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Exterior Lighting for Energy Savings, Security, and Safety

EE Richman

November 2009



Pacific Northwest
NATIONAL LABORATORY

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Richland, Washington 99352

Summary

The potential for energy savings with exterior lighting is large both from a technology efficiency and controls perspective. However, exterior environments can present security and safety challenges that hold lighting as a primary component which can hinder maximum energy savings.

The public or private perception and the effective treatment of exterior environment for safe and secure function do not necessarily coincide. More lighting has often been associated with safer environments but the generally accepted authority on lighting (IESNA) does not support this. Instead, the collective wisdom denotes a combination of good design elements that include appropriate lighting levels as well as other design features. This combination provides a complete package that supports safety and security elements such as visual identification capability and effective lighting for security cameras. Exterior areas that have security issues unusual enough to warrant additional specific lighting design elements or increased light levels are uncommon but addressed with additional guidance from IESNA.

A critical issue with many business entities is the litigation climate surrounding exterior environments and safety/security concerns. A review of case law shows that environments that have a specified flaw in design or negligence of conditions have some traction in litigation. However, no cases show any successful legal actions when spaces incorporate reasonable lighting design practice including light levels based on appropriate design references (i.e. IESNA).

Energy savings opportunities exist for all major exterior elements including parking lots, streets and roadways, and other building mounted lighting. The universal basic approach to achieving maximum savings includes design to appropriate levels and incorporation of controls that reduce lighting when not used but provide for activation when needed in security identified locations.

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1.0 Security and Safety Concerns

Security in parking areas, walkways, and other areas around buildings and their grounds is commonly raised as an issue with many public, private, and federal facilities. Some facilities (e.g., military) may be considered potential terrorist targets and therefore have special security needs because of specific functions (secure communications, ammunition, weapons research, etc.). Some commercial businesses may also have a need or at least increased interest in enhanced security because of their function (i.e., banks) or because of a concern for neighboring crime issues. The site management and/or security personnel of other facilities may claim special security needs because:

- The facility is in the vicinity of surroundings that may be considered to have security or crime issues
- There is general concern related to potential litigation from accidents or crime related events

Safety for patrons and employees is also a concern for facility operators and appropriate lighting should be provided to ensure this capability. These security and safety concerns can cause the application of lighting levels above accepted standard practice or actual needs. This is not unexpected given the potential for litigation in today's society as well as the common business interest in customer satisfaction and comfort. However, this increased lighting can then in turn inhibit effective energy savings but will not necessarily improve conditions for safety or security.

In reality, the majority of buildings and associated exterior areas typically have no special safety or security issues or requirements. However, safety and security are issues that have potentially strong implications that are not easily argued against and this leads to lost energy savings opportunities. The information in this document and associated references may be useful in convincing those concerned that the existing industry recommendations from the Illuminating Engineering Society (IES) are the appropriate standards for facility exterior areas in the absence of specific security issues requiring enhanced lighting.

2.0 Effective Exterior Lighting for Safety and Security

The IES 9th Edition Lighting Handbook (2001) along with other IES documents (RP-33, RP-20, RP-8, and DG-5) provide an industry accepted set of recommended practice for common exterior applications. The IES is considered the lighting authority throughout North America and design professionals and those looking for standards of care for illumination look to this organization for the appropriate values and principles. Site conditions requiring enhanced lighting beyond these basic recommendations have also been evaluated by the IES and found to be specific to unusual surroundings or special property function. Guidance on when and how to provide appropriate enhanced lighting in these cases is outlined in “Guideline for Security Lighting for People, Property, and Public Spaces” (IES G-1). Guideline G-1 explains that effective lighting for safety and security should consider:

- **Horizontal Illuminance**
This is the standard for assessing effective lighting primarily because many tasks are horizontal and the measurements are easy to make. However, this is less critical for security than other metrics such as vertical illuminance and uniformity.
- **Vertical Illuminance**
This is critical because one of the main security issues is identifying persons and vehicles and their movement which is best done by viewing their vertical surfaces.
- **Uniformity/Shadows**
This is important primarily to avoid dark areas where persons or objects may be hidden. Uniformity has also been found to be useful in enhancing video camera effectiveness.
- **Glare**
Lighting aimed in the wrong direction can cause glare that can adversely affect the ability of occupants and security personnel to identify persons and/or objects

Numerous case studies and related research further show that simply increasing light levels or maintaining high lighting levels does not necessarily promote or maintain enhanced safety or security. It is primarily other factors associated with the placement and quality characteristics of exterior lighting that tends to enhance security. The need for enhanced lighting for security and the methods of achieving this capability need to be specifically evaluated for each application.

The guideline notes that in the 1960s many municipalities across the nation improved their street lighting partially to address crime. However, a review of the studies performed to evaluate the changes showed that there was no statistical evidence that improved lighting influenced the level of crime. There was evidence in the studies that the improved lighting tended to decrease the anticipation or fear of crime among residents. Additional studies throughout the 80s and 90s primarily in England showed mixed results. Summaries of US and overseas studies looking at lighting related to crime also offer only mixed results with one statistical study in the UK indicating that internal and external lighting had little or no influence on crime rates. At least one study indicated that increased lighting can support increased crime opportunities by identifying targets for criminals.

Section 4.0 of the guideline document discusses when security would typically be considered an issue and therefore different lighting should be considered above or beyond standard IES recommendations. A summary of the basic exterior characteristics and applications where advanced lighting for security reasons should be considered include:

- Persons or property are a desirable criminal target
- The property has a history of crime
- Crime in surrounding areas is notably high compared to other areas
- Surrounding neighborhood includes: high crime profile facilities/activities such as night clubs, gambling, gang gatherings, convenience stores, night depositories, restricted access facilities, and rail yards
- The results of a physical security survey or analysis indicate a problem
- Obvious physical signs of antisocial behavior are present near or on the property such as graffiti, vagrants, and poorly maintained facilities.
- Recurring, reasonable customer complaints regarding crime exist.

Section 4.0 also provides suggestions on where to start to address possible site security issues through building objectives, plans, and methods. These suggestions are offered in the form of a series of questions as follows:

- Are the security mission or objective and associated policies and procedures in place including additional personnel where needed?
- Have occupants and tenants been advised of potential threat levels?
- Have law enforcement agencies been notified of conditions? Did this include a call for additional patrols or assistance?
- Has a security audit been performed?
- Do existing illumination levels, uniformity, glare control, and maintenance plans meet recommended standards and requirements?

The discussion makes it clear that normal operation of typical facilities and tasks does not constitute a security issue. Special circumstances need to exist.

3.0 Applicable Litigation Issues with Exterior Lighting

It is important to consider potential legal risks during facility design to address potential lawsuit situations. However, a lack of understanding of actual litigation experience related to exterior lighting can drive corporate policy to promote excessive light levels or other low efficiency elements as part of facility design. The same limited understanding of the drivers for litigation can also inhibit effective energy saving lighting retrofits. Therefore, an examination of what situations can trigger and eventually be successful in exterior lighting related litigation may help in avoiding roadblocks to effective energy savings applications.

A review of US case law summaries related to exterior lighting shows that the critical issues prompting possible litigation were:

- Minimum Illumination levels below the accepted industry standard for the specific application [the summary references illumination recommendations provided by IES as the source of an appropriate standard for lighting].
- Illuminance insufficient for operation of security cameras [the summary generally relates this to non-uniform illumination].
- Lighting fixtures insufficiently safeguarded from vandalism.
- Lamps not inspected and sufficiently cleaned in high dirt accumulation conditions.
- Lamps not replaced before they burn out thereby creating non-uniform lighting conditions.
- Lack of notice by signage of any specific safety or security risk.

A summary conclusion from this representation of litigation issues is that all issues are based on negligence in meeting typical industry standards of care related to exterior lighting. The case law also general notes IES as providing this standard of care. The IES Handbook and associated related documents provide the recommended design practice that forms this collective standard. Lighting design that exceeds these recommendations is not shown to provide any specific additional protection from potential litigation.

4.0 Exterior Area Lighting Evaluation and Retrofit Recommendations

The following exterior lighting evaluation and retrofit suggestions can help identify areas where lighting for safety and/or security may be in need of attention or where lighting retrofit opportunities exist and recommended actions.

In each case, perform detailed audits of selected areas that represent the application. Ensure that areas that appear to be under lighted are part of the evaluation. Characterize by measured light levels any under lighted or over lighted areas according to IES light level recommendations (currently based on the 9th edition Lighting Handbook and related IES documents). Also note other characteristics such as glare, color, and shadows that may be issues with effective lighting of the space. Any locations with substandard lighting according to industry standards (IES) should be considered for correction. Areas with over lighted conditions present an opportunity for energy savings.

4.1 Parking Lot Lighting

Full-output lighting for most parking facilities (see section on security and safety concerns) is only needed during business or occupied hours and only needed for traversing and parking vehicles safely and pedestrian traffic. For most commercial facilities this will involve only part of the evening (dark) hours. The minimum horizontal illuminance on typical asphalt parking surfaces according to general IES guidelines is 0.2 footcandles (fc) at any given point (not the average).

4.1.1 Recommendations

Ensure that all parking lot lighting is controlled with a photocell or similar control to eliminate daytime operation (for uncovered parking) in addition to any other time switch or occupancy controls. When lot lighting is scheduled for replacement or when economic analysis supports immediate replacement, consider lower wattage lamp and ballast replacements in overlighted areas. Consider light emitting diode (LED) technology as an effective replacement option. LEDs provide potentially more uniform distribution, “whiter” light for better contrast and identification of objects, dimmability and instant on capability, and potentially longer useful life.

Evaluate the use of parking areas and categorize as either:

- Defined operating hours use (office, retail, maintenance/storage, etc.)
- Potential intermittent 24/7 use (i.e., barracks, security)

In defined hours of use facilities with known shift hours, apply time switching that will turn off most parking lot lighting after expected use of the parking area. This could be accomplished by time switching all but a few “night-lite” fixtures in the lot. It could also be accomplished by dimming the lot lighting after expected use hours (LEDs can be dimmed successfully).

For expected intermittent use lighting, consider the use of lighting controlled by occupancy sensors. This would require a change to instant on technology such as LED or fluorescent. The sensors would activate part or all of the lot (depending on size) when occupants or vehicles approach or enter the area. This could be applied in place of dimming or switching in lots with defined use hours for after hours use.

4.2 Wallpack Lighting

The use of wallpacks is a typical design application intended to provide perceived security lighting as well as after dark door access lighting but is commonly over applied. Wallpacks on blank walls are commonly perceived as security lighting but in many cases are not directly tied to any expected security issue. In other cases wallpack lighting serves as façade lighting that is applied to give the facility a sense of spatial or corporate identity. However, the general need for this type of identity for many standard facilities is minimal. In some cases, existing parking or street lighting provides sufficient lighting for spatial identity. The wall lighting over doors is typically needed only for after dark access to the building and a small amount of lighting is reasonable to maintain door location identification. For roll-up doors, additional lighting that may be needed for loading and similar activities will only be needed for that specific activity. Note that doors serving as points of exit discharge (egress) have special code requirements and restrictions in terms of output and control.

4.2.1 Recommendations

1. Wattage

When appropriate (at burnout, on scheduled replacement, or based on economic payback), replace existing high pressure sodium (HPS) and metal halide (MH) over door wallpacks with lower wattage sources. Personnel doors require only small sources such as a residential style entry door light. Lighting at roll-up doors for area loading functions may require more. Also see the recommendations under wallpack lighting (controls). Consider LED products due to their more even distribution, whiter light for better contrast and visual distinction, and potentially longer life than HPS and MH. Re-evaluate the need for wallpack lighting on blank walls at all facilities and identify those that truly have a security or safety concern. In some cases fewer lights can be retained and lower wattages can be incorporated.

2. Controls

Ensure that all exterior lighting on buildings is controlled with a photocell or similar control to eliminate daytime use. Consider “manual-on timed control” for any additional lighting associated with loading or similar activities outside of roll-up doors. This would either require a separate fixture for the additional wattage or a multiple source fixture. This could be accomplished with a small residential type door location light that is automatically controlled by photosensor, plus a separate higher wattage HPS or MH wallpack that is operated manually with a 1-hour timed override switch. This would require that users manually turn on the lighting when needed and would need to re-energize if needed for more than one hour. Locations that have scheduled after hour use of these

areas could be provided with longer time settings. This could be similarly done with LED lighting in the form of separate fixtures or a combination fixture (similar to a standard incandescent 3-way lamp).

4.3 Street Lighting

Locations that are higher than IES recommendations may provide some opportunities for retrofits. Current recommendations for average horizontal illuminance on typical asphalt road surfaces include:

- local road in area of low pedestrian conflict (typically residential) = 0.4 fc
- local road in area of high pedestrian conflict (typically commercial) = 0.9 fc
- collector road in area of low pedestrian conflict (typically residential) = 0.6 fc
- collector road in area of high pedestrian conflict (typically commercial) = 1.2 fc.

4.3.1 Recommendations

Lower wattage HPS or MH lamps and ballasts could be retrofitted where appropriate to bring light levels to the appropriate level and increase the efficacy of the lamp and ballast combinations. LED technology should be considered as a long term retrofit strategy because of its potential for better uniformity, whiter color, and expected long life.

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