



DEPARTMENT OF COMMUNITY DEVELOPMENT SERVICES

Planning Division

m e m o r a n d u m

TO: Mayor Laurel Lunt Prussing

FROM: Elizabeth H. Tyler, FAICP, Director

DATE: April 8, 2009

SUBJECT: Plan Case 2081-T-08: Request by the Zoning Administrator to amend Article VI of the Urbana Zoning Ordinance include Outdoor Lighting Standards

Introduction

The Urbana City Council considered the proposed text amendment to add outdoor lighting standards to the Zoning Ordinance on March 16, 2009. At that meeting several issues were discussed and the item was moved to the Committee meeting of April 13th for further discussion. Staff has provided more information regarding the issues raised.

Discussion

Single Family Lighting Requirements

During discussion, Council asked why single-family homes and duplexes would be exempted from light limit requirements. A few other communities do limit the level of light on single-family and duplex properties, but most do not. In the Zoning Ordinance, lower-intensity residential uses are generally not subject to stricter requirements that apply to multi-family, commercial, and industrial zones. As mentioned in the previous memorandum to Council, many single-family homes are in areas without any public street lighting. In order to provide an adequate level of safety and sidewalk lighting, the homeowners associations in some of these areas require the front yard to be lit. These homeowner's requirements could potentially conflict with any City provisions that prevent light from spilling beyond the property line. While it may still be possible to limit the average light level within these properties, it is difficult to know what those levels are without a photometric analysis. Staff believes that it would cause an undue burden to require single-family and duplex homes to submit a lighting plan, unlike income-generating properties.

Backlight/Uplight/Glare System

The backlight/uplight/glare (BUG) measurement system has replaced the semi-cutoff, cutoff and full-cutoff categorizations in the Illuminating Engineering Society of North America (IESNA) standards. The cutoff system rated light fixtures by looking at percentage of light output in three zones, as shown in Figure 1: above 90 degrees, between 80 and 90 degrees, and below 80 degrees. The BUG system rates net light output levels (lumens) in ten zones, as shown in Exhibit B.

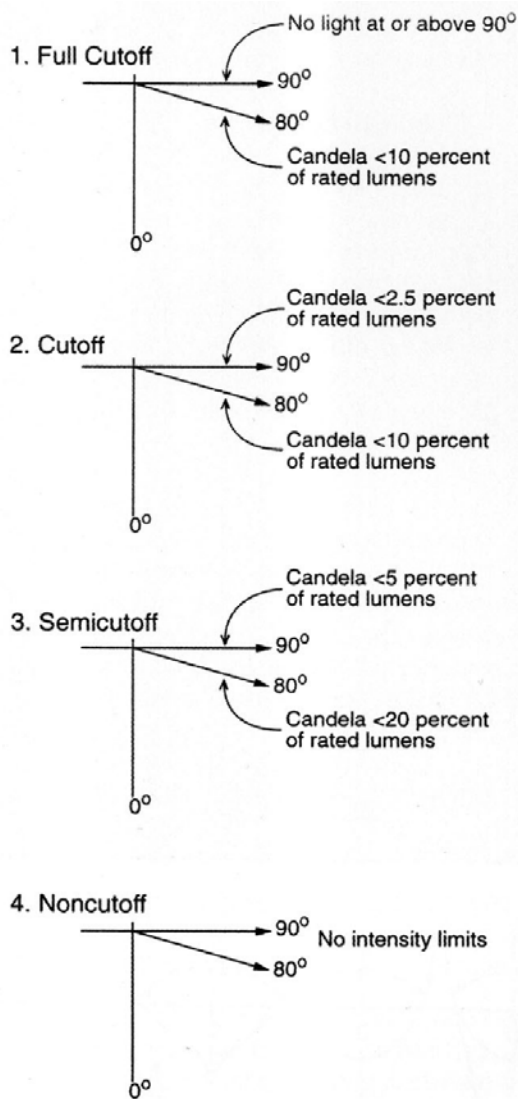


Figure 1: Cutoff System Classification

provided by most lighting manufacturers. In order to provide BUG ratings, the manufacturers would need to upgrade their testing facilities. In the long term, it is possible that manufacturers will adopt the BUG ratings and will no longer provide a cutoff system rating. Because of this, staff recommends adoption of a hybrid standard that will allow for either cutoff or BUG rating for non-residential luminaires.

There are two methods of adopting the BUG rating system. The International Dark-Sky Association / IESNA Model Lighting Ordinance, while still in draft form, provides suggested BUG rating limits for five lighting overlay zones. The zones are described in Exhibit B. In order to adopt this method, the City would need to establish a lighting zone map, the process for which could be complicated and time-consuming. The other option for adopting a BUG rating is to establish a city-wide limit for one or more of the three BUG components. As Glare and Backlight (trespass) are regulated in other

The attached Exhibit B explains how BUG ratings are calculated. Basically, there is a table for each of the three ratings: backlight, uplight, and glare. Each rating is based on three or four of the metrics shown in Figure 2. The backlight rating is meant to measure light trespass. This is an informative measurement if a property is lit with fixtures positioned around its boundaries, but less useful in other applications, such as in the middle of a large parking lot. The cutoff system does not address backlight. Uplight is a measure of how much light is projected directly into the sky. An uplight rating of zero would be equivalent to a full-cutoff fixture. The glare rating reveals how much light is projected in a horizontal direction, between 60 and 90 degrees. A fixture with a high glare rating will produce a sensation of glare if seen from a distance. The cutoff system also addresses glare; the amount of light projected between 80 and 90 degrees factors into the cutoff rating.

Light trespass and glare are addressed by other requirements of the proposed text amendment. There is a limit on the amount of light that may trespass into a neighbor's property. This limit is based on the aggregate total of light fixtures on any given property, where as BUG ratings only limit individual fixtures. Finally, if the light trespass is below the allowed threshold and a light fixture causes glare or a nuisance, the City can order it to be shielded or removed.

According to lighting professionals Phillips, McCully & Associates, BUG standards are not currently

sections of the proposed lighting ordinance, staff recommends a city-wide limit on Uplight of U1. This change is shown in underline in Section E.2 of the attached lighting ordinance text amendment.

Nonconforming Light Fixtures

Of the surveyed ordinances, very few require properties to retroactively comply with new regulations. Champaign's requirements do not apply retroactively. The Town of Normal requires canopy lighting to conform to their requirements five years after their ordinance was adopted. Other lighting that does not meet requirements is considered non-conforming. The Village of Homer Glen required all non-conforming light fixtures to be removed within 12 years of the passage of their ordinance.

Staff suggests granting non-conforming status to existing fixtures that do not meet the requirements of the text amendment. This will allow for non-conforming fixtures to gradually be replaced over the next 15 to 20 years, the estimated lifespan of a parking lot luminaire. Establishing a "sunset" provision for non-conforming luminaires would be difficult from an administrative standpoint. Determining which properties conform to light level limits is only possible with a photometric plan. It would be difficult, if not impossible, to obtain photometric plans for lighting systems installed years ago. It should be noted that the City rarely imposes updated zoning regulations retroactively, due to the administrative burden, liability concerns, and the fiscal impact upon the business community.

Lighting Context

One of the goals of the proposed text amendment is to establish an appropriate lighting context across Urbana. Certain areas of the city will always have higher ambient light levels than others. Residential areas are relatively dark and commercial corridors are brighter, due to higher levels of activity. Lighting in commercial districts should not necessarily be relied upon to draw the attention of potential customers. Over-lighting of a commercial property makes it stand out in a corridor and can cause problems with lighting uniformity and safety. In order to compete with existing businesses, a new business may install higher light levels when they move in. As the corridor develops, this can lead to escalating levels of over-lighting. The limits in the proposed text amendment will ensure that over-lighting does not occur. As businesses upgrade or redevelop their properties, the new limits will be applied and the overall light levels of Urbana's commercial corridors will return to a reasonable level.

Gas Station Canopy Lighting

Council members gave multiple comments about gas station canopy lighting. One member asked if the proposed limit of 15 footcandles was bright enough to provide a safe environment. Another member suggested that the proposed limit is too high. Staff recommends adoption of the proposed 15 footcandle limit, which is lower than the existing city-wide average of about 32 footcandles. Safety is influenced by relative light levels and lighting uniformity. Under the proposed ordinance, gas canopies would be lit at a higher level than surrounding properties, and all properties would be subject to a 15:1 lighting uniformity ratio.

Lighting Efficiency

At the meeting some Council members were concerned about energy efficiency. As a part of the building code, external lighting must meet the Illinois Energy Code. The Energy Code spells out

limits for energy densities for several different exterior lighting situations, as shown in Exhibit C. The Energy Code also requires all light sources above 100 watts to have an efficacy of at least 60 lumens per watt. This requirement limits the use of low-efficiency incandescent and LED sources.

Education

The City has already begun efforts to educate developers of the impending lighting controls. Staff presented the proposed lighting ordinance at the Developer's Roundtable Luncheon on February 24, 2009. The Department of Community Development Services will continue to reach out to developers, architects, and engineers once the ordinance is adopted. Another resource for public education is Urbana's Sustainability Advisory Commission. The Commission, through the Urbana Sustainability Initiative, could adopt programs to educate the public about the energy saving potential of efficient site lighting and fixtures.

Average Light Level Limits

During the Council meeting, it was suggested that the light level limits in the proposed ordinance are not adequate, and that the limits proposed in IESNA RP-33-99, Lighting for Exterior Environments or those of the IDA/IESNA Model Lighting Ordinance should be adopted. Staff has suggested an average light limit of 1.0 footcandle for residential properties and 2.5 footcandles for commercial and industrial districts. These limits were based on a survey of adopted lighting ordinances, as this was felt to be the best data available to provide guidance for average illumination levels. Other sources provide different types of data. IESNA RP-33-99 provides guidelines for light trespass levels, but not on-site average light levels. It suggests a light trespass limit of 0.8 footcandles in Light Zone 3 and 1.5 footcandles in Light Zone 4. These numbers are higher than the light trespass limits suggested by staff of 0.1 footcandles (adjacent to R-1, R-2, and R-3 zoning districts) and 0.2 for all other districts.

The IDA/IESNA Draft Model Lighting Ordinance (MLO) provides limits to total light emitted by fixtures on the site (lumens), but does not limit the average level of light on the site (footcandles). The Draft MLO contains tables that have lumen limits per square foot, parking space, or total site for each Light Zone. The uniformity or dispersal pattern of light on or off of the site is not addressed, but all of the light fixtures must have the appropriate BUG ratings.

Recommendation

Staff recommends the Committee of the Whole forward the proposed lighting standards text amendment as revised in the attached Ordinance to City Council with a recommendation for **APPROVAL**.

Attachments:

Exhibit A: Lighting Text Amendment Adopting Ordinance, with changes underlined

Exhibit B: BUG System Bulletin

Exhibit C: Illinois Energy Code Excerpt

ORDINANCE NO. 2009-03-018

**AN ORDINANCE APPROVING A TEXT AMENDMENT TO THE ZONING ORDINANCE
OF THE CITY OF URBANA, ILLINOIS**

**(Addition of Section VI-8, "Outdoor Lighting Standards" -
Plan Case No. 2081-T-09)**

WHEREAS, the City Council of the City of Urbana, Illinois, adopted Ordinance No. 9293-124 on June 21, 1993 consisting of a comprehensive amendment to the 1979 Zoning Ordinance of the City of Urbana, also known as the Urbana Zoning Ordinance; and

WHEREAS, the 2005 Urbana Comprehensive Plan contains goals to promote site design requirements that conserve energy and to minimize incompatible land uses; and

WHEREAS, the 2005 Urbana Comprehensive Plan includes an implementation strategy reading "Amend the Urbana Zoning Ordinance to address appropriate private property lighting standards for commercial and industrial areas"; and

WHEREAS, the City Council Common Goals promote the implementation of the 2005 Urbana Comprehensive Plan and the adoption of lighting standards; and

WHEREAS, the adoption of modern lighting standards for private property will provide for a safe and secure lighting environment, promote efficient use of light and energy conservation, and will protect against light trespass and lighting nuisances; and

WHEREAS, the Urbana Zoning Administrator has requested to amend Article VI of the Urbana Zoning Ordinance to include lighting standards for private property; and

WHEREAS, said text amendment was presented to the Urbana Plan Commission as Plan Case No. 2081-T-08; and

WHEREAS, after due publication in accordance with Section XI-7 of the Urbana Zoning Ordinance and with Chapter 24, Section 11-13-14 of the Illinois Revised Statutes, the Urbana Plan Commission held a public hearing to consider the case on February 5, 2009, which was continued to March 5, 2009; and

WHEREAS, the Urbana Plan Commission voted 5 ayes to 0 nays on March 5, 2009 to forward the proposed text amendment set forth in Plan Case No. 2081-T-08 to the Urbana City Council with a recommendation for approval;

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF URBANA, ILLINOIS, that the Urbana Zoning Ordinance shall be amended as follows:

Section 1. Section 8, Outdoor Lighting Requirements, is hereby added to Article VI as follows:

Section VI-8. Outdoor Lighting Requirements

A. Purpose

The purpose of this section is to establish regulations and controls which promote the goals, objectives, and policies of the City of Urbana Comprehensive Plan. These controls aim to provide modern lighting standards for private property that protect against light trespass and nuisances, promote efficient use of light and energy conservation, and provide for a safe and secure lighting environment appropriate for the context of the areas to be lit.

B. Definitions

Candela: A measure of luminous intensity, or power emitted by a light source in a particular direction.

Cutoff Light Fixture: A fixture installed such that the luminous flux at 90 degrees above nadir is less than 5 percent of rated lumens, and less than 20 percent of rated lumens at 80 degrees above nadir.

Fixture (or Luminaire): A device which directs, diffuses, or modifies the light given out by the illuminating source in such a manner as to make its use more economical, effective and safe to the eye. The fixture includes the assembly that holds the lamp in a lighting system, including elements such as the reflector, refractor, housing, and shielding, ballasts in fluorescent and HID (High Intensity Discharge) units, and stems and canopies where used.

Floodlight: a light fixture or lamp which projects light in a wide beam, typically 100 degrees or more.

Footcandle (fc): A unit of measure of luminous flux, the illumination which is produced by a one-candela point source on a surface which is exactly one-foot distant from the point source. All measurements of footcandles shall be in the horizontal plane at ground level unless otherwise specified.

Full Cutoff Light Fixture: A fixture, as installed, designed or shielded in such a manner that all light rays emitted by the fixture, either directly from the lamp(s) or indirectly from the fixture, are projected below a horizontal plane running through the lowest point on the fixture where light is emitted. The luminous flux emitted in the band between 80 degrees and 90 degrees above nadir in all directions is no more than 10 percent of the total luminous flux for the luminaire. A luminaire that meets the Illumination Engineering Society of North America (IESNA) full-cutoff definition shall be considered full cutoff for the purposes of this Ordinance.

Glare: The sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort or loss in visual performance and visibility. Often the result of a direct line of sight to the filament or cathode in a light fixture.

IESNA Standards: Lighting guidelines provided by the IESNA, Illuminating Engineering Society of North America. These standards are found in IESNA guidebooks such as RP-33-99, *Lighting for Exterior Environments* and RP-20-98, *Lighting for Parking Facilities*.

Initial Light Levels: The amount of light produced on a site upon installation of a new lamp. As lamps age, they become less efficient and produce less light. Initial light levels represent the brightest portion of a lamp's life cycle.

Lamp: An artificial source of visible illumination.

Light Pollution: term used to describe light trespass, over-illumination, glare, clutter and/or skyglow from an artificial light source

Light Trespass: light projected onto a property from a fixture not located on that property.

Lumen: quantity of incident luminous flux which will, when uniformly distributed over a surface having an area of one square foot, produce an illumination of one footcandle on every point of the surface. Typical luminous flux values for incandescent bulbs are 100 watts: 1,550 lumens, 75 watts: 1,080 lumens, 60 watts: 780 lumens, and 40 watts: 450 lumens. Note: When luminous flux impinges nonuniformly on a surface, then a lumen is the quantity of luminous flux which will, on a one-square foot surface, produce an average illumination of one footcandle

Luminance: a photometric measure of the luminous intensity per unit area of light travelling in a given direction.

Luminous Flux: The power emitted from a source of electromagnetic radiation, such as a lamp, in the form of visible light. Luminous flux is measured in lumens (lux) or footcandles (fc) and is typically specified by the manufacturer for a given lamp or luminaire.

Nadir: The direction pointing directly downward from the light source of the luminaire.

Spill Zone: The area immediately outside of an area intended to be lit, onto which low levels of excess light may spill.

Spotlight: A light fixture or bulb which projects light in a narrow beam, typically 45 degrees or less.

Uniformity Ratio: A measure of the dispersion of light on an area. For the purposes of this Ordinance, the ratio is measured as maximum light level to minimum light level. Lower uniformity ratios help eliminate places to hide, give better depth perception, and a greater feeling of security to individuals in the area

C. Applicability

1. It shall be unlawful for any person, firm, or institution to install or operate any outdoor light fixture on private property which does not comply with the requirements of this Ordinance. Lighting fixtures on single and two-family residential properties shall not be subject to the requirements of Section IX-8.E.

2. The Zoning Administrator, in consultation with the Building Official, may alter or waive certain requirements of this Section in order to alleviate site security concerns or other practical difficulties. In such cases an alternative lighting plan shall be provided demonstrating that lighting conforms to current IESNA standards.
- 3 Lighting fixtures installed prior to July 1, 2009 and any of the following types of lighting shall be exempt from the requirements of this Ordinance, except that fixtures found by the Zoning Administrator to be a nuisance or cause excessive glare creating a public hazard can be ordered to be removed or altered at any time.
 - a. All temporary lighting needed by the police, fire, public works, or other public agencies or emergency services.
 - b. Vehicular luminaires.
 - c. All hazard warning luminaires required by law.
 - d. Properly permitted recreational and outdoor event lighting during times that the lighted area is actually in use and for a period of one hour before the event and one half hour after. Nonetheless, recreational and outdoor event lighting shall be installed in a way that minimizes light trespassing onto adjacent property.
 - e. Temporary lighting, such as holiday or special event lighting.
 - f. City street lights, traffic lights, and other lighting required for public safety.
 - g. Other exceptions as required by law.

D. General Requirements

The following shall apply to all properties in the City of Urbana, except as noted in Section VI-8.C:

1. Limits on Glare. Outdoor lighting shall not create a glare that hinders sight to the extent that it is hazardous for motorists, bicyclists, or pedestrians. Lighting shall be aimed or shielded so as not to cause a nuisance to the public or nearby properties.
2. Façade and Landscape Lighting.
 - a. Floodlights directed at buildings shall be shielded such that light emitted falls upon the building façade. The initial average exterior building façade luminance shall not exceed five foot candles on the illuminated surface. Floodlights used for facade lighting may be no farther from the building than one-third of the building height. The mounting height of such floodlights shall not exceed the building height.
 - b. The lamp of landscape luminaires shall be shielded such that it is not directly visible from any adjacent properties.

E. Additional Requirements

The following shall apply to all properties except for single-family and duplex uses and as noted in Section VI-8.C:

1. Lighting Plan Submission Requirements. A lighting plan shall be submitted to and approved by the Urbana Building Safety Division prior to installation or replacement of a lighting system. Lighting plans shall not be required for the installation or replacement of less than three fixtures or less than 20 percent of the existing fixtures. Lighting plans shall be submitted for review as a part of the building permit process and shall include the following information:
 - a. A site photometric plan indicating initial footcandle levels in a ten-foot by ten-foot point spacing at grade to a distance of 20 feet beyond the lot lines.
 - b. Specifications for all luminaires, poles, luminaire mounting arms, and lighting control products.
 - c. Lighting specifications including footcandle initial averages, and maximum-to-minimum uniformity ratio for the areas to be lit, excluding the spill zone, in conformance with the requirements of paragraph VI-8.E.4.
 - d. The location, mounting height, lamp intensity for all exterior luminaires.
 - e. An after-hours security lighting plan indicating reduced light levels as specified in VI-8.E.4.
2. Luminaires. In order to prevent unreasonable light pollution, any luminaire and all wall-mounted luminaires used for outdoor area light shall use a non-adjustable, full-cutoff fixture, or a fixture with an IESNA Uplight rating of U1 or less, positioned in a way that the cutoff effect is maximized.
3. Lighting Context. Outdoor lighting design must take into account existing light sources that impact the site as well as the presence of sensitive land uses that may be impacted by the lighting.
 - a. In order to prevent over-lighting, proposed new outdoor lighting shall consider existing light affecting the site.
 - b. Outdoor lighting shall have fixtures that shield residential areas from direct light.
4. Light Levels, Luminaire Mounting Position, and Timing.
 - a. In order to help eliminate places to hide, give better depth perception, and a greater sense of security to individuals in the area, lighting levels shall not exceed an initial maximum to minimum uniformity ratio of 20:1 for the areas to be illuminated. Areas to be illuminated may be different for after-hours security lighting as required in this section.

- b. Average initial light levels at ground level shall not exceed one footcandle in residential zoning districts and 2.5 footcandles in all other districts.
- c. Light levels created by proposed new outdoor lighting shall not exceed 0.2 footcandles as measured at a point six feet beyond the property line or farther, except that light levels shall not exceed 0.1 footcandles as measured at a point six feet beyond the property line or farther where the adjacent property is zoned R-1, R-2, or R-3.
- d. Canopy lighting. All lighting under a canopy shall be cutoff or recessed, and no luminaires shall extend below the horizontal plane of the canopy. Light levels under the canopy shall not exceed an initial average of 15 footcandles at grade.
- e. Display areas. Areas dedicated to the display of merchandise may have an initial average light level no greater than ten footcandles while the business on the site is open to the public, and shall have an initial average light level no greater than five footcandles thereafter.
- f. Building entrance areas and access drives shall have an average light level no greater than ten footcandles.
- g. All exterior lighting on non-residential properties shall be controlled by a photo sensor, occupancy sensor, or time switch which shall:
 - i) automatically reduce exterior lighting when sufficient daylight is available, and
 - ii) automatically extinguish subject lights no more than one hour following the close of business on subject property, excluding lighting for security purposes. Security lighting shall not exceed 33 percent of the total light output (in lumens) from all outdoor lighting located on the zoning lot. Individual luminaires shall not emit more light for security lighting purposes.

Section 2. The City Clerk is directed to publish this Ordinance in pamphlet form by authority of the corporate authorities. This Ordinance shall be in full force and effect from and after its passage and publication in accordance with the terms of Chapter 65, Section 1-2-4 of the Illinois Compiled Statutes (65 ILCS 5/1-2-4).

This Ordinance is hereby passed by the affirmative vote, the "ayes" and "nays" being called of a majority of the members of the City Council of the City of Urbana, Illinois, at a regular meeting of said Council on the ____ day of _____, 2009.

PASSED by the City Council this ____ day of _____, 2009.

AYES:

NAYS:

ABSTAINED:

Phyllis D. Clark, City Clerk

APPROVED by the Mayor this _____ day of _____, 2009.

Laurel Lunt Prussing, Mayor

CERTIFICATE OF PUBLICATION IN PAMPHLET FORM

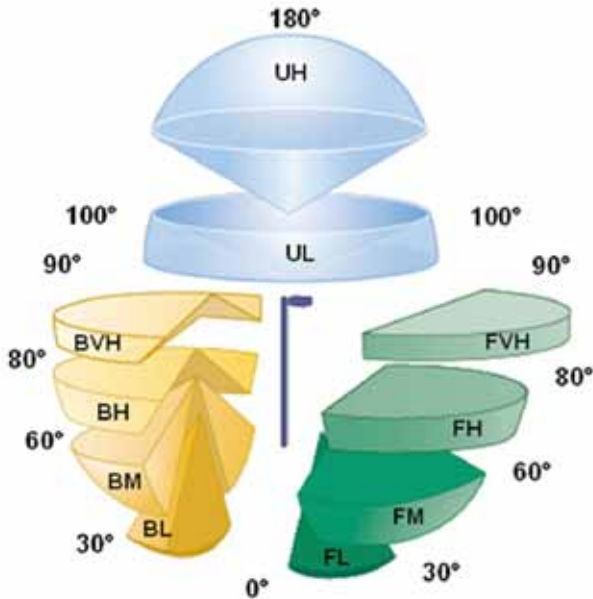
I, Phyllis D. Clark, certify that I am the duly elected and acting Municipal Clerk of the City of Urbana, Champaign County, Illinois. I certify that on the ____ day of _____, 2009, the corporate authorities of the City of Urbana passed and approved "AN ORDINANCE APPROVING A TEXT AMENDMENT TO THE ZONING ORDINANCE OF THE CITY OF URBANA, ILLINOIS (Addition of Section VI-8, "Outdoor Lighting Standards" - Plan Case No. 2081-T-09) which provided by its terms that it should be published in pamphlet form. The pamphlet form of Ordinance No. _____ was prepared, and a copy of such Ordinance was posted in the Urbana City Building commencing on the _____ day of _____, 2009, and continuing for at least ten (10) days thereafter. Copies of such Ordinance were also available for public inspection upon request at the Office of the City Clerk.

DATED at Urbana, Illinois, this _____ day of _____, 2009.

Specifier Bulletin

for Dark Sky Applications

VOLUME 2: ISSUE 1 : 2009 — [International Dark-Sky Association](http://www.darksky.org)



A Classification System
for Lighting Zones

The BUG System—A New Way To Control Stray Light from Outdoor Luminaires



For more information on FSA approved luminaires please visit the IDA Web site www.darksky.org.

BUG STANDS FOR “Backlight”, “Uplight” and “Glare.” The acronym describes the types of stray light escaping from an outdoor lighting luminaire. “B” stands for backlight, or the light directed in back of the mounting pole. “U” stands for uplight, or the light directed above the horizontal plane of the luminaire, and “G” stands for glare, or the amount of light emitted from the luminaire at angles known to cause glare.

It is expected that BUG values will be published by luminaire manufacturers so lighting specifiers, designers or purchasers can tell at a glance how well a certain luminaire controls stray light or compares with other luminaires under consideration for an installation.

The BUG system was developed by the Illuminating Engineering Society (IES) to make comparing and evaluating outdoor luminaires fast, easy and more complete than older systems.

Work on the BUG system started in 2005 when the IES upgraded the roadway shielding classification system. The original system, which included the ratings full cutoff, cutoff, semi-cutoff and non cutoff, had been designed as a rating system solely for street lighting. However, increasing demand for control of glare, and light trespass extended these terms to all types of outdoor lighting, and the IES realized that a more comprehensive system was needed.

The Lighting Research Center, acting as an IES contractor, developed a new classification concept that addresses light emitted from the luminaire in all directions, not just up into the sky. This system, released to the public as IES Technical Memorandum TM-15, technically replaced the old system. It divides the sphere around a luminaire into zones assigning values according to expected environmental impact. This rating system offers the most complete evaluation of the total light emitted from luminaires to date. A point to

The BUG System

remember, however, is that while the values assigned by the new system are good indicators, they may not in all cases directly correlate to light pollution. *It still depends upon the site, the application and how the luminaire is installed.*

The Model Lighting Ordinance (MLO) divides lighting requirements into lighting zones according to environmental impact. See **Appendix A**. The MLO Task Force reviewed TM-15 and realized that it could be modified to serve as a key measure of all forms of light pollution related to shielding and the direction of light, becoming an important tool to determine which luminaires are appropriate for each zone. Modifications were made, including subdividing the TM-15 uplight zone to better address artificial sky glow, and subdividing the upper downlight zone to better address glare. The IES accepted these adjustments and released TM-15-07 (revised). **See figure 1.**

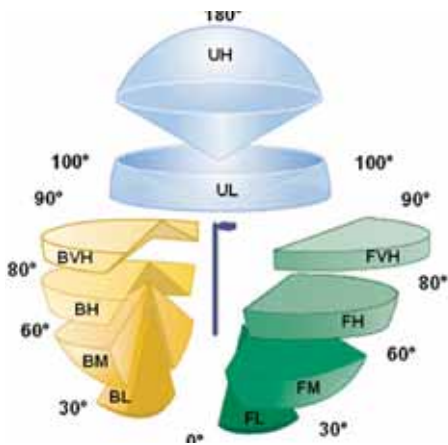


Figure 1: the revised outdoor luminaire distribution measuring system from TM-15-07 (revised)

After reviewing hundreds of candidate luminaires, the MLO task force established the three composite (BUG) ratings based on TM-15-07 (revised):

Backlight, which creates light trespass onto adjacent sites. The B rating takes into account the amount of light in the BL, BM, BH and BVH zones, which are direction of the luminaire OPPOSITE from the area intended to be lighted.

Uplight, which causes artificial sky glow. Lower uplight (zone UL) causes the most sky glow and negatively affects professional and academic astronomy. Upper uplight (UH) is mostly energy waste. The U rating accounts the amount of light into the upper hemisphere with greater concern for the lower uplight angles in UL.

Glare, which can be annoying or visually disabling. The G rating takes into account the amount of frontlight in the FH and FVH zones as well as BH and BVH zones.

Appendix A:

Lighting Zone Definitions: The Lighting Zone shall define the limitations for outdoor lighting as specified in this ordinance. The policymaking body is able to designate areas according to the following descriptions, thereby creating a custom lighting plan according to local needs, functions, and geography.

LZ0: No ambient lighting Areas where the natural environment will be seriously and adversely affected by lighting. Impacts include disturbing the biological cycles of flora and fauna and/or detracting from human enjoyment and appreciation of the natural environment. Little or no lighting is expected. When not needed, lighting should be extinguished.

LZ1: Low ambient lighting Areas where lighting might adversely affect flora and fauna or disturb the character of the area. The vision of human residents and users is adapted to low light levels. Lighting may be used for safety, security and/or convenience but it is not necessarily uniform or continuous. After curfew, most lighting should be extinguished or reduced as activity levels decline.

LZ2: Moderate ambient lighting Areas of human activity where the vision of human residents and users is adapted to moderate light levels. Lighting may typically be used for safety, security and/or convenience but

it is not necessarily uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

LZ3: Moderately high ambient lighting Areas of human activity where the vision of human residents and users is adapted to moderately high light levels. Lighting is generally desired for safety, security and/or convenience and it is often uniform and/or continuous. After curfew, lighting may be extinguished or reduced in most areas as activity levels decline.

LZ4: High ambient lighting Areas of human activity where the vision of human residents and users is adapted to high light levels. Lighting is generally considered necessary for safety, security and/or convenience and it is mostly uniform and/or continuous. After curfew, lighting may be extinguished or reduced in some areas as activity levels decline.

Figure 1: the revised (or BUG) outdoor luminaire distribution measuring system from TM-15-07 (revised)

The resulting rating system, called BUG for obvious reasons, is a comprehensive system that takes into account uplight shielding, glare shielding and backlight shielding as well as limiting lamp lumens to values appropriate for the lighting zone. BUG is a simple system consisting of a table of consensus acceptable values against which any luminaire having photometric data can be judged. A luminaire's numerical rating is the LOWEST light zone number in which it can be used. BUG will be part of the latest IES outdoor lighting system update, TM-15-09.

The BUG rating system is a principal component of the Model Lighting Ordinance (MLO). The MLO is also a simple system that considers BUG ratings in the context of total lumens allowed per site, which the total site lumens are restricted. Use of the BUG system as the measuring tool for the MLO creates a straightforward system of controlling light pollution that can be implemented by persons having minimal experience or education in outdoor lighting design.

BUG FAQs

Are BUG luminaire ratings better than using the old full cut off, semi cut off, non cut off, etc. designations for shielding?

Yes, because BUG ratings provide backlight and glare information as well as how well the luminaire controls uplight. These additional measurements provide a much more accurate picture of lumen distribution and the overall efficiency of a luminaire.

Does BUG allow any uplight?

BUG requires downlight only with low glare (better than full cut off) in lighting zones 0, 1 and 2, but allows a minor amount of uplight in lighting zones 3 and 4. In lighting zones 3 and 4, the amount of allowed uplight is enough to permit the use of very well shielded luminaires that have a decorative drop lens or chimney so that dark sky friendly lighting can be installed where in places that traditional-appearing fixtures are required.

Will all outdoor lighting manufacturers rate their luminaires according to BUG?

Not at first. Since BUG is designed to prevent bad lighting practices, a lot of current outdoor products won't pass BUG, so there will be no point in rating them. But it is expected that manufacturers will rate their "good" luminaires and make changes to current products to improve BUG ratings.

Will BUG apply to residential lighting?

No. BUG can't be used for residential luminaires because they generally are not photometrically tested. The IDA Fixture Seal of Approval Program can be used to rate residential outdoor luminaires.

Is BUG as strict as the toughest anti-light pollution ordinances in effect today?

BUG, by itself, is a luminaire rating tool. It can easily be applied more stringently by using the zonal factors in response to community choices of lighting zones. While lighting zone determinants are clearly outlined in the MLO, the community decides upon zone placement. If a community adopts the MLO and chooses all lighting zones LZ0 and LZ1, the MLO with BUG is actually more restrictive than any of the toughest ordinances. However, zone assignment will always remain at the discretion of the community.

Addendum A for IES TM-15-07: Backlight, Uplight, and Glare (BUG) Ratings

Text, charts, and photograph from IES TM-15-07:

<http://www.iesna.org/PDF/Erratas/TM-15-07BUGRatingsAddendum.pdf>

The following **Backlight**, **Uplight**, and **Glare** ratings may be used to evaluate luminaire optical performance related to light trespass, sky glow, and high angle brightness control. These ratings are based on a zonal lumen calculations for secondary solid angles defined in TM-15-07. The zonal lumen thresholds listed in the following three tables are based on data from photometric testing procedures approved by the Illuminating Engineering Society for outdoor luminaires (LM-31 or LM-35).

Notes to Tables **A-1**, **A-2**, and **A-3**:

1. Any one rating is determined by the maximum rating obtained for that table. For example, if the BH zone is rated B1, the BM zone is rated B2, and the BL zone is rated B1, then the backlight rating for the luminaire is B2.
2. To determine BUG ratings, the photometric test data must include data in the upper hemisphere unless no light is emitted above 90 degrees vertical (for example, if the luminaire has a flat lens and opaque sides), per the IES Testing Procedures Committee recommendations.
3. It is recommended that the photometric test density include values at least every 2.5 degrees vertically. If a photometric test does not include data points every 2.5 degrees vertically, the BUG ratings shall be determined based on appropriate interpolation.
4. A “quadrilateral symmetric” luminaire shall meet one of the following definitions:
 - a. Type V luminaire is one with a distribution that has circular symmetry, defined by the IES as being essentially the same at all lateral angles around the luminaire.
 - b. Type VS luminaire is one where the zonal lumens for each of the eight horizontal octants (0-45, 45-90, 90-135, 135-180, 180-225, 225-270, 270-315, 315-360) are within ± 10 percent of the average zonal lumens of all octants.

Table A-1: Backlight Ratings (maximum zonal lumens)

		Backlight Rating					
Secondary Solid Angle		B0	B1	B2	B3	B4	B5
Backlight / Trespass	BH	110	500	1000	2500	5000	>5000
	BM	220	1000	2500	5000	8500	>8500
	BL	110	500	1000	2500	5000	>5000

Table A-2: Uplight Ratings (maximum zonal lumens)

		Uplight Rating					
Secondary Solid Angle		U0	U1	U2	U3	U4	U5
Uplight / Skyglow	UH	0	10	100	500	1000	>1000
	UL	0	10	100	500	1000	>1000
	FVH	10	75	150	>150		
	BVH	10	75	150	>150		

Table A-3: Glare Ratings (maximum zonal lumens)

		Glare Rating for Asymmetrical Luminaire Types (Type I, Type II, Type III, Type IV)					
Secondary Solid Angle		G0	G1	G2	G3	G4	G5
Glare / Offensive Light	FVH	10	250	375	500	750	>750
	BVH	10	250	375	500	750	>750
	FH	660	1800	5000	7500	12000	>12000
	BH	110	500	1000	2500	5000	>5000
		Glare Rating for Quadrilateral Symmetrical Luminaire Types (Type V, Type V Square)					
Secondary Solid Angle		G0	G1	G2	G3	G4	G5
Glare / Offensive Light	FVH	10	250	375	500	750	>750
	BVH	10	250	375	500	750	>750
	FH	660	1800	5000	7500	12000	>12000
	BH	660	1800	5000	7500	12000	>12000

“BUG” RATING EXAMPLE:

A 250-watt MH area luminaire, Type IV forward throw optical distribution. Based on the photometric test data, the luminaire has the following zonal lumen distribution:

	Lumens	% Lamp Lumens
Forward Light		
FL (0–30 degrees)	1618	5.9%
FM (30–60 degrees)	6093	22.2%
FH (60–80 degrees)	3748	13.6%
FVH (80–90 degrees)	27	0.1%
Backlight		
BL (0–30 degrees)	985	3.6%
BM (30–60 degrees)	930	3.4%
BH (60–80 degrees)	136	0.5%
BVH (80–90 degrees)	16	0.1%
Uplight		
UL (90–100 degrees)	0	0.0%
UH (100–180 degrees)	0	0.0%

**Backlight Rating:**

Determine the lowest rating where the lumens for all of the secondary solid angles do not exceed the threshold lumens from **Table A-1**. In this example the backlight rating would be B2 based on the BL lumen limit.

Uplight Rating:

Determine the lowest rating where the lumens for all of the secondary solid angles do not exceed the threshold lumens from **Table A-2**. In this example the uplight rating would be U1 based on the FVH and BVH lumen limits.

Glare Rating:

Determine the lowest rating where the lumens for all of the secondary solid angles do not exceed the threshold lumens from **Table A-3** for a Type IV distribution. In this example, the glare rating would be G2 based on the FH lumen limit.

Therefore, the BUG rating for this luminaire would be: **B2 U1 G2**