Malibu City Council
Zoning Ordinance Revisions and
Code Enforcement Subcommittee (ZORACES)
Special Meeting Agenda

Monday, May 9, 2016

3:30 P.M.

City Hall – Zuma Room
23825 Stuart Ranch Road

Mayor Laura Rosenthal
Councilmember Skylar Peak

Call to Order

Approval of Agenda

Report on Posting of the Agenda – May 5, 2016

Public Comment *This is the time for the public to comment on any items not appearing on this agenda. Each public speaker shall be allowed up to three (3) minutes for comments. The Subcommittee may not discuss or act on any matter not specifically identified on this agenda, pursuant to the Ralph M. Brown Act.*

Discussion Items

1. Approval of Minutes – April 26, 2016

   Recommended action: Approve the minutes of the Zoning Ordinance Revisions and Code Enforcement Subcommittee (ZORACES) Special meeting of April 26, 2016.

   Staff contact: Planning Director Blue, 310-456-2489, ext. 258

2. Zoning Text Amendment No. 13-001 to Establish a Citywide Lighting Ordinance

   Recommended action: Review the residential portion of the proposed citywide lighting ordinance and provide staff with comments and recommendations.

   Staff contact: Planning Manager Deleau, 310-456-2489, ext. 273

Adjournment

I hereby certify under penalty of perjury, under the laws of the State of California, that the foregoing agenda was posted in accordance with the applicable legal requirements. Dated May 5, 2016.

Mary Linden, Executive Assistant

Zoning Ordinance Revisions & Code Enforcement Subcommittee Meeting 05/09/16

Item 1

Zoning Ordinance Revisions and Code Enforcement Subcommittee Agenda Report

To: Zoning Ordinance Revisions and Code Enforcement Subcommittee (ZORACES) Members Rosenthal and Peak

Prepared by: Bonnie Blue, Planning Director BB

Date prepared: May 2, 2016 **Meeting date:** May 9, 2016

Subject: Approval of Minutes – April 26, 2016

RECOMMENDED ACTION: Approve the minutes of the Zoning Ordinance Revisions and Code Enforcement Subcommittee (ZORACES) Special meeting of April 26, 2016.

DISCUSSION: Staff has prepared draft minutes for the ZORACES Special meeting of April 26, 2016 and hereby submits the minutes to the Subcommittee for approval.

ATTACHMENT: Draft Minutes of the April 26, 2016 ZORACES Special meeting

MINUTES
MALIBU ZONING ORDINANCE REVISIONS AND CODE ENFORCEMENT
SUBCOMMITTEE
SPECIAL MEETING
APRIL 26, 2016
CITY HALL - ZUMA ROOM
9:30 A.M.

CALL TO ORDER

Mayor Rosenthal called the meeting to order at 9:40 a.m.

ROLL CALL

The following persons were recorded in attendance:

PRESENT: Mayor Laura Rosenthal and Councilmember Skylar Peak

ALSO PRESENT: Bonnie Blue, Planning Director; Adrian Fernandez, Senior Planner; and Craig George, Acting Environmental Sustainability Director.

APPROVAL OF AGENDA

CONSENSUS
By consensus, the Subcommittee approved the agenda.

REPORT ON POSTING OF AGENDA

Planning Director Bonnie Blue reported that the agenda for the meeting was properly posted on April 19, 2016.

PUBLIC COMMENT

Norman Haynie addressed the Subcommittee regarding rezoning of property.

DISCUSSION ITEMS

1. Approval of Minutes – December 14, 2015

Recommended Action: Approve the minutes of the Zoning Ordinance Revisions and Code Enforcement Subcommittee (ZORACES) Special Meeting of December 14, 2015.

CONSENSUS
By consensus, the Subcommittee approved the minutes of the ZORACES Special Meeting of December 14, 2015.

2. Amendments Addressing Beachfront and Non-Beachfront Development

   Recommended Action: Provide comments on proposed amendments addressing policy issues with beachfront and non-beachfront development standards and property zoning.

CONSENSUS

By consensus, the Subcommittee recommended that:

1. Staff update the definition of "beachfront lot" in ZTA No. 05-007 as recommended;
2. Staff add new language to ZTA No. 05-007 (and a corollary Local Coastal Program Amendment) to limit the amount of total development square footage allowed on beachfront lots in a manner similar to the limits for non-beachfront lots, and clarify stringline, setback and height standards for Rural Residential and Multifamily-zoned lots with frontage on the beach; and
3. Initiate amendments to the Malibu Municipal Code and Local Coastal Program to rezone Multifamily-zoned lots on the beach that are less than 10,000 square feet in size to Multifamily Beachfront.

ADJOURNMENT

CONSENSUS

By consensus, the Subcommittee adjourned the meeting at 10:37 a.m.

Approved and adopted by the Zoning Ordinance Revisions and Code Enforcement Subcommittee of the City of Malibu on May 9, 2016.

_____
LAURA ROSENTHAL, Mayor

ATTEST:

_____
MARY LINDEN, Executive Assistant

Zoning Ordinance Revisions & Code Enforcement Subcommittee Meeting 5-09-16

Item 2

Zoning Ordinance Revisions and Code Enforcement Subcommittee Agenda Report

To: Zoning Ordinance Revision and Code Enforcement Subcommittee (ZORACES) Members Rosenthal and Peak

Prepared by: Bonnie Blue, Planning Director and BB
Christopher M. Deleau, Planning Manager CD

Date prepared: May 4, 2016 **Meeting date:** May 9, 2016

Subject: Zoning Text Amendment No. 13-001 to Establish a Citywide Lighting Ordinance

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RECOMMENDED ACTION: Review the residential portion of the proposed citywide lighting ordinance (Attachment 1) and provide staff with comments and recommendations.

BACKGROUND: On April 8, 2013, the City Council initiated ZTA No. 13-001 to establish a Citywide Outdoor Lighting Standards Ordinance.

On April 16, 2014, the City Council authorized the City Manager to approve an agreement with the International Dark-Sky Association (IDA) to assist City staff with the preparation of the ordinance. The City Council directed staff, in close coordination with IDA, to prepare a modified version of the Model Lighting Ordinance (Attachment 2) for Malibu (MLO), as this model lighting code was determined to be more appropriate overall than the previously considered Pattern Outdoor Lighting Code for rural areas.

Due to the complexity of lighting regulations, staff has split up the major portions of the ordinance for discussion. This report covers an overview of the key features of the MLO and draft lighting regulations for residential properties. The City's lighting consultant will attend the meeting. Upon receiving comments, staff will prepare the non-residential portion of the ordinance and present it at the next ZORACES meeting for comment. Note that portions of the ordinance that will be presented at the next meeting are indicated as **(Reserved).**

DISCUSSION: The proposed ordinance has been prepared in consultation with the City's lighting consultant, IDA to establish outdoor lighting standards that will:

1. Provide safe and effective levels of outdoor lighting;
2. Curtail light pollution to preserve enjoyment of the night-time sky and the City's rural environment;
3. Avoid impacts to wildlife and natural habitats; and
4. Promote the City's goal of conserving energy and natural resources.

According to IDA, the effects of polluting light can persist as far as 200 kilometers (about 120 miles) from the source. In a community surrounded by sensitive natural habitats like Malibu, the environmental benefits are expected to be significant.

The building code basically only requires lighting at the egress points of buildings. Currently, the City's land use documents (the Local Coastal Program (LCP), Title 17 of the MMC, and the General Plan) have minimal outdoor lighting standards. The standards found in the various sections of each document are summarized in Attachment 3. Most focus on public scenic viewing areas and environmentally sensitive habitat area (ESHA).

Conditions of approval for lighting are currently imposed on project approvals on an ad hoc basis, if at all, since some projects are not in scenic areas or ESHA. The ordinance is intended to be consistent with and more restrictive than the standards in the LCP. As long as the ordinance is more restrictive than the LCP, an LCP amendment is not required.

Overview of the MLO

The MLO is an outdoor lighting ordinance template designed to help municipalities develop outdoor lighting standards that reduce glare, light trespass, and sky glow. The MLO was developed jointly by the IDA and the Illuminating and Engineering Society of North America (IES) over a period of seven years; the most recent version was adopted in June 2011. More recently, color temperature of lighting has become a concern and will be addressed in a future version of the MLO. All types of properties and uses are covered by the MLO. As a model ordinance, the features of the MLO can be customized to suit the specific needs of any community. Some of the key features are:

- Lighting Zones – The MLO uses five lighting zones to classify land use and apply appropriate lighting levels for each. Zones range from LZ-0, designed for pristine natural environments and very limited outdoor lighting, to LZ-4, for limited application in areas of extensive development in the largest cities. IDA/IES recommend that communities assign lighting zones based the type of lighting environment the community wants to achieve, rather than existing conditions.

- Controls and Curfew – The curfew sets the time after which most outdoor lighting must be turned off or partial-off and triggered only by occupancy sensors with timers, or some combination of these.

- Prescriptive and Performance Standards – The MLO provides prescriptive standards for most residential properties and the option of prescriptive or performance standards for non-residential properties.

- Total Site Lumen Limit – This is a cap on the total amount of light (in lumens[1]) that can be used on a parcel based on the lighting zone, the size of the property, the underlying use of the property (larger multi-family and non-residential) and the degree of development on the property. *[Will be used in the next phase of the ordinance]*

- Backlight-Uplight-Glare (BUG) rating system – This rating system for luminaires (or light fixtures) regulates the trajectory in which light is permitted to travel while focusing the light where it is most needed. *[Will be used in the next phase of the ordinance]*

- Flexibility Provisions – The MLO includes mechanisms to address unique, community-specific or property-specific lighting needs.

- Existing Lighting – The MLO encourages jurisdictions to require existing lighting to be brought into compliance with standards within a certain period of time. It also suggests other triggers for compliance, such as additions and modifications to buildings and resumption of use after abandonment.

Proposed Ordinance

The proposed ordinance adapts the MLO to Malibu's specific needs and characteristics. As mentioned previously, the residential portions of the ordinance are discussed here, although certain citywide provisions are also covered. For example, the proposed ordinance applies lighting zones to all properties within the City to regulate new lighting and also includes a compliance period for property owners to bring existing non-conforming outdoor lighting into compliance with the standards. Additionally, the ordinance includes language to address other triggers, such as resumption of use after abandonment.

Definitions based on the MLO are included at the end of the draft ordinance. Some of the definitions pertain to non-residential portions of the ordinance that have not been drafted yet. They have been included at this time since they are mentioned in the staff report. Complete definitions will be provided in the next version of the ordinance. Staff notes that the definitions and some of the standards are fairly technical and may not

[1] A "lumen" is unit of measure used to quantify the amount of visible light produced by a lamp or emitted from a luminaire (as distinct from "watt," which is a measure of power consumption).

be easily accessible to laypeople. If ZORACES feels modifications should be made to address this, revisions will be presented as part of the next version of the ordinance.

1. The Establishment of Lighting Zones Appropriate for Malibu

The MLO lighting standards and allowances are different for each lighting zone. These standards are use driven, correlating to the baseline need for outdoor lighting while requiring or otherwise incentivizing the use of best available technologies (e.g., LED, low and high pressure sodium lighting, partial off controls, motion sensors, timers, etc.).

Since Malibu is a rural, ocean side residential community with largely, low-intensity neighborhood serving commercial uses, staff recommends that LZ-3 and LZ-4 be omitted from the City's ordinance and that LZ-0, LZ-1 and LZ-2 be assigned to the parcels in the City to accommodate the rural uses and levels of night time activity present in Malibu. LZ-0, LZ-1 and LZ-2 are most appropriate for low intensity uses in rural areas such as Malibu, whereas LZ-3 and LZ-4 are more appropriate to urban environments with modest to significant night time activity.

The draft Lighting Zone Overlay Map is included as Attachment 4. As shown on the map, LZ-1 has been applied to most properties within the City, both residential and non-residential; however, this report and the draft ordinance focus on LZ-1 single-family residential properties and multi-family properties with six units or less.

LZ-1 non-residential properties and multi-family properties with more than six units will be covered in the next draft of the ordinance, along with LZ-2 and LZ-0 properties. Staff will request input on the mapping of these properties at that time.

LZ-2, the most intense of the three zones proposed, is characterized as moderate ambient lighting, and is expected to be applied only in areas such as core Civic Center properties not located immediately adjacent to residential development. The most restricted zone, LZ-0 has only been applied to publicly owned beaches, parks and open space areas that are zoned Public Open Space (POS). Staff will be working with the City Parks and Recreation Department as well as Los Angeles County Department of Beaches and Harbors and other agencies to determine how best to accommodate their needs while achieving the ordinance goals.

Under the ordinance, future amendments to the Lighting Zone Overlay Map would be processed as a zoning map amendment pursuant to MMC Chapter 17.74.

2. Applicability

The draft ordinance exempts certain types of outdoor lighting from the standards, such as public street lights, indoor lighting, underwater lighting, low voltage landscape lighting that turns off at curfew, seasonal lighting (as long as wattage and lumens are limited), emergency condition lighting, infrastructure/utility construction lighting and lighting associated with temporary use permits, special event permits or film permits.

Lighting for signs will be addressed in the non-residential curfew requirements in the upcoming draft of the ordinance.

3. Lighting Controls

For all properties, including residential, the draft ordinance requires automatic controls so that all outdoor lighting is extinguished when sufficient daylight is available. For residential properties, the ordinance calls for all outdoor lighting to be extinguished after 12 midnight, or whenever the outdoor area is no long occupied by people, and thereafter operated by occupancy sensor. ZORACES could recommend either increasing or decreasing these restrictions. Since Malibu primarily consists of residential properties, these limits could greatly enhance community dark skies.

4. Correlated Color Temperature (CCT)/ Chromaticity

Correlated color temperature primarily applies to LED lighting, which is the predominant technology in new lighting today. The draft ordinance specifies that the correlated color temperature for LED lights not exceed 3,000 Kelvin CCT (see Attachment 5 for more information on CCT). The ordinance includes the option for amber light to be used on properties near ESHA where the Planning Director determines this type of warmer light is necessary to avoid adverse impacts. Several studies have been conducted linking "blue" or "white" light to the disruption of circadian rhythms/ sleep patterns in people as well as disease and other negative health impacts (See Attachment 6). Blue or white light appears to have a significantly greater impact upon human health than warmer hues of light such as red and yellow which have a CCT of less than 3,000 Kelvin.[2] Experts now recommend that lighting at night be minimized and limited to warmer lights so as to avoid, to the maximum extent feasible, the negative health and environmental impacts.

5. Prescriptive and Performance Standards

Since most of the property in the City is residential, the proposed ordinance is designed with a set of prescriptive standards that can be used by most residential properties to achieve compliance. The prescriptive standards specify luminaire type and lumen limit so that a property owner does not need to hire a professional for a new project, or to come into conformance with existing lighting. Rather, off the shelf products can be used and label information can be provided on a compliance form that accompanies the lighting plan submittal. The ordinance limits are slightly more restrictive than the MLO. Fully shielded luminaires and those controlled by occupancy sensors have the highest lumen limits and least restrictions. The ordinance includes graphics of examples of fully shielded luminaires that are acceptable under the standards.

[2] http://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side

Any outdoor luminaires that are fully shielded and do not exceed 1,260 lumens of output are allowed. Additional luminaires are allowed on residential properties as follows:

- One partly shielded luminaire at the main entry of each building, not exceeding 420 lumens.
- Any other partly shielded or unshielded luminaire not exceeding 315 lumens.
- Low voltage landscape lighting aimed away from adjacent properties not exceeding 525 lumens.
- Open flame gas lamps, excluding mantle types.[3]
- Lighting installed with an occupancy sensor, where the sensor extinguishes the lights no more than 15 minutes after the area is vacated.

The ordinance provides a performance method for residential property owners who want a more complex lighting scheme. The performance method will require an applicant to use a qualified lighting designer to prepare plans and demonstrate compliance, and to cover the cost of review by an expert lighting consultant engaged by the City. This method is described starting on page 17 of the MLO and will be included in the upcoming version of the draft ordinance. The intent in the draft ordinance will be to allow property owners more flexibility than the prescriptive method allows, but not a greater light budget overall for the property.

6. Flexibility Provisions – Site Plan Review

It is anticipated that certain projects, depending upon their nature, may have complicated or specialized lighting needs that do not meet the strict technical requirements of the ordinance. The ordinance would allow a property owner to apply for a site plan review in such cases. The ordinance would include new language in MMC 17.62.040 to list deviations from this chapter as a type of development allowed with a site plan review. The ordinance would also include a new site plan review finding for lighting modifications that requires substantial evidence that the proposed lighting will not adversely affect community character. Other findings already required for a site plan review address adverse impacts to natural resources and consistency with the MMC, LCP and General Plan, as well as state and local law.

7. Existing Lighting / Compliance Period

Staff is recommending a five-year compliance period in which property owners would make their non-conforming lighting consistent with these standards. The City may enact retroactive ordinances under its police power, even when vested rights are involved, when it is reasonably necessary to protect the health, safety, morals and general welfare of the people. The City must tread carefully though and consider the purpose and effect of a retroactive ordinance to avoid violating the due process rights of individuals. Determining whether a retroactive ordinance violates due process by impairing vested rights requires weighing several factors including: 1) the significance

[3] Mantle-type open flames use a "lacy" hood or sheath of some refractory material that gives light by incandescence when placed over the flame.

of the interest served by the ordinance; 2) the importance of retroactive application of the ordinance to it being effective; 3) the extent of reliance on the former state of the law by individuals; 4) the legitimacy of that reliance; and 5) the extent to which the retroactive application of the new ordinance would disrupt those actions.

The proposed ordinance balances these considerations by limiting the financial burden on property owners and granting them time to budget for the retrofitting of their outdoor lighting. Given these mitigating measures related to implementation, the health and safety issues involved, and the need for retroactive action, retroactive application is appropriate here.

For implementation of this provision, the City could choose to prioritize certain types of non-conforming lighting, either based on ease or urgency; for example:

1. LZ-0 (OS-zoned parcels) – most environmentally sensitive
2. LZ-2 – highest lighting intensity
3. LZ-1 (non-residential) – next highest intensity, fewer property owners
4. LZ-1 (residential) – most numerous property owners, likely to be least intensive existing lighting

Another compliance trigger included in the draft ordinance is resumption of use after abandonment. If a property were abandoned for a period of six months or more, then all outdoor lighting would have to be brought into conformance with the standards prior to resumption of use. If the City were to include this provision, consideration should be given to whether it would apply to all properties or just non-residential properties, and how to address properties that are for sale or lease. Another option is a point of sale compliance requirement, such as exists for onsite wastewater treatment systems.

Staff will address compliance triggers for remodels, additions and other property alterations with the next draft of the ordinance.

CEQA: Staff is reviewing options for compliance with California Environmental Quality Act requirements and will report back at the next ZORACES meeting.

STAFF FOLLOW-UP: Staff requests that ZORACES provide comments and recommendations on the draft ordinance. Based on input from ZORACES, staff will address the "Reserved" sections in the draft ordinance and return to the subcommittee for additional comments.

ATTACHMENTS:

1. Lighting Ordinance (Residential LZ-1 Draft)
2. Model Lighting Ordinance (MLO)
3. Existing City Lighting Regulations
4. Draft Lighting Zone Overlay Map
5. Information on Correlated Color Temperature
6. Information on Negative Health Impacts of Blue/White Light

Chapter 17.41

17.41.010. Title.

This chapter shall be known as the "Outdoor Lighting Standards Ordinance."

17.41.020. Purpose.

The purpose of this chapter is to establish regulations governing outdoor lighting that will:

A. Allow the use of outdoor lighting that meets the recommendations of the Illuminating Engineering Society (IES) for nighttime safety, utility, security, productivity, enjoyment, and commerce.

B. Avoid adverse offsite impacts of lighting such as light trespass and obtrusive light.

C. Curtail light pollution, reduce skyglow and improve the nighttime environment for astronomical observation.

D. Help protect the natural environment from the adverse effects of night lighting.

E. Help protect and enhance wildlife habitation and migration, in rural and natural areas, by minimizing light pollution into and adjacent to such areas.

F. Promote lighting practices and systems to conserve energy, decrease dependence on fossil fuels and limit greenhouse gas emissions consistent with the California Global Warming Solutions Act and other applicable state and federal law.

17.41.030. Lighting Zones and Lighting Zone Overlay Map.

A. The city shall be divided into the following lighting zones:

1. LZ-0 (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. Human activity is subordinate in importance to nature. The vision of users and nearby human residents is adapted to the darkness, and they expect to see little or no lighting. When not needed, lighting should be extinguished. LZ-0 zoning shall be limited to publicly owned parcels zoned Public Open Space (OS) zoning according to Chapter 17.06.

2. LZ-1 (Low ambient lighting). Areas where lighting may 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 and convenience but is not uniform or continuous. After curfew,

most lighting should be extinguished or reduced as activity levels decline. LZ-1 shall be applicable to all zoning districts except OS.

3. LZ-2 (Moderate ambient lighting). Areas of human activity where the vision of users is adapted to moderate light levels. Lighting may typically be used for safety and convenience but it is not uniform or continuous. After curfew, lighting may be extinguished or reduced as activity levels decline.

B. The lighting zone for a particular property or site shall determine the lighting limitations as specified in this chapter.

C. Lighting zones for all parcels in the city are designated on the Lighting Zone Overlay Map.

D. Amendments to the Lighting Zone Overlay Map shall be processed in the same manner as a zoning map amendment as set forth in Chapter 17.74 of this title.

17.41.040. General Requirements for Lighting in All Lighting Zones.

A. Conformance with All Applicable Codes. Except as provided below, all new lighting and replacement lighting installed after the effective date of this ordinance shall comply with the requirements of this chapter.

B. Lighting and Activities Not Regulated by This Chapter.

The following lighting and activities are not regulated by this chapter:

1. Indoor lighting

2. Lighting within public right-of-way for the principal purpose of illuminating public streets or roads

3. Lighting solely for signs (lighting for signs is regulated by the Sign Ordinance), except that sign lighting shall be subject to the Curfew provisions.

4. Replacement of up to 25 percent of the total number of existing luminaires (cumulatively).

5. Underwater lighting in swimming pools and other water features.

6. In LZ-1 and LZ-2, low voltage landscape lighting controlled by an automatic device that is set to turn the lights off at one hour after the site is closed to the public (for non-residential zones) or curfew, whichever is later.

7. Seasonal lighting and temporary lighting, provided that individual lamps are less than 10 watts and 70 lumens.

8. Emergency conditions lighting.

9. Lighting required for infrastructure repairs or improvements conducted by public utilities or their contractors where work cannot reasonably be done during daytime hours.

10. Lawfully permitted fireworks displays.

11. Short-term lighting associated with activities authorized by a valid temporary use permit, special event permit or film permit.

C. Lighting Control Requirements.

1. Automatic Switching Requirements. Controls shall be provided that automatically extinguish all outdoor lighting when sufficient daylight is available and that are fully programmable and supported by battery or similar backup.

2. Automatic Lighting Reduction Requirements (Curfews by Lighting Zone).

a. LZ-0. **(RESERVED).**

b. LZ-1 (single-family residential and multifamily residential with six dwelling units or less) – Except for lighting activated by occupancy sensor and lighting at the main building entrance and property egress point, outdoor lighting shall be extinguished at 12 midnight or after exterior areas are no longer being occupied by people, whichever is later.

c. LZ-1 (non-residential and multi-family residential with more than six dwelling units). **(RESERVED).**

d. LZ-2. **(RESERVED).**

D. Lighting Color (Chromaticity). The correlated color temperature of all outdoor lighting shall be 3000 Kelvin or less, with tolerance within the ANSI standard C78.377 of LED sources, except:

1. Amber sources (approximately 589 nanometers) necessary to protect beach and environmentally sensitive habitat areas, as determined by the planning director.

2. In the LZ-2 zone, **(RESERVED)**

17.41.050 Open Space Zone LZ-0 Requirements. **(RESERVED)**

17.41.060 Residential LZ-1 Requirements.

A. For residentially zoned properties in LZ-1 (including multifamily residential properties with six or fewer dwelling units), each outdoor luminaire shall be fully shielded and shall not exceed 1,260 lumens, except for the following permitted lighting:

1. One partly shielded luminaire at the main entry of each building, not exceeding 420 lumens.

2. Any other partly shielded luminaire not exceeding 315 lumens.

3. Open flame gas lamps, excluding mantle types.

4. Lighting installed with an occupancy sensor, where the sensor extinguishes the lights no more than five minutes after the area is vacated.

B. In lieu of the requirements of (A), a property owner may demonstrate compliance with this ordinance by using the performance standard described in Section 17.41.070(A).

17.41.070 Non-Residential and Multifamily Residential with More than Six Dwelling Units LZ-1 and LZ-2 Requirements. **(RESERVED)**

A. Performance Method. **(RESERVED)**

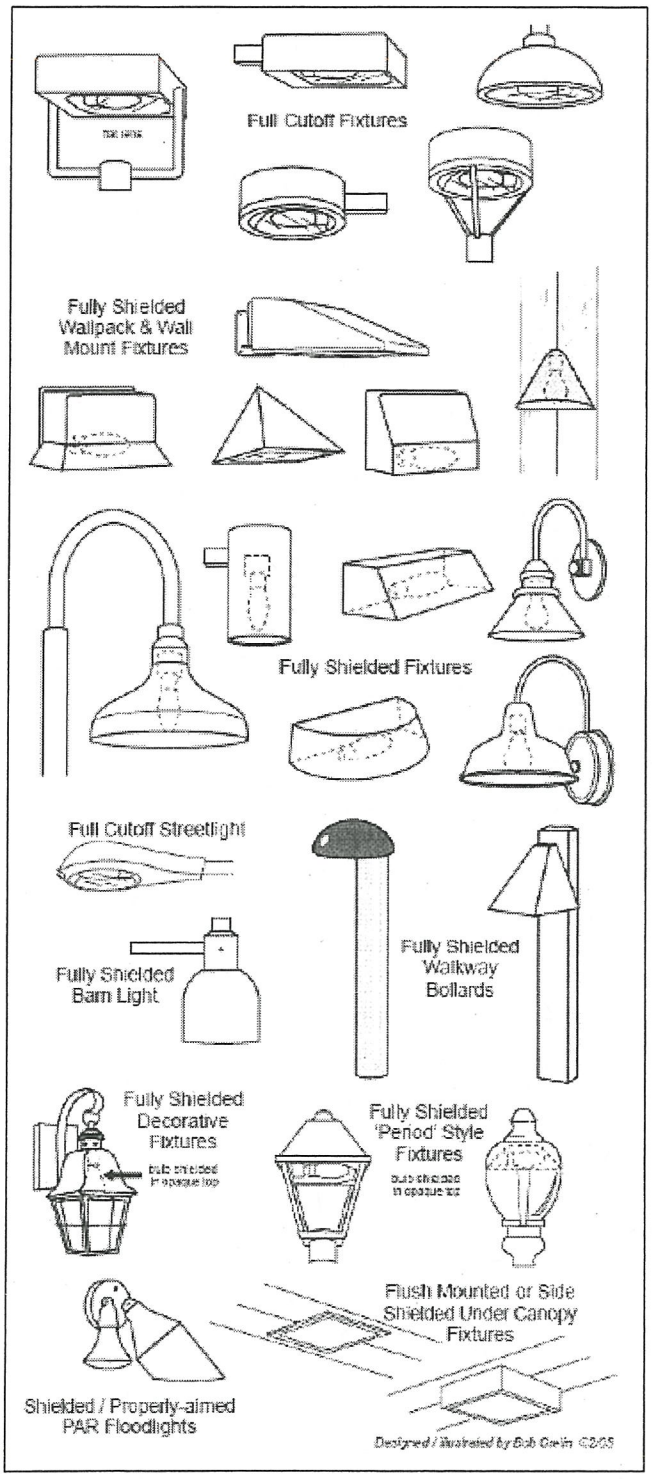
B. Prescriptive Method **(RESERVED)**

17.41.080 Public Open Space LZ-0 Requirements. **(RESERVED)**

17.41.090. Fully Shielded Luminaires.

Fully shielded luminaires allowed under this ordinance include, but are not limited to, the luminaire types shown in Figure 1.

Figure 1. Fully Shielded Luminaires.



17.41.100. Street Lighting. **(RESERVED)**

17.41.110. Site Plan Review.

In addition to the lighting described below, deviations from the lighting standards provided in this chapter may be approved pursuant to a site plan review in accordance with Section 17.62.040.

17.41.120. Complex and Non-Conforming Uses. **(RESERVED)**

17.41.130. Lighting Allowed by Temporary Use Permit Only. **(RESERVED)**

17.41.140. Conflicts with other Laws.

In the event the provisions in this Chapter conflict with other laws or the City's Local Coastal Program, this section shall be applied in a manner intended to carry out all provisions of law to the maximum extent feasible. When there is an irreconcilable conflict between the provisions of this Chapter and the provisions of federal or state law, or the Local Coastal Program, the provisions of federal or state law or the Local Coastal Program shall prevail over the provisions contained in this section only to the extent necessary to avoid a violation of those other laws or code provisions.

17.41.150. Application of Ordinance to Legal Non-conforming Lighting.

A. Compliance Period. Notwithstanding the provisions in Chapter 17.60 (Non-conforming Structures and Uses) of this Title and (conflicts with other laws section), a property owner shall comply with the requirements of this chapter by --- date 60 months from effective date ---. A property owner may apply for an extension of this deadline by submitting a request to the planning director thirty days before the deadline detailing why an extension is needed. Upon demonstration of good cause for providing a property owner additional time to comply with the requirements of this section, the planning director may extend the property owner's time to comply and/or may require a plan for compliance that required partial compliance in advance of full compliance. For purposes of this section, the term "good cause" shall mean a significant financial or other hardship which warrants an extension or conditional extension of the time limit for compliance established herein. In no instance shall the planning director issue an extension of the compliance period in excess of one year's time. The planning director's decision shall be appealable pursuant to the provisions of Section 17.04.220.

B. Change of Use. **(RESERVED).**

C. Resumption of Use after Abandonment. If a property with non-conforming lighting is abandoned for a period of six months or more, then all outdoor lighting shall be brought into compliance with this chapter before any resumption of use of the property occurs.

D. Remodels. **(RESERVED).**

17.41.160. Enforcement and Penalties. **(RESERVED)**

17.41.170. Definitions.

Notwithstanding the provisions of Section 17.02.060, for the purposes of this Chapter only, the following words and phrases are defined as follows:

"Absolute Photometry" means photometric measurements (usually of a solid-state luminaire) that directly measure the light output of the luminaire. Reference Standard IES LM-79.

"Backlight" means, for an exterior luminaire, lumens emitted in the quarter sphere below horizontal and in the opposite direction of the intended orientation of the luminaire. For luminaires with symmetric distribution, backlight will be the same as front light.

"BUG" means a luminaire classification system described by IES TM-15-11 that consists of backlight (B), uplight (U) and glare (G).

"Curfew" means the time of day when lighting restrictions, as prescribed by the lighting zone, are in effect.

"Emergency Conditions Lighting" means lighting that is energized only during an emergency; lighting fed from a backup power source; or lighting for illuminating the path of egress solely during a fire or other emergency situation; or, lighting for security purposes used solely during an alarm.

"Fully Shielded" means a luminaire constructed and installed in such a manner that all light emitted by the luminaire, either directly from the lamp or a diffusing element, or indirectly by reflection or refraction from any part of the luminaire, is projected below the horizontal plane through the luminaire's lowest light-emitting part.

"Glare" means lighting entering the eye directly from luminaires or indirectly from reflective surfaces that causes visual discomfort or reduced visibility.

"International Dark-Sky Association" (IDA).

"Illuminating Engineering Society of North America" (IES).

"Lamp" means, in generic terms, a source of optical radiation (i.e., "light"), often called a "bulb" or "tube". Examples include incandescent, fluorescent, high-intensity discharge (HID) lamps, and low pressure sodium (LPS) lamps, as well as light-emitting diode (LED) modules and arrays.

"Landscape Lighting" means the lighting of trees, shrubs, or other plant material as well as ponds and other landscape features.

"Light-Emitting Diode" (LED).

"Light Pollution" means adverse effect of artificial light including, but not limited to, glare, light trespass, sky-glow, energy waste, compromised safety and security, and impacts on the nocturnal environment.

"Light Trespass" means light that falls beyond the property it is intended to illuminate.

"Lighting" means "Electric" or "man-made" or "artificial" lighting. See "lighting equipment".

"Lighting Equipment" means equipment specifically intended to provide gas or electric illumination, including but not limited to, lamp(s), luminaire(s), ballast(s), poles, posts, lens(s), and related structures, electrical wiring, and other necessary or auxiliary components.

"Lighting Zone" means an overlay zoning system establishing legal standards and limits for lighting of particular parcels, areas, or districts in the city.

"Low-Voltage Landscape Lighting" means landscape lighting powered at less than 15 volts and having a rated initial luminaire lumen output of 200 lumens or less.

"Lumen" means the unit of measure used to quantify the amount of visible light produced by a lamp or emitted from a luminaire (as distinct from "watt," a measure of power consumption).

"Luminaire" means the complete lighting unit (fixture), consisting of a lamp, or lamps and ballast(s) (when applicable), together with the parts designed to distribute the light (reflector, lens, diffuser), to position and protect the lamps, and to connect the lamps to the power supply.

"Luminaire Lumens" means, for luminaires with relative photometry per IES, the sum of the initial lamp lumens for all lamps within an individual luminaire, multiplied by the luminaire efficiency. If the efficiency is not known for a residential luminaire, assume 70%. For luminaires with absolute photometry per IES LM-79, it is the total luminaire lumens. The lumen rating of a luminaire assumes the lamp or luminaire is new and has not depreciated in light output.

"New Lighting" means lighting for areas not previously illuminated; newly installed lighting of any type, except for lighting repairs. New lighting includes replacement lighting and installation of major new components such as the capacitor, ballast or optics, but not repair.

"Outdoor Lighting" means lighting equipment installed within the property lines and outside the building footprint, whether attached to building eaves or other portions of a structure, poles, the earth, or any other location; and any associated lighting control equipment. Outdoor lighting shall also include lighting that is necessary to light driveways located outside of the property boundaries but within areas where the applicant has easement rights.

"Partial Off" means outdoor lighting controls that reduce lighting power by at least 50% after curfew. If permitted, partial off controls can be augmented by motion sensors to temporarily increase light levels to full but must return to reduced levels within 10 minutes of cessation of movement.

"Partly Shielded Luminaire" means a luminaire with opaque top and translucent or perforated sides, designed to emit most light downward.

"Relative Photometry" means measurements made of the lamp plus luminaire, and adjusted to

allow for light loss due to reflection or absorption within the luminaire. Reference standard: IES LM-63.

"Repair" means the reconstruction or renewal of any part of an existing luminaire for the purpose of its ongoing operation, such as relamping or replacement of components such as a photocell that maintain the existing fixture technology/operation.

"Replacement Lighting" means lighting installed specifically to replace existing lighting equipment that is sufficiently broken to be beyond repair.

"Seasonal Lighting" means lighting installed and operated in connection with holidays or traditions which lighting shall be utilized for no longer than 45 consecutive days or 60 days cumulatively during any calendar year.

"Sign" means advertising, directional or other outdoor promotional display of art, words and/or pictures.

"Sky Glow" means the brightening of the nighttime sky that results from scattering and reflection of artificial light by moisture and dust particles in the atmosphere. Sky glow is caused by light directed or reflected upwards or sideways and reduces one's ability to view the night sky.

"Street Lighting" means lighting for streets and roads including street parking and adjacent walkways and bikeways.

"Temporary Lighting" means lighting installed and operated for periods not to exceed 60 days, and completely removed and not operated again for at least 30 days.

"Translucent" means allowing light to pass through, diffusing it so that objects beyond cannot be seen clearly (not transparent or clear).

"Unshielded Luminaire" means a luminaire capable of emitting light in any direction including downwards.

"Uplight" means an exterior luminaire, flux radiated in the hemisphere at or above the horizontal plane.

Illuminating
ENGINEERING SOCIETY

JOINT IDA - IES

MODEL LIGHTING ORDINANCE (MLO)

with USER'S GUIDE

June 15, 2011

The User Notes

The User Notes are intended to clarify the sections of the MLO for the various audiences who will use it: lighting designers, city officials, engineers, citizen groups, and others. Every effort has been made to keep the language technically accurate and clear, but since different disciplines may use the same term in different ways, or have different interpretations, some guidance may be helpful. While these Notes can not be a full tutorial on modern lighting design, it is hoped that the Notes will help facilitate the dialogue necessary to adopt the MLO.

Background

The problems of light pollution first became an issue in the 1970s when astronomers identified the degradation of the night sky due to the increase in lighting associated with development and growth. As more impacts to the environment by lighting have been identified, an international "dark sky" movement is advocating for the precautionary approach to outdoor lighting design.

Many communities have passed anti-light-pollution laws and ordinances. However, there is little or no agreement among these laws, and they vary considerably in language, technical quality, and stringency. This is confusing for designers, engineers, and code officials. The lack of a common basis prevents the development of standards, educational programs, and other means of achieving the goal of effective lighting control.

This MLO will allow communities to drastically reduce light pollution and glare and lower excessive light levels. The recommended practices of the IES can be met using readily available, reasonably priced lighting equipment. However, many conventional lighting practices will no longer be permitted, or will require special permits.

This Model Lighting Ordinance (MLO) is the result of extensive efforts by the International Dark Sky Association (IDA) and the Illuminating

Engineering Society of North America (IES). Among its features is the use of lighting zones (LZ0-4) which allow each governing body to vary the stringency of lighting restrictions according to the sensitivity of the area as well as accommodating community intent. In this way, communities can fine-tune the impact of the MLO without having to customize the MLO. The MLO also incorporates the Backlight-Uplight-Glare (BUG) rating system for luminaires, which provides more effective control of unwanted light.

Joint IDA-IESNA Model Outdoor Lighting Ordinance (MLO)

June 15, 2011

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General Notes in Adopting this Model Ordinance

Adoption of this ordinance should follow the established development, review, and approval processes of the adopting authority. If no such processes are in place, this ordinance may be adopted as a new independent section of the Municipal Code.

The MLO is probably best adopted as an "overlay zoning" ordinance. This means that it overlays, but is different from, land-use zoning. It can be added to or integrated into existing ordinances or codes and cross-referenced to other applicable codes and ordinances such as the electrical code, the sign code, planning ordinances, etc.

The MLO may best be managed by assigning it to planning officials and using existing administrative structures.

Because of the diverse community and lighting needs across large areas, this MLO is not intended for adoption as a state, provincial or national ordinance. Regional coordination is encouraged. Light pollution knows no boundaries, and the effects of polluting light persist as far as 200 kilometers (about 120 miles) from the source. One large city could adopt the MLO and dramatically affect a region, but adoption in suburbs and small towns must be part of a regional effort to achieve significant improvements in the overall quality of the night sky.

Adopting agencies should also consider that the MLO, like all other modern codes, is designed to evolve over time. Lighting technology will change, and MLO changes will be needed every few years. On-going renewal cycles are strongly recommended as any part of an adopting ordinance.

MLO Development and Task Force Members

This Model Lighting Ordinance has been developed as a joint undertaking by the Illuminating Engineering Society and the International Dark-Sky Association.

The Joint Task Force responsible for developing the MLO include

IDA	IES
Co-Chair: Jim Benya	Naomi Miller
Co-Chair: Nancy Clanton	Cheryl English
Leslie Lipstein	Denis Lavoie
Leo Smith	Eric Gibson
Michael Mutmansky	

John Walter representing the electric utility industry also contributed as a member of the Joint Task Force.

I. PREAMBLE - User's Guide

In general, the preamble is part of the ordinance but is typically not part of the code. It establishes the reasons why the municipality is undertaking these regulations.

Local governments may add other purposes to the Preamble including established local government environmental or energy goals that support the model lighting ordinance. The environmental impacts of outdoor lighting fall into two categories: carbon footprint (energy used in the life of a lighting product) and obtrusive light.

CARBON FOOTPRINT	OBTRUSIVE LIGHT
Cost & Impact of Mining the Materials Used	Impact on Humans
Energy Used in Production	Impact on the Environment
Energy Used during Product Life	
Disposal/Recylcing Costs	

II. LIGHTING ZONES - User's Guide

Lighting zones reflect the base (or ambient) light levels desired by a community. The use of lighting zones (LZ) was originally developed by the International Commission on Illumination (CIE) and appeared first in the US in IES Recommended Practice for Exterior Environmental Lighting, RP-33-99.

It is recommended that lower lighting zone(s) be given preference when establishing zoning criteria. Selection of lighting zone or zones should be based not on existing conditions but rather on the type of lighting environments the jurisdiction seeks to achieve. For instance, new development on previously rural or undeveloped land may be zoned as LZ-1.Using lighting zones allows a great deal of flexibility and customization without the burden of excessive regulation. For example, a jurisdiction may choose to establish vertical lighting zones with the lighting zone at street level at a higher zone than the residential housing on upper levels.

I. PREAMBLE - Ordinance Text

The purpose of this Ordinance is to provide regulations for outdoor lighting that will:

a. Permit the use of outdoor lighting that does not exceed the minimum levels specified in IES recommended practices for night-time safety, utility, security, productivity, enjoyment, and commerce.

b. Minimize adverse offsite impacts of lighting such as light trespass, and obtrusive light.

c. Curtail light pollution, reduce skyglow and improve the nighttime environment for astronomy.

d. Help protect the natural environment from the adverse effects of night lighting from gas or electric sources.

e. Conserve energy and resources to the greatest extent possible.

II. LIGHTING ZONES - Ordinance Text

The Lighting Zone shall determine the limitations for lighting as specified in this ordinance. The Lighting Zones shall be as follows:

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. Human activity is subordinate in importance to nature. The vision of human residents and users is adapted to the darkness, and they expect to see little or no lighting. When not needed, lighting should be extinguished.

II. LIGHTING ZONES (cont.) - User's Guide

However, if an adjacent use could be adversely impacted by allowable lighting, the adopting authority may require that a particular site meet the requirements for a lower lighting zone. For example, the authority could specify Lighting Zone 1 or 2 requirements if a commercial development were adjacent to a residence, hospital or open space, or to any land assigned to a lower zone.

Lighting zones are best implemented as an overlay to the established zoning especially in communities where a variety of zone districts exists within a defined area or along an arterial street. Where zone districts are cohesive, it may be possible to assign lighting zones to established land use zoning. It is recommended that the lighting zone includes churches, schools, parks, and other uses embedded within residential communities.

Zone	Recommended Uses or Areas	Zoning Considerations
LZ-0	Lighting Zone 0 should be applied to areas in which permanent lighting is not expected and when used, is limited in the amount of lighting and the period of operation. LZ-0 typically includes undeveloped areas of open space, wilderness parks and preserves, areas near astronomical observatories, or any other area where the protection of a dark environment is critical. Special review should be required for any permanent lighting in this zone. Some rural communities may choose to adopt LZ-0 for residential areas.	Recommended default zone for wilderness areas, parks and preserves, and undeveloped rural areas. Includes protected wildlife areas and corridors.
LZ-1	Lighting Zone 1 pertains to areas that desire low ambient lighting levels. These typically include single and two family residential communities, rural town centers, business parks, and other commercial or industrial/ storage areas typically with limited nighttime activity. May also include the developed areas in parks and other natural settings.	Recommended default zone for rural and low density residential areas. Includes residential single or two family; agricultural zone districts; rural residential zone districts; business parks; open space include preserves in developed areas.

II. LIGHTING ZONES (cont.) - Ordinance Text

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 and 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 and 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.

II. LIGHTING ZONES (cont.) - User's Guide

Zone	Recommended Uses or Areas	Zoning Considerations
LZ-2	Lighting Zone 2 pertains to areas with moderate ambient lighting levels. These typically include multifamily residential uses, institutional residential uses, schools, churches, hospitals, hotels/motels, commercial and/or businesses areas with evening activities embedded in predominately residential areas, neighborhood serving recreational and playing fields and/or mixed use development with a predominance of residential uses. Can be used to accommodate a district of outdoor sales or industry in an area otherwise zoned LZ-1.	**Recommended default zone for light commercial business districts and high density or mixed use residentialdistricts.** Includes neighborhood business districts; churches, schools and neighborhood recreation facilities; and light industrial zoning with modest nighttime uses or lighting requirements.
LZ-3	Lighting Zone 3 pertains to areas with moderately high lighting levels. These typically include commercial corridors, high intensity suburban commercial areas, town centers, mixed use areas, industrial uses and shipping and rail yards with high night time activity, high use recreational and playing fields, regional shopping malls, car dealerships, gas stations, and other nighttime active exterior retail areas.	**Recommended default zone for large cities' business district.** Includes business zone districts; commercial mixed use; and heavy industrial and/or manufacturing zone districts.
LZ-4	Lighting zone 4 pertains to areas of very high ambient lighting levels. LZ-4 should only be used for special cases and is not appropriate for most cities. LZ-4 may be used for extremely unusual installations such as high density entertainment districts, and heavy industrial uses.	**Not a default zone.** Includes high intensity business or industrial zone districts.

III. GENERAL REQUIREMENTS - User's Guide

This Section sets out the requirements that apply to all lighting, both residential and non-residential.

Each adopting jurisdiction should incorporate their existing standards as to when compliance with new regulations is required, when repair or remodeling triggers compliance and if the new ordinance will be retroactive to existing development. The Applicability section of this model ordinance should serve as a guide if the adopting jurisdiction does not have standards or policies in place. Likewise, the adopting jurisdiction should use their existing policies and definitions of what constitutes public monuments, and temporary and/or emergency lighting. Community attitudes and precedents should be taken into account in deciding to regulate seasonal holiday lighting.

EXEMPTIONS - User's Guide

This is standard language intended to prevent conflict of laws and to give the community the ability to set specific lighting requirements in special plans and under use permits. It can be amended to conform to similar language in other ordinances. For example, while public monuments, statuary, and flags should be lighted, the lighting also should be limited to avoid excess.

Lighting for streets, roads, and highways is usually regulated by a street lighting ordinance, and is not covered by this model ordinance. However, since street lighting can affect nearby areas, some recognition of its effect is appropriate. (See Section XI)

SIGN LIGHTING - User's Guide

A sign lighting ordinance is strongly recommended if not already in place. It should carefully limit lighting to prevent over-lighted signs from being used to circumvent lighting ordinances.

III. GENERAL REQUIREMENTS - Ordinance Text

A. Conformance with All Applicable Codes

All outdoor lighting shall be installed in conformance with the provisions of this Ordinance, applicable Electrical and Energy Codes, and applicable sections of the Building Code.

B. Applicability

Except as described below, all outdoor lighting installed after the date of effect of this Ordinance shall comply with these requirements. This includes, but is not limited to, new lighting, replacement lighting, or any other lighting whether attached to structures, poles, the earth, or any other location, including lighting installed by any third party.

Exemptions from III.(B.) The following are not regulated by this Ordinance

a. Lighting within public right-of-way or easement for the principal purpose of illuminating streets or roads. No exemption shall apply to any lighting within the public right of way or easement when the purpose of the luminaire is to illuminate areas outside the public right of way or easement, unless regulated with a streetlighting ordinance.

Note to adopting agency: if using the street lighting ordinance (Section XI), this exemption should read as follows:

Lighting within the public right-of-way or easement for the principal purpose of illuminating roads and highways. No exemption shall apply to any street lighting and to any lighting within the public right of way or easement when the purpose of the luminaire is to illuminate areas outside of the public right of way or easement.

b. Lighting for public monuments and statuary.

c. Lighting solely for signs (lighting for signs is regulated by the Sign Ordinance).

d. Repairs to existing luminaires not exceeding 25% of total installed luminaires.

LIGHTING CONTROLS - User's Guide

This section requires all outdoor lighting to have lighting controls that prohibit operation when sufficient daylight is available, and to include the capability, either through circuiting, dimming or alternating sources, to be able to reduce lighting without necessarily turning all lighting off.

III. GENERAL REQUIREMENTS (cont.) - Ordinance Text

e. Temporary lighting for theatrical, television, performance areas and construction sites;

f. Underwater lighting in swimming pools and other water features

g. Temporary lighting and seasonal lighting provided that individual lamps are less than 10 watts and 70 lumens.

h. Lighting that is only used under emergency conditions.

i. In lighting zones 2, 3 and 4, low voltage landscape lighting controlled by an automatic device that is set to turn the lights off at one hour after the site is closed to the public or at a time established by the authority.

Exceptions to III. (B.) All lighting shall follow provisions in this ordinance; however, any special requirements for lighting listed in a) and b) below shall take precedence.

a. Lighting specified or identified in a specific use permit.

b. Lighting required by federal, state, territorial, commonwealth or provincial laws or regulations.

C. Lighting Control Requirements

1. Automatic Switching Requirements
   Controls shall be provided that automatically extinguish all outdoor lighting when sufficient daylight is available using a control device or system such as a photoelectric switch, astronomic time switch or equivalent functions from a programmable lighting controller, building automation system or lighting energy management system, all with battery or similar backup power or device.

CURFEW REQUIREMENTS - User's Guide

The intent is to reduce or eliminate lighting after a given time. Benefits include reduced environmental impact, longer hours of improved astronomy, energy savings, and improved sleeping conditions for residents. Additionally, some police departments have indicated that post-curfew light reductions make drive-by patrolling easier because it allows them to see further into and through a site.

The authority should determine the time of curfew and the amount of lighting reduction based on the character, norms and values of the community.

Typically, curfews go into effect one hour after the close of business. Restaurants, bars and major entertainment facilities such as sports stadiums, may require the curfew go into effect two hours after the close of business. The authority may elect to have no curfew for facilities with shift workers and 24 hour operations, or to extend the curfew time to meet specific needs. The MLO can be modified to address those concerns.

Areas without street lights or with very low ambient light levels should consider turning off all non-emergency lighting at curfew while commercial areas or urban areas may prefer a reduction in lighting levels. A reduction of at least 30% is recommended for most uses.

III. GENERAL REQUIREMENTS (cont.) - Ordinance Text

Exceptions to III.(C.) 1. Automatic lighting controls are not required for the following:

a. Lighting under canopies.

b. Lighting for tunnels, parking garages, garage entrances, and similar conditions.

2. Automatic Lighting Reduction Requirements
The Authority shall establish curfew time(s) after which total outdoor lighting lumens shall be reduced by at least 30% or extinguished.

Exceptions to III.(C.) 2. Lighting reductions are not required for any of the following:

a. With the exception of landscape lighting, lighting for residential properties including multiple residential properties not having common areas.

b. When the outdoor lighting consists of only one luminaire.

c. Code required lighting for steps, stairs, walkways, and building entrances.

d. When in the opinion of the Authority, lighting levels must be maintained.

e. Motion activated lighting.

f. Lighting governed by special use permit in which times of operation are specifically identified.

g. Businesses that operate on a 24 hour basis.

IV. NON-RESIDENTIAL LIGHTING - User's Guide

This section addresses non-residential lighting and multiple-family residences having common spaces, such as lobbies, interior corridors or parking. Its intent is to:

- Limit the amount of light that can be used
- Minimize glare by controlling the amount of light that tends to create glare
- Minimize sky glow by controlling the amount of uplight
- Minimize the amount of off-site impacts or light trespass

This MLO provides two methods for determining compliance. The *prescriptive method* contains precise and easily verifiable requirements for luminaire light output and fixture design that limit glare, uplight, light trespass and the amount of light that can be used. The *performance method* allows greater flexibility and creativity in meeting the intent of the ordinance. Note that both the prescriptive and the performance method limit the *amount* of light that can be used, but do not control *how* the lighting is to be used.

Most outdoor lighting projects that do not involve a lighting professional will use the prescriptive method, because it is simple and does not require engineering expertise.

For the prescriptive method, the initial luminaire lumen allowances defined in Table A (Parking Space Method) or B (Hardscape Area Method) will provide basic lighting (parking lot and lighting at doors and/or sensitive security areas) that is consistent with the selected lighting zone. The prescriptive method is intended to provide a safe lighting environment while reducing sky glow and other adverse offsite impacts. The Per Parking Space Method is applicable in small rural towns and is a simple method for small retail "mom and pop" operations without drive lane access and where the parking lot is immediately adjacent to the road. A jurisdiction may

IV. NON-RESIDENTIAL LIGHTING - Ordinance Text

For all non-residential properties, and for multiple residential properties of seven domiciles or more and having common outdoor areas, all outdoor lighting shall comply either with Part A or Part B of this section.

PRESCRIPTIVE METHOD - User's Guide

also allow a prescriptive method for classes of sites, such as car dealerships, gas stations, or other common use areas.

Note that the values are for initial luminaire lumens, not footcandles on the target (parking lot, sidewalk, etc). Variables such as the efficiency of the luminaire, dispersion, and lamp wear can affect the actual amount of light so the lumens per square foot allowance is not equal to footcandles on the site. By specifying initial luminaire lumen values, it is easier for officials to verify that the requirement is being met. Initial luminaire lumens are available from photometric data. Each initial luminaire lumens calculation should be supplied on the submittal form.

Solid state luminaires, such as LEDs, do not have initial lamp lumens, only initial luminaire lumens (absolute photometry). Other luminaires tested with relative photometry will have initial luminaire lumens which can be calculated by multiplying initial lamp lumens by the luminaire efficiency. In this example, three types of luminaires are used to light a parking area and building entry in a light commercial area. Two of these three luminaires use metal halide lamps: 70 watt wall mounted area lights and 150 watt pole mounted area lights. For these, the Initial Luminaire Lumens is equal to the initial lamp lumens multiplied by the luminaire efficiency. These values are entered into the compliance chart. The lumen value for the building mounted LED luminaires is equal to the lumens exiting the luminaire. Therefore, the value already represents the Initial Luminaire Lumens and no luminaire efficiency is needed. The total Luminaire Lumens for the site is equal to 247,840.

The allowable lumens are based on the lighting zone and the total hard-scape area. Referencing Table B, the allowed lumens are 2.5/SF for LZ2. Multiplying this by the total hardscape square footage gives a value of 250,000 lumens allowed. Because this value is greater than the value calculated for the site, the project complies. Listed below is an example on a typical compliance worksheet for the Prescriptive Method.

IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

A. Prescriptive Method

An outdoor lighting installation complies with this section if it meets the requirements of subsections 1 and 2, below.

1. Total Site Lumen Limit

   The total installed initial luminaire lumens of all outdoor lighting shall not exceed the total site lumen limit. The total site lumen limit shall be determined using either the Parking Space Method (Table A) or the Hardscape Area Method (Table B). Only one method shall be used per permit application, and for sites with existing lighting, existing lighting shall be included in the calculation of total installed lumens.

   The total installed initial luminaire lumens is calculated as the sum of the initial luminaire lumens for all luminaires.

IV. NON-RESIDENTIAL LIGHTING (cont.) - User's Guide

In this example, three types of luminaires are used to light a parking area and building entry in a light commercial area. Two of these three luminaires use metal halide lamps: 70 watt wall mounted area lights and 150 watt pole mounted area lights. For these, the Initial Luminaire Lumens is equal to the initial lamp lumens multiplied by the luminaire efficiency. These values are entered into the compliance chart. The lumen value for the building mounted LED luminaires is equal to the lumens exiting the luminaire. Therefore, the value already represents the Initial Luminaire Lumens and no luminaire efficiency is needed. The total Luminaire Lumens for the site is equal to 247,840. The allowable lumens are based on the lighting zone and the total hardscape area. Referencing Table B, the allowed lumens are 2.5/SF for LZ2. Multiplying this by the total hardscape square footage gives a value of 250,000 lumens allowed. Because this value is greater than the value calculated for the site, the project complies.

PRESCRIPTIVE METHOD EXAMPLE - COMPLIANCE CHART			
Lamp Descriptions	*QTY*	*Initial Luminaire Lumens*	*Total*
70 W Metal Halide	8	3,920	31,360
150 W Metal Halide	20	9,600	192,000
18 W LED	24	1,020	24,480
TOTAL INITIAL LUMINAIRE LUMENS			247,840
SITE ALLOWED TOTAL INITIAL LUMENS*			250,000
PROJECT IS COMPLIANT?			YES

* Listed below is the method of determining the allowed total initial lumen for non-residential outdoor lighting using the hardscape areamethod. (Table B).

SITE ALLOWED TOTAL INITIAL LUMENS	
Site Description	Light Commercial
Lighting Zone	LZ-2
Hardscape Area (SF)	100,000
Allowed Lumens per SF of Hardscape (Table B)	2.5
Site Allowed Total Initial Lumens (lumens per SF X hardscape area)	250,000

IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

PRESCRIPTIVE METHOD (cont.) - User's Guide

LIMITS TO OFFSITE IMPACTS

The prescriptive method of the MLO restricts uplighting, including upward light emitted by decorative luminaires. A jurisdiction may choose to preserve some types of lighting, including lighting of monuments or historic structures. In this case, the adopting jurisdiction should exempt or otherwise regulate these types of lighting carefully so that it does not inadvertently allow glaring or offensive lighting systems.

Offsite effects of light pollution include glare, light trespass, sky glow, and impacts on the nocturnal environment . All of these are functions of the fixture or luminaire design and installation. This document replaces the previous luminaire classification terminology of full cut-off, semi cut-off, and cut-off because those classifications were not as effective in controlling offsite impacts as with the new IESNA luminaire classification system as described in TM-15-07.

A traditional method of defining light trespass is to identify a maximum light level at or near the property line. However, this method does not address offensive light that is not directed toward the ground, or the intensity of glaring light shining into adjacent windows. The requirements defined in Table C limit the amount of light in all quadrants that is directed toward or above the property line. The Backlight/Uplight/Glare (BUG) rating will help limit both light trespass and glare. (A detailed explanation of the BUG system is provided in the section on Table C.)

The limits for light distribution established in Table C (for the BUG rating system) prevent or severely limit all direct upward light. A small amount of uplight reflected by snow, light-colored pavement or a luminaire's supporting arms is inevitable and is not limited by the prescriptive method of this ordinance.

IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

PRESCRIPTIVE METHOD

2. Limits to Off Site Impacts

All luminaires shall be rated and installed according to Table C.

3. Light Shielding for Parking Lot Illumination

All parking lot lighting shall have no light emitted above 90 degrees.

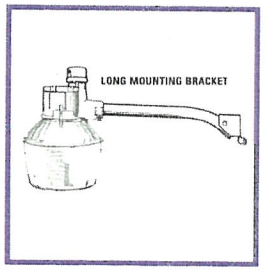
Exception:

a) Ornamental parking lighting shall be permitted by special permit only, and shall meet the requirements of Table C-1 for Backlight, Table C-2 for Uplight, and Table C-3 for Glare, without the need for external field-added modifications.

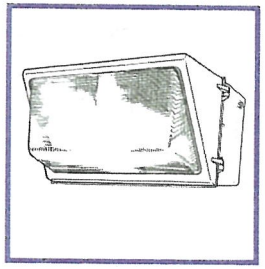
PRESCRIPTIVE METHOD (cont.) - User's Guide

LIMITS TO OFFSITE IMPACTS

A seemingly non-compliant fixture, such as a post-top translucent acorn luminaire, may in certain cases meet the BUG ratings, as long as it has proper interior baffling within the acorn globe. However, the BUG ratings in Table C will limit the use of the following types of luminaires in all lighting zones:



Barn Lights



Non-Shielded Wall Packs

Floodlights or lights not aimed downward

IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

PERFORMANCE METHOD - User's Guide

The performance method is best for projects with complex lighting requirements or when the applicant wants or needs more flexibility in lighting design. The performance method is also used when any lighting designer plans to aim or direct any light fixture upward (above 90 degrees). An engineer or lighting professional generally will be required to design within the performance method. An adopting jurisdiction may also wish to hire an engineer or lighting professional to review and approve projects using this method and/or incorporate review of the performance method into special review procedures.

The Performance Method is also best for projects where higher lighting levels are required compared to typical area lighting. An example might be a car sales lot where more light might be required on the new cars than would be needed for a standard parking lot. Another example is a gas station canopy requiring more light than a building entrance canopy.

The first step in the Performance Method regulates overlighting by establishing the Total Initial Site Lumens (Table D) that are allowed.

Allowances include the summation of the following (Table D):

1) Initial lumen allowance per site
2)Per area (SF) of hardscape

Table E allows additional lumens for unique site conditions.
Examples of allowances include:

1)Per building entrance/exit
2)Per length (linear feet) of Outdoor Sales Frontage Perimeter
3)Per area (SF) of Vehicle Service Station Canopy
4)Plus more ...

The Site Total Initial Site Lumens allowed are a combination of allowances from Table D and Table E.

IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

B. Performance Method

1. Total Site Lumen Limit

The total installed initial luminaire lumens of all lighting systems on the site shall not exceed the allowed total initial site lumens. The allowed total initial site lumens shall be determined using Tables D and E. For sites with existing lighting, existing lighting shall be included in the calculation of total installed lumens.

The total installed initial luminaire lumens of all is calculated as the sum of the initial luminaire lumens for all luminaires.

IV. NON-RESIDENTIAL LIGHTING (cont.) - User's Guide

LIMITS TO OFFSITE IMPACTS (cont.)

The second step in the Performance Method is to determine if the proposed luminaires are producing off site impacts such as glare, sky glow and light trespass. One may either use Option A which are the Maximum Allowable BUG Ratings in Table C, or Option B through computer lighting calculations show compliance with Maximum Vertical Illuminance at any point in the plane of the property line in Table F. Option B will be required for all non-residential luminaires that

A) do not have BUG ratings, or
B) exceed the BUG ratings,
C) are not fully shielded, or
D) have adjustable mountings.

For the performance method, Option B (2) requires photometric calculations for the site perimeter, to a height of no less than 33 feet (10 meters) above the tallest luminaire. Vertical illuminances at eye height (5 feet above grade) will give values that can be used to verify compliance by comparing actual site conditions to the photometric plan submitted during review.

Note that the MLO specifies 'total initial luminaire lumens' as a measurement in addition to footcandles/lux. The footcandle (lux) is equal to one lumen per square meter. Lux is the metric unit and is equal to one lumen per square meter.

IV. NON-RESIDENTIAL LIGHTING (cont.) - Ordinance Text

PERFORMANCE METHOD

2. Limits to Off Site Impacts

All luminaires shall be rated and installed using either Option A or Option B. Only one option may be used per permit application.

Option A: All luminaires shall be rated and installed according to Table C.

Option B: The entire outdoor lighting design shall be analyzed using industry standard lighting software including inter-reflections in the following manner:

1) Input data shall describe the lighting system including luminaire locations, mounting heights, aiming directions, and employing photometric data tested in accordance with IES guidelines. Buildings or other physical objects on the site within three object heights of the property line must be included in the calculations.

2) Analysis shall utilize an enclosure comprised of calculation planes with zero reflectance values around the perimeter of the site. The top of the enclosure shall be no less than 33 feet (10 meters) above the tallest luminaire. Calculations shall include total lumens upon the inside surfaces of the box top and vertical sides and maximum vertical illuminance (footcandles and/or lux) on the sides of the enclosure.

The design complies if:

a) The total lumens on the inside surfaces of the virtual enclosure are less than 15% of the total site lumen limit; and

b) The maximum vertical illuminance on any vertical surface is less than the allowed maximum illuminance per Table F.

DESIGN COMPLIANCE - User's Guide

The application form will require information about the number of luminaires, the number of lamps in each luminaire, the initial luminaire lumens for each luminaire and the initial lumen output for each lamp (based on the wattage and type of lamp selected) as well as plans showing the site area measurements. This will allow the reviewer to verify that the lumen output of all the luminaires does not exceed the allowance.

Field verification can be achieved by asking the applicant and/or owner to verify that the luminaire type, lamp type and wattages specified have been used. Also ask the applicant for photometric data for each luminaire, since the initial luminaire lumens and B-U-G ratings are stated on the photometric report.

However, if a jurisdiction requires additional on-site verification, it may also request a point-by-point photometric plan. While this will not be a true measure of compliance with the criteria of this Ordinance, comparing the actual measured levels on site to the photometric plan can be an indication whether or not the installed lighting varies from the approved design.

V. RESIDENTIAL LIGHTING - User's Guide

This section applies to single family home, duplexes, row houses, and low rise multi-family buildings of 6 dwelling units or less.

RESIDENTIAL LIGHTING EXCEPTIONS

The exceptions allow for typical lighting that might exceed the specified limits.

Landscape Lighting - While not common in residential areas, it can cause light pollution and light trespass if it is not controlled.

Lighting controlled by Vacancy (Motion) Sensor - Reduces light pollution and light trespass and should be encouraged.

RESIDENTIAL LIGHTING EXAMPLE

In this example on the following page, five different luminaires are used on a residential property. Each luminaire must comply to meet the requirements. The site plan following shows luminaire types followed by a tabulation of each uminaire, whether or not it is fully shielded, lamp type, and initial luminaire lumens. If the luminaire lumens are not known, multiply the initial lamp lumens by the luminaire efficiency. If the efficiency is not known, multiply the initial lamp lumens by 0.7 as a reasonable assumption. The maximum allowable lumen values come from Table G, based on the shielding classification and location on the site. In this case, each luminaire complies with the requirements of Table G.

Comparison of efficacy by power
(120 Volt Incandescent lamps)

Output (Lumens)	Power (Watt)		
	Incan	CFL	LED
500	40	8 - 10	9
850	60	13 - 18	12 - 15
1,200	75	18 - 22	15
1,700	100	23 - 28	18

V. RESIDENTIAL LIGHTING - Ordinance Text

A. General Requirements

For residential properties including multiple residential properties not having common areas, all outdoor luminaires shall be fully shielded and shall not exceed the allowed lumen output in Table G, row 2.

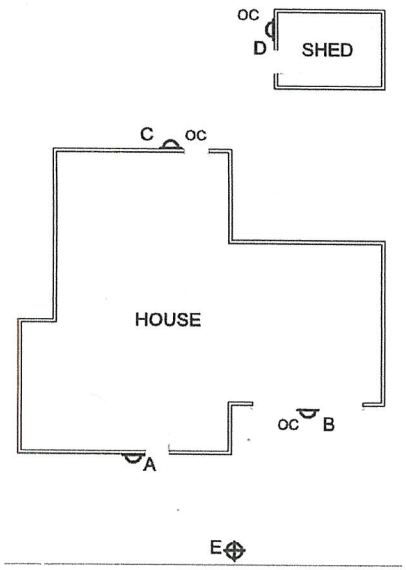
Exceptions

1. **One partly shielded or unshielded luminaire at the main entry, not exceeding the allowed lumen output in Table G row 1.**
2. **Any other partly shielded or unshielded luminaires not exceeding the allowed lumen output in Table G row 3.**
3. **Low voltage landscape lighting aimed away from adjacent properties and not exceeding the allowed lumen output in Table G row 4.**
4. **Shielded directional flood lighting aimed so that direct glare is not visible from adjacent properties and not exceeding the allowed lumen output in Table G row 5.**
5. **Open flame gas lamps.**
6. **Lighting installed with a vacancy sensor, where the sensor extinguishes the lights no more than 15 minutes after the area is vacated.**
7. **Lighting exempt per Section III (B.).**

B. Requirements for Residential Landscape Lighting

1. **Shall comply with Table G.**
2. **Shall not be aimed onto adjacent properties.**

V. RESIDENTIAL LIGHTING - User's Guide



WALL SCONCE
POST TOP LUMINAIRE
OC OCCUPANCY SENSOR

Property Type: Residential
Lighting Zone 1

Luminaire Type	Location	Luminaire Description	Fully Shielded	Lamp Type	Initial Luminiare Lumens*	Maximum Allowed Initial Luminaire Lumens (Table G)	Controls	Compliant
A	Front Entry	Decorative wall sconce	No	9W CFL	420	420	None	Yes
B	Garage Door	Fully shielded wall pack	Yes	23W CFL	1050	1260	Occupancy Sensor	Yes
C	Back Entry	Decorative wall sconce	No	7W CFL	280	315	Occupancy Sensor	Yes
D	Shed Entry	Fully shielded wall pack	Yes	40W INC	343	1260	Occupancy Sensor	Yes
E	Driveway	Fully shielded post top	Yes	13W CFL	1260	1260	None	Yes

*Initial Luminaire Lumens are calculated by multiplying the total initial lamp lumens by the luminaire efficiency.
If the luminaire efficiency is not known, assume an efficiency of 70% and multiply the lamp lumen value by 0.7.

VI. LIGHTING BY SPECIAL PERMIT ONLY - User's Guide

This section addresses types of lighting that are intrusive or complex in their impacts and need a higher level of scrutiny and/or site sensitivity.

It should be noted that safety could be compromised if lighting conforming to this ordinance is located adjacent to excessively bright and/or glaring lighting.

It is important that the authority set clear and reasonable guidelines for applying for a special lighting use permit, and establish rules and procedures for granting or refusing them. They may differ from existing special use policies, in which case one or the other may be changed to achieve the overall goal of effective lighting without glare, sky glow, or light trespass.

SPORTS FIELD LIGHTING

For athletic and sports fields, the appropriate level of lighting will depend on the Class of Play and Facilities. Class of Play is divided into 4 categories, depending on the number of fixed spectator seats. (Competition play intended for nighttime TV broadcast may require higher lighting levels).

CLASS I: Competition play at facilities with 5,000 or more fixed spectator seats. (Professional, Colleges & Universities, some Semi-Professional & Large Sports Cubs)

CLASS II: Games at facilities with over 1,500 fixed spectator seats. (Smaller Universities and Colleges, some Semi-pro, large amateur leagues and high schools with large spectator facilities)

CLASS III: Games at facilities with over 500 fixed spectator seats. (Sports Clubs and amateur leagues, some high schools and large training professional training facilities with spectator sections)

CLASS IV: Competition or recreational play at facilities with 500 fixed spectator seats or less. Class IV Class of Play applies to games at which family and close friends of the players and staff are usually the majority of spectators. (Smaller amateur leagues, park and recreation department facilities, most Little Leagues smaller high schools, elementary and middle schools, and social events)

VI. LIGHTING BY SPECIAL PERMIT ONLY - Ordinance Text

A. High Intensity and Special Purpose Lighting

The following lighting systems are prohibited from being installed or used except by special use permit:

1. Temporary lighting in which any single luminaire exceeds 20,000 initial luminaire lumens or the total lighting load exceeds 160,000 lumens.
2. Aerial Lasers.
3. Searchlights.
4. Other very intense lighting defined as having a light source exceeding 200,000 initial luminaire lumens or an intensity in any direction of more than 2,000,000 candelas.

B. *Complex and Non-Conforming Uses*

Upon special permit issued by the Authority, lighting not complying with the technical requirements of this ordinance but consistent with its intent may be installed for complex sites or uses or special uses including, but not limited to, the following applications:

1. Sports facilities, including but not limited to unconditioned rinks, open courts, fields, and stadiums.
2. Construction lighting.
3. Lighting for industrial sites having special requirements, such as petrochemical manufacturing or storage, shipping piers, etc.
4. Parking structures.
5. Urban parks
6. Ornamental and architectural lighting of bridges, public monuments, statuary and public buildings.
7. Theme and amusement parks.
8. Correctional facilities.

To obtain such a permit, applicants shall demonstrate that the proposed lighting installation:

a. Has sustained every reasonable effort to mitigate the effects of light on the environment and surrounding properties, supported by a signed statement describing the mitigation measures. Such statement shall be accompanied by the calculations required for the Performance Method.

SPORTS FIELD LIGHTING

When Class of Play is above Class IV, a dual control should be installed to limit illumination to Class IV levels during practices where spectators are fewer than 500.

(See IES Recommended Practice for Sports and Recreational Area Lighting RP-6)

VII. EXISTING LIGHTING - User's Guide

Adoption of this section on existing lighting is strongly encouraged.

If the adopting jurisdiction has criteria in place that require a property to come into compliance with the current zoning ordinance, it is recommended that the criteria also be applied to bringing existing lighting into compliance. If there are no established criteria, this section of the MLO is recommended.

Amortization allows existing lighting to gradually and gracefully come into compliance. Substantial changes or additions to existing properties are considered the same as new construction, and must comply.

Most outdoor lighting can be fully depreciated once it is fully amortized, usually no longer than 10 years, if not sooner, from the date of initial installation. Some jurisdictions may prefer to require phase-out in a substantially shorter period. The Authority may also wish to require compliance much sooner for "easy fixes" such as re-aiming or lowering lumen output of lamps. Where lighting is judged to be a safety hazard, immediate compliance can be required.

VI. LIGHTING BY SPECIAL PERMIT ONLY (cont.) - Ordinance Text

b. Employs lighting controls to reduce lighting at a Project Specific Curfew ("Curfew") time to be established in the Permit.
c. Complies with the Performance Method after Curfew.

The Authority shall review each such application. A permit may be granted if, upon review, the Authority believes that the proposed lighting will not create unwarranted glare, sky glow, or light trespass.

VII. EXISTING LIGHTING - Ordinance Text

Lighting installed prior to the effective date of this ordinance shall comply with the following.

A. Amortization

On or before [amortization date], all outdoor lighting shall comply with this Code.

B. New Uses or Structures, or Change of Use

Whenever there is a new use of a property (zoning or variance change) or the use on the property is changed, all outdoor lighting on the property shall be brought into compliance with this Ordinance before the new or changed use commences.

C. Additions or Alterations

1. Major Additions.
   If a major addition occurs on a property, lighting for the entire property shall comply with the requirements of this Code. For purposes of this section, the following are considered to be major additions:

VIII. ENFORCEMENT AND PENALTIES - User's Guide

Enforcement and penalties will vary by jurisdiction. There are, however, certain practices that will promote compliance with lighting regulations. Education is a key tool in promoting compliance. Proactive enforcement procedures can include providing a copy of the lighting regulations to every contractor at the time they visit to obtain a building permit. Another effective tool is a requirement that the builder or developer acknowledge in writing that the he or she is familiar with the lighting requirements and will submit a lighting plan for approval.

VII. EXISTING LIGHTING (cont.) - Ordinance Text

Additions of 25 percent or more in terms of additional dwelling units, gross floor area, seating capacity, or parking spaces, either with a single addition or with cumulative additions after the effective date of this Ordinance.

Single or cumulative additions, modification or replacement of 25 percent or more of installed outdoor lighting luminaires existing as of the effective date of this Ordinance.

2. Minor Modifications, Additions, or New Lighting Fixtures for Non-residential and Multiple Dwellings

For non-residential and multiple dwellings, all additions, modifications, or replacement of more than 25 percent of outdoor lighting fixtures existing as of the effective date of this Ordinance shall require the submission of a complete inventory and site plan detailing all existing and any proposed new outdoor lighting.

Any new lighting shall meet the requirements of this Ordinance.

3. Resumption of Use after Abandonment

If a property with non-conforming lighting is abandoned for a period of six months or more, then all outdoor lighting shall be brought into compliance with this Ordinance before any further use of the property occurs.

VIII. ENFORCEMENT & PENALTIES - Ordinance Text

(Reserved)

VIII. ENFORCEMENT AND PENALTIES (cont.) - User's Guide

Submission of the Lighting Plan should be required as a precondition to any approvals. The Lighting Plan should include the location and BUG rating for each luminaire, specify whether compliance is by the performance or prescriptive method, and a worksheet to show that the luminaires and their BUG ratings are compliant.

IX. TABLES - User's Guide

The tables are to be reviewed periodically by a joint committee of the IES and IDA, and adjusted as standards and technology permit. If more research on the impacts of outdoor lighting shows the effects of light pollution to be a significant concern, then the values in the tables may be modified. Such changes will have no significant impact to the balance of the language of the Ordinance or Code.

VIII. ENFORCEMENT & PENALTIES - Ordinance Text

IX. TABLES - Ordinance Text

Table A - Allowed Total Initial Luminaire Lumens per Site for Non-residential Outdoor Lighting, Per Parking Space Method
May only be applied to properties up to 10 parking spaces (including handicapped accessible spaces).

LZ-0	LZ-1	LZ-2	LZ-3	LZ-4
350 lms/space	490 lms/space	630 lms/space	840 lms/space	1,050 lms/space

Table B - Allowed Total Initial Lumens per Site for Non-residential Outdoor Lighting, Hardscape Area Method
May be used for any project. When lighting intersections of site drives and public streets or road, a total of 600 square feet for each intersection may be added to the actual site hardscape area to provide for intersection lighting.

LZ-0	LZ-1	LZ-2	LZ-3	LZ-4
Base Allowance				
0.5 lumens per SF of Hardscape	1.25 lumens per SF of Hardscape	2.5 lumens per SF of Hardscape	5.0 lumens per SF of Hardscape	7.5 lumens per SF of Hardscape

IX. TABLES - Ordinance Text

Table B - *Lumen Allowances, in Addition to Base Allowance*

	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Additional allowances for sales and service facilities. No more than two additional allowances per site, Use it or Lose it.					
Outdoor Sales Lots. This allowance is lumens per square foot of uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale, and may not include driveways, parking or other non sales areas. To use this allowance, luminaires must be within 2 mounting heights of sales lot area.	**0**	**4 lumens per square foot**	**8 lumens per square foot**	**16 lumens per square foot**	**16 lumens per square foot**
Outdoor Sales Frontage. This allowance is for lineal feet of sales frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. In order to use this allowance, luminaires must be located between the principal viewing location and the frontage outdoor sales area	**0**	**0**	**1,000 per LF**	**1,500 per LF**	**2,000 per LF**
Drive Up Windows. In order to use this allowance, luminaires must be within 20 feet horizontal distance of the center of the window.	**0**	**2,000 lumens per drive-up window**	**4,000 lumens per drive-up window**	**8,000 lumens per drive-up window**	**8,000 lumens per drive-up window**
Vehicle Service Station. This allowance is lumens per installed fuel pump.	**0**	**4,000 lumens per pump (based on 5 fc horiz)**	**8,000 lumens per pump (based on 10 fc horiz)**	**16,000 lumens per pump (based on 20 fc horiz)**	**24,000 lumens per pump (based on 20 fc horiz)**

IX. TABLES - TABLE C BUG RATING - User's Guide

Work on the BUG system started in 2005 when the IES upgraded the roadway cutoff classification system. The original system, which included the ratings full cutoff, cutoff, semi-cutoff and non cutoff, had been designed as a rating system focused on brightness and glare control. However, with increasing demand for control of uplight and light trespass in addition to glare, IES realized that a more comprehensive system was needed. IES developed TM-15 *Luminaire Classification System for Outdoor Luminaires*.

As this is a relatively new rating system, and many people may not be familiar with it, more explanation of how the rating system works is provided here. For example, some people are familiar with terms such as "full cutoff" and they may expect the MLO to include those terms. It will be very important that all groups recognize that older terms and concepts are inadequate for the complex tasks of controlling light pollution. It is recommended that the new rating system adopted in TM-15, as followed herein by the MLO, be used intact and exclusively.

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 in places that traditional-appearing luminaires are required. BUG typically cannot be used for residential luminaires unless they have been photometrically tested. For non-photometrically tested residential luminaires, shielding description is used instead.

The lumen limits established for each lighting zone apply to all types of lighting within that zone. This includes, but is not limited to, specialty lighting, façade lighting, security lighting and the front row lighting for auto dealerships. BUG rating limits are defined for each luminaire and

IX. TABLES (cont.) - Ordinance Text

Table C - Maximum Allowable Backlight, Uplight and Glare (BUG) Ratings

May be used for any project. A luminaire may be used if it is rated for the lighting zone of the site or lower in number for all ratings B, U and G. Luminaires equipped with adjustable mounting devices permitting alteration of luminaire aiming in the field shall not be permitted.

TABLE C-1	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Allowed Backlight Rating*					
Greater than 2 mounting heights from property line	B1	B3	B4	B5	B5
1 to less than 2 mounting heights from property line and ideally oriented**	B1	B2	B3	B4	B4
0.5 to 1 mounting heights from property line and ideally oriented**	B0	B1	B2	B3	B3
Less than 0.5 mounting height to property line and properly oriented**	B0	B0	B0	B1	B2

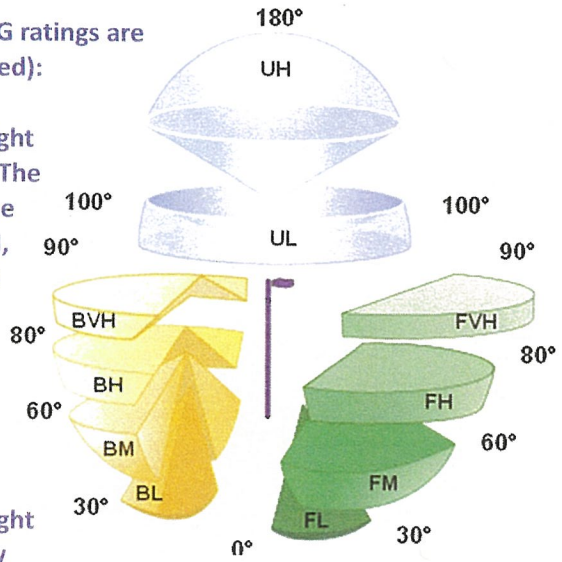
*For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 feet beyond the actual property line for purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the center-line of the public roadway or public transit corridor for the purpose of determining compliance with this section. NOTE: This adjustment is relative to Table C-1 and C-3 only and shall not be used to increase the lighting area of the site.

** To be considered 'ideally oriented', the luminaire must be mounted with the backlight portion of the light output oriented perpendicular and towards the property line of concern.

IX. TABLES - TABLE C BUG RATING (cont.) - User's Guide

are based on the internal and external design of the luminaire, its aiming, and the initial luminaire lumens of the specified luminaires. The BUG rating limits also take into consideration the distance the luminaire is installed from the property line in multiples of the mounting height (See Table C).

The three components of BUG ratings are based on IES 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 in the 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) not reflected off a surface is mostly energy waste. The U rating defines the amount of light into the upper hemisphere with greater concern for the light at or near the horizontal angles (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.

BUG ratings apply to the Lighting Zone of the property under consideration.

IX. TABLES (cont.) - Ordinance Text

IX. TABLES - TABLE C BUG RATING (cont.) - User's Guide

(Key: UH=Uplight High, UL=Uplight Low, BVH=Backlight Very High, BH=Backlight High, BM=Backlight Medium, BL=Backlight Low, FVH=Forward Light Very High, FH=Forward Light High, FM=Forward Light Medium, FL=Forward Light Low.)

In general, a higher BUG rating means more light is allowed in solid angles, and the rating increases with the lighting zone. However, a higher B (backlight) rating simply indicates that the luminaire directs a significant portion of light behind the pole, so B ratings are designated based on the location of the luminaire with respect to the property line. A high B rating luminaire maximizes the spread of light, and is effective and efficient when used far from the property line. When luminaires are located near the property line, a lower B rating will prevent unwanted light from interfering with neighboring properties.

At the 90-180 degree ranges:

- Zone 0 allows no light above 90 degrees.
- Zone 1 allows only 10 lumens in the UH and UL zones, 20 lumens total in the complete upper hemisphere. (This is roughly equivalent to a 5 W incandescent lamp).
- Zone 2 allows only 50 lumens in the UH and UL zones, 100 lumens total (less than a 25W incandescent lamp).
- Zone 3 allows only 500 lumens in the UH and UL zones, 1000 lumens total (about the output of a 75W incandescent bulb).
- Zone 4 allows only 1,000 lumens in the UH and UL zones, 2000 lumens total (about the output of a 100W incandescent bulb).

IX. TABLES (cont.) - Ordinance Text

Table C - 2 Maximum Allowable Uplight (BUG) Ratings - Continued

TABLE C-2	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Allowed Uplight Rating	U0	U1	U2	U3	U4
Allowed % light emission above 90° for street or Area lighting	0%	0%	0%	0%	0%

Table C - 3 Maximum Allowable Glare (BUG) Ratings - Continued

TABLE C-3	Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Allowed Glare Rating	G0	G1	G2	G3	G4
Any luminaire not ideally oriented*** with 1 to less than 2 mounting heights to any property line of concern	G0	G0	G1	G1	G2
Any luminaire not ideally oriented*** with 0.5 to 1 mounting heights to any property line of concern	G0	G0	G0	G1	G1
Any luminaire not ideally oriented*** with less than 0.5 mounting heights to any property line of concern	G0	G0	G0	G0	G1

*** Any luminaire that cannot be mounted with its backlight perpendicular to any property line within 2X the mounting heights of the luminaire location shall meet the reduced Allowed Glare Rating in Table C-3.

TABLE D EXAMPLE - PERFORMANCE METHOD - User's Guide

The first step in the Performance Method is to establish the Site Total Initial Site Lumens which regulates overlighting. The performance method allows layers of light depending on the complexity of the site.

Table D establishes the basic total initial site lumens allowed. These lumen allowances are added together for a total initial site lumen allowance. Allowances include:

1) Initial lumen allowance per site

2) Per area (SF) of hardscape

IX. TABLES (cont.) - Ordinance Text

Table D Performance Method Allowed Total Initial Site Lumens

May be used on any project.

Lighting Zone	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Allowed Lumens Per SF	0.5	1.25	2.5	5.0	7.5
Allowed Base Lumens Per Site	0	3,500	7,000	14,000	21,000

Table E Performance Method Additional Initial Luminaire Lumen Allowances. All of the following are "use it or lose it" allowances.

All area and distance measurements in plan view unless otherwise noted.

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Additional Lumens Allowances for All Buildings except service stations and outdoor sales facilities. A MAXIMUM OF THREE (3) ALLOWANCES ARE PERMITTED. THESE ALLOWANCES ARE "USE IT OR LOSE IT".					
Building Entrances or Exits. This allowance is per door. In order to use this allowance, luminaires must be within 20 feet of the door.	400	1,000	2,000	4,000	6,000
Building Facades. This allowance is lumens per unit area of building façade that are illuminated. To use this allowance, luminaires must be aimed at the façade and capable of illuminating it without obstruction.	0	0	8/SF	16/SF	24/SF

TABLE E PERFORMANCE METHOD - User's Guide

The allowable light levels for these uses defined in Table E may be used to set a prescriptive lighting allowance for these uses in each lighting zone. It should be noted that the lighting allowance defined in Table E is only applicable for the area defined for that use and cannot be transferred to another area of the site. For some uses, such as outdoor sales, the jurisdiction is encourages to define a percentage of the total hardscape area that is eligible for the additional lighting allowance. For example, a set percentage of a car dealership's lot may be considered a display area and receive the additional lighting allowance where the remainder of the lot would be considered storage, visitor parking, etc. and cannot exceed the base light levels defined in Table A.

TABLE E EXAMPLE - PERFORMANCE METHOD - User's Guide

IX. TABLES (cont.) - Ordinance Text

Table E - Performance Method Additional Initial Lumen Allowances (cont.)

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Sales or Non-sales Canopies. This allowance is lumens per unit area for the total area within the drip line of the canopy. In order to qualify for this allowance, luminaires must be located under the canopy.	0	3/SF	6/SF	12/SF	18/SF
Guard Stations. This allowance is lumens per unit area of guardhouse plus 2000 sf per vehicle lane. In order to use this allowance, luminaires must be within 2 mounting heights of a vehicle lane or the guardhouse.	0	6/SF	12/SF	24/SF	36/SF
Outdoor Dining. This allowance is lumens per unit area for the total il-luminated hardscape of outdoor dining. In order to use this allowance, luminaires must be within 2 mounting heights of the hardscape area of outdoor dining	0	1/SF	5/SF	10/SF	15/SF
Drive Up Windows. This allowance is lumens per window. In order to use this allowance, luminaires must be within 20 feet of the center of the window.	0	2,000 lumens per drive-up window	4,000 lumens per drive-up window	8,000 lumens per drive-up window	8,000 lumens per drive-up window
Additional Lumens Allowances for Service Stations only. Service stations may not use any other additional allowances.					
Vehicle Service Station Hardscape. This allowance is lumens per unit area for the total illuminated hardscape area less area of buildings, area under canopies, area off property, or areas obstructed by signs or structures. In order to use this allowance, luminaires must be illuminating the hardscape area and must not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.	0	4/SF	8/SF	16/SF	24/SF

IX. TABLES (cont.) - Ordinance Text

Table E - Performance Method Additional Initial Lumen Allowances (cont.)

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Vehicle Service Station Canopies. This allowance is lumens per unit area for the total area within the drip line of the canopy. In order to use this allowance, luminaires must be located under the canopy.	0	8/SF	16/SF	32/SF	32/SF
Additional Lumens Allowances for Outdoor Sales facilities only. Outdoor Sales facilities may not use any other additional allowances. **NOTICE:** lighting permitted by these allowances shall employ controls extinguishing this lighting after a curfew time to be determined by the Authority.					
Outdoor Sales Lots. This allowance is lumens per square foot of uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale, and may not include driveways, parking or other non sales areas and shall not exceed 25% of the total hardscape area. To use this allowance, Luminaires must be within 2 mounting heights of the sales lot area.	0	4/SF	8/SF	12/SF	18/SF
Outdoor Sales Frontage. This allowance is for lineal feet of sales frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides provided that a different principal viewing location exists for each side. In order to use this allowance, luminaires must be located between the principal viewing location and the frontage outdoor sales area.	0	0	1,000/ LF	1,500/ LF	2,000/ LF

IX. TABLES (cont.) - Ordinance Text

Table F Maximum Vertical Illuminance at any point in the plane of the property line

Lighting Zone 0	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
0.05 FC or 0.5 LUX	0.1 FC or 1.0 LUX	0.3 FC or 3.0 LUX	0.8 FC or 8.0 LUX	1.5 FC or 15.0 LUX

TABLE G RESIDENTIAL LIGHTING - User's Guide

Residential Light Levels

Most residential lighting has traditionally used incandescent lamps which are identified by their wattage. However, since new technologies provide more light for fewer watts, it is no longer possible to regulate residential lighting solely by providing a maximum wattage. Table G, therefore, lists maximum initial luminaire lumens only.

IX. TABLES (cont.) - Ordinance Text

Table G - Residential Lighting Limits

Lighting Application	LZ 0	LZ 1	LZ 2	LZ 3	LZ 4
Row 1 Maximum Allowed Luminaire Lumens* for Unshielded Luminaires at one entry only	Not allowed	420 lumens	630 lumens	630 lumens	630 lumens
Row 2 Maximum Allowed Luminaire Lumens* for each Fully Shielded Luminaire	630 lumens	1,260 lumens	1,260 lumens	1,260 lumens	1,260 lumens
Row 3 Maximum Allowed Luminaire Lumens* for each Unshielded Luminaire excluding main entry	Not allowed	315 lumens	315 lumens	315 lumens	315 lumens
Row 4 Maximum Allowed Luminaire Lumens* for each Landscape Lighting	Not allowed	Not allowed	1,050 lumens	2,100 lumens	2,100 lumens
Row 5 Maximum Allowed Luminaire Lumens* for each Shielded Directional Flood Lighting	Not allowed	Not allowed	1,260 lumens	2,100 lumens	2,100 lumens
Row 6 Maximum Allowed Luminaire Lumens* for each Low Voltage Landscape Lighting	Not allowed	Not allowed	525 lumens	525 lumens	525 lumens

*** Luminaire lumens equals Initial Lamp Lumens for a lamp, multiplied by the number of lamps in the luminaire**

X. DEFINITIONS - User's Guide

Definitions are typically generally added to any code when new code sections are added. The definitions are legally required and play a significant role in the interpretation of the ordinance and code.

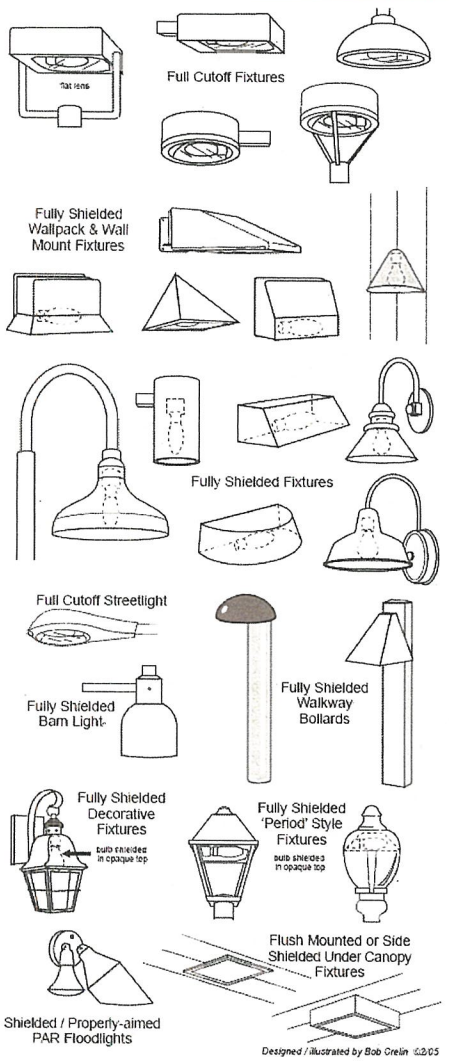
Most city attorneys will not accept references to outside sources regardless of credibility, such as the IES Handbook. Thus as a general rule, a definition for an unfamiliar term (e.g. lumens) must be added by the adopting ordinance.

When adopting or integrating the MLO definitions, be sure to retire conflicting technical terminology. In particular, the latest IES Luminaire Classification System as defined in IES TM-15-07 is likely to need attention.

X. DEFINITIONS - Ordinance Text

Absolute Photometry	Photometric measurements (usually of a solid-state luminaire) that directly measures the footprint of the luminaire. Reference Standard IES LM-79
Architectural Lighting	Lighting designed to reveal architectural beauty, shape and/or form and for which lighting for any other purpose is incidental.
Authority	The adopting municipality, agency or other governing body.
Astronomic Time Switch	An automatic lighting control device that switches outdoor lighting relative to time of solar day with time of year correction.
Backlight	For an exterior luminaire, lumens emitted in the quarter sphere below horizontal and in the opposite direction of the intended orientation of the luminaire. For luminaires with symmetric distribution, backlight will be the same as front light.
BUG	A luminaire classification system that classifies backlight (B), uplight (U) and glare (G).
Canopy	A covered, unconditioned structure with at least one side open for pedestrian and/or vehicular access. (An unconditioned structure is one that may be open to the elements and has no heat or air conditioning.)
Common Outdoor Areas	One or more of the following: a parking lot; a parking structure or covered vehicular entrance; a common entrance or public space shared by all occupants of the domiciles.
Curfew	A time defined by the authority when outdoor lighting is reduced or extinguished.

Examples of Fully Shielded Luminaires



X. DEFINITIONS - Ordinance Text

Emergency conditions	Generally, lighting that is only energized during an emergency; lighting fed from a backup power source; or lighting for illuminating the path of egress solely during a fire or other emergency situation; or, lighting for security purposes used solely during an alarm.
Footcandle	The unit of measure expressing the quantity oflight received on a surface. One footcandle is the illuminance produced by a candle on a surface one foot square from a distance of one foot.
Forward Light	For an exterior luminaire, lumens emitted in the quarter sphere below horizontal and in the direction of the intended orientation of the luminaire.
Fully Shielded Luminaire	A luminaire constructed and installed in such a manner that all light emitted by the luminaire, either directly from the lamp or a diffusing element, or indirectly by reflection or refraction from any part of the luminaire, is projected below the horizontal plane through the luminaire's lowest light-emitting part.
Glare	Lighting entering the eye directly from luminaires or indirectly from reflective surfaces that causes visual discomfort or reduced visibility.
Hardscape	Permanent hardscape improvements to the site including parking lots, drives, entrances, curbs, ramps, stairs, steps, medians, walkways and non-vegetated landscaping that is 10 feet or less in width. Materials may include concrete, asphalt, stone, gravel, etc.
Hardscape Area	The area measured in square feet of all hardscape. It is used to calculate the Total Site Lumen Limit in both the Prescriptive Method and Performance Methods. Refer to Hardscape definition.

X. DEFINITIONS - Ordinance Text

Hardscape Perimeter	The perimeter measured in linear feet is used to calculate the Total Site Lumen Limit in the Performance Method. Refer to Hardscape definition.
IDA	International Dark-Sky Association.
IESNA	Illuminating Engineering Society of North America.
Impervious Material	Sealed to severely restrict water entry and movement
Industry Standard Lighting Software	Lighting software that calculates point-by-point illuminance that includes reflected light using either ray-tracing or radiosity methods.
Lamp	A generic term for a source of optical radiation (i.e. "light"), often called a "bulb" or "tube". Examples include incandescent, fluorescent, high-intensity discharge (HID) lamps, and low pressure sodium (LPS) lamps, as well as light-emitting diode (LED) modules and arrays.
Landscape Lighting	Lighting of trees, shrubs, or other plant material as well as ponds and other landscape features.
LED	Light Emitting Diode.
Light Pollution	Any adverse effect of artificial light including, but not limited to, glare, light trespass, sky-glow, energy waste, compromised safety and security, and impacts on the nocturnal environment.

X. DEFINITIONS - Ordinance Text

Light Trespass	Light that falls beyond the property it is intended to illuminate.
Lighting	"Electric" or "man-made" or "artificial" lighting. See "lighting equipment".
Lighting Equipment	Equipment specifically intended to provide gas or electric illumination, including but not limited to, lamp(s), luminaire(s), ballast(s), poles, posts, lens(s), and related structures, electrical wiring, and other necessary or auxiliary components.
Lighting Zone	An overlay zoning system establishing legal limits for lighting for particular parcels, areas, or districts in a community.
Lighting Equipment	Equipment specifically intended to provide gas or electric illumination, including but not limited to, lamp(s), luminaire(s), ballast(s), poles, posts, lens(s), and related structures, electrical wiring, and other necessary or auxiliary components.
Low Voltage Landscape Lighting	Landscape lighting powered at less than 15 volts and limited to luminaires having a rated initial luminaire lumen output of 525 lumens or less.
Lumen	The unit of measure used to quantify the amount of light produced by a lamp or emitted from a luminaire (as distinct from "watt," a measure of power consumption).
Luminaire	The complete lighting unit (fixture), consisting of a lamp, or lamps and ballast(s) (when applicable), together with the parts designed to distribute the light (reflector, lens, diffuser), to position and protect the lamps, and to connect the lamps to the power supply.

Mounting Height: The horizontal spacing of poles is often measured in units of "mounting height". Example: "The luminaires can be spaced up to 4 mounting heights apart."

X. DEFINITIONS - Ordinance Text

Luminaire Lumens	For luminaires with relative photometry per IES, it is calculated as the sum of the initial lamp lumens for all lamps within an individual luminaire, multiplied by the luminaire efficiency. If the efficiency is not known for a residential luminaire, assume 70%. For luminaires with absolute photometry per IES LM-79, it is the total luminaire lumens. The lumen rating of a luminaire assumes the lamp or luminaire is new and has not depreciated in light output.
Lux	The SI unit of illuminance. One lux is one lumen per square meter. 1 Lux is a unit of incident illuminance approximately equal to 1/10 footcandle.
Mounting height	The height of the photometric center of a luminaire above grade level.
New lighting	Lighting for areas not previously illuminated; newly installed lighting of any type except for replacement lighting or lighting repairs.
Object	A permanent structure located on a site. Objects may include statues or artwork, garages or canopies, outbuildings, etc.
Object Height	The highest point of an entity, but shall not include antennas or similar structures.
Ornamental lighting	Lighting that does not impact the function and safety of an area but is purely decorative, or used to illuminate architecture and/or land-scaping, and installed for aesthetic effect.

X. DEFINITIONS - Ordinance Text

Ornamental Street Lighting	A luminaire intended for illuminating streets that serves a decorative function in addition to providing optics that effectively deliver street lighting. It has a historical period appearance or decorative appearance, and has the following design characteristics: · designed to mount on a pole using an arm, pendant, or vertical tenon; · opaque or translucent top and/or sides; · an optical aperture that is either open or enclosed with a flat, sag or drop lens; · mounted in a fixed position; and · with its photometric output measured using Type C photometry per IESNA LM-75-01.
Outdoor Lighting	Lighting equipment installed within the property line and outside the building envelopes, whether attached to poles, building structures, the earth, or any other location; and any associated lighting control equipment.
Partly shielded luminaire	A luminaire with opaque top and translucent or perforated sides, designed to emit most light downward.
Pedestrian Hardscape	Stone, brick, concrete, asphalt or other similar finished surfaces intended primarily for walking, such as sidewalks and pathways.
Photoelectric Switch	A control device employing a photocell or photodiode to detect daylight and automatically switch lights off when sufficient daylight is available.
Property line	The edges of the legally-defined extent of privately owned property.

X. DEFINITIONS - Ordinance Text

Relative photometry	Photometric measurements made of the lamp plus luminaire, and adjusted to allow for light loss due to reflection or absorption within the luminaire. Reference standard: IES LM-63.
Repair(s)	The reconstruction or renewal of any part of an existing luminaire for the purpose of its on-going operation, other than relamping or replacement of components including capacitor, ballast or photocell. Note that retrofitting a luminaire with new lamp and/or ballast technology is not considered a repair and for the purposes of this ordinance the luminaire shall be treated as if new. "Repair" does **not** include normal relamping or replacement of components including capacitor, ballast or photocell.
Replacement Lighting	Lighting installed specifically to replace existing lighting that is sufficiently broken to be beyond repair.
Sales area	Uncovered area used for sales of retail goods and materials, including but not limited to automobiles, boats, tractors and other farm equipment, building supplies, and gardening and nursery products.
Seasonal lighting	Temporary lighting installed and operated in connection with holidays or traditions.
Shielded Directional Luminaire	A luminaire that includes an adjustable mounting device allowing aiming in any direction and contains a shield, louver, or baffle to reduce direct view of the lamp.
Sign	Advertising, directional or other outdoor promotional display of art, words and/or pictures.

X. DEFINITIONS - Ordinance Text

Sky Glow	The brightening of the nighttime sky that results from scattering and reflection of artificial light by moisture and dust particles in the atmosphere. Skyglow is caused by light directed or reflected upwards or sideways and reduces one's ability to view the night sky.
Temporary lighting	Lighting installed and operated for periods not to exceed 60 days, completely removed and not operated again for at least 30 days.
Third Party	A party contracted to provide lighting, such as a utility company.
Time Switch	An automatic lighting control device that switches lights according to time of day.
Translucent	Allowing light to pass through, diffusing it so that objects beyond cannot be seen clearly (not transparent or clear).
Unshielded Luminaire	A luminaire capable of emitting light in any direction including downwards.
Uplight	For an exterior luminaire, flux radiated in the hemisphere at or above the horizontal plane.
Vertical Illuminance	Illuminance measured or calculated in a plane perpendicular to the site boundary or property line.

XI. OPTIONAL STREETLIGHT ORDINANCE - User's Guide

This section was added since the first public review. It is designed to work closely with the proposed revision to ANSI/IES RP-8 Standard Practice for Roadway and Street Lighting.

Street and roadway lighting is one of the world's largest causes of artificial skyglow. Many adopting agencies will recognize that the MLO will make privately owned lighting more efficient and environmentally responsible than their street lighting systems. But because the process of designing street lighting often requires more precise lighting calculations, applying the MLO directly to street lighting is not advised. Using existing standards of street lighting is recommended, particularly IES RP-8 and AASHTO standards.

Until a new recommended practice for street lighting can be developed, this section can serve to prevent most of the uplight of street lighting systems without setting specific requirements for the amount of light, uniformity of light, or other performance factors. Adopting agencies should include these basic improvements to street lighting along with regulations to private lighting.

Lighting streets with "period" ornamental luminaires that evoke the look of a time when the light source was a gas flame can cause glare if high-lumen lamps are used. Such ornamental street lights should not exceed a BUG rating of G1. If additional illuminance and/or uniformity is desired, the ornamental fixtures should be supplemented by higher mounted fully shielded luminaires, as illustrated in RP-33-99.

Few street lighting warranting processes exist. The adopting agency needs to gauge whether a complex warranting systems is required, or if a simple one using posted speeds, presence of pedestrians, or other practical considerations is sufficient.

Examples of a current street lighting warranting system are included in the Transportation Association of Canada's Guide for the Design of Roadway Lighting 2006.

XI. OPTIONAL STREETLIGHT ORDINANCE - Ordinance Text

Note to the adopting authority: the intent of this section is that it only applies to streets and not to roadways or highways.

A. Preamble

The purpose of this Ordinance is to control the light pollution of street lighting, including all collectors, local streets, alleys, sidewalks and bikeways, as defined by ANSI/IES RP-8 Standard Practice for Roadway and Street Lighting and in a manner consistent with the Model Lighting Ordinance.

B. Definitions

Roadway or Highway lighting is defined as lighting provided for freeways, expressways, limited access roadways, and roads on which pedestrians, cyclists, and parked vehicles are generally not present. The primary purpose of roadway or highway lighting is to help the motorist remain on the roadway and help with the detection of obstacles within and beyond the range of the vehicle's headlights.

Street lighting is defined as lighting provided for major, collector, and local roads where pedestrians and cyclists are generally present. The primary purpose of street lighting is to help the motorist identify obstacles, provide adequate visibility of pedestrians and cyclists, and assist in visual search tasks, both on and adjacent to the roadway.

Ornamental Street Lighting is defined as a luminaire intended for illuminating streets that serves a decorative function in addition to providing optics that effectively deliver street lighting. It has a historical period appearance or decorative appearance, and has the following design characteristics:

- designed to mount on a pole using an arm, pendant, or vertical tenon;
- opaque or translucent top and/or sides;
- an optical aperture that is either open or enclosed with a flat, sag or drop lens;
- mounted in a fixed position; and
- with its photometric output measured using Type C photometry per IESNA LM-75-01.

XI. OPTIONAL STREETLIGHT ORDINANCE - Ordinance Text

C. Scope

All street lighting not governed by regulations of federal, state or other superceding jurisdiction.

EXCEPTION: lighting systems mounted less than 10.5 feet above street level and having less than 1000 initial lumens each.

D. Master Lighting Plan

The Authority shall develop a Master Lighting Plan based on the American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide GL-6, October 2005, Chapter 2. Such plan shall include, but not be limited to, the Adoption of Lighting Zones and:

1. Goals of street lighting in the jurisdiction by Lighting Zone
2. Assessment of the safety and security issues in the jurisdiction by Lighting Zone
3. Environmentally judicious use of resources by Lighting Zone
4. Energy use and efficiency by Lighting Zone
5. Curfews to reduce or extinguish lighting when no longer needed by Lighting Zone

E. Warranting

The Authority shall establish a warranting process to determine whether lighting is required. Such warranting process shall not assume the need for any lighting nor for continuous lighting unless conditions warrant the need. Lighting shall only be installed where warranted.

XI. OPTIONAL STREETLIGHT ORDINANCE - Ordinance Text

F. Light Shielding and Distribution

All street lighting shall have no light emitted above 90 degrees.

Exception: Ornamental street lighting for specific districts or projects shall be permitted by special permit only, and shall meet the requirements of Table H below without the need for external field-added modifications.

Table H - Uplight Control Requirements for Ornamental Street Lights - by Special Permit Only

Lighting Zone	Maximum Uplight Rating
LZ-0	U-0
LZ-1	U-1
LZ-2	U-2
LZ-3	U-3
LZ-4	U-4

LCP Local Implementation Plan (LIP)

Ch. 3 Zoning Designations and Permitted Uses 3.11 Development Standards for Special Uses 3.14.5 Development Standards	F. Lighting. All lighting fixtures shall be located so as to shield direct rays from adjoining properties. Luminaries [*sic*] shall be of a low level, indirect diffused type and shall not exceed the height of the building.
Ch. 3 Zoning Designations and Permitted Uses 3.14 Parking Regulations 3.14.5 Development Standards	F. Lighting, where provided to illuminate a parking area, shall be hooded and so arranged and controlled so as not to cause a nuisance either to highway traffic or to adjacent properties.
Ch. 4 Environmentally Sensitive Habitat Area (ESHA) 4.6 Development Standards 4.6.2 Lighting [Applies to ESHA and ESHA buffer areas only]	Exterior lighting ... shall be minimized, restricted to low intensity features, shielded, and directed away from ESHA to minimize impacts on wildlife. Night lighting ... in ESHA, ESHA buffer, or where night lighting would increase illumination in ESHA shall be prohibited. Permitted lighting shall conform to the following standards: A. The minimum necessary to light walkways used for entry and exit to the structures, including parking areas, on the site. This lighting shall be limited to fixtures that do not exceed two feet in height, are directed downward, and use bulbs that do not exceed 60 watts, or the equivalent, unless a higher wattage is authorized by the Planning Manager. B. Security lighting attached to the residence that is controlled by motion detectors and is limited to 60 watts, or the equivalent. C. The minimum lighting necessary for safe vehicular use of the driveway. The lighting shall be limited to 60 watts, or the equivalent. D. A light, not to exceed 60 watts or the equivalent, at the entrance to the (identify non-residential accessory structures). E. No lighting around the perimeter of the site, no lighting for sports courts or other private recreational facilities, and no lighting for aesthetic purposes is allowed. F. Prior to issuance of Coastal Development Permit, the applicant shall be required to execute and record a deed restriction reflecting the above restrictions. G. Lighting of the main sports field at Malibu High School may only be permitted if it complies with the following standards: ...

Ch. 6 Scenic, Visual, and Hillside Resource Protection Ordinance 6.5 Development Standards G. Lighting [Applies to areas visible from public viewing areas only]	Lighting. Exterior lighting ... shall be minimized, restricted to low intensity features, shielded, and concealed to the maximum feasible extent so that no light source is directly visible from public viewing areas. Night lighting ... in scenic areas designated for residential use shall be prohibited. Permitted lighting shall conform to the following standards: 1. The minimum necessary to light walkways used for entry and exit to the structures, including parking areas, on the site. This lighting shall be limited to fixtures that do not exceed two feet in height, are directed downward, and use bulbs that do not exceed 60 watts, or the equivalent, unless a higher wattage is authorized by the Planning Manager. 2. Security lighting attached to the residence that is controlled by motion detectors and is limited to 60 watts, or the equivalent. 3. The minimum lighting necessary for safe vehicular use of the driveway. The lighting shall be limited to 60 watts, or the equivalent. 4. A light, not to exceed 60 watts or the equivalent, at the entrance to the (identify nonresidential accessory structures). 5. No lighting around the perimeter of the site, no lighting for sports courts or other private recreational facilities, and no lighting for aesthetic purposes is allowed. 6. Lighting of the main sports field at Malibu High School may only be permitted if it complies with the following standards:

LCP Land Use Plan (LUP)

Ch. 3 Marine and Land Resources A. Introduction 2. Land Use Plan Provisions	... The LUP policies require that new development be sited and designed to minimize impacts to ESHA ... The LUP requires exterior lighting to be limited in intensity and shielded to minimize impacts on wildlife.
Ch. 3 Marine and Land Resources C. Land Use Plan Policies 1. Land Resources g. New Development 3.56	Exterior night lighting shall be minimized, restricted to low intensity fixtures, shielded, and directed away from ESHA in order to minimize impacts on wildlife. High intensity perimeter lighting and lighting for sports courts or other private recreational facilities in ESHA, ESHA buffer, or where night lighting would increase illumination in ESHA is prohibited.
Ch. 6 Scenic and Visual Resources C. Land Use Policies 2. New Development 6.23	Exterior lighting (except traffic lights, navigational lights, and other similar safety lighting) shall be minimized, restricted to low intensity fixtures, shielded, and concealed to the maximum feasible extent so that no light source is directly visible from public viewing areas. Night lighting for sports courts or other private recreational facilities in scenic areas designated for residential use shall be prohibited.

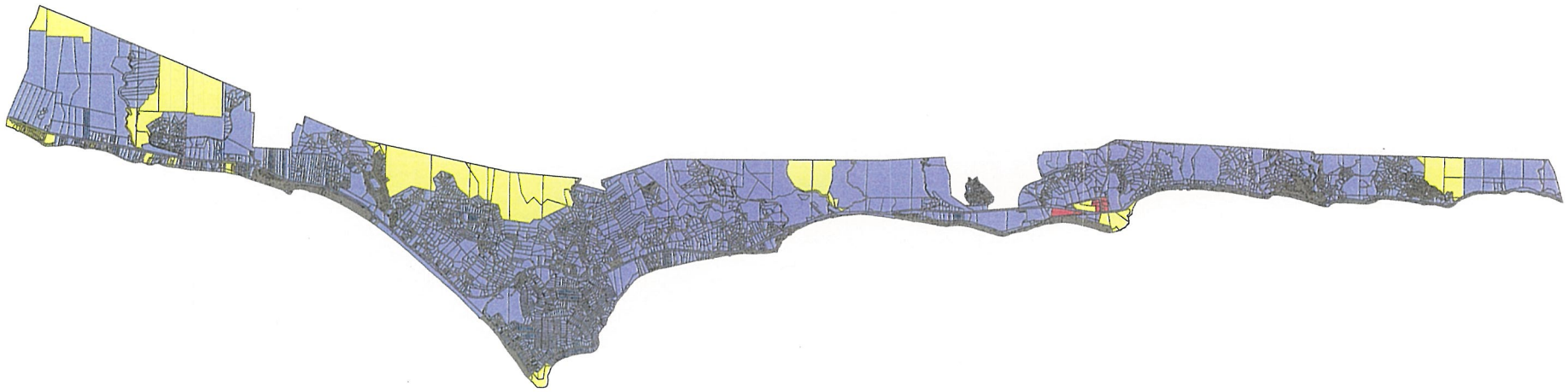
MMC

17.40.090(F) Service Station Requirements	Lighting. All lighting fixtures shall be located so as to shield direct rays from adjoining properties. Luminaries [*sic*] shall be of a low level, indirect diffused type and shall not exceed the height of the building.
17.48.050(F) Off-Street Parking and Loading Requirements	Lighting, where provided to illuminate a parking area, shall be hooded and so arranged and controlled so as not to cause a nuisance either to highway traffic or to adjacent properties.
17.66.120(B)(1) Medical Marijuana Dispensaries	Dispensaries shall install lighting to illuminate the exterior of the building and all entrances and exits to the facility. Exterior lighting shall be one foot candle, and shall remain on until at least one hour after the closing of the dispensary.

General Plan

Section III. Glossaries Appendix A Glossary of Terms Rural	Respect for nature; proximity and ease of access to the shore, ocean and mountains; a sense of open space, residential privacy and closeness to nature from within and without the dwelling; predominance of natural topography and vegetation over the built environment creating the feeling, scent, sound and visual presence of "country"; low-density and low-intensity land uses subordinate to the natural setting; a non-urban environment characterized by the minimization of urban services and facilities; and unobtrusive commercial signs as well as low levels of artificial light and sound.
Section II. Elements of the General Plan Ch. 1.0 Land Use Element 1.4 Goals, Objectives, Policies and Implementation Measures 1.4.2 LU Goal 2: Manage Growth and Preserve a Rural Community Character LU Objective 2.4 Rural Residential Neighborhoods in Western Malibu LU Policy 2.4.6	The City shall avoid improvements which create a suburban atmosphere such as sidewalks and street lights.
Section II. Elements of the General Plan Ch. 2.0 Open Space and Recreation Element 2.5 Goals, Objectives, Policies and Implementation Measures 2.5.2 OS Goal 2: Diverse Opportunities for Recreation and Leisure OS Objective 2.2 Adequate Recreational Facilities To Accommodate Residents And Visitors OS Implementation Measure 23	Develop design criteria for recreation-serving facilities to minimize traffic, noise and visual impacts on adjacent neighborhoods. The criteria shall, at minimum, prohibit outdoor lighting from illuminating beyond the parameter [*sic*] of the site, require appropriate fencing and screens for ball fields, golf and tennis courts and similar recreation facilities, and require access from an arterial street where feasible.
Section II. Elements of the General Plan Ch. 3 Conservation Element 3.4 Goals, Objectives, Policies and Implementation Measures 3.4.1 CON Goal 1: Natural Resources Preserved and Protected CON Objective 1.2 Wildlife And Biota Resources Preserved, Protected And Reclaimed CON Policy 1.2.7 CON Implementation Measure 28	CON Policy 1.2.7 The City shall reduce impacts resulting from night lighting so as not to disturb natural habitats. CON Implementation Measure 28 Require all exterior lighting to be low intensity and shielded to reduce its visibility from surrounding areas and to minimize impact to wildlife. Maintain dark corridors as a priority

Lighting Ordinance Zones Draft



Legend

- LZ-0
- LZ-1
- LZ-2

Draft 4-22-16 B

ATTACHMENT 4

Chris Deleau

From: pete@darksky.org
Sent: Monday, April 25, 2016 3:04 PM
To: Chris Deleau
Cc: scottf@darksky.org
Subject: RE: Correlated Color Temperature

Hi Chris. What we are trying too achieve with the warmer temperatures is a reduction in the amount of blue light found in cooler devices. The blue light component is most causative to circadian disruption. Blue light is more energetic than light towards the other end of the spectrum and as such has more of an impact on the environment. Most notably is the glare that is produced by blue light. Have you been driving at night, looking towards oncoming traffic and seen "those headlights" that look annoyingly bright compared to other headlights? It is the extra blue light found in HID and LED lights that give that appearance. The other times you notice the glare is in fog. The energetic blue light causes extreme scatter and glare, inhibiting visibility. We are advised to never use high beams in fog as more light does not improve visibility. More light does not mean more safe. To put a point on this notion, what is the color of fog lights? Amber...zero blue light for a very good reason. Coastal communities are seeing this function. I have had calls from folks in Pismo Beach and the glare in fog with new PG&E 4000k LEDs is blinding. Lighting should always enhance visibility, never detract from it. The skyglow from colder LEDs is also substantially greater owing to Rayleigh Scattering. This is getting into some physics and is best left for in depth discussion.

Sources of light that produce glare inhibit visibility by another factor called veiling luminance. Our eyes, in the cornea, lens, and vitreous humor react to the short wavelengths and scatter it, causing internal glare that gets worse as we age. Retirement communities are seeing this the most. I had a call that likened it to driving with cataracts again. Again, the lighting levels were the same when compared to the HPS source the LEDs were replacing, but the quality of the light is profoundly different, causing glare and impeding visibility when there was none before the retrofit.
In sum, cold cct LEDs and their inherent blue light produce more glare. Reducing glare is necessary to improve visibility.

With the advent of 3000k LEDs having the same lumen per watt output of 4000k LEDs (Cree's latest products) there is no reason to willfully chose something that can make visibility worse when better products are now being manufactured. This rapidly changing technology is causing confusion. Specifying a product that is 6 months old is now considered obsolete. We get that, but if better products are available now, consideration must be given to sources that minimize those problems found in this new technology.

There is also another reason why your community should choose warm LEDs and that is aesthetics. There are communities that have made the change to 4000k LEDs and experiencing buyers remorse, most notably Davis Ca, which opted to replace their new 4000k streetlights with 3000k ones after just a few months. I am getting calls every day from around the globe going through this. Being proactive, having the chance that others did not, is a gift. I'd hate to see your city join the call of dismay we hear daily.
I hope this helps. please contact me again if you have any more questions.
Best, Pete

> -------- Original Message --------
> Subject: Correlated Color Temperature
> From: Chris Deleau <CDeleau@malibucity.org>
> Date: Mon, April 25, 2016 1:53 pm
> To: "Pete Strasser (pete@darksky.org)" <pete@darksky.org>,
> "'scottf@darksky.org'" <scottf@darksky.org>

Pete, besides the potential health benefits of using "warm light" below 3000k, (e.g.., to avoid disruptions to circadian rhythms, etc.) are there other reasons that the City should be supporting the use of such warm light?

Best Regards,

Christopher M. Deleau, JD, AICP | **Planning Manager** | **City of Malibu** |
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(310) 456-2489 ext. 273

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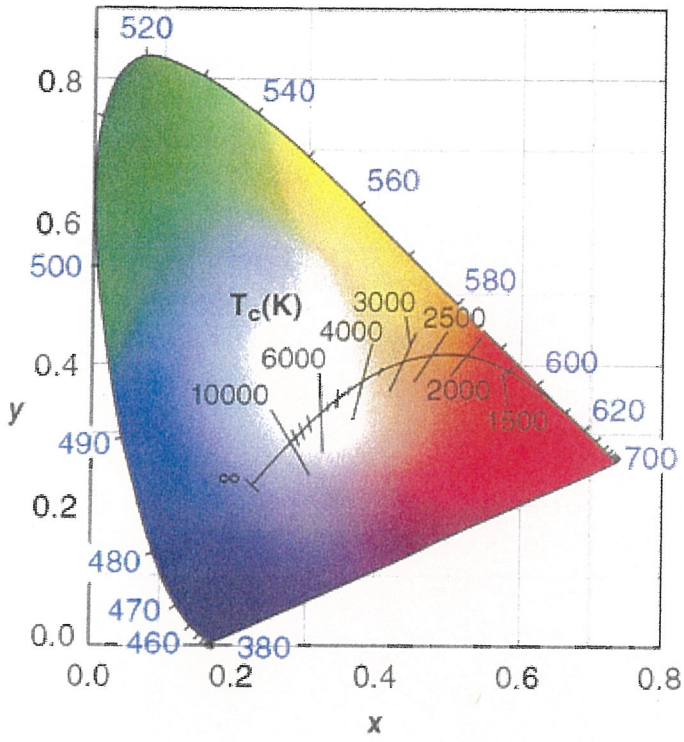
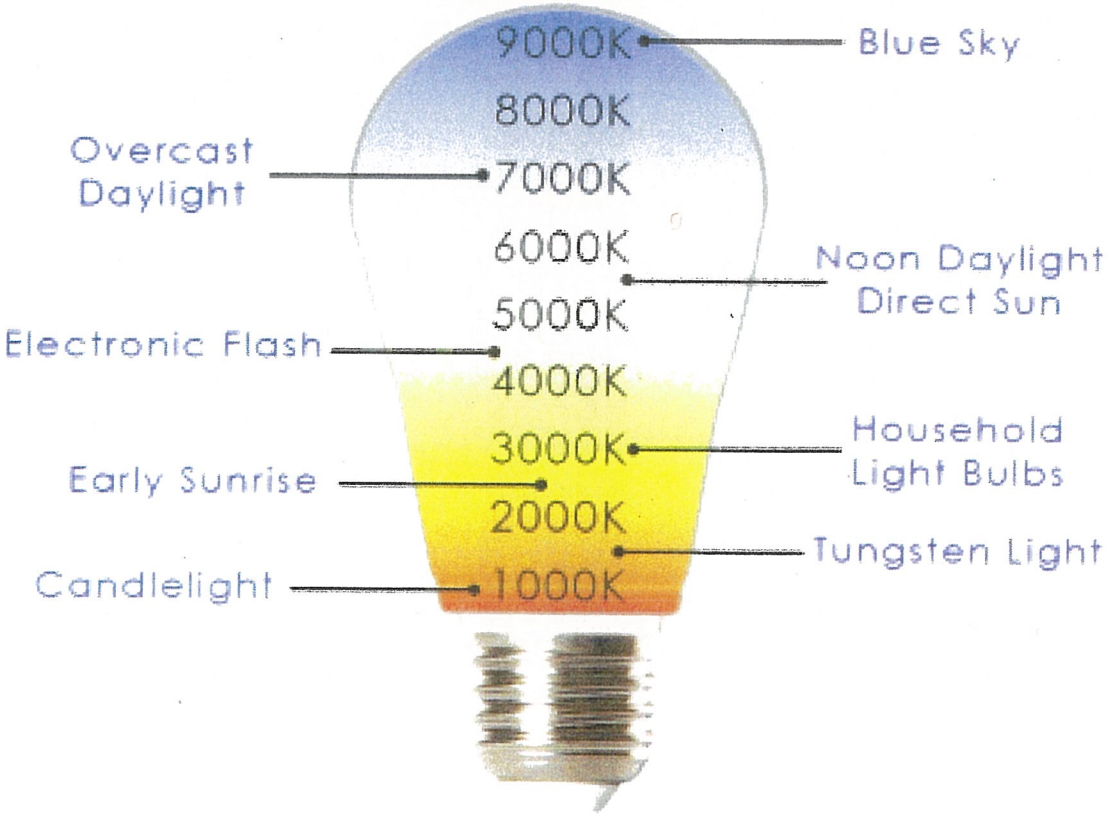


LED Color Temperature Chart



Blue light has a dark side

Harvard Health Letter {http://www.health.harvard.edu/newsletters/harvard_health_letter/2012/may}

Light at night is bad for your health, and exposure to blue light emitted by electronics and energy-efficient lightbulbs may be especially so.

Until the advent of artificial lighting, the sun was the major source of lighting, and people spent their evenings in (relative) darkness. Now, in much of the world, evenings are illuminated, and we take our easy access to all those lumens pretty much for granted.

But we may be paying a price for basking in all that light. At night, light throws the body's biological clock—the circadian rhythm—out of whack. Sleep suffers. Worse, research shows that it *may* contribute to the causation of cancer, diabetes, heart disease, and obesity.

But not all colors of light have the same effect. Blue wavelengths—which are beneficial during daylight hours because they boost attention, reaction times, and mood—seem to be the most disruptive at night. And the proliferation of electronics with screens, as well as energy-efficient lighting, is increasing our exposure to blue wavelengths, especially after sundown.

Daily rhythms influenced by light

Everyone has slightly different circadian rhythms, but the average length is 24 and one-quarter hours. The circadian rhythm of people who stay up late is slightly longer, while the rhythms of earlier birds fall short of 24 hours. Dr. Charles Czeisler of Harvard Medical School showed, in 1981, that daylight keeps a person's internal clock aligned with the environment.

The health risks of night time light

Study after study has linked working the night shift and exposure to light at night to several types of cancer (breast, prostate), diabetes, heart disease, and obesity. It's not exactly clear why nighttime light exposure seems to be so bad for us. But we do know that exposure to light suppresses the secretion of melatonin, a hormone that influences circadian rhythms, and there's some experimental evidence (it's very preliminary) that lower melatonin levels might explain the association with cancer.

A Harvard study shed a little bit of light on the possible connection to diabetes and possibly obesity. The researchers put 10 people on a schedule that gradually shifted the timing of their circadian rhythms. Their blood sugar levels increased, throwing them into a prediabetic state, and levels of leptin, a hormone that leaves people feeling full after a meal, went down.

Even dim light can interfere with a person's circadian rhythm and melatonin secretion. A mere eight lux—a level of brightness exceeded by most table lamps and about twice that of a night light—has an effect, notes Stephen Lockley, a Harvard sleep researcher. Light at night is part of the reason so many people don't get enough sleep, says Lockley, and researchers have linked short sleep to increased risk for depression, as well as diabetes and cardiovascular problems.

The power of the blues

While light of any kind can suppress the secretion of melatonin, blue light does so more powerfully. Harvard researchers and their colleagues conducted an experiment comparing the effects of 6.5 hours of exposure to blue light to exposure to green light of comparable brightness. The blue light suppressed melatonin for about twice as long as the green light and shifted circadian rhythms by twice as much (3 hours vs. 1.5 hours).

In another study of blue light, researchers at the University of Toronto compared the melatonin levels of people exposed to bright indoor light who were wearing blue-light–blocking goggles to people exposed to regular dim light without wearing goggles. The fact that the levels of the hormone were about the same in the two groups strengthens the hypothesis that blue light is a potent suppressor of melatonin. It also suggests that shift workers and night owls could perhaps protect themselves if they wore eyewear that blocks blue light. Inexpensive sunglasses with orange-tinted lenses block blue light, but they also block other colors, so they're not suitable for use indoors at night. Glasses that block out only blue light can cost up to $80.

Less-blue light

If blue light does have adverse health effects, then environmental concerns, and the quest for energy-efficient lighting, could be at odds with personal health. Those curlicue compact fluorescent lightbulbs and LED lights are much more energy-efficient than the old-fashioned incandescent lightbulbs we grew up with. But they also tend to produce more blue light.

The physics of fluorescent lights can't be changed, but coatings inside the bulbs can be so they produce a warmer, less blue light. LED lights are more efficient than fluorescent lights, but they also produce a fair amount of light in the blue spectrum. Richard Hansler, a light researcher at John Carroll University in Cleveland, notes that ordinary incandescent lights also produce some blue light, although less than most fluorescent lightbulbs.

What you can do

- Use dim red lights for night lights. Red light has the least power to shift circadian rhythm and suppress melatonin.
- Avoid looking at bright screens beginning two to three hours before bed.
- If you work a night shift or use a lot of electronic devices at night, consider wearing blue-blocking glasses.
- Expose yourself to lots of bright light during the day, which will boost your ability to sleep at night, as well as your mood and alertness during daylight.

May 1, 2012

Updated: September 2, 2015

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LEDs MAGAZINE

Light and human health: LED risks highlighted

Issues relating to the effects on health and well-being of artificial light are discussed in three recent publications; including one that says the blue-light component in white LEDs causes toxic stress to the retina.

By Tim Whitaker

It is now accepted that artificial night-time lighting has various effects on humans (not to mention wildlife) and that exposure to optical radiation affects human physiology and behavior, both directly and indirectly. Many areas are not well understood, and a position statement from the Illumination Engineering Society (IES) emphasizes mainly the need for further research. At the other end of the scale, a French government report emphasizes the risks of LED lighting and makes various recommendations.

IES position statement and DOE white paper

The Illumination Engineering Society (IES) has released a position statement entitled "Effects of Exterior Lighting on Human Health (PS-03-10)," which is not specific to LEDs. The document states that "optical radiation detected by the retina impacts an individual's behavior, psychology, and perception of the environment. The position of the IES is to promote and encourage a more complete understanding of human responses to optical radiation leading to improved designs for all lighted environments."

The way to achieve this, says IES, is through additional research with specific emphasis on additional field research to document typical exposures to optical radiation in exterior settings. The document also states that "the position of the IES is that typical exposures to exterior lighting after sunset have not been shown to lead to cancer or other life-threatening conditions."

Meanwhile, the DOE Solid-State Lighting program has produced a White Paper entitled "Light at Night: The Latest Science," which resulted from a panel session at the SSL Market Introduction workshop held in July 2010.

The white paper concludes that, given the available research, it is unclear what changes, if any, should be made to current best-practice lighting design. "It is clear that additional peer-reviewed

research and validation are required to determine the relative significance of the visual and the photo-neural effects of typical light exposures," says the report.

ANSES highlights risks from LED lighting

ANSES, the French Agency for Food, Environmental and Occupational Health & Safety, has published a report entitled (in English): " Lighting systems using light-emitting diodes: health issues to be considered," which focuses squarely on potential problems caused by LED lighting.

The full report is available in French only, but the report summary (in English) says that risks have been identified concerning the use of certain LED lamps, raising potential health concerns for the general population and professionals. "The issues of most concern identified by the Agency concern the eye due to the toxic effect of blue light and the risk of glare," says the report, adding that the blue light necessary to obtain white LEDs causes "toxic stress" to the retina.

Blue light causes a photochemical risk to the eye, says the report, the level of which depends on the accumulated dose of blue light to which the person has been exposed, which is generally the result of low-intensity exposure repeated over long periods. "Blue light is…recognized as being harmful and dangerous for the retina, as a result of cellular oxidative stress," says the report, adding that 3 groups are particularly at risk; children, populations which are already light-sensitive, and workers likely to be exposed to high-intensity lighting.

The other main risk is from glare. The report say that, for indoor lighting, it is generally agreed that luminance higher than 10,000 cd/m² causes visual discomfort whatever the position of the lighting unit in the field of vision. Because the emission surfaces of LEDs are highly-concentrated point sources, the luminance of each individual source can be 1000 times higher than the discomfort level. The level of direct radiation from this type of source can therefore easily exceed the level of visual discomfort. Other risks related to the use of LED lighting systems have also been raised, but futher study is required.

The report says that the photobiological safety standard (EN 62471) seems ill-adapted to lighting systems using LEDs, and that the Unified Glaring Rate used for the other types of lighting is unsuitable for LEDs. Among various recommendations, ANSES says that only LEDs falling into risk groups similar to those of traditional lighting systems be available to the general public, and that the highest risk lighting systems be reserved for professional use under conditions in which it is possible to guarantee the safety of workers.

Manufacturers and integrators of lighting systems using LEDs are encouraged to use optics or diffusers, for example, so that the beams of light emitted by the LEDs cannot be seen directly, to avoid glare. Manufacturers should also take account of the progressive wear of layers of phosphor in white LEDs, which in time could lead to devices being moved from one

photobiological risk group to a higher one, according to ANSES.

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Exposure to 'white' light LEDs appears to suppress body's production of melatonin more than certain other lights, research suggests

Date: September 12, 2011

Source: University of Haifa

Summary: Exposure to the light of 'white' LED bulbs appears to suppress melatonin five times more than exposure to the light of high pressure sodium bulbs that give off an orange-yellow light, according to new research.

FULL STORY

Exposure to the light of white LED bulbs, it turns out, suppresses melatonin 5 times more than exposure to the light of high pressure sodium bulbs that give off an orange-yellow light. "Just as there are regulations and standards for 'classic' pollutants, there should also be regulations and rules for the pollution stemming from artificial light at night," says Prof. Abraham Haim of the University of Haifa.

"White" light bulbs that emit light at shorter wavelengths are greater suppressors of the body's production of melatonin than bulbs emitting orange-yellow light, a new international study has revealed.

Melatonin is a compound that adjusts our biological clock and is known for its anti-oxidant and anti-cancerous properties.

The study investigated the influence of different types of bulbs on "light pollution" and the suppression of melatonin, with the researchers recommending several steps that should be taken to balance the need to save energy and protecting public health.

"Just as there are regulations and standards for 'classic' pollutants, there should also be regulations and rules for pollution stemming from artificial light at night," says Prof. Abraham Haim, head of the Center for Interdisciplinary Chronobiological Research at the University of Haifa and the Israeli partner in the research.

The study, by Fabio Falchi, Pierantonio Cinzano, Christopher D. Elvidge, David M. Keith and Abraham Haim, was recently published in the *Journal of Environmental Management.*

The fact that "white" artificial light (which is actually blue light on the spectrum, emitted at wavelengths of between 440-500 nanometers) suppresses the production of melatonin in the brain's pineal gland is already known. Also known is the fact that suppressing the production of melatonin, which is responsible, among other things, for the regulation of our biological clock, causes behavior disruptions and health problems.

In this study, conducted by astronomers, physicists and biologists from ISTIL- Light Pollution Science and Technology Institute in Italy, the National Geophysical Data Center in Boulder, Colorado, and the University of Haifa, researchers for the first time examined the differences in melatonin suppression in a various types of light bulbs, primarily those used for outdoor illumination, such as streetlights, road lighting, mall lighting and the like.

In the first, analytical part of the study, the researchers, relying on various data, calculated the wavelength and energy output of bulbs that are generally used for outdoor lighting. Next, they compared that information with existing research regarding melatonin suppression to determine the melatonin suppression level of each bulb type.

Taking into account the necessity for artificial lighting in cities, as well as the importance of energy-saving bulbs, the research team took as a reference point the level of melatonin suppression by a high-pressure sodium (HPS) bulb, a bulb that gives off orange-yellow light and is often used for street and road lighting, and compared the data from the other bulbs to that one.

From this comparison it emerged that the metal halide bulb, which gives off a white light and is used for stadium lighting, among other uses, suppresses melatonin at a rate more than 3 times greater than the HPS bulb, while the light-emitting diode (LED) bulb, which also gives off a white light, suppresses melatonin at a rate more than 5 times higher than the HPS bulb.

"The current migration from the now widely used sodium lamps to white lamps will increase melatonin suppression in humans and animals," the researchers say.

The researchers make some concrete suggestions that could alter the situation without throwing our world into total darkness, but first and foremost, they assert that it is necessary to understand that artificial light creates "light pollution" that ought to be addressed in the realms of regulation and legislation.

Their first suggestion of course, is to limit the use of "white" light to those instances where it is absolutely necessary. Another suggestion is to adjust lampposts so that their light is not directed beyond the horizon, which would significantly reduce light pollution. They also advise against "over-lighting," using only the amount of light needed for a task, and, of course, to simply turn off lighting when not in use -- "Just like we all turn off the light when we leave the room. This is the first and primary way to save energy," the researchers say.

"Most Italian regions have legislations to lower the impact of light pollution, but they still lack a regulation on the spectrum emitted by lamps. Unless legislation is updated soon, with the current trend toward sources as white LEDs, which emit a huge amount of blue light, we will enter a period of elevated negative effects of light at night on human health and environment. Lamp manufacturers cannot claim that they don't know about the consequences of artificial light at night," says Dr. Fabio Falchi of ISTIL.

"As a first step in Israel, for example, the Standards Institution of Israel should obligate bulb importers to state clearly on their packaging what wavelengths are produced by each bulb. If wavelength indeed influences melatonin production, this is information that needs to be brought to the public's attention, so consumers can decide whether to buy this lighting or not," Prof. Haim says.

Story Source:

The above post is reprinted from materials provided by **University of Haifa**. *Note: Materials may be edited for content and length.*

Journal Reference:

1. Fabio Falchi, Pierantonio Cinzano, Christopher D. Elvidge, David M. Keith, Abraham Haim. **Limiting the impact of light pollution on human health, environment and stellar visibility**. *Journal of Environmental Management*, 2011; 92 (10): 2714 DOI: 10.1016/j.jenvman.2011.06.029

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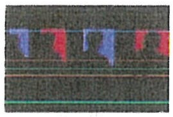

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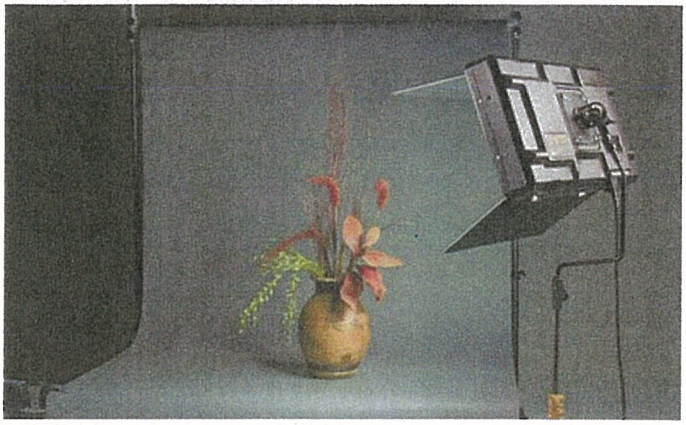
Color Temperature & Color Rendering Index DeMystified

"What is color? No object of itself alone has color.

We know that even the most brightly colored object, if taken into total darkness, loses its color. Therefore, if an object is dependent upon light for color, color must be a property of light.

And so it is."



Paul Outerbridge, Photographer 1896 - 1958

Color Temperature Defined

Color temperature has been described most simply as a method of describing the color characteristics of light, usually either warm (yellowish) or cool (bluish), and measuring it in degrees of Kelvin (°K).

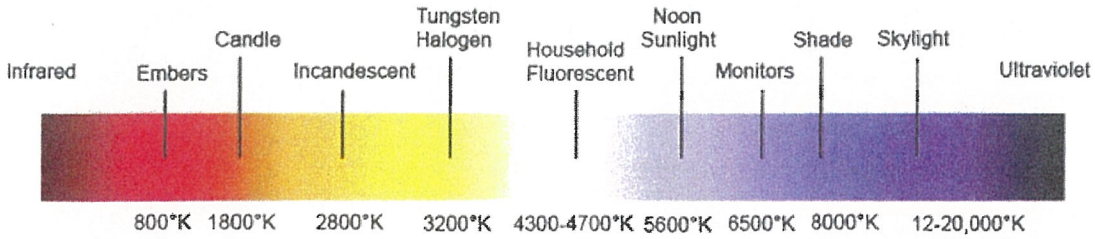
That's a little too simple to be of more than introductory value.

A more technical definition assigns a numerical value to the color emitted by a light source, measured in degrees of Kelvin. The **Kelvin Color Temperature scale** imagines a black body object--- (such as a lamp filament) being heated. At some point the object will get hot enough to begin to glow. As it gets hotter its glowing color will shift, moving from deep reds, such as a low burning fire would give, to oranges & yellows, all the way up to white hot. Light sources that glow this way are called "incandescent radiators", and the advantage to them is that they have a continuous spectrum. This means that they radiate light energy at all wavelengths of their spectrum, therefore rendering all the colors of a scene being lit by them, equally. Only light from sources functioning this way can meet the truest definition of color temperature.

Note - the light spectrum is wider than our ability to see it. Light values falling beneath the visible part of the spectrum are referred to as infrared, and above the spectrum as ultraviolet. Each can adversely affect an image, and you may need to add some filtration to remove them.

Light sources that are not incandescent radiators have what is referred to as a **"Correlated Color Temperature" (CCT)**. It's connotations to any part of the color temperature chart are strictly visually based. Lights with a correlated color temperature do not have an equal radiation at all wavelengths in their spectrum. As a result, they can have disproportionate levels (both high & low) when rendering certain colors. These light sources are measured in their ability to accurately render all colors of their spectrum, in a scale is called the **Color Rendering Index (CRI)**. Incandescant radiators have a CRI of 100 (the max.) More on this below.

Color Temperature in Imaging



The above is not a true Color Temperature chart. Instead it is a hybrid, showing the color temperatures of light sources most commonly encountered in professional imaging. In our scale, tungsten-halogen has a color temperature of 3200°K. Household fluorescents are accepted to be around 4500°K, depending on the lamp. (They are shown for reference, but would not be part of a true Color Temperature chart, for reasons described below).

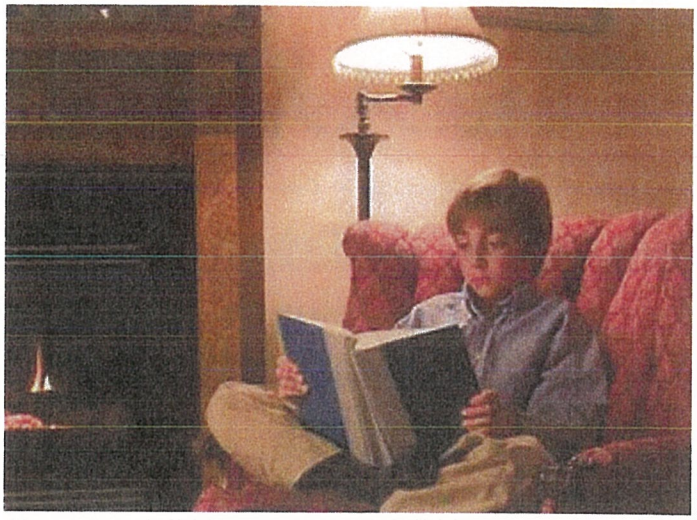
Sunlight is 5600°K, with shade & skylight hitting higher temperatures. These are basically averages which became standards when they were selected, back at the beginning of color film manufacturing, as the choices for various emulsions to be made sensitive to (daylight film, tungsten film, etc).

There are variations on these standards, but this is a good start to understanding the relationship between different colored light sources. It's important to keep in mind that even tho' reddish light has a technically lower color temperature, its frequently described as warm. Bluish light, which has a higher color temperature, is described as cool. In this instance, warmer & cooler describe color, not temperature.

The greenish color of 4500°K fluorescent would not appear in a true Color Temperature chart because a fluorescent lamp does not get its color by heating a black body object to the point of glowing, it uses gases & phosphors instead.

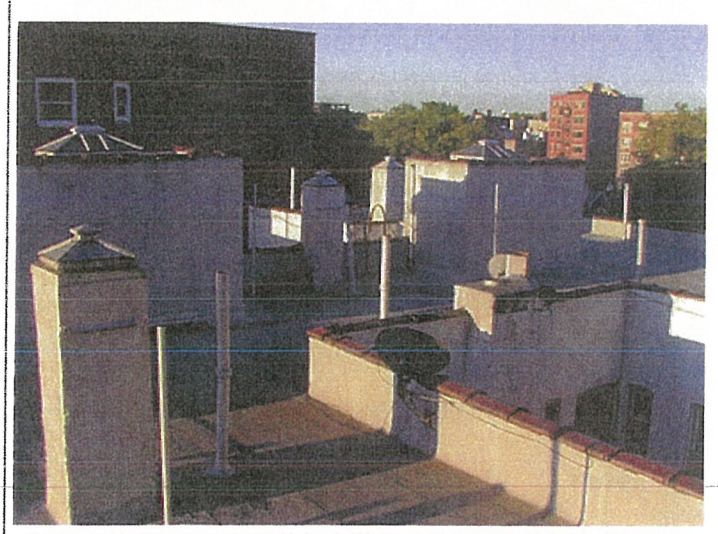
Household quality fluorescent lamps can have either too much green or magenta rendered in their color. The degree to which this occurs will affect the lamps CRI rating.

See Color Rendering Index (CRI) below for more information.



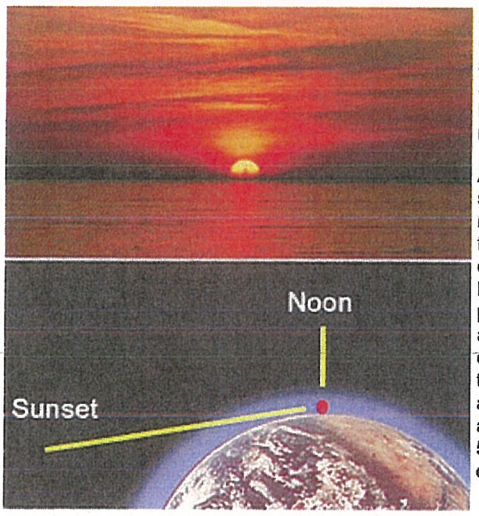
Tungsten incandescent, most common in household lamps, has a slightly lower color temperature at 2900°K than tungsten-halogen (aka quartz) at 3200°K, so its output will be slightly warmer. Incandescant lamps also shift their color, growing warmer as they age, something tungsten-halogen lamps don't suffer from.

Cinematographer Tom Robotham has a theory that we prefer the warm color of tungsten in our living environments because of our long pre-historic practice of sitting around campfires, and our pre-electric history of lighting early dwellings with fireplaces & candles. How many people have a wall dimmer in the dining room to set an intimate mood? Notice that when you dim tungsten lights, they get warmer in color, closer to flames & candles. Their color temperature is shifting lower when this happens.



Daylight is not the same as sunlight. Sunlight is the light of the sun only, where daylight is a combination of both sunlight & skylight.

Outdoors, shadows are lit by skylight, since sunlight is being blocked to create them. This is why shadows in exterior day-lit shots are bluish in color.



Sunlight changes its color as it crosses the sky (or more accurately, as the Earth rotates in relation to it).

At dawn & sunset the sun appears more reddish, due to the filtering nature of the denser atmospheric layer it's rays are passing thru at that angle. It has a correlated color temperature of approximately 2000°K at sunrise / sunset, and 5600°K when directly overhead.

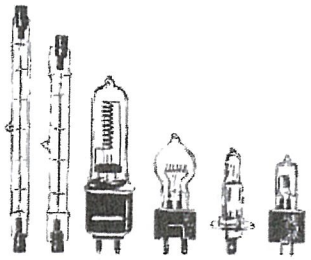
Sunset Photo by Marrike Van Irsel

Color Rendering Index

Color Rendering Index (CRI) Defined

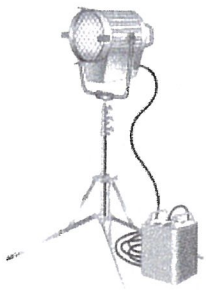
A simple definition of Color Rendering Index (CRI) would measure the ability of a light source to accurately render all frequencies of its color spectrum when compared to a perfect reference light of a similar type (color temperature). It is rated on a scale from 1-100. The lower the CRI rating, the less accurately colors will be reproduced. Light sources that are incandescent radiators have a CRI of 100 since all colors in their spectrum are rendered equally. As stated earlier, light sources that are not incandescent radiators will have Correlated Color Temperatures.

Examples of light sources with Correlated Color Temperatures, having CRI levels that are less than 100 would include: HMIs, and also most photo quality fluorescent lamps, as well as LEDs. With lower CRI ratings these sources may also have too much green or magenta in their spectrums. An acceptable Color Rendering Index level for professional imaging is considered to be 90 or above.



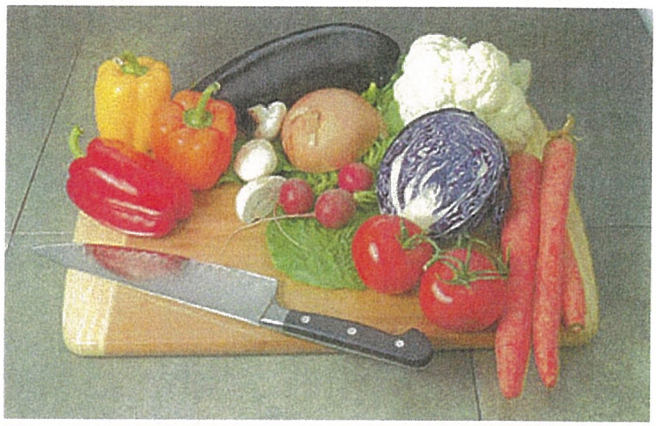
Tungsten-halogen 3200K
The lamp formerly known as Quartz has a more stable color temperature throughout the life of the lamp, than tungsten-incandescant. These lamps get hot and have shorter lifespans than some others. CRI is 100.

Fluorescent (Photo Quality) 3000-3200K, or 5000-5600K
Fluorescent lamps made for photo use are available in tungsten-halogen or daylight colors, with CRI's over 90. High frequency ballasts are flicker free even when shooting slo-motion.



HMI 6000K
HMI stands for Hydrargyrum Medium-arc Iodide lamp. This discharge lamp has a very high output of daylight color (usually 6000K), normally with a CRI of 95+.

LED (for imaging) 3000-6000K
LED stands for Light Emitting Diode. A semi-conductor based light source, that is energy efficient, with a long life. CRI is normally 70 - 90+, but subject to controversy.



Comparison of High & Low CRI Fluorescent Lamps
These 2 images are worth really studying. Both were shot with daylight colored fluorescent lamps and a camera with daylight preset white balance. The image on the left was shot with Lowel 27w day-flo lamps (CRI 92+), and the image on the right side was shot with a household day-flo lamps (CRI not listed, but assumed to be aprox. 80). Compare the details of each image, noting where the colors are pretty similar, such as the red & orange peppers, and the radishes. Then look at the items with colors rendered differently, such as the floor, cutting board, carrots, cabbage, and lettuce leaf, for example. A low Color Rendering Index does not mean all colors will shift, and no 2 lamps with the same low CRI rating will necessarily have the same errors in rendering.

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