comparison of the direct contribution of uplight (Table 7) and the uplight calculated from the dome metric (Tables 8–10) shows that the reflected component of uplight is a larger portion of the total uplight. In terms of the luminaire type, the cobra head luminaires, as measured by the uplight dome metric, produced a greater degree of uplight than arm-mounted or post-top luminaires. This is based on the percentage of lamp luminous flux being directed or reflected upward. However, this consideration should be balanced by the generally higher downward efficiencies cobra head luminaires tend to exhibit. The higher degree of uplight per luminaire could be counterbalanced by being able to use a smaller number of luminaires for a particular installation.

As for lamp orientation, the luminaires tested showed higher amounts of uplight from luminaires with horizontally oriented lamps than from luminaires with vertically oriented lamps. However, since horizontal-lamp luminaires tend to have greater downward efficiency than vertical-lamp luminaires, fewer horizontal-lamp luminaires may be needed for a particular installation, so the total uplight for the installation could be less.

Finally, grouping the luminaires by cutoff classification showed that the cutoff luminaires resulted in greater amounts of uplight than the full cutoff or semicutoff luminaires that were tested. Because the luminaire downward efficiency of the cutoff types did not vary significantly among the types, these data illustrate that specifiers must consider individual luminaires and their performance characteristics carefully when specifying equipment for outdoor area lighting.

Key to Abbreviations in Tables 11 and 13a

Lamp.
HPS ... high pressure sodium
MH .... metal halide

Lamp Wattage. The range is limited to 35 watts–400 watts.

Lamp Position. Position of lamp within the luminaire.
H .... horizontal
V .... vertical

Reflector Type. Type of reflector including the material and the manufacturing process used to make the reflector.
die .... die-cast aluminum
hydro .... hydroformed (deep drawn) aluminum
seg .... segmented aluminum
spun .... spun aluminum

Tested product. Products with this mark were tested by NLPIP.

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Company A	ABC ✓	HPS, MH	250–400	H, V	II, III, IV	SC, FC	spun	yes	silic
Company B	DEF	HPS, MH	50–400	H	II, III, V	*	hydro, seg	—	rubber
Company C	GHI	HPS, MH	175–400	H, V	II, III, IV, V	SC, FC	seg	yes	poly

Cutoff Class. Manufacturer-claimed cutoff classification is obtained from the cut sheet or online information. Manufacturer IES file cutoff classification is obtained from calculations using the manufacturer-supplied photometric files of individual luminaires. Test report cutoff classification is obtained from the independent laboratory test report.
FC .... Full Cutoff
C .... Cutoff
SC .... Semicutoff
NC .... Noncutoff
* .... cutoff term mentioned in the text

IES Lat. Dist. (IESNA lateral distribution). Lateral distributions of light cast by the luminaire. IESNA light distributions, Types I, II, III, IV, or V

Rotatable optics. Option to rotate the optics or luminaire for proper aiming.

Gasket. Material used to seal the optical system.
poly .... polyester (dacron)
rubber ...... rubber (Neoprene/Poron/EPDM/EPT)
silic .... silicone
* .... gasket material not specified

Manufacturer	Product	Lamp Pos.	Cutoff Classification: Mfr. Claim	Cutoff Classification: Mfr. IES File	Cutoff Classification: Test Report	Max. Lum. Inten. ≥ 90° (%)	GZ Max. Lum. Inten. (%)	GZ Lum. Flux (%)	IES Lat. Dist.	IES Vert. Dist.	Efficiency: Down (%)	Efficiency: Up (%)	Efficiency: Total (%)
Company J	MNO	V	C	FC	NC	0.9	34.5	4.5	IV	M	74.3	0.1	74.4
Company K	PQR	H	FC	FC	FC	0.0	1.6	0.3	III	M	88.6	0.0	88.6
Company L	STU	H	FC	SC	SC	0.1	15.0	0.5	III	M	71.6	0.2	71.8

Max. Lum. Intensity ≥ 90° (maximum luminous intensity). Value obtained from the photometric file for each luminaire given as a percentage of lamp luminous flux for all angles above 90° vertical.

GZ Max. Lum. Inten. (glare zone maximum luminous intensity). Maximum intensity in all angles in the glare zone (80° and 90° vertical) as a percentage of lamp luminous flux.

GZ Lum. Flux (glare zone luminous flux). Summation of flux in all horizontal angles from 80° and 90°, vertical calculated from the luminaire's photometric file as a percentage of the lamp luminous flux.

IES Vert. Dist. (IESNA vertical distribution) Describes the location of the maximum luminous intensity point in terms of the mounting height (see Fig. 7).
S .... short
M .... medium
L............................... long

Efficiency. Percentage of luminous flux leaving the luminaire as a percentage of the lamp luminous flux.
Down (%) .... downward efficiency
Up (%) .... upward efficiency
Total (%) ..... total efficiency

Table 11. Manufacturer-Supplied Information

Cobra Head Luminaires

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
American Electric Lighting	DuraStar 20	HPS, MH	35–175	—	II, III	—	—	—	—
American Electric Lighting	DuraStar 30	HPS, MH	200–400	—	II, III	—	—	—	—
American Electric Lighting	Roadway 115 ✓	HPS, MH	35–250	—	II, III	*	—	—	—
American Electric Lighting	Roadway 315	HPS, MH	35–400	—	II, III	*	—	—	—
American Electric Lighting	Roadway 125	HPS, MH	175–400	—	II, III, IV	*	—	—	—
American Electric Lighting	Roadway 325	HPS, MH	175–400	—	II, III, IV	*	—	—	—
American Electric Lighting	Roadway 327	HPS, MH	310–400	—	I, II, III, IV	—	—	—	—
American Electric Lighting	Roadway 413	HPS, MH	35–150	—	II, III	—	—	—	—
GE Lighting Systems	M-250	HPS, MH	50–250	H	II, III, IV	NC, SC, C	—	—	—
GE Lighting Systems	M-400 ✓	HPS, MH	100–400	H	II, III, IV	NC, SC, C	—	—	—
GE Lighting Systems	Solaris	HPS	70–150	H	II, III, IV	SC, C	—	—	—
Hubbell Lighting	Roadway	HPS, MH	70–400	—	II, III	NC, C	—	—	poly, silic
Lithonia Lighting	CHE	HPS	35–150	H	II, III	FC	—	—	poly
Lithonia Lighting	CHL, CHLD	HPS, MH	50–250	H	II, III	FC	—	—	poly
Lithonia Lighting	CHM, CHMD	HPS, MH	175–400	H	II, III	C, FC	—	—	poly
Lithonia Lighting	CHX	HPS	310–400	H	II, III	—	—	—	poly
Lumark	Roadway	HPS, MH	50–400	H	II, III	—	hydro	—	rubber
Lumec-Schréder	Helios	HPS, MH	70–400	H	II, III	NC, SC, C	hydro	—	silic
Streetworks	OV ✓	HPS, MH	50–400	H	II, III, IV	NC, SC, C	hydro	—	—

Arm Mount Luminaires

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
American Electric Lighting	AVL	HPS, MH	250–400	V	II, III, IV	*	—	—	silic
Architectural Area Lighting	Mitre	HPS, MH	70–400	H	II, III, IV, V	FC	die, seg	—	silic
Architectural Landscape Lighting	AL-01	HPS, MH	100–400	H	II, III, V	—	seg	yes	poly
Architectural Landscape Lighting	AL-02	HPS, MH	100–400	H	II, III, V	—	seg	yes	poly
Architectural Landscape Lighting	AL-04	HPS, MH	70–175	—	II, V	—	—	—	poly
Architectural Landscape Lighting	AL-05	HPS, MH	100–400	—	II, III, V	—	seg	yes	poly
Architectural Landscape Lighting	AL-11	HPS, MH	100–400	H, V	II, III, V	—	seg	yes	poly
Architectural Landscape Lighting	AL-12	HPS, MH	100–400	—	II, III, V	—	—	yes	silic
Bega	8071, 8171	HPS, MH	100–175	H	—	*	—	—	*
Bega	8141, 8145	MH	70–150	H	—	—	—	—	silic
Bega	8381, 8383, 9372	HPS, MH	70–175	V	—	—	—	—	*
Bega	8821, 8881	HPS, MH	100	V	—	—	—	yes	—
Bega	9804, 9900, 9998	HPS, MH	50–175	V	—	*	—	—	*
Bieber Lighting	Arlington	HPS, MH	35–400	—	III, V	—	seg	—	rubber
Bieber Lighting	Century	HPS, MH	70–400	H, V	III	—	seg	—	—
Bieber Lighting	Denver	HPS, MH	50–400	H	II, III, V	—	seg	—	rubber
Bieber Lighting	Geodome	HPS, MH	70–400	H, V	II, III, V	—	seg	—	*
Bieber Lighting	Le Mans	HPS, MH	70–400	H, V	II, III, V	—	hydro, seg	—	*
Bieber Lighting	Orlando Select	HPS, MH	70–400	H, V	II, III, V	—	hydro, seg	—	rubber
Bieber Lighting	Park Circle	HPS, MH	50–400	H	II, III, V	—	seg	—	rubber

Table 11. Manufacturer-Supplied Information

Arm Mount Luminaires (cont'd)

(Key to Abbreviations, p. 32)

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Bieber Lighting	Park Lane	HPS, MH	50–400	H	II, III, V	—	hydro, seg	—	rubber
Bieber Lighting	Park View	HPS, MH	50–400	H	—	—	seg	—	rubber
Bieber Lighting	Parkette	HPS, MH	50–400	H	II, III, V	—	hydro, seg	—	rubber
Bieber Lighting	PCV	HPS, MH	70–400	V	III, V	—	seg	—	rubber
Bieber Lighting	Phoenix	HPS, MH	70–400	H, V	III, V	—	seg	—	*
Bieber Lighting	Seattle	HPS, MH	70–400	V	III, V	—	seg	—	*
Bieber Lighting	Solitaire	HPS, MH	70–400	V	III, V	—	seg	—	rubber
C.E.W. Lighting	FP	HPS, MH	35–400	—	III	—	—	yes	silic
C.E.W. Lighting	FVL	HPS, MH	320–400	V	V	—	seg	—	rubber
Day-Brite Lighting	SBX400	HPS, MH	150–400	H	II, III, IV	C	—	—	silic
Emco Lighting	Decolume	HPS, MH	70–400	H, V	II, III, IV, V	SC	seg	yes	silic
Emco Lighting	Ecolume ECA/ECW	HPS, MH	70–400	H, V	II, III, IV, V	SC	seg	yes	silic
Emco Lighting	Ecoround ERA/ERW	HPS, MH	70–400	H, V	II, III, IV, V	SC, C	seg	yes	silic
Emco Lighting	Infinity II	HPS, MH	70–400	H	II, III, V	C	seg	—	—
ExceLine	Panorama	HPS, MH	150–400	H	II, III, IV, V	*	seg	yes	silic
ExceLine	SiteMaster	HPS, MH	100–400	H	II, III, IV	*	hydro	—	*
ExceLine	SiteMaster Bantam	HPS, MH	35–150	H	III	C	—	—	—
ExceLine	VertiLyte	HPS, MH	250–400	V	II, III, IV, V	*	seg	yes	*
Gardco Lighting	Circa	HPS, MH	100–400	H, V	I, II, III, IV, V	*	seg	yes	silic
Gardco Lighting	Form10 EH/H/HT/A-Style	HPS, MH	100–400	H, V	I, III, IV, V	FC	seg	yes	silic
Gardco Lighting	Hardtop CA/MA	HPS, MH	50–400	H, V	I, III, IV, V	FC	seg	yes	silic
Gardco Lighting	Gullwing ✓	HPS, MH	50–400	H	I, II, III, IV, V	—	seg	—	rubber
GE Lighting Systems	Criterion	HPS, MH	250–400	H, V	II, III, IV, V	SC,C	hydro	yes	*
GE Lighting Systems	Decashield 175	HPS, MH	50–175	H	III, V	C	—	yes	*
GE Lighting Systems	Decashield 400	HPS, MH	150–400	H	II, III, IV, V	NC,SC,C	—	yes	*
GE Lighting Systems	Decasphere	HPS, MH	70–400	H, V	II, III, IV, V	SC, C	—	yes	*
GE Lighting Systems	Dimension ✓	HPS, MH	70–400	H, V	II, III, IV, V	SC, C	—	yes	*
GE Lighting Systems	Nexell	HPS, MH	70–400	H	I, II, III	NC, SC, C	—	—	silic
GE Lighting Systems	Tiger	HPS, MH	250–400	H	—	—	—	—	—
Hadco Lighting	Capella	HPS, MH	150–400	H, V	II, III, IV, V	C	hydro, seg	yes	silic
Hadco Lighting	Die-Cast	HPS, MH	70–400	H	II, III, V	—	seg	yes	silic
Hadco Lighting	Disc	HPS, MH	70–400	H	II, III, IV, V	—	seg	yes	silic
Hadco Lighting	Hemisphere	HPS, MH	70–400	H	II, III, IV, V	—	seg	yes	silic
Hadco Lighting	Profiler	HPS, MH	150–400	H	I, II, III, IV, V	—	seg	yes	silic
Holophane	MirroStar	HPS, MH	250–400	H	III, V	FC	—	—	*
Holophane	Mongoose	HPS, MH	100–400	—	I, II, III, IV	NC, SC, C, FC	—	—	—
Holophane	PoleStar II	HPS, MH	250–400	H, V	—	C	hydro	—	*
Holophane	Somerset	HPS, MH	100–400	H	—	—	hydro	—	—
Hubbell Lighting	Magnudisc II	HPS, MH	70–400	H, V	I, III, IV, V	C	seg	yes	—
Hubbell Lighting	Magnudrum	HPS, MH	150–400	H, V	II, III, IV, V	C, FC	—	yes	—
Hubbell Lighting	Magnuform III	HPS, MH	100–400	H	III, IV, V	C	—	—	*
Hubbell Lighting	Magnuliter II	HPS, MH	250–400	V	III	C	—	—	—
Hubbell Lighting	Magnuspec	HPS, MH	70–175	—	I, III, V	C	—	—	—
Hubbell Lighting	Magnusquare II	HPS, MH	400	V	I, III, IV, V	C, FC	seg	—	—

Table 11. Manufacturer-Supplied Information

Arm Mount Luminaires (cont'd)

(Key to Abbreviations, p. 32)

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Kim Lighting	Arc	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	yes	silic
Kim Lighting	Archetype	HPS, MH	70–400	H	II, III, IV, V	FC, C	die	yes	silic
Kim Lighting	Curvilinear	HPS, MH	70–400	H	II, III, IV, V	C	seg	yes	silic
Kim Lighting	EKG	HPS, MH	70–400	H	—	—	hydro	—	silic
Kim Lighting	Entablature	HPS, MH	70–400	H	II, III, IV, V	—	seg	yes	silic
Kim Lighting	Matrix	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	yes	silic
Kim Lighting	Structural	HPS, MH	70–400	H	II, III, IV, V	—	seg	yes	silic
Kim Lighting	Type 5	HPS, MH	150–400	H	—	—	hydro	—	*
Kim Lighting	VL	HPS, MH	70–400	V	III	—	seg	yes	*
Lithonia Lighting	Aeris	HPS, MH	35–400	H	II, III, IV, V	*	seg	yes	silic
Lithonia Lighting	KAD, KAC	HPS, MH	70–400	H	II, III, IV, V	*	hydro, seg	—	silic
Lithonia Lighting	KAR	HPS, MH	100–400	H	II, III, IV, V	*	hydro	yes	rubber
Lithonia Lighting	KC	HPS, MH	250–400	H	III, IV	*	hydro, seg	—	silic
Lithonia Lighting	KSE	HPS, MH	70–400	H	II, III, IV, V	C	seg	yes	silic
Lithonia Lighting	KSF	HPS, MH	70–400	H	II, III, IV, V	C	seg	yes	silic
Lithonia Lighting	KVE	HPS, MH	175–400	H, V	II, III, IV, V	SC, FC	seg	yes	*
Lithonia Lighting	KVF	HPS, MH	250–400	H, V	II, III, IV	SC, FC	spun	yes	silic
Lithonia Lighting	KVR	HPS, MH	175–400	H, V	II, III, IV, V	SC, FC	seg	yes	*
Lithonia Lighting	KVS	HPS, MH	70–250	H, V	II, III, IV, V	C	hydro	—	rubber
LSI Lighting Systems	Challenger	HPS, MH	100–400	H, V	II, III, V	FC	—	yes	silic
LSI Lighting Systems	Citation	HPS, MH	100–400	H, V	III, V	FC	—	yes	rubber
LSI Lighting Systems	Classic	HPS, MH	150–400	H	—	*	—	—	rubber
LSI Lighting Systems	Greenbriar	HPS, MH	250–400	V	II, III, V	FC	—	yes	rubber
LSI Lighting Systems	Heritage	HPS, MH	250–400	H	III, V	—	—		rubber
LSI Lighting Systems	Hilton	HPS, MH	100–400	H, V	II, III, V	SC, FC	—	yes	rubber
LSI Lighting Systems	Starbeam II	MH	250–400	V	—	*	—	—	rubber
Lumark	Hammer	HPS, MH	70–400	H	I, II, III	—	hydro		poly
Lumark	Landau	HPS, MH	320–400	H	III	*	—	yes	—
Lumca	100	HPS, MH	70–400	H	III, IV, V	—	seg	—	rubber
Lumec-Schréder	Citea	HPS, MH	70–400	H,V	II, III	NC, SC, C	hydro	—	silic
Lumec-Schréder	Opticone	HPS, MH	50–400	H, V	I, II, III, V	C	seg	—	rubber
Lumec-Schréder	Optilux	HPS, MH	35–400	H	I, II, III, V	C	seg	yes	silic
McGraw-Edison	CLM	HPS, MH	250–400	V	I, II, III	C	—	yes	rubber
Pappi Lighting	Aquaform	HPS, MH	35–400	H, V	II, III, V	*	seg	yes	rubber
Pappi Lighting	Auraform	HPS, MH	35–400	—	II, III, V	*	seg	yes	rubber
Pappi Lighting	Eliminator	HPS, MH	35–400	H, V	II, III, V	*	seg	yes	rubber
Pappi Lighting	Mid Rexsquare	HPS, MH	150–400	H	II, III, V	—	seg	yes	rubber
Pappi Lighting	Mid Square	HPS, MH	35–250	H	II, III, V	—	seg	yes	rubber
Pappi Lighting	Mid Square 11	HPS, MH	150–400	H, V	V	—	seg	yes	rubber
Pappi Lighting	Minisquare	HPS, MH	35–175	H, V	II, III, V	—	seg	yes	rubber
Pappi Lighting	Rexsquare	HPS, MH	150–400	H	III	—	seg	yes	rubber
Pappi Lighting	Squareline	HPS, MH	150–400	H	II, III, V	—	seg	yes	rubber
Quality Lighting	123	HPS, MH	70–400	H, V	III, V	—	—	—	poly, silic
Quality Lighting	125	HPS, MH	70–400	H, V	III, V	—	—	—	poly, silic

Table 11. Manufacturer-Supplied Information

Arm Mount Luminaires (cont'd)

(Key to Abbreviations, p. 32)

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Quality Lighting	129	HPS, MH	70–400	H, V	III, V	—	—	—	poly, silic
Quality Lighting	CH	HPS, MH	400	V	V	—	spun	—	—
Quality Lighting	PDM	HPS, MH	250–400	H, V	II, III, IV, V	—	seg	—	silic
Quality Lighting	SJ	HPS, MH	100–400	H, V	II, III, V	—	—	yes	poly, silic
Quality Lighting	SJH	HPS, MH	70–400	H, V	II, III, V	*	seg	yes	poly, silic
Quality Lighting	SL	HPS, MH	70–400	H, V	I, II, III, V	—	—	yes	rubber, silic
Quality Lighting	SND	HPS, MH	100–400	H, V	II, III, V	—	—	yes	poly, silic
Ruud Lighting	AC	HPS, MH	35–400	H	—	*	—	—	silic
Ruud Lighting	LAC	HPS, MH	35–175	H	—	*	—	—	silic
Ruud Lighting	LPR	HPS, MH	35–175	V	III	—	—	—	silic
Ruud Lighting	PR	HPS, MH	35–400	H	II, III	—	hydro	—	silic
Ruud Lighting	QV	HPS, MH	50–400	V	V	—	spun	—	silic
Ruud Lighting	S3V	HPS, MH	200–400	V	III	*	hydro	—	silic
Ruud Lighting	S4V	HPS, MH	200–400	V	IV	*	seg	—	silic
Ruud Lighting	VFT	HPS, MH	200–400	V	—	—	—	—	silic
Ruud Lighting	VPR	HPS, MH	200–400	V	—	—	—	—	silic
Ruud Lighting	WAC	HPS, MH	100–400	H	—	*	—	—	silic
Ruud Lighting	WPR	HPS, MH	100–400	H	II, III	—	hydro	yes	silic
Security Lighting Systems	Maxicube	HPS, MH	250–400	V	—	—	—	—	—
Security Lighting Systems	RSB	HPS, MH	100–400	H	II, III, IV, V	—	hydro	yes	silic
Security Lighting Systems	Signature	HPS, MH	250–400	V	III, V	—	—	—	—
Security Lighting Systems	Wedge	HPS, MH	150–400	H	III	—	—	—	—
SELUX	Arc	HPS, MH	50–400	H	II	C, FC	—	—	silic
SELUX	Cityliter	HPS, MH	50–150	H	I, II, III	NC, SC, FC	—	—	silic
SELUX	Cometa	HPS	70–250	H	II	—	—	—	—
SELUX	Discera	HPS, MH	70–250	H	I, II	—	—	—	—
SELUX	Orbita	HPS	70–250	H	II	—	—	—	—
SELUX	Ovalis	HPS, MH	70–250	H	—	—	—	—	—
SELUX	Polygon	HPS, MH	100–250	H	—	SC, C	seg	—	rubber
SELUX	Stradex	HPS, MH	50–400	H	II, III	SC, C, FC	—	—	*
SELUX	Vektor	HPS, MH	50–400	H, V	II, V	FC	—	—	silic
Spaulding Lighting	Alaire	HPS, MH	400	V	III, IV, V	FC	seg	yes	silic
Spaulding Lighting	Aurora	HPS, MH	100–400	H	II, III, IV, V	—	seg	—	*
Spaulding Lighting	Cambridge	HPS, MH	100–400	H, V	II, III, IV, V	—	seg	yes	*
Spaulding Lighting	Catalina	HPS, MH	100–400	H	II, III, IV, V	—	seg	yes	*
Spaulding Lighting	Cordova	HPS, MH	100–400	H	II, III, IV, V	—	seg	yes	*
Spaulding Lighting	Dallas	HPS, MH	100–400	H	II, III, IV, V	—	seg	—	*
Spaulding Lighting	Fairlane	HPS, MH	400	V	IV	—	seg	—	*
Spaulding Lighting	Lincoln	HPS, MH	150–400	H	IV	*	—	—	*
Spaulding Lighting	Medallion	HPS, MH	100–400	H, V	II, III, IV, V	FC	seg	—	silic
Spaulding Lighting	Monterey	HPS, MH	100–400	V	III, IV, V	FC	seg	—	*
Spaulding Lighting	Newark	HPS, MH	100–400	H, V	II, III, IV, V	FC	seg	—	*
Spaulding Lighting	Orlando	HPS, MH	250–400	V	III, IV, V	FC	seg	—	*
Spaulding Lighting	Proformer	HPS, MH	250–400	V	III, IV, V	FC	seg	—	*

Table 11. Manufacturer-Supplied Information

Arm Mount Luminaires (cont'd) *(Key to Abbreviations, p. 32)*

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Spaulding Lighting	Santa Fe	HPS, MH	100–400	H	II, III, IV, V	—	seg	—	*
Spaulding Lighting	Vertilite	HPS, MH	150–400	V	IV	—	—	—	*
Spaulding Lighting	Washington	HPS, MH	100–400	H, V	II, III, IV, V	FC	seg	—	*
Sterner Lighting Systems	ARSRD	HPS, MH	150–400	H, V	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	ARSRT	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	ARSSQ	HPS, MH	150–400	H, V	II, III, IV, V	C, FC	—	—	—
Sterner Lighting Systems	Berkley	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Concord	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Corona	HPS, MH	150–250	H	II, III, IV, V	C, FC	—	—	—
Sterner Lighting Systems	Delano	HPS, MH	70–400	H	II, III, IV	C	—	—	—
Sterner Lighting Systems	Edge	HPS, MH	70–400	—	II, III, IV, V	FC	hydro, seg	yes	rubber, silic
Sterner Lighting Systems	Executive	HPS, MH	70–400	H	II, III, IV, V	FC	hydro, seg	—	rubber, silic
Sterner Lighting Systems	Fontana	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Franklin	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Glendale	HPS, MH	150–400	H, V	II, III, IV, V	C, FC	—	—	—
Sterner Lighting Systems	Humboldt	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Madison	HPS, MH	150–400	H	II, III, IV, V	C, FC	—	—	—
Sterner Lighting Systems	Marquette	HPS, MH	70–400	H	II, III, IV	C	—	—	—
Sterner Lighting Systems	Polaris	HPS, MH	70–400	H	II, III, IV, V	FC	hydro, seg	yes	silic
Sterner Lighting Systems	Sedona	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Stonco Lighting	MCL	HPS, MH	150–400	H	II, III, IV	C	hydro, seg	—	rubber, silic
Stonco Lighting	RMS	HPS, MH	35–150	V	III	C	—	—	rubber
Stonco Lighting	SVL ✓	HPS, MH	250–400	V	II, III, IV, V	—	seg	yes	—
Streetworks	Cirrus	HPS, MH	70–400	H	II, III, IV, V	C	hydro	yes	—
Streetworks	Concourse III	HPS, MH	70–400	H	II, III, IV, V	C	hydro, seg	—	silic
Streetworks	Credenza	HPS, MH	70–400	H	II, III, IV, V	C	hydro	yes	—
Streetworks	Galleria	HPS, MH	250–400	H, V	I, II, III	C	hydro, spun	—	—
Streetworks	Landau	HPS, MH	400	H	III	C	—	yes	—
Streetworks	RC	HPS, MH	70–400	H	I, II, III	C	hydro	—	—
Streetworks	Vision	HPS, MH	100–400	H	II, III, IV, V	—	hydro, seg	yes	silic
Techlight	Orion	HPS, MH	150–400	H	V	C	seg	—	silic
Techlight	Polaris	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	—	silic
Techlight	Titan	HPS, MH	400	H	IV	—	—	—	rubber
U.S. Architectural Lighting	Aerolume	HPS, MH	100–400	H	I, II, III, IV, V	*	seg	yes	rubber
U.S. Architectural Lighting	Galaxy1	HPS, MH	70–250	H, V	II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	Galaxy3	HPS, MH	70–400	H, V	II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	Galaxy4	HPS, MH	70–400	H, V	II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	Galaxy6	HPS, MH	70–400	H, V	II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	Lumenato - SEG	HPS, MH	100–400	H	III, IV, V	*	seg	—	rubber
U.S. Architectural Lighting	RSB	HPS, MH	100–400	H	I, II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	RVL	HPS, MH	250–400	H, V	IV, V	—	seg	—	rubber
U.S. Architectural Lighting	Stealth	HPS, MH	150–400	H	I, II, III, IV, V	*	hydro, seg	yes	rubber
U.S. Architectural Lighting	SVL22	HPS, MH	250–400	H, V	IV, V	—	seg	—	rubber
U.S. Architectural Lighting	Versalux	HPS, MH	100–400	H	I, II, III, IV, V	*	hydro, seg	yes	rubber

Table 11. Manufacturer-Supplied Information

Arm Mount Luminaires (cont'd)

(Key to Abbreviations, p. 32)

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Visionaire Lighting	American	HPS, MH	100–400	V	II, III, IV, V	FC	seg	—	silic
Visionaire Lighting	AutoLux	HPS, MH	100–400	H	I, II, III, IV, V	*	seg	—	silic
Visionaire Lighting	Cairo	HPS, MH	100–400	H	I, II, III, IV, V	—	seg	—	*
Visionaire Lighting	Caribbean	HPS, MH	70–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Century	HPS, MH	150–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Concourse	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Dominator	HPS, MH	70–400	H, V	II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Hillsboro	HPS, MH	100–400	H, V	II, III, IV, V	—	seg	—	silic
Visionaire Lighting	LumenStar	HPS, MH	100–400	H, V	II, III, IV, V	—	—	—	—
Visionaire Lighting	Mark VII	HPS, MH	100–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	OrbiStar	HPS, MH	70–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	ParkingStar	HPS, MH	50–400	H	I, II, III, IV, V	*	hydro, seg	—	silic
Visionaire Lighting	Polera	HPS, MH	100–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Questar	HPS, MH	70–400	V	III, IV	—	seg	—	silic
Visionaire Lighting	Sahara	HPS, MH	70–400	V	I, II, III, IV, V	—	—	—	*
Visionaire Lighting	SquareForm	HPS, MH	100–400	H	I, II, III, IV, V	*	seg	—	silic
Visionaire Lighting	Toronto ✓	HPS, MH	70–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	ViewStar	HPS, MH	70–400	H	III, IV	—	—	—	—
Wide-Lite	Effex ✓	HPS, MH	150–400	H, V	I, II, III, IV, V	SC, C, FC	seg	yes	silic
Wide-Lite	Excel-Lyte	HPS, MH	150–400	H	II, III	FC	hydro	yes	—
Wide-Lite	Spectra	HPS, MH	70–400	H, V	II, III, IV, V	SC, C, FC	seg	yes	—

Post-top Luminaires

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Architectural Area Lighting	Largent	HPS, MH	70–175	H	II, III, IV, V	FC	die	—	silic
Architectural Landscape Lighting	AL-06	HPS, MH	100–400	H, V	II, III, V	—	seg	yes	poly
Architectural Landscape Lighting	AL-11	HPS, MH	100–400	H, V	II, III, V	—	seg	yes	poly
Bega	8081, 8082, 8085	HPS, MH	100–400	H	—	*	hydro	—	—
Bega	8190	HPS, MH	100–175	H	—	*	hydro	—	—
Bieber Lighting	Geodome	HPS, MH	70–400	H, V	II, III, V	—	seg	—	*
Bieber Lighting	Ontario	HPS, MH	35–400	H	II, III, V	*	hydro, seg	—	rubber
Bieber Lighting	Park Circle	HPS, MH	50–400	H	II, III, V	—	seg	—	rubber
Bieber Lighting	PCV ✓	HPS, MH	70–400	V	III, V	—	seg	—	rubber
Bieber Lighting	Phoenix	HPS, MH	70–400	H, V	III, V	—	seg	—	*
Bieber Lighting	Sagittarius	HPS, MH	35–250	H	II, III, V	—	—	—	—
Bieber Lighting	Seattle	HPS, MH	70–400	V	III, V	—	seg	—	*
Bieber Lighting	Valencia	HPS, MH	35–400	H, V	II, III, V	—	seg	—	rubber
Emco Lighting	Decolume	HPS, MH	250–400	H, V	II, III, IV, V	SC	seg	yes	silic
Emco Lighting	Ecolume ECP	HPS, MH	250–400	H, V	II, III, IV, V	SC	seg	yes	silic
Emco Lighting	Ecoround ERP ✓	HPS, MH	70–400	H, V	II, III, IV, V	SC, C	seg	yes	silic
ExceLine	VertiLyte Tenon ✓	HPS, MH	250–400	V	II, III, IV, V	*	seg	yes	*

Table 11. Manufacturer-Supplied Information

Post-top Luminaires (cont'd) *(Key to Abbreviations, p. 32)*

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Gardco Lighting	Form10 JEH/JH/JHT	HPS, MH	100–400	H, V	I, III, IV, V	*	seg	yes	silic
Gardco Lighting	Hardtop CP/MP	HPS, MH	50–400	H, V	I, III, IV, V	*	seg	yes	silic
GE Lighting Systems	Decashield 175	HPS, MH	50–175	H	III, V	C	—	yes	*
GE Lighting Systems	Dimension	HPS, MH	70–400	H, V	II, III, IV, V	SC, C	—	yes	*
Hadco Lighting	Capella	HPS, MH	150–400	H, V	II, III, IV, V	C	hydro, seg	yes	silic
Hadco Lighting	Disc	HPS, MH	70–400	H	II, III, IV, V	—	seg	yes	silic
Hadco Lighting	Hemisphere	HPS, MH	70–400	H	II, III, IV, V	—	seg	yes	silic
Holophane	PoleStar II ✓	HPS, MH	250–400	H, V	—	C	hydro	—	*
Hubbell Lighting	Magnudisc II	HPS, MH	70–400	H, V	I, III, IV, V	C	seg	yes	—
Hubbell Lighting	Magnudrum	HPS, MH	150–400	H, V	II, III, IV, V	C, FC	—	yes	—
Hubbell Lighting	Magnuspec	HPS, MH	70–175	—	I, III, V	C	—	—	—
Kim Lighting	Arc	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	yes	silic
Kim Lighting	Curvilinear	HPS, MH	70–400	H	II, III, IV, V	C	seg	yes	silic
Kim Lighting	NeoSphere	HPS, MH	70–175	H, V	II, III, IV, V	*	seg	—	silic
Kim Lighting	VL	HPS, MH	70–400	V	III	—	seg	yes	*
Kim Lighting	WTH, WTV	HPS, MH	150–250	H, V	II, III, IV, V	—	seg	—	silic
Lithonia Lighting	KKR	HPS, MH	70–400	H	III, IV, V	C	hydro	—	rubber
Lithonia Lighting	KKS	HPS, MH	70–400	—	III, IV, V	C	hydro	—	rubber
Lithonia Lighting	KQR	HPS, MH	150–400	H	III, V	C	hydro, seg	—	rubber
Lithonia Lighting	KQS	HPS, MH	150–400	H	III, V	C	hydro, seg	—	rubber
Lithonia Lighting	KVE	HPS, MH	175–400	H, V	II, III, IV, V	SC, FC	seg	yes	*
Lithonia Lighting	KVF	HPS, MH	250–400	H, V	II, III, IV	SC, FC	spun	yes	silic
Lithonia Lighting	KVR	HPS, MH	175–400	H, V	II, III, IV, V	SC, FC	seg	yes	*
LSI Lighting Systems	Greenbriar	HPS, MH	250–400	V	II, III, V	FC	—	yes	rubber
LSI Lighting Systems	Hilton	HPS, MH	100–400	H, V	II, III, V	SC, FC	—	yes	rubber
Lumec-Schréder	Optilux	HPS, MH	35–400	H	I, II, III, V	C	seg	yes	silic
Lumec-Schréder	Transit	HPS, MH	70–400	V	III, IV	SC, C	hydro	—	silic
Pappi Lighting	Eliminator	HPS, MH	35–400	H, V	II, III, V	*	seg	yes	rubber
Quality Lighting	124	HPS, MH	70–400	H, V	III, V	—	—	—	poly, silic
Quality Lighting	126	HPS, MH	70–400	H, V	III, V	—	die, seg, spun	—	poly, silic
Quality Lighting	130	HPS, MH	70–400	H, V	III, V	—	—	—	poly, silic
Quality Lighting	134	HPS, MH	70–400	H, V	III, V	—	—	—	poly, silic
Quality Lighting	140	HPS, MH	70–400	H, V	III, V	—	seg	—	poly, silic
Quality Lighting	SLY	HPS, MH	70–400	H, V	I, II, III, V	—	—	yes	rubber, silic
Quality Lighting	SNDY	HPS, MH	100–400	H, V	II, III, V	—	—	—	silic
Ruud Lighting	QHA	HPS, MH	175–400	H	—	—	—	—	silic
Ruud Lighting	QHC	HPS, MH	175–400	H	—	—	—	—	silic
Ruud Lighting	QHF	HPS, MH	175–400	H	—	—	—	—	silic
Ruud Lighting	QHH	HPS, MH	175–400	H	—	—	—	—	silic
Ruud Lighting	QVA	HPS, MH	50–400	V	V	—	—	—	silic
Ruud Lighting	QVC	HPS, MH	50–400	V	V	—	—	—	silic
Ruud Lighting	QVD	HPS, MH	250–400	V	V	—	—	—	silic
Ruud Lighting	QVF	HPS, MH	50–175	V	V	—	—	—	silic
Ruud Lighting	QVH	HPS, MH	50–175	V	V	—	—	—	silic

Table 11. Manufacturer-Supplied Information

Post-top Luminaires (cont'd) *(Key to Abbreviations, p. 32)*

Manufacturer	Product	Lamp	Wattage	Lamp Pos.	IES Lat. Dist.	Cutoff Class.	Reflector Type	Rotatable Optics	Gasket
Ruud Lighting	S4V	HPS, MH	200–400	V	IV	*	seg	—	silic
Ruud Lighting	S5V	HPS, MH	175–400	V	V	*	hydro	—	silic
SELUX	Quadro	HPS, MH	100–400	H	II, V	FC	—	—	—
Spaulding Lighting	Aurora	HPS, MH	100–400	H	II, III, IV, V	—	seg	—	*
Spaulding Lighting	Catalina	HPS, MH	100–400	H	II, III, IV, V	—	seg	yes	*
Spaulding Lighting	Concord	HPS, MH	100–400	H, V	II, III, IV, V	—	—	—	—
Spaulding Lighting	Dallas	HPS, MH	100–400	H	II, III, IV, V	—	seg	—	*
Spaulding Lighting	Monterey	HPS, MH	100–400	V	III, IV, V	FC	seg	—	*
Spaulding Lighting	Orlando	HPS, MH	250–400	V	III, IV, V	FC	seg	—	*
Spaulding Lighting	Proformer	HPS, MH	250–400	V	III, IV, V	FC	seg	—	*
Spaulding Lighting	Santa Fe	HPS, MH	100–400	H	II, III, IV, V	—	seg	—	*
Spaulding Lighting	Washington	HPS, MH	100–400	H, V	II, III, IV, V	FC	seg	—	*
Sterner Lighting Systems	Alameda	HPS, MH	150–400	H, V	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	ARSRD	HPS, MH	150–400	H, V	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Berkley ✓	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Concord	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Corona	HPS, MH	150–250	H	II, III, IV, V	C, FC	—	—	—
Sterner Lighting Systems	Diplomat	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Franklin	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Sterner Lighting Systems	Humboldt	HPS, MH	150–400	H	II, III, IV, V	FC	—	—	—
Stonco Lighting	SVLT	HPS, MH	400	—	II, III, IV, V	—	seg	yes	*
Streetworks	Cirrus	HPS, MH	70–400	H	II, III, IV, V	C	hydro	yes	—
Streetworks	Credenza	HPS, MH	70–400	H	II, III, IV, V	C	hydro	yes	—
Streetworks	Galleria	HPS, MH	250–400	H, V	I, II, III	C	hydro, spun	—	—
Techlight	Polaris	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	—	silic
U.S. Architectural Lighting	Galaxy7	HPS, MH	70–400	H, V	II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	Lumenator PT2	HPS, MH	100–400	H	III, V	*	seg	—	rubber
U.S. Architectural Lighting	RSB	HPS, MH	100–400	H	I, II, III, IV, V	*	hydro, seg	—	rubber
U.S. Architectural Lighting	RVL	HPS, MH	250–400	H, V	IV, V	—	seg	—	rubber
U.S. Architectural Lighting	SVLPT222 ✓	HPS, MH	250–400	V	IV, V	—	seg	—	rubber
Visionaire Lighting	American	HPS, MH	100–400	V	II, III, IV, V	FC	seg	—	silic
Visionaire Lighting	Concourse	HPS, MH	150–400	H, V	II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Dominator	HPS, MH	70–400	H, V	II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Hillsboro	HPS, MH	100–400	H, V	II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Nightscaper	HPS, MH	100–400	V	III, V	—	seg	—	—
Visionaire Lighting	OrbiStar	HPS, MH	70–400	H, V	I, II, III, IV, V	—	seg	—	silic
Visionaire Lighting	Rosewood	HPS, MH	70–400	—	I, II, III, IV, V	—	seg	—	*
Visionaire Lighting	RoyalStar	HPS, MH	70–400	H, V	III, IV, V	—	—	—	—
Visionaire Lighting	SquareForm	HPS, MH	100–400	H	I, II, III, IV, V	*	seg	—	silic
Wide-Lite	Effex ✓	HPS, MH	150–400	H, V	I, II, III, IV, V	SC, C, FC	seg	yes	silic
Wide-Lite	Spectra	HPS, MH	70–400	H, V	II, III, IV, V	SC, C, FC	seg	yes	—

Table 12. Manufacturer Contact Information

Manufacturer	Parent Company	Mfr. Phone	Web Site
American Electric Lighting	Acuity Brands, Inc.	800-754-0463	www.americanelectriclighting.com
Architectural Area Lighting	Hubbell Lighting, Inc.	714-994-2700	www.aal.net
Architectural Landscape Lighting (ALLSCAPE)	JJI Lighting Group, Inc.	714-668-3660	www.alllighting.com
Bega	Bega/US	805-684-0533	www.bega-us.com
Bieber Lighting	Bieber Lighting Corporation	800-243-2375	www.bieberlighting.com
C.E.W. Lighting	SIMKAR Corporation	215-831-7700	www.simkar.com
Day-Brite Lighting	Genlyte-Thomas Group LLC	662-842-7212	www.daybrite.com/day-brite
Emco Lighting	Genlyte-Thomas Group LLC	800-227-0758	www.emcolighting.com
ExceLine	Genlyte-Thomas Group LLC	908-964-7000	www.exceline.com
Gardco Lighting	Genlyte-Thomas Group LLC	510-357-6900	www.gardcolighting.com
GE Lighting Systems	General Electric Company	800-305-1372	www.ge-lightingsystems.com
Hadco Lighting	Genlyte-Thomas Group LLC	717-359-7131	www.hadcolighting.com
Holophane	Acuity Brands, Inc.	740-345-9631	www.holophane.com
Hubbell Lighting	Hubbell Lighting, Inc.	540-382-6111	www.hubbell-ltg.com
Kim Lighting	Hubbell Lighting, Inc.	626-968-5666	www.kimlighting.com
Lithonia Lighting	Acuity Brands, Inc.	770-922-9000	www.lithonia.com
LSI Lighting Systems	LSI Industries Inc.	513-793-3200	www.lsi-industries.com
Lumark	Cooper Lighting	770-486-4800	www.cooperlighting.com/brands/lumark
Lumca	Lumca Inc.	418-650-1693	www.lumca.com
Lumec-Schréder	Genlyte-Thomas Group LLC	450-430-7040	www.lumec.com
McGraw-Edison	Cooper Lighting	770-486-4800	www.cooperlighting.com/brands/mcgraw-edison
Pappi Lighting	Pappi Lighting Ltd.	888-453-1139	www.pappilighting.com
Quality Lighting	JJI Lighting Group Inc	800-545-1326	www.qualitylighting.com
Ruud Lighting	Ruud Lighting Inc.	800-236-7000	www.ruudlighting.com
Security Lighting Systems	Hubbell Lighting, Inc.	800-544-4848	www.securitylightingsystems.com
SELUX	Semperlux AG	800-735-8927	www.selux.com
Spaulding Lighting	Hubbell Lighting, Inc.	513-541-3486	www.spauldinglighting.com
Sterner Lighting Systems	Hubbell Lighting, Inc.	800-328-7480	www.sternerlighting.com
Stonco Lighting	Crescent Stonco, Genlyte-Thomas Group LLC	908-964-7000	www.stonco.com
Streetworks	Cooper Lighting	770-486-4800	www.cooperlighting.com/brands/streetworks
Techlight	Techlight	214-350-0591	www.techlightusa.com
U.S. Architectural Lighting	U.S. Architectural Lighting	661-233-2000	www.usaltg.com/mainframe.htm
Visionaire Lighting	Visionaire Lighting	877-977-5483	www.visionairelighting.com
Wide-Lite	Genlyte-Thomas Group LLC	512-392-5821	www.wide-lite.com

Table 13a. NLPIP-Tested Information

Type III Luminaires with 250-Watt MH Lamps *(Key to Abbreviations, p. 32)*

	Manufacturer	Product	Lamp Pos.	Cutoff Classification: Mfr. Claim	Cutoff Classification: Mfr. IES File	Cutoff Classification: Test Report	Max. Lum. Inten. ≥ 90° (%)	GZ Max. Lum. Inten. (%)	GZ Lum. Flux (%)	IES Lat. Dist.	IES Vert. Dist.	Efficiency: Down (%)	Efficiency: Up (%)	Efficiency: Total (%)
Cobra Head	American Electric Lighting	Roadway 115	H	–	C	C	2.1	6.4	2.7	II [e]	S	83.8	3.1	86.9
	GE Lighting Systems	M-400 (cutoff opt.)	H	FC	FC	FC	0.0	1.6	0.3	III	M	88.6	0.0	88.6
	GE Lighting Systems	M-400	H	SC	SC	SC	1.6	11.6	2.1	III	S	80.2	2.0	82.2
	Streetworks	OV (F Flat Glass)	H	C	C [a]	FC	0.0	1.7	0.1	I	M	88.7	0.0	88.7
Arm Mount	Gardco Lighting	Gullwing	H	–	FC	FC	0.0	1.3	0.2	III	S	80.3	0.0	80.3
	GE Lighting Systems	Dimension	H	C	FC	SC [d]	0.0	10.5 [d]	0.4	III	M	77.9	0.0	77.9
	Kim Lighting	Archetype	H	C	FC	FC	0.0	1.1	0.2	III	S	81.4	0.0	81.4
	Kim Lighting	Curvilinear	H	C	FC	FC	0.0	1.5	0.2	III	S	83.3	0.0	83.3
	LSI Lighting Systems	Hilton	V	FC	FC [c]	FC	0.0	4.2	0.4	III	S	54.8	0.0	54.8
	Lumark	Hammer	H	–	C [c]	FC	0.0	7.8	0.6	II [f]	S	79.5	0.0	79.5
	Lumec-Schréder	Citea	V	C	C	SC [d]	0.2	10.1 [d]	1.0	III	M	72.9	0.1	73.0
	Ruud Lighting	S3V (2)	V	–	FC [b]	FC	0.0	2.8	0.4	III	S	75.6	0.0	75.6
	Spaulding Lighting	Proformer	V	FC	C [b]	FC	0.0	4.4	0.2	II	S	58.4	0.0	58.4
	Stonco Lighting	SVL	V	–	FC [b]	FC	0.0	1.1	0.2	II	S	76.2	0.0	76.2
	Visionaire Lighting	Toronto	H	–	C [b]	FC	0.0	1.7	0.0	II	S	88.6	0.0	88.6
	Wide-Lite	Effex	H	FC	C	FC	0.0	1.9	0.1	IV [g]	S	75.1	0.0	75.1
Post-top	Bieber Lighting	PCV	V	–	NC [b]	FC	0.0	3.4	0.5	II [h]	S	60.7	0.0	60.7
	Emco Lighting	Ecoround (ERP)	H	C	FC	FC	0.0	7.8	0.4	III	M	69.8	0.0	69.8
	ExceLine	VertiLyte Tenon	V	–	SC [b]	SC	1.9	10.7	1.0	III	S	67.6	0.1	67.7
	Holophane	PoleStar II	H	C	C	C	0.3	2.1	0.4	III	S	75.0	0.4	75.4
	Sterner Lighting Systems	Berkley-21	H	FC	SC	SC	0.1	15.0	0.5	III	M	71.6	0.2	71.8
	U.S. Architectural Lighting	SVLPT222	V	–	C	FC	0.0	9.3	1.3	III	S	66.7	0.0	66.7
	Wide-Lite	Effex	V	C	FC	NC	0.9	34.5	4.5	IV	M	74.3	0.1	74.4

Notes

[a] 250-W HPS

[b] 400-W MH

[c] 175-W MH

[d] May be cutoff fixtures. Measurement of the maximum intensity at or above 90° exceeds the 10% limit, but falls within the uncertainty of the measurement system.

[e] On boundary with Type III

[f] If categorized as very short, would be Type I

[g] If categorized as very short, would be Type III

[h] On boundary with Type I

Table 13b. NLPIP-Tested Information
Tested Products with Model Numbers

	Manufacturer	Product	Model #
Cobra Head	American Electric Lighting	Roadway 115	115-25M-CA-MT7-R3-DG
	GE Lighting Systems	M-400 (cutoff opt.)	MSCL-25-M-4-A-1-1-F-MC3
	GE Lighting Systems	M-400	MSRL-25-M-4-A-1-1-R-MS3
	Streetworks	OV (F Flat Glass)	OVF-25-M-W-W-3-D
Arm Mount	Gardco Lighting	Gullwing	G18-1-3XL-250MH-277
	GE Lighting Systems	Dimension	DMA-25-M-4-A-1-G-MC3-DB
	Kim Lighting	Archetype	1AR-AR3-250MH277-DB-P
	Kim Lighting	Curvilinear	1A/CC25A3/250MH277/DB-P/CGL
	LSI Lighting Systems	Hilton	HFSV-3-250-MH-F-MT-BRZ
	Lumark	Hammer	MHHR-R3-250-MT
	Lumec-Schréder	Citea	CTM-250MH-SCB3M-277-CWA-GLS
	Ruud Lighting	S3V (2)	S3V2425-M
	Spaulding Lighting	Proformer	PFI-PM-M250-III-MT-FG
	Stonco Lighting	SVL	SVL-3-250-MA-FG-8
	Visionaire Lighting	Toronto	TRO-1-T3-250-M-6-BOA-BZ
	Wide-Lite	Effex	EALM-250-3H-277-S-DB
Post-top	Bieber Lighting	PCV	PCV-15-N2-7-L-3V-I
	Emco Lighting	Ecoround (ERP)	ERP-25-3H-250MH-QUAD-BRP
	ExceLine	VertiLyte Tenon	VLT-25-3-MA-8
	Holophane	PoleStar II	PT-4-250MH-27-A-P-R-V
	Sterner Lighting Systems	Berkley-21	BERK-21-YK-250MH-3H-277-C
	U.S. Architectural Lighting	SVLPT222	SVLPT222-ASY-250MH277-PTA
	Wide-Lite	Effex	EALM-250-3V-277-PT-DB

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Guide to Selecting Frequently Switched T8 Fluorescent Lamp-Ballast Systems, 1998

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