Outdoor Environmental Lighting Guide

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LEADER IN LIGHTING SOLUTIONS

Architectural | Commercial | Roadway
Lighting Solutions

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Ultimately, the goal is to provide education to our potential customers, so that they can make a truly "informed" decision that is best for their outdoor application and community.

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Introduction

Holophane has been designing, developing, and manufacturing optical systems for outdoor luminaires for over 100 years. Throughout the 20th Century, Holophane pioneered the use of optical technology to provide highly efficient lighting systems in the interest of increased design effectiveness, energy savings, and reduced costs. We look forward to the future by embracing new technologies associated with outdoor lighting, and are excited about the next 100 years.

Today's outdoor lighting issues can present new challenges to people involved with outdoor lighting specifications, design, and selection. Very often, the goal to provide safety and security for nighttime activity can drive a new lighting project. In addition, revitalization of cities, towns, boulevards, shopping districts, and residential developments for increased commerce has inspired new lighting installations. Many communities have considered the need for decorative lighting equipment, perhaps with a specific theme or style in mind (historical, contemporary, "art-deco", etc.), to promote commerce, inspire community spirit, and gain public recognition.

Awareness of light pollution ("sky glow"), light trespass, and veiling luminance ("glare") has increased greatly in recent years, and has provided new considerations for decision makers associated with selecting luminaire types. In addition, costs associated with the new initial lighting installation, as well as operating expenses (energy consumption, maintenance, etc.), have played a significant role in choice as well. Perhaps the greatest challenge has been incorporating all these issues into the luminaire and design choice, and finding the best solution for a specific project and community. Often, that can involve a balance of all these factors, as well as certain compromises.

Within the outdoor lighting industry, these topics continue to be discussed and debated among specifiers, government agencies, special interest groups, manufacturers, trade organizations, and other influences. By providing this guide, Holophane hopes to play a significant role in empowering people to gain additional knowledge about the current environmental outdoor lighting issues. Ultimately, the goal is to provide education to our potential customers, so that they can make a truly "informed" decision that is best for their outdoor application and community.

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Illuminating Engineering Society of North America (IESNA) — The recognized technical authority on illumination. Founded with Holophane's involvement in New York City back in 1906, the IESNA publishes standard practices, which provide guidelines for outdoor lighting.

International Dark Sky Association (IDA) — A tax-exempt, non-profit organization founded in 1988. Based in Tucson, AZ, "the IDA's goals are to be effective in stopping the adverse environmental impact on dark skies by building awareness to the problem of light pollution and of the solutions…"

Luminaire — A complete lighting unit consisting of a lamp(s) together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply. Sometimes includes ballast and photocontrol.

Lumen — Lumens (Lm) represent the quantity of light produced by a lamp or emitted from a luminaire.

Illuminance — A term that quantifies light striking a point on a surface. It is expressed either in lumens per square foot (footcandles) or lumens per square meter. (lux)

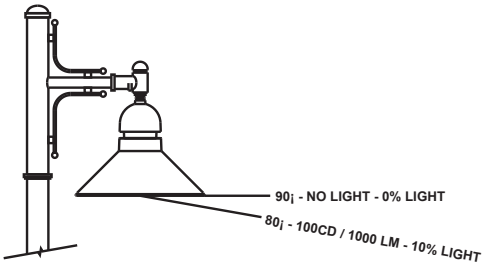
Luminance — A term that quantifies directional brightness of a light source or of a surface that is illuminated and reflects light. It is expressed as candela per square meter (Metric).

Intensity — The amount of luminous flux in a specific direction. Luminous intensity may be expressed in candelas (cd) or in lumens per steradian.

Efficiency — A ratio of the light emitted from a luminaire to the light produced by the bare lamp.

Visual Acuity — The ability to measure and distinguish fine detail. For additional information, please refer to the IESNA handbook.

IESNA Recognized Cutoff Classifications



Full Cutoff — A luminaire light distribution with zero candela (intensity) at an angle of 90 degrees or above. Additionally, the candela per 1000 lamp lumens does not exceed 100 (10%) at a vertical angle of 80 degrees.

Benefits:

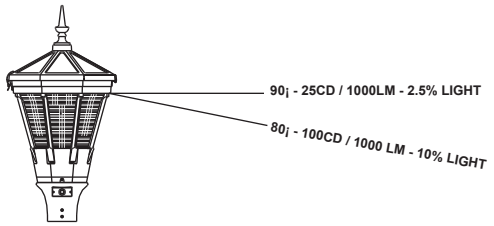
- Perceived reduction in "sky glow"
- Excellent light control at property line
- Limits spill light
- Reduces perceived glare

Uplight:

- No uplight allowed

Limitations:

- Reduces pole spacing
- Increases pole and luminaire quantity
- Least cost effective of all cutoff categories
- Concentrated down light component results in maximum reflected uplight
- Potential to have decreased uniformity due to higher light levels directly under the pole



Cutoff — A luminaire light distribution where the candela per 1000 lumens does not exceed 25 (2.5%) at an angle of 90 degrees or any angle above. Additionally, the candela per 1000 lamp lumens does not exceed 100 (10%) at a vertical angle of 80 degrees.

Benefits:

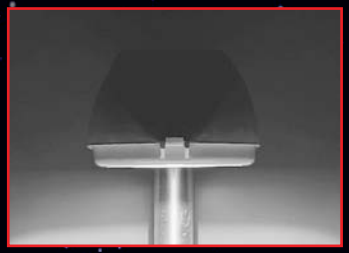
- Small increase in high-angle light compared to full cutoff
- Good light control at property line
- Potential for increased pole spacing and lower overall power consumption when compared to full cutoff

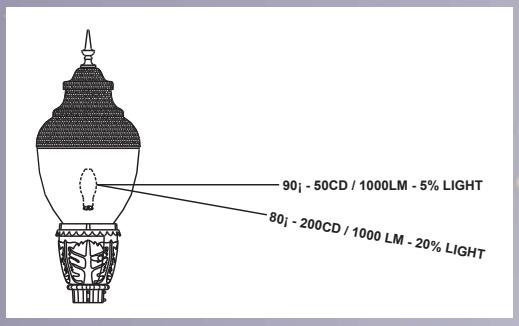
Uplight:

- From as little as 0% to a maximum of 16%

Limitations:

- Can allow uplight, a problem when uplight is not desired
- Light control at property line less than full cutoff
- Higher amount of reflected light off pavement can contribute to sky glow





Semi-Cutoff — A luminaire light distribution where the candela per 1000 lumens does not exceed 50 (5%) at an angle of 90 degrees or any angle above. Additionally, the candela per 1000 lamp lumens does not exceed 200 (20%) at a vertical angle of 80 degrees.

Benefits:

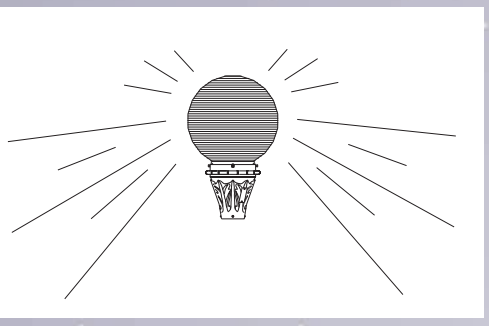
- Potential for increased pole spacing and lower overall power consumption when compared to cutoff
- High angle light accents taller surfaces
- Less reflected light off pavement than cutoff luminaires
- Vertical illumination increases pedestrian security and sense of safety.

Uplight:

- Less than 1% to a maximum of 32%

Limitations:

- Greater potential for direct uplight component than cutoff
- Light trespass a concern near residential areas
- Increased high angle light compared to cutoff



Non-Cutoff — A luminaire light distribution where there is no candela restriction at any angle.

Benefits:

- Potential for increased pole spacing and lower overall power consumption when compared to the other classifications
- Accents taller surfaces
- Highest vertical illumination increases pedestrian safety and security
- Potential for excellent uniformity
- Least amount of reflected light off pavement
- "Open visual environment" provides vertical surface visibility

Uplight:

- No restriction

Limitations:

- Greatest potential for direct uplight component to all classifications
- Least control of direct uplight
- Increased high angle light compared to semi-cutoff

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IESNA Recognized Cutoff Classifications

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Environmental Lighting Terms

Light Trespass — Occurs when occupants of a neighboring space are affected by the lighting system's inability to contain its light within an intended area. A common cause of light trespass is the inappropriate selection, tilting, or aiming of outdoor luminaires for a particular task. Light trespass is also referred to as "spill light".

Glare — The sensation produced by luminance within the visual field that exceeds the eye's ability to adapt. This can cause annoyance, discomfort, or loss in visual performance and visibility.

- ***Nuisance glare* —** Known as annoyance glare, it is defined as glare that causes complaints. The IESNA defines nuisance glare as the "light shining in my window" phenomenon.
- ***Discomfort glare* —** Glare that does not keep the viewer from seeing an object but does cause physical discomfort.
- ***Disability glare* —** The effect of a bright source causing stray light to scatter in the eye. The stray light obscures the primary image on the retina and restricts the viewer from seeing detail and items of importance. The "scattered" background light that reduces contrast is also called Veiling Luminance.

Sky Glow — The haze or "glow" that surrounds highly populated areas and reduces the ability to view the nighttime sky. The sky glow phenomenon is a result of light reflected from atmospheric particles such as fog, dust, or smog. Light enters the sky from an outdoor lighting system by indirect light reflected off of surfaces below the luminaire as well as light directed by the lighting fixture above the horizontal. Sky glow is also referred to as "light pollution".

Uplight — The definition of uplight is the percentage of lamp lumens directed from a luminaire at or above 90 degrees.

If a community is considering drafting and enacting a lighting ordinance, careful consideration should be made to the trade-offs associated with certain restrictions.

Lighting Ordinances

In recent years, communities have enacted lighting ordinances in the interest of eliminating sky glow (e.g. "lighting pollution"), light trespass, and glare. This can pose a challenge in many cases, because of the complex considerations involved when choosing a lighting design objective. Furthermore, the nighttime activities and needs within an outdoor space can change considerably from application to application.

Nevertheless, lighting ordinances written with design flexibility and freedom of lighting system choice may have a positive influence on a given community. Today, the intent of lighting ordinances by most government bodies is to have a positive effect on the nighttime for citizens, free of annoying or disabling glare and reduced light pollution.

Unfortunately, many lighting ordinances in existence today have definitions and criteria that are technically inaccurate, ambiguous, or impossible to discern. Some examples of actual ordinance criteria include:

"All lights should be shielded in such a way as to direct all light toward the Earth's surface and away from reflective surfaces."

Or

"All light shall maximize energy conservation and minimize light pollution, glare and light trespass."

Although the intent of these examples is admirable, achieving them is scientifically challenging. In addition, specific restrictions on luminaire type may be contrary to the original intent of the ordinance. For example, if there is a requirement to restrict luminaire types to full cutoff only, depending on the application and its objectives, there may be a need to add more luminaire assemblies to meet the requirements. As a result, there would be a potential increase in lighting system energy consumption and reflected light contribution to sky glow.

The following is a list of items that are commonly regulated in a lighting ordinance:

-Luminaire type (e.g. degree of "cutoff")
-Direct uplight percentage
-Wattage
-Energy consumption (e.g. watts per acre)
-Lamp type
-Lumens
-Illuminance values
-Mounting heights

Finally, if a community is considering drafting and enacting a lighting ordinance, careful consideration should be made to the tradeoffs associated with certain restrictions. A clear, well-defined objective is essential to ascertain what specific requirements are needed.

Sufficient vertical illumination is the key component in providing pedestrian security and safety.

Lighting for Pedestrians

When lighting an area for nighttime pedestrian use, the primary objective is very often to provide a three-dimensional space that looks nearly the same at night as it does during the day. An open, visual environment that is bright and free of shadows will help inhabitants distinguish details and specific characteristics of other people or objects within the space.

Sufficient vertical illumination is the key component in providing pedestrian security and safety. In order to instill a feeling of comfort and safety, a lighting system must provide portal to portal illumination. This will ensure there are no hidden areas where an unidentified assailant can wait for an unsuspecting passerby. A subtle, controlled uplight component can help to create an open, visual environment similar to daylight conditions and avoid the "cavern effect" created by common cutoff and full cutoff luminaires. An enhanced visual field in the area created by vertical illumination and a small percentage of uplight will promote nighttime activity in the community.

Designers typically should avoid reliance on silhouette lighting (see Figure 1) in this type of application, because it outlines people or objects without allowing occupants to discern specifics: whether another person is a man or woman, how he or she is dressed, or whether he or she is holding an object, such as a weapon. Often, when silhouette lighting is provided, the occupant will not be able to determine whether the other person is approaching or walking away, and whether the person is a threat.

Importantly, when lighting an application for pedestrian use, the need to see detailed characteristics of people and objects through vertical illumination is imperative for security, safety, and comfort (see Figure 2).

Figure 1
Lighting by silhouette makes it very difficult to identify a passer-by, thus increasing potential danger to nighttime pedestrians.

Figure 2
The positive vertical illumination provided in the above example allows easy identification of approaching pedestrians and greatly increases security.

A uniformly lit space that eliminates potential hiding spaces for attackers and criminals is essential. Further-more, utilizing a lighting system that accents building facades and penetrates foliage and parked vehicles to create an open, visual environment is ideal.

All this being said, is there any one type of luminaire that is ideal for pedestrian use after dark? Certainly, a highly efficient lighting system that provides adequate levels of vertical illumination is essential. This is more often an inherent characteristic of luminaires with less “cutoff”. However, it may be found in any one of the IESNA cutoff classification types. Designers must be sensitive to glare, light trespass, and sky glow. Any one of those concerns may affect a decision on design. Ultimately, it is dependent on the lighting objectives and concerns of a given community. Special consideration of mounting height, wattage, pole spacing and layout, pole setback, light distribution, and luminaire uplight (direct and indirect) must be made when creating a design.

In regions sensitive to direct uplight component, such as nearby observatories, every effort should be made to use shielding, and to restrict or reduce the intensity at vertical angles above 90 degrees of the luminaire.

Common Pedestrian Applications

-City boulevards and streets
-Residential streets and sidewalks
-College/University campuses
-Schools
-Plazas
-Shopping centers
-Parks and recreational areas
-Parking lots
-Biking and walking paths

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Lighting for Pedestrians

Light trespass is also a very important consideration in roadway lighting.

Lighting for Roadways

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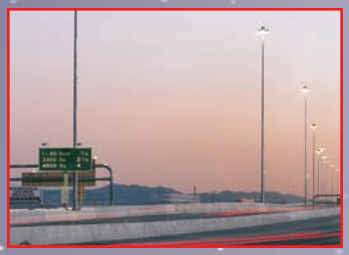


The purpose of roadway lighting is to provide visibility to vehicular traffic and maximize vehicular safety. Roadway lighting systems illuminate the environment beyond the range of headlamps and mitigate the glare from oncoming vehicles. This can increase the adaptation level of the driver's eyes and improve decision and reaction times. Properly designed roadway lighting can also provide other benefits that are desirable, such as encouraging the nighttime use of public facilities, providing aid to police and rescue personnel, and providing for an efficient utilization of roadways and vehicles.

There are many issues the designer must address when planning lighting for a roadway: the type of roadway, whether it is urban or rural, pedestrian traffic, pavement classification, and energy consumption, to name a few. Light trespass, glare, sky glow, and local regulations are also very important considerations. Selecting the proper type of luminaire to provide the required illumination that also addresses the other lighting issues is very important. Full cutoff, cutoff, semi-cutoff or non-cutoff type luminaires can all provide required illumination for a roadway, but at different levels of cost and maintenance structures.

Ideally, the roadway luminance (or "brightness) should be of proper value and uniform, thus enabling drivers to identify other vehicles and objects in order to avoid collision. It is especially critical that careful attention be paid to selecting a lighting system that minimizes veiling luminance (or "glare") so as not to hinder drivers from proper visibility. Optical devices such as reflectors, refractors, and shields may be utilized to reduce the possibility of disabling glare in the interest of safety.

In highly urbanized, commercial areas, light trespass may be less of an issue. Adjacent lighted areas may have higher illumination levels than the roadway and the proposed roadway lighting would not have any adverse effect. Illumination for roadways adjacent to residential or other sensitive areas should be evaluated based on location of the lighting in relation to the adjoining properties. The use of luminaires with distributions suited for the application, appropriate mounting heights and luminaire positioning combined with shielding when required can successfully limit light trespass.

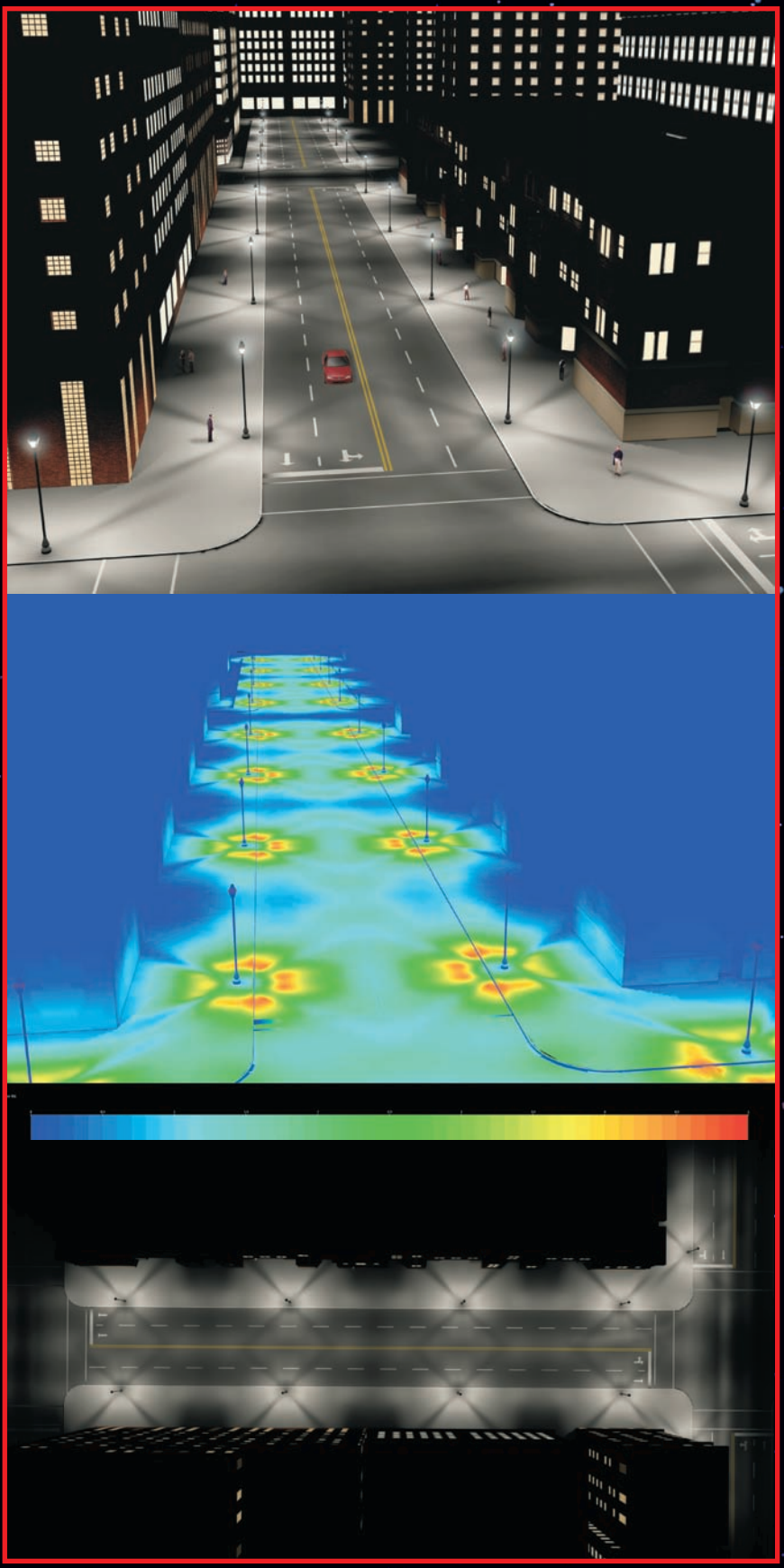
As stated above, the objective in lighting roadways is to maximize vehicular safety. The designer should strive to create a lighted environment that resembles natural lighting, with a high degree of uniformity that allows the driver's eyes to stabilize and not have to adjust to great differences in vertical or horizontal illumination. The designer should utilize the most efficient and effective lighting tools available while also understanding the interaction of various design criteria to provide the most valuable solution.

A recommended reference for standards and design dealing with roadway lighting is the Illuminating Engineering Society of North America (IESNA) publication RP-8-00 (Recommended Practice for Roadway Lighting/ANSI Approved).

Common Roadway Applications

-Interstate highways
-Interchanges
-Freeways
-Boulevards
-Tollways and turnpikes
-Local collectors

Holophane Urban Simulation



These simulations visually show how luminaire types perform in specific applications with pedestrian conflict. Although the values of quantifiable metrics should be used as a basis for lighting design and layout, perhaps nothing is more important than the setting ambiance and "feel", which ultimately will have the greatest impact on inhabitant's visibility.

Luminaire Types: Traditional Post Top (IESNA Cutoff)

Source: Metal Halide

Wattage: 175 watt

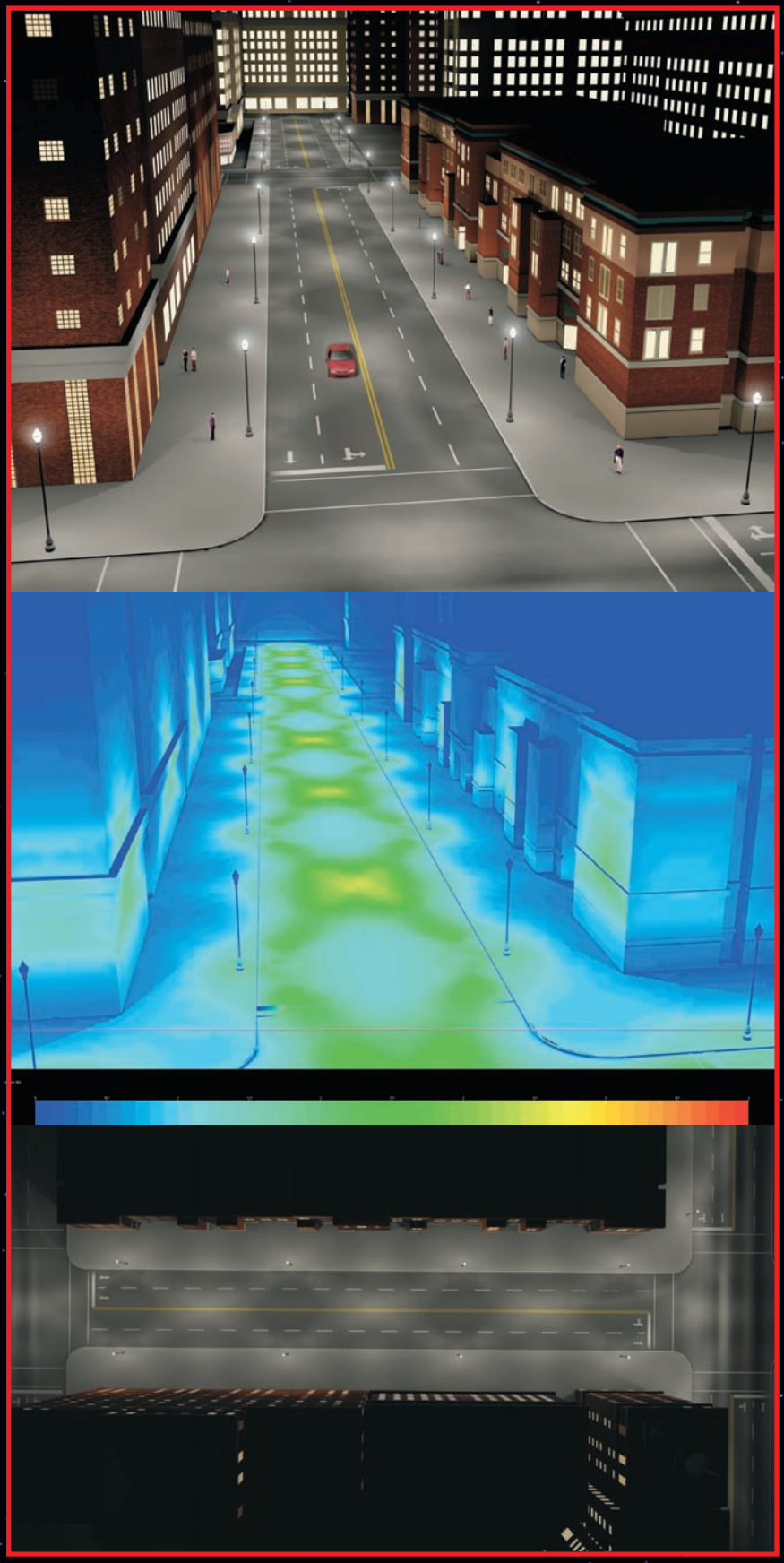
Spacing: Opposite, 165'

Mounting Height: 18'

Please note that the illuminance values shown in the simulations represent the actual published photometry for the luminaire.

The results of the Traditional Post Top simulation appear to show adequate roadway pavement illuminance. However, after careful examination, the following observations can be made:

- **The uniformity is less than desirable.** Illuminance values are high under the light pole assemblies, yet drop off significantly between poles. The resulting "dark spaces" provide potential hiding places for assailants.
- **The dark building facades create the "cavern effect",** making the space less inviting to pedestrians and other night-time activity.
- **Inadequate vertical illuminance** makes it more difficult for pedestrians and vehicles to see detailed characteristics of oncoming pedestrians.



Luminaire Types: Holophane Prismatic Acorn (IESNA Non-cutoff)

Source: Metal Halide

Wattage: 175 watt

Spacing: Opposite, 165′

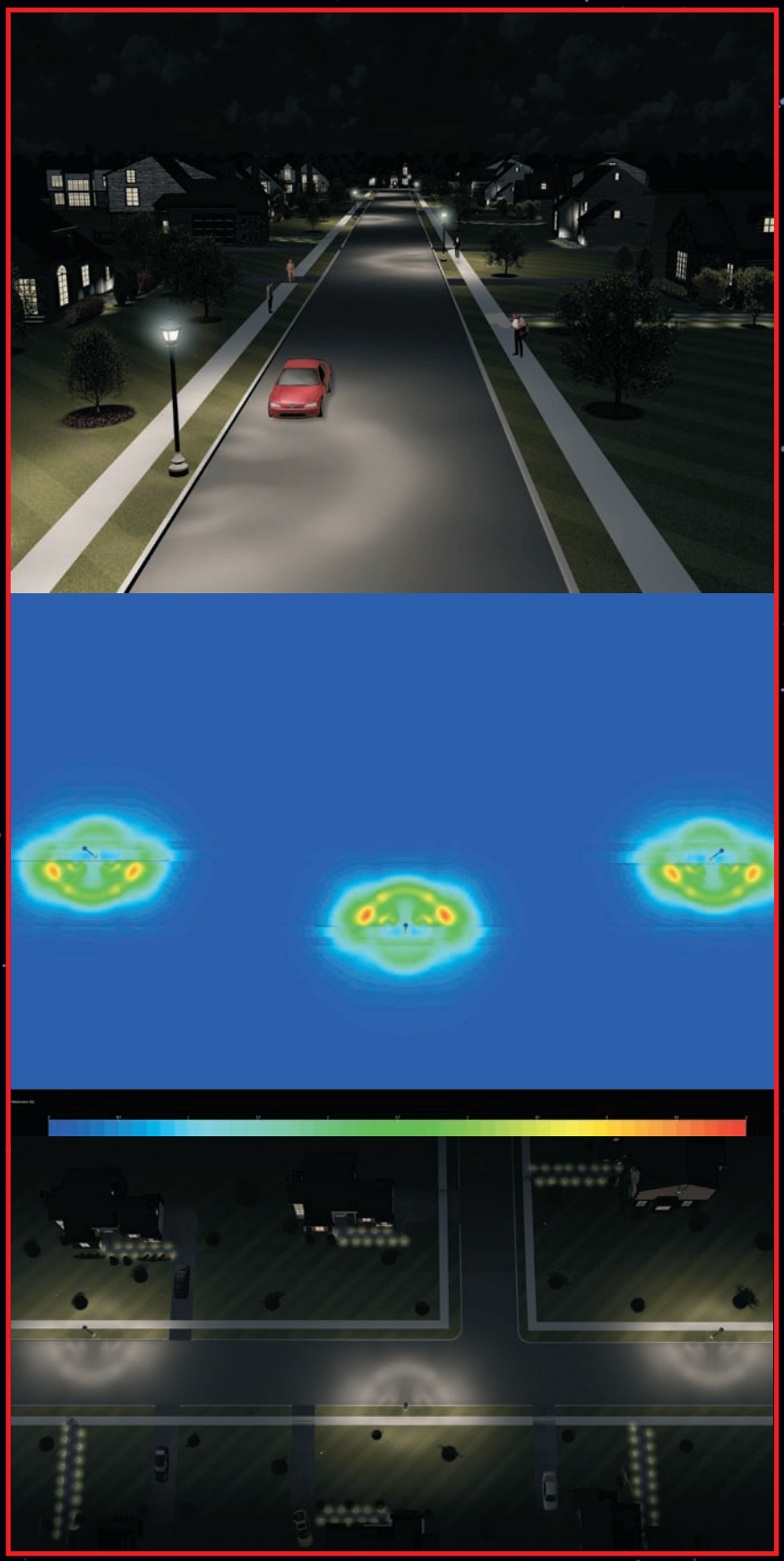
Mounting Height: 18′

Please note that the illuminance values shown in the simulations represent the actual published photometry for the luminaire.

The results of the Holophane prismatic acorn show an inviting, open, visual environment that is free of shadows and "dark spots". After careful examination, the following observations can be made:

- **The uniformity is quite desirable.** The critical areas between poles reveal an ev\en, consistent amount of illumination throughout the space.
- **The illuminated building facades create an open, visual environment** that provides a comfortable nighttime atmosphere. A subtle, controlled uplight component provides the necessary illumination on the facades to eliminate the "cavern effect".
- **High levels of vertical illumination** allow pedestrians to see detailed characteristics of approaching people and objects.
- **Roadway pavement illuminance values are adequate and highly uniform,** promoting good visibility for drivers in areas of pedestrian conflict.

Residential Simulation



Luminaire Types: Holophane "Cutoff" Post Top

Source: High Pressure Sodium

Wattage: 100 watt

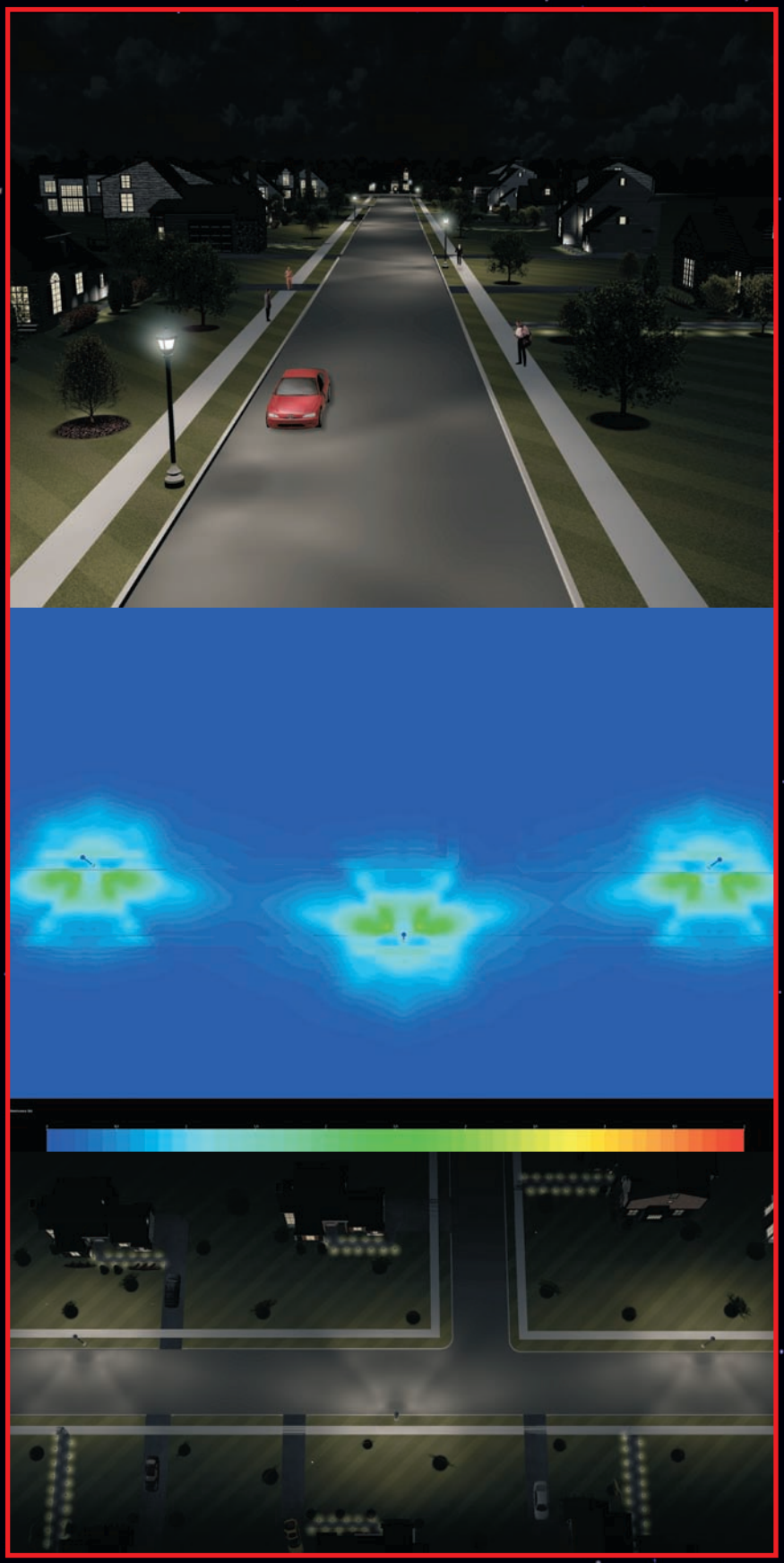
Spacing: Staggered, 250'

Mounting Height: 12'

Please note that the illuminance values shown in the simulations represent the actual published photometry for the luminaire.

The use of a "Cutoff" post top luminaire is quite common in residential applications. From the simulation, one can conclude the following:

- **Light trespass is minimized** by the use of an engineered optical assembly. There is actually a "house side" and a "street side" to effectively utilize the given light source.
- **Minimal veiling luminance** ("glare") can be a positive result of "cutoff" luminaires. The reduction of luminaire intensity at the critical angles can reduce discomfort and increase visibility.
- **Illuminance values under the pole assemblies are high,** and the values have sharp drop off as one moves away from the poles. This may hurt the uniformity values, but is a trade off to the other benefits.



Luminaire Types: Holophane "Semi Cutoff" Post Top

Source: High Pressure Sodium

Wattage: 100 watt

Spacing: Staggered, 250′

Mounting Height: 12′

Please note that the illuminance values shown in the simulations represent the actual published photometry for the luminaire.

The use of a "Semi Cutoff" post top luminaire is quite common in residential applications. From the simulation, one can conclude the following:

- **Light trespass is minimized** by the use of an engineered optical assembly. There is actually a "house side" and a "street side" to effectively utilize the given light source.
- **Veiling luminance ("glare") is minimal.** The reduction of luminaire intensity at the critical angles can reduce discomfort and increase visibility. In addition to luminaire type, mounting height and wattage can have an impact on controlling "glare".
- **Illuminance values are uniform** along the street and sidewalk. This improved uniformity may contribute to better visibility, increased safety, and improved visual comfort.

...the type of luminaire cutoff classification is only one characteristic that you must consider before deciding on the lighting equipment

Luminaire Comparison

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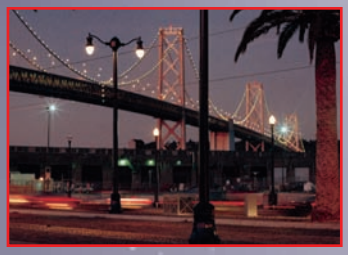


In recent years, much discussion among lighting professionals has taken place over what degree of "cutoff" is the most appropriate for an outdoor lighting application. Before answering that question, one would have to ask a series of important questions like the following examples before making a recommendation:

- What is the application?
- Why is the client lighting the specific area?
- What types of activities will take place at night?
- What is the overall goal of the lighting project?
- What is the preferred light source, if any?
- Are there adjacent properties sensitive to high ambient light levels?
- Are there any restrictions?
- How will the luminaire type affect the layout?
- How will the luminaire type affect the initial and operating costs?
- How important is daytime appearance? Nighttime appearance?

There are dozens of other questions and answers that may have a significant impact on what type of lighting system should be specified. Furthermore, the type of luminaire cutoff classification is only one characteristic that one must consider before deciding on the lighting equipment.

Specifically, the following layout example focuses on how generally the cutoff classifications may affect two important metrics and considerations in an outdoor lighting design.

Urban Street Example

	Decorative Cutoff Luminaire	Decorative Non-cutoff Luminaire
Spacing	60′	95′
Illuminance (ave.)	1.26fc (0.9fc)	0.91fc (0.9fc)
Illuminance Uniformity (ave./min.)	5.5:1 (6:1)	4.8:1 (6:1)

** ( ) denotes IESNA recommendation*

Basic Parameters:

- 15′ Mounting height
- 48′ Wide street
- 2′ Setback
- Staggered spacing
- 175W Metal halide, 14,000 lumen lamp
- Initial conditions

Conclusion:

Both luminaire types have been purposefully designed to have a specific performance so as to maximize their efficiency and still meet a specific IESNA cutoff classification. The two important metrics in this particular case are the illuminance average value and the illuminance uniformity ratio value (average/minimum) for the street. As noted in the above table, the IESNA published RP-8-00 recommends a 0.9 fc average and a 6:1 average/minimum uniformity ratio for this application. The two luminaire types being compared are spaced to achieve **both** critical metrics.

Here is how they compare:

Light levels: The average light levels are higher with the cutoff luminaire, primarily because of the need to have closer spacing so as to achieve the recommended uniformity ratio value. Furthermore, the especially high values directly underneath the cutoff luminaires bring the average value up as well.

Uniformity: The uniformity value is lower, thus more desirable for the non-cutoff luminaire.

Spacing: The non-cutoff decorative luminaire results in wider spacing to achieve the recommended values.

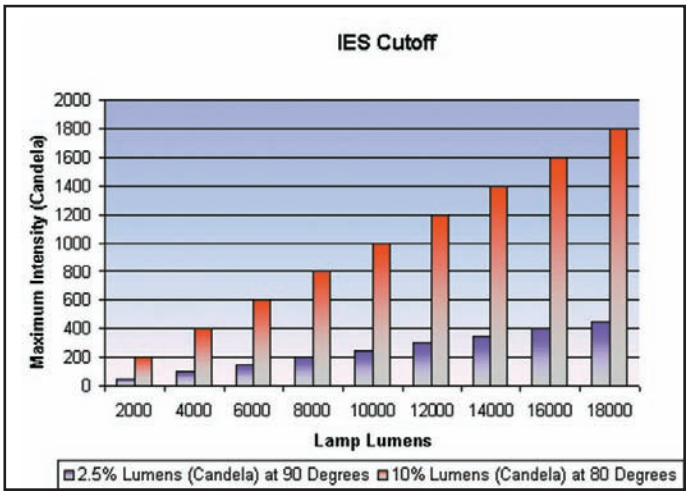
Spacing may have a significant impact on overall energy consumption as well as initial and operating costs because of the number of luminaires needed to meet the requirement. Clearly, quantities depend on the size of the intended area, as well as desired metric values.

It is important to note that other quantifiable lighting metrics may be important to a given design, as well as the non-quantifiable visual characteristics such as ambiance, theme, visual effect, scale, and appearance.

Commonly Asked Questions

How is "cutoff" determined?

For IESNA cutoff, the intensity measured in candelas, is limited to 2.5% lamp lumens at or above 90 degrees and the intensity at 80 degrees is limited to 10% of the lamp lumens. For example, if the luminaire is equipped with a 16,000-lumen lamp, the maximum candela at 90 degrees and above is limited to 400 (2.5% of 16,000). The maximum candela at 80 degrees is limited to 1600 (10% of 16,000 lumens). One would look at the candlepower distribution curve on photometric test report to determine the intensity values for these specified vertical angles. If the defined limits are not exceeded, then IESNA cutoff is achieved.

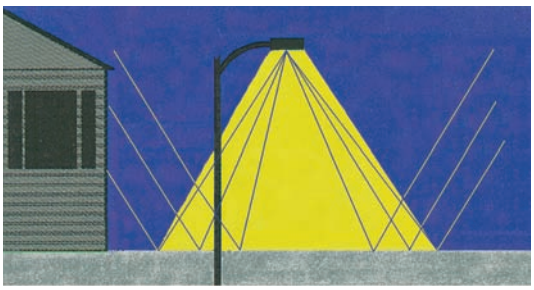


What is the relationship between uplight and cutoff?

Uplight is the percentage of total lamp lumens emitted at or above 90 degrees. Degree of "cutoff" has been described as the limitation of intensity at the 90 degree and above angles as well as intensity limitation at 80 degrees. Uplight and cutoff are two separate metrics. Full cutoff is the only IESNA classification that allows for zero uplight. The IESNA cutoff classifications were originally established as a means to categorize basic outdoor luminaire types and glare control.

Will full cutoff luminaires reduce sky glow?

The use of full cutoff luminaires has been promoted in aiding the reduction of "sky glow" on the premise that all the light escaping the luminaire is being aimed downward. In general, that seems completely rational. However, there may be more to the story scientifically. Moreover, contribution of reflected light (e.g. pavement luminance or "brightness") into the night sky must also be considered. As a result, the use of full cutoff luminaires may not be as effective at reducing total uplight component as originally



thought. Very often, with a full cutoff system, there is a need for additional luminaires (or lumens) to light a given space. It is this potential increase in the overall lumens being reflected off of the pavement surface and other objects that may contribute to an overall increase in indirect uplight component. It should be said that an overall conclusion of comparing different systems and their contribution to "sky glow" is completely dependent upon the lighting parameters, and may vary from application to application. Nevertheless, further research is required to determine a universally accepted measurement criterion for quantifying "sky glow".

Who is the International Dark Sky Association (IDA)?

The International Dark Sky Association is a non-profit organization that promotes effective nighttime lighting to reduce light pollution. The IDA has been instrumental in educating consumers on environmental issues such as light trespass, glare, and sky glow. Effective lighting design encompasses the awareness of these environmental issues when choosing a lighting system. Ideal lighting systems should improve visibility, increase the sense of safety and security, and provide comfortable nighttime viewing, all without wasting energy. Holophane is a lifetime organizational member of the IDA.

How is light trespass defined, measured, and enforced through ordinances?

By definition light trespass is unwanted light directed onto neighboring properties; because adjacent property receives spill light or excessive brightness occurs in the normal field of vision. The topic of light trespass can be subjective because it relates to both light that can be measured and visible light sources that are non-measurable.

The IESNA publication RP-33-99 makes general suggestions that will help control light trespass. These suggestions include inspecting areas adjacent to proposed lighting design considering any potential problems involving residences, roadways, shopping districts, and airports. Careful consideration should be made to contain the light within the intended area through efficient lighting design with proper selection of luminaire type, mounting height, and location. Luminaires should be selected with tightly controlled candela distributions. When floodlighting is required, the aiming angles should be kept low.

Sources and recommended publications:

Illuminating Engineering Society of North America Lighting Handbook; 9th Edition (www.iesna.org)

Illuminating Engineering Society of North America RP-8-00 (Roadway Lighting Practices/ANSI Approved)

Illuminating Engineering Society of North America RP-33-99 (Lighting for Exterior Environments)

Public Works: Engineering Construction & Maintenance; "Quality Illumination", by Ray Yeager, P.E.

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Luminaires may utilize fluorescent or high intensity discharge sources that contain small amounts of mercury. New disposal labeling for these lamps includes the mercury identifier shown below to indicate that the lamp contains mercury and should be disposed of in accordance with local requirements.

Hg

Information sources regarding lamp recycling and disposal are included on the packaging of most mercury-containing lamps and also can be located at www.lamprecycle.org.

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