This guide is designed to help builders and lighting industry professionals become more familiar with the nonresidential outdoor lighting measures in California’s Building Energy Efficiency Standards (Title 24, Part 6). The guide provides information on current lighting technologies, lighting design terms and principles, and best-practice recommendations. It is designed to complement lighting courses developed through CLTC and sponsored by Pacific Gas and Electric Company through its participation in the Statewide Codes and Standards program.
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THE BENEFITS OF EFFICIENT OUTDOOR LIGHTING

Energy and Cost Savings
Exterior lighting has shown a slow yet steady increase in California over the past several years. Outdoor lighting now accounts for approximately one fifth of California’s lighting electricity consumption. Inefficient light sources waste energy, as do luminaires that operate for long hours at full power, even when outdoor areas are vacant. California’s 2013 Building Energy Efficiency Standards (Title 24, Part 6) outdoor lighting requirements are designed to substantially reduce this energy waste. Lighting power allowances and other requirements are based on the most recent Illuminating Engineering Society (IES) recommendations, industry best practices, and the market availability of cost-effective, energy-efficient lamps, luminaires and controls.

Reduced Light Pollution
The 2013 iteration of Title 24, Part 6 replaces the cutoff classification system with the current IES-standard rating system for assessing backlight, uplight and glare (BUG). The new standards do not address backlight, but they specify uplight and glare rating requirements for luminaires based on their installed lighting zone. This will help minimize light pollution and reduce hazardous glare, creating a safer, healthier environment at night.

Improved Safety
Lighting plays a critical role in helping people navigate outdoor spaces safely at night. Implementing motion-sensing lighting controls, photosensors and scheduling controls are strategies included in the standards for improving efficiency and minimizing light pollution without compromising safety and security.

1 California Lighting Technology Center, Energy Efficiency & Renewable Energy Lighting Electricity Use in California: Baseline Assessment to Support AB 1109 (Task 2.18), May 2014.
2 TM-15-11: Luminaire Classification System for Outdoor Luminaires defines a classification system for outdoor luminaires that provides information to lighting professionals regarding the lumen distribution in zones of specific interest.
ABOUT THIS GUIDE

This guide is designed to supplement Section 6 of the California Energy Commission’s Nonresidential Compliance Manual, which covers the requirements for outdoor lighting. The guide is designed to help lighting industry professionals, contractors and others become more familiar with the latest Title 24, Part 6 nonresidential standards as they apply to outdoor lighting of hardscape areas.

The introductory section includes guidance for identifying and specifying compliant lighting products as well as an overview of the compliance process, from design to final inspection.

Concepts & Principles
This section of the guide covers lighting concepts such as lumen output, efficacy, color temperature, and color rendering.

Technology Overview
This portion of the guide describes the most common luminaire types for outdoor spaces, as well as available source technologies, sensors and control devices.

Requirements & Recommendations
The most critical code requirements for outdoor lighting and controls are explained in this section, along with recommendations for deploying effective and efficient outdoor lighting systems. Recommendations for meeting or exceeding the standards are provided, with case studies and examples of calculations that must be performed to verify compliance.

NOTE: This guide is not intended to be used in lieu of California’s Title 24 Building Energy Efficiency Standards, and it is not a substitute for the code itself. Please visit www.energy.ca.gov/title24 to download the official 2013 Title 24 Building Energy Efficiency Standards, Errata, Reference Appendices, and the Residential Compliance Manual.
OUTDOOR LIGHTING APPLICATIONS

The Title 24, Part 6 requirements for outdoor lighting apply to hardscape areas. This typically consists of the paved portions of an outdoor building site but may also include planters or other small areas of landscaping within the application area. Sections 110.9, 130.0, 130.2, 130.4, 140.7, and 150.0 apply to newly constructed outdoor lighting systems. Section 141.0 applies to outdoor lighting systems that are either additions or alterations.

The following outdoor lighting applications are regulated under Title 24, Part 6:

<table>
<thead>
<tr>
<th>Application</th>
<th>Code Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardscape areas:</td>
<td></td>
</tr>
<tr>
<td>Parking lots, private roadways, driveways, sidewalks, walkways, bikeways, and plazas</td>
<td>§ 130.2 Outdoor lighting controls and equipment</td>
</tr>
<tr>
<td></td>
<td>§ 140.7 Requirements for outdoor lighting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signage</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>§ 130.3(a)2 Outdoor sign lighting controls</td>
<td></td>
</tr>
<tr>
<td>§ 140.8(a) Maximum allowed lighting power</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>§ 140.8(b) Alternate lighting sources</td>
<td></td>
</tr>
</tbody>
</table>

The following items are not regulated under Title 24, Part 6:

- Outdoor lighting that serves facilities in occupancy group "I" such as hospitals and correctional facilities
- Temporary outdoor lighting
- Landscape lighting
- Lighting for athletic fields and playgrounds
- Lighting for outdoor live performances
- Outdoor lighting in qualified historic buildings
- Industrial site lighting
- Lighting of public monuments
- Lighting on public streets, roadways, highways, and traffic signs
- Lighting required and regulated by the Federal Aviation Administration (FAA) or US Coast Guard
THE COMPLIANCE PROCESS

Lighting industry professionals must understand and apply the standards during the design phase in order to create energy-efficient, code-compliant and cost-effective lighting systems. This guide focuses on the first three steps in the compliance process. Primary responsibility for compliance enforcement rests with the authority having jurisdiction (AHJ). An AHJ is typically associated with a city or county government.

Step 1: Comply with All Mandatory Measures
Sections 110.9, 130.0, 130.2, 130.3, 130.4, 141.0
All outdoor spaces must be designed to comply with the mandatory measures of Title 24, Part 6.

Step 2: Comply with All Prescriptive Requirements
Sections 140.7 and 140.8
In addition to meeting the mandatory requirements, hardscape areas must meet lighting power allowances specified within the standards. Lighting may not exceed the maximum lighting power allowance for the area where the lighting is installed. There are no allowance trade-offs available between outdoor and indoor lighting.

Step 3: Prepare and Submit Plans
The design team must make sure that plans include all required documents that building officials will need to verify compliance. The California Energy Commission’s Nonresidential Compliance Manual provides worksheets to ensure all necessary information is included. See the appendix of this guide for a list of required forms.

Step 4: Plans Examination
A building department plans examiner must check that the proposed lighting satisfies Title 24, Part 6 requirements and that the plans contain the information to be verified during field inspection. Once plans are approved, a building permit is issued.

Step 5: Complete Construction
The installation team must follow the approved plans and specifications, and the building department field inspector(s) must verify that the outdoor lighting is installed according to the approved plans.
Step 6: Commission Systems
Once installation is complete, lighting control systems must be properly commissioned. The site operators must also be advised of their responsibilities to maintain compliance with Title 24, Part 6 standards. They must be provided information or training on how to maintain and operate the area’s lighting and its energy features.

Step 7: Pass Inspection by an Acceptance Test Technician
Title 24, Part 6 requires that Acceptance Test Technicians (CLCATTs) review and test outdoor lighting controls installations to ensure controls operate as required by the standards.

CLCATTs trained and certified through an approved curriculum provider will:
- Review installation certificates and associated documentation
- Test installations to ensure controls are positioned and calibrated to operate in compliance with the standards
- Check that all necessary set points or schedules are in place as required by the standards
- Fill out required Certificates of Acceptance and submit these to the enforcement agency

Visit energy.ca.gov/title24/attcp for information on ATT certification providers.

Step 8: Provide Documentation to System Owners
Upon occupancy, the property owner or manager must be provided with copies of the energy compliance documents, along with instructions for operation and maintenance of lighting systems.

CALCTP-AT Technician Training

calctp.org
CALCTP is one of two training and certification programs recognized and approved by the California Energy Commission to carry out lighting controls acceptance testing as required by Title 24, Part 6.

In order to be certified as a CALCTP Acceptance Test Technician, a person must:
- Be employed by a listed CALCTP-certified employer: calctp.org/acceptance-technicians/contractors
- Have at least three years of experience with lighting controls
- Register on the CALCTP website: calctp.org/acceptance-technicians
- Take the training course offered at one of the CALCTP training centers: calctp.org/training-center-list
A Cure for the Common Pole: 66% Energy Savings
NorthBay VacaValley Hospital, Vacaville, CA

In 2014, a state-of-the-art outdoor lighting system was installed at NorthBay VacaValley Hospital. Dimmable LED luminaires were installed in the site’s parking lots, walkways, and emergency vehicle routes, replacing 40 induction luminaires, 13 high-pressure sodium luminaires and seven metal halide luminaires. The switch to LED reduced lighting energy use at the site by about 34%. Controls then cut the LED lighting’s energy use 49%, reducing the site’s lighting energy use by a total of 66% compared to pre-retrofit levels.

A photocell, time-clock, and motion sensor (PIR or long-range microwave) control each luminaire. Luminaires are also connected to a wireless mesh network lighting control system that allows the facility manager to adjust lighting schedules, luminaire groupings and light levels, gather revenue-grade energy metering data, receive automated maintenance alerts, and more.

A case study of the project is available at cltc.ucdavis.edu/publication/networked-adaptive-exterior-lighting-health-care-sector.
BEST PRACTICES

A layered and balanced approach to outdoor lighting is generally the most energy efficient, safe and comfortable. Rather than flooding an outdoor space with light, it is important to select the right sources and luminaires, place them strategically, and pair them with appropriate lighting controls.

Consult the recommended practice guides published by the Illuminating Engineering Society for each lighting application to ensure light levels meet the requirements for amenity while maintaining the required LPD.

Primary responsibility for compliance enforcement rests with the AHJ.

IES Recommended Practices

The following publications provide detailed guidance for outdoor lighting professionals. A complete list of IES publications is available at: ies.org/pdf/membership/lightinglibrary.pdf

- TM-11-00: Light Trespass: Research Results and Recommendations
- TM-15-11: Luminaire Classification System for Outdoor Luminaires
- TM-23-11: Lighting Control Protocols
- PB-315-09: Outdoor Lighting: Physics, Vision, and Perception
- HB-10-11: The Lighting Handbook
EFFICACY & PERCEIVED BRIGHTNESS

A number of new, energy-efficient, outdoor lighting solutions are available that can produce the same amount of light (lumens) as legacy sources while consuming less power (watts).

Luminous Output
The amount of visible light emitted by a light source is measured in lumens (lm). The more lumens, the more light emitted, but other factors also affect visibility and perception of brightness, such as contrast ratios and color characteristics. In addition, the type of fixture or housing can greatly affect the amount of lighting reaching its intended target.

★ Recommendations
- Compare the light output, not the power consumption, of existing and replacement light sources or luminaires to ensure adequate lighting is maintained.
- Consider other factors, such as contrast, distribution and color quality; these also affect nighttime vision and perceived brightness.
- Install lighting controls, such as motion sensors, to maximize energy savings while automatically tailoring light levels to occupants’ needs.

Luminous Efficacy
In lighting, the term efficacy refers to the ratio of luminous output produced by a light source to power consumed by that source (lm/W).

\[
\text{Efficacy} = \frac{\text{Lumens}}{\text{Rated Watts}}
\]

Different source technologies provide different efficacy levels. For example, a ceramic metal halide lamp typically has an efficacy of 75–110 lm/W while an LED source may produce up to 130 lm/W.

A Prescription for More Efficient Lighting
Kaiser Permanente, Fresno, CA
In May 2010, Kaiser Permanente joined five leading healthcare systems in forming the Healthier Hospitals Initiative with the goal of improving sustainability and lowering operating costs in the healthcare sector. Fresno was the first medical center within the Kaiser Permanente system to replace all of its existing HID parking lot lighting with LED luminaires. Annual energy savings from the retrofit are estimated at about 57%, saving approximately $20,000 in annual energy costs and bringing the project’s payback period to just five years. The LED luminaires also dramatically reduced maintenance costs.

The new lighting met the project team’s goal of improving illumination levels and uniformity for staff and visitors “The parking lots are well lit, and feel safe and secure,” says Kathy Boswell, staff project manager with National Facilities Services (NFS).

A case study of the project is available at cree.com/Lighting/Applications/Indoor-and-Outdoor-Applications/Healthcare/Kaiser-Permanente-Medical-Fresno-CA.
LIFE & LUMEN MAINTENANCE

When assessing the value of a new lighting system, initial product costs are only one factor to consider. It is also important to compare lifetime lighting performance, including how well the system will maintain the necessary light levels.

Electric light sources have the potential to fail due to several factors, including faulty electrical components or corrosion inside the lamp. Light sources also lose some of their initial lumen output over time. This gradual decrease in light output is called lumen depreciation.

High-pressure sodium lamps, like those often found in cobrahead luminaires, typically last 20,000–40,000 hours and lose about 20% of their initial lumen output before burning out. An induction lamp lasts about 100,000 hours and loses about 30% of its lumen output before failing.

LEDs do not fail suddenly in the same way that high-pressure sodium and many other legacy sources do. Instead, their lumen output decreases gradually over time. LED cobrahead luminaires are typically rated to last 50,000–100,000 hours before losing 30% of their initial lumen output.

Data from LED life testing programs indicates the diodes may maintain useful light output longer than previously predicted. Capacitors or other components that provide power to the LED circuit are more likely to fail before the LEDs reach their end of useful life.

★ Recommendations

Follow these best practices to achieve long-lived outdoor lighting systems:

- Pair LED luminaires with manufacturer recommended controls
- Observe manufacturers’ recommendations on operating temperature to prevent heat-related performance degradation
- Order models with dimming drivers
- When possible, connect light points with networked controls to improve control strategies
- If networked controls are not yet possible, plan for the future. Consider luminaires that can accept controls such as those have the NEMA 7-pin twist-lock receptacle on board.


COLOR CHARACTERISTICS

Color Temperature (CCT)
Correlated color temperature (CCT) indicates the warmth or coolness of a light’s appearance and is measured in Kelvin (K). Light sources with a low CCT emit a warmer light that is more yellow or amber in appearance while those with higher CCT values provide light with a cool white, or more bluish, appearance. Outdoor luminaires and lamps are available with CCTs ranging from about 2500 K to 6000 K.

Choose CCTs that are appropriate for the community. Encourage buy-in for installations by gathering input from occupants through surveys and smaller demonstration projects.

Metal Halide Retrofit in Davis, CA
The high-pressure sodium lamps to the left in this photo have a lower CCT, and a lower CRI, than the metal halide lamps to the right.
## Color Rendering (CRI)

The color rendering index (CRI) is the current industry standard for measuring how accurately a light source renders the colors of the objects it illuminates when compared to a reference light source. The maximum CRI value is 100. The Illuminating Engineering Society and the U.S. Department of Energy Municipal Solid-State Street Lighting Consortium recommend a CRI of 50 or higher for roadway and street lighting. For parking and area lighting, the DesignLights Consortium recommends a minimum CRI of 65.

<table>
<thead>
<tr>
<th>0 CRI, 1700 – 1800 K CCT</th>
<th>75 CRI, 6000 K CCT</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Image" /></td>
<td><img src="image2.jpg" alt="Image" /></td>
</tr>
</tbody>
</table>

**LED Retrofit in San Jose, CA**

These photos were taken before and after a streetlight retrofit in San Jose, CA. The pre-retrofit low-pressure sodium lights (left) have a low CRI while the post-retrofit LED lights (right) have a high CRI.

Beginning with the 2005 Title 24 standards, the California Energy Commission has specified lighting power allowances based on project locations and whether the surrounding environment is wild (dark), rural (characterized by low ambient light levels) or urban (characterized by higher ambient light levels).

The standards assign lighting power allowances based on four outdoor lighting zones, LZ1–LZ4. Lighting Zone 1 (LZ1) maintains the lowest illumination level with the lowest lighting power allowances; this is the default designation for government parks, recreation areas and wildlife preserves. LZ2 is the state default designation for rural areas, and LZ3 is the state default designation for urban areas. There are no Lighting Zone 4 (LZ4) areas in California, but LZ4 allows the highest lighting power allowances.

Lighting zones are based on the latest (2010) U.S. Census Bureau data. They are designed to help limit light pollution and ensure light levels are appropriate for the purposes different areas serve. General hardscape power allowances have been updated for Lighting Zones 1, 3 and 4 in the 2013 standards.

To determine the lighting zone for a project, visit the U.S. Census Bureau’s FactFinder website, factfinder2.census.gov, select Advanced Search, Geographies, and the Address tab. Then enter the site address to determine if the site is in an urban area. If this is not indicated, the site is designated as rural.

**Lighting Zone 1 (LZ1)**
Dark: parks and preserves

**Lighting Zone 2 (LZ2)**
Low: rural areas

**Lighting Zone 3 (LZ3)**
Medium: urban areas

**Lighting Zone 4 (LZ4)**
High

**NOTE:** LZ4 is not a default designation. LZ4 designation can only be granted by the Energy Commission when a local government applies for exceptionally high lighting power allowances.
Conscientious lighting designers have long sought to minimize adverse effects of nighttime lighting with luminaires that limit **backlight** (or light trespass), **uplight** (sky glow or light pollution) and **glare** (high-angle brightness). In 2005, the Illuminating Engineering Society (IES) began implementing the TM-15-07/BUG system in place of its older cutoff system of luminaire classification.

The BUG rating system helps lighting designers and engineers select luminaires that meet state and local requirements for different outdoor lighting zones (LZ1–LZ4). The BUG system also allows for better comparison of solid-state luminaires with traditional HID luminaires.

The 2013 Title 24, Part 6 standards replace the cutoff system with the BUG rating system and include requirements limiting uplight and glare in certain applications. These requirements are based on best practices for lighting different applications while minimizing light pollution and energy waste.
A BUG rating consists of three parts, which indicate how well the luminaire controls backlight, uplight and glare. Lower ratings indicate minimal amounts of stray light, light pollution or glare. The lowest possible rating in each category is 0 (B0, U0 or G0). Higher ratings, the highest being 5 (B5, U5 or G5), indicate poorer control. For example, a luminaire rated B2 - U0-G1 delivers mediocre control of backlight, offers excellent control of uplight, and controls glare well.

BUG ratings correspond with the amount of light emitted at each secondary solid angle within the backlight, uplight or glare angles. Tables 130.2-A and 130.2-B of the standards list the zonal lumen maximums allowed for uplight and glare within each outdoor lighting zone. The standards do not include backlight requirements. The BUG ratings for different luminaires are included in most manufacturers’ photometric reports.

**Compliance Requirements**

**Applications with Uplight and Glare Limits:** Outdoor luminaires using lamps or light sources rated greater than 150 watts must comply with uplight and glare limitations if installed in the following areas:

1. Parking lots and service stations
2. Building entrances
3. All canopies
4. Outdoor dining areas
5. All outdoor sales areas

**Applications without BUG Limits:** Lamps and luminaires in these applications are not required to comply with BUG requirements:

1. Signs
2. Building facades, public monuments, statues, and vertical surfaces of bridges
3. Lighting required for health or safety
4. Temporary lighting
5. Replacement pole-mounted luminaires in areas where all of the following are true:
   - Connected lighting power is not increased
   - No new wiring is being installed
   - No additional poles are being added
   - Spacing between poles is greater than six times the mounting height of the existing luminaires

State standards do not require luminaires selected for these purposes to comply with BUG limits, but best practices dictate limiting light trespass and preserving dark skies whenever possible.
### Maximum Zonal Lumens per Outdoor Lighting Zone

<table>
<thead>
<tr>
<th>Secondary Solid Angle</th>
<th>LZ1</th>
<th>LZ2</th>
<th>LZ3</th>
<th>LZ4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BACKLIGHT RATING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The standards do not include backlight requirements.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>UPLIGHT RATING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uplight High (UH) 100 to 180 degrees</td>
<td>10</td>
<td>50</td>
<td>500</td>
<td>1,000</td>
</tr>
<tr>
<td>Uplight Low (UL) 90 to &lt; 100 degrees</td>
<td>10</td>
<td>50</td>
<td>500</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>GLARE RATING FOR ASYMMETRICAL LUMINAIRE TYPES (TYPE I, TYPE II, TYPE III, TYPE IV)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Very High (FVH) 80 to 90 degrees</td>
<td>100</td>
<td>225</td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>Backlight Very High (BVH) 80 to 90 degrees</td>
<td>100</td>
<td>225</td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>Forward High (FH) 60 to &lt; 80 degrees</td>
<td>1,800</td>
<td>5,000</td>
<td>7,500</td>
<td>12,000</td>
</tr>
<tr>
<td>Backlight High (BH) 60 to &lt; 80 degrees</td>
<td>500</td>
<td>1,000</td>
<td>2,500</td>
<td>5,000</td>
</tr>
<tr>
<td><strong>GLARE RATING FOR QUADRILATERAL SYMMETRICAL LUMINAIRE TYPES (TYPE V, TYPE V SQUARE)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward Very High (FVH) 80 to 90 degrees</td>
<td>100</td>
<td>225</td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>Backlight Very High (BVH) 80 to 90 degrees</td>
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<td>750</td>
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<td>7,500</td>
<td>12,000</td>
</tr>
<tr>
<td>Backlight High (BH) 60 to &lt; 80 degrees</td>
<td>1,800</td>
<td>5,000</td>
<td>7,500</td>
<td>12,000</td>
</tr>
</tbody>
</table>

*Tables 130.2-A and 130.2-B in Title 24, Part 6*
Shelor Auto Mall replaced its 470 W metal halide shoebox luminaires with 280 W LED luminaires from American Electric Lighting® (AEL). The retrofit increased illumination levels, improved uniformity, and increased CRI from 65 to 70, enhancing the appearance of the vehicles on display. The LED luminaires are currently controlled by a time clock to operate until 1 a.m. The site plans to install an occupancy sensor on each pole, along with the ROAM network control system by Acuity Brands, which would increase scheduling flexibility and bring the lights up to full brightness any time an occupant is detected. Based on their daily hours of operation, the lights are expected to continue operating, virtually maintenance-free, for more than 20 years, a dramatic improvement over the MH luminaires, which required maintenance every two to three years.

A case study of the project is available at: acuitybrands.com/solutions/inspire-me/case-studies/shelor-motor-mile.
CHOOSING THE RIGHT LIGHT

An effective outdoor lighting system combines the right source technology with the right luminaire and the right lighting controls for the specific application it is designed to serve. The activities supported by each outdoor space, along with factors such as temperature and occupancy patterns, will determine which products offer the best solutions for a given project.

Selecting the right type of light source and the right lighting controls for a given application means comparing a variety of factors, including:

- Light output
- Efficacy
- Distribution
- Color characteristics
- Controls compatibility
- Product life performance and manufacturer warranties
- Long-term energy and cost savings

In many cases, a somewhat higher up-front investment in a more efficient, more functional lighting system yields a much higher return in the long term. This overview briefly describes the benefits and limitations of technologies currently on the market and offers guidance for selecting products that comply with state standards under Title 24, Part 6 and the Appliance Efficiency Regulations under Title 20.
COMMON SOURCE TYPES

This is an overview of common source technologies used in outdoor luminaires, with advantages and disadvantages of each technology. More information on how each type of lamp functions can be found in the glossary of this guide.

High-intensity discharge (HID) lamps are the most common type of lamp used for outdoor lighting, comprising more than 80% of outdoor lamps in the U.S.\(^4\) HID lamps include high-pressure sodium and metal halide lamps.

**High-pressure Sodium (HPS)**
These are the most prevalent type of lamp used in roadway and street lighting in California, accounting for an estimated 76% of installed sources.\(^5\) HPS lamps produce light with an amber or yellow appearance, and they provide color rendering with an average of 22–70.

**Low-pressure Sodium (LPS)**
LPS lamps are slightly more efficient than HPS lamps and produce light that is more yellow or amber in color. The narrow spectral output of LPS lamps makes them a good choice near observatories. LPS lamps take 5–10 minutes to reach full light output and must cool down before restarting, so they are better suited to applications requiring sustained lighting.

**Metal Halide (MH) & Ceramic Metal Halide (CMH)**
These lamps can produce white light with CRI ratings of 60–96. They take about 2–10 minutes to reach full light output, and color tends to shift as the lamps age. These lamps have poor lumen maintenance and relatively low efficacy, but they produce more light than mercury vapor lamps and provide better color rendering.

**Compact Fluorescent Lamp (CFL)**
CFLs are about 75% more efficient than incandescent lamps and last about 8–10 times longer. CFLs do not perform well in cold temperatures, making them a poor fit for outdoor installations in cold climates.

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\(^5\) California Lighting Technology Center, University of California, Davis: The State of Street Lighting in California, 2012.
Linear Fluorescent
Commonly used in carports and parking garages, fluorescent lamps are fairly energy efficient and provide uniform levels of illumination over long periods. Fluorescent luminaires with dimmable electronic ballasts can be controlled with motion sensors to save energy.

Induction
Induction lamps have extremely long lifetimes due to the fact that they do not use filaments or electrodes, components which can limit product life. Induction lamps can also provide very good color rendering.

Halogen
Halogen lamps are 25% more efficient than standard incandescent lamps and emit a brighter white light with a somewhat higher color temperature. Halogen lamps are used outdoors in floodlights. They operate at extremely high temperatures and can emit intense glare without proper positioning and shielding.

Incandescent
Incandescent lamps are highly inefficient and short-lived, as compared to other outdoor sources. They do offer excellent color rendering, but they are generally better suited to indoor, rather than outdoor, applications.

Light-Emitting Diodes (LEDs)
A type of solid-state light source, LED lighting is highly energy efficient and offers very long life. LED luminaires are also compatible with many types of lighting controls and energy management systems. LED luminaires can produce light in a variety of colors. In addition to white-light LED lighting, there are color-changing LED lighting products available for decorative design purposes such as building facade lighting. LEDs are well suited to cold temperatures, but they are sensitive to heat.
OUTDOOR LIGHT SOURCES

When considering various lighting products, lumen output, efficacies, light quality metrics performance, lifetimes, and cost factors should be considered. The technology selection chart below compares common source types used for outdoor lighting.

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Typical Power Consumption (W)</th>
<th>Source Efficacy (LPW)</th>
<th>CCT (K)</th>
<th>CRI</th>
<th>Lifetime (Hours)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-pressure sodium</td>
<td>70–400</td>
<td>80–120</td>
<td>1,900–2,200</td>
<td>22–70</td>
<td>20,000–40,000</td>
<td>$$</td>
</tr>
<tr>
<td>Low-pressure sodium</td>
<td>55–180</td>
<td>130–170</td>
<td>1,700–1,800</td>
<td>—</td>
<td>16,000–20,000</td>
<td>$$</td>
</tr>
<tr>
<td>Ceramic metal halide</td>
<td>20–400</td>
<td>75–110</td>
<td>3,000–4,200</td>
<td>80–94</td>
<td>10,000–30,000</td>
<td>$$–$$$$</td>
</tr>
<tr>
<td>Metal halide</td>
<td>70–400</td>
<td>40–70</td>
<td>3,000–4,200</td>
<td>60–80</td>
<td>10,000–20,000</td>
<td>$$</td>
</tr>
<tr>
<td>CFL</td>
<td>20–70</td>
<td>80–85</td>
<td>2,700–5,000</td>
<td>80–85</td>
<td>6,000–12,000</td>
<td>$</td>
</tr>
<tr>
<td>Linear fluorescent</td>
<td>25–32</td>
<td>80–100</td>
<td>2,700–6,500</td>
<td>75–85</td>
<td>20,000–80,000</td>
<td>$</td>
</tr>
<tr>
<td>Induction</td>
<td>70–250</td>
<td>50–85</td>
<td>3,500–5,000</td>
<td>80–85</td>
<td>100,000</td>
<td>$$–$$$$</td>
</tr>
<tr>
<td>LED</td>
<td>40–250</td>
<td>Up to 130</td>
<td>2,700–6,000</td>
<td>50–90</td>
<td>Up to 35,000 or more</td>
<td>$$–$$$$</td>
</tr>
</tbody>
</table>

**NOTE:** Values are based on lamp sizes typically used in outdoor applications. These numbers are subject to change as technologies improve and market conditions change. When selecting a particular product, carefully consider the site, including its uses, occupancy patterns and end-users. Source efficacy is based on initial lumen output; system efficacy depends on the specifications of the luminaires and ballasts or drivers employed. Some outdoor applications may be best served by products with characteristics that fall outside of the ranges listed in this table.

*Source: California Lighting Technology Center (2013)*
CONTROL STRATEGIES

Sensors and lighting controls can achieve significant energy savings by automatically switching or dimming lights based on time of day, available daylight, occupancy, vacancy, or the scheduling commands of a lighting control system or building energy management system (EMS). An EMS can control an entire facility or multiple sites. Some control functionality is limited by the source it controls.

Motion Sensors
When an occupant is detected, luminaires are signaled brighten or turn ON. When the field has been vacant for a set “time-out” period, the lights automatically dim or switch OFF. A single motion sensor can be set to control an individual luminaire or several luminaires within a zone.

- Passive-infrared (PIR) sensors require a direct line of sight to function correctly
- Microwave sensors can detect motion through some, but not all, barriers
- Dual-technology sensors typically combine PIR and microwave technologies to reduce false triggers
- Ultrasonic sensors are not well suited to outdoor spaces because objects, such as trees moving in the wind, can cause false triggers

Tuning
Tuning, also known as high-end trimming, allows dimmable luminaires to operate at a level below maximum output. For example, a set of parking lot lights controlled by motion sensors can be set to use 80% of full lighting power, instead of 100%, when occupants are detected. Tuning also allows for adjustments to low-level light settings. This reduces energy use and tailors illumination levels to each application.

Time Clocks
Astronomical time clocks, commonly used in outdoor applications, such as parking lots, switch lights ON or OFF based on daylight hours and geographical location. Some time-clocks and curfew dimming controls can automatically adjust dimmable sources, such as LEDs or CMH lamps, to operate at different levels according to a schedule. Dimming lights during the least active hours of the night reduces energy waste and light pollution.

Dimmable lighting systems also allow for transitional outdoor lighting during dusk or dawn hours. Dimming, as opposed to ON/OFF switching, is often preferred in applications where safety or security concerns merit maintaining some lighting even during typically unoccupied periods.

Daylight Harvesting Controls
Also called photocontrols, daylight harvesting controls use daylight sensors (photocells) to increase or decrease lighting loads based on a preset threshold and the ambient light level registered by the sensor. Photosensors can detect visible light, infrared (IR) light, or ultraviolet (UV) light.
Networked Control Systems

Networked lighting control systems can maximize energy savings and minimize maintenance requirements. The network can connect luminaires using pre-existing wiring, a new cable system, or a wireless communication system that employs radio frequency (RF) modules. Networked systems often allow users to see a detailed energy use profile, receive automated maintenance alerts, and adjust operating schedules. These features can often be accessed remotely, via the internet.

WIRELESS NETWORKED LIGHTING SYSTEM

In 2012, UC Davis installed a network of more than 1,400 “smart” LED luminaires controlled by occupancy sensors and connected through a radio-frequency mesh network.

The control system has a direction of travel feature that allows it to tailor light levels according to occupants’ rate and direction of travel, maximizing energy savings and safety. The network system’s software also allows facility managers to monitor energy use and occupancy patterns, receive automated maintenance alerts, and adjust lighting schedules, all from a laptop computer.

The lighting system has reduced lighting energy use in some areas of the campus by as much as 89%, saving about 1 million kWh and $100,000 annually in electricity and maintenance costs.

A case study of the project is available at: cltc.ucdavis.edu/publication/speed-case-study-campus-wide-networked-adaptive-led-lighting-uc-davis
EMERGING TECHNOLOGIES

Photovoltaic (PV) Lighting Systems
PV lighting systems gather solar energy using photovoltaic modules on solar panels, then store the energy collected in batteries that power the luminaires at night. Applications include pathway lighting, post-top luminaires, and canopies in parking lots. Some PV lighting systems are “stand-alone” systems entirely powered by solar energy, while others are hybrid systems that use both solar energy and electricity from the grid. In California today, the lighting installed under most PV canopies is connected to a utility grid. Specifying motion sensors and scheduling controls for PV lighting systems maximizes their energy efficiency.

Plasma Light Sources
Plasma lamps are in development as alternatives to other HID sources. Plasma offers the potential for high-efficacy lighting and long life, in a compact form factor.

Xenon Light Sources
Xenon technology has recently been applied to outdoor parking and area lighting. Research, development and testing are underway to determine how xenon products compare to LED, induction and ceramic metal halide products.
FINDING COMPLIANT LIGHTING DEVICES

California Appliance Efficiency Regulations (Title 20)

Some lighting products are regulated by the state’s Appliance Efficiency Regulations, Title 20, Article 4 of the California Code of Regulations. Lighting products regulated by Title 20 may be sold, specified or installed only if the appliance complies with the requirements in Title 20 and applicable products are certified to the California Energy Commission. Both federally-regulated and non-federally-regulated appliances are covered by Title 20.

Lighting technologies occasionally used in outdoor applications such as general service lamps, metal halide lamp ballasts and fluorescent lamp ballasts are regulated products. Dedicated LED luminaires designed for use in outdoor parking and area applications are not regulated by Title 20 at this time. A complete list of products for use in indoor and outdoor applications that comply with Title 20 and are certified to the Energy Commission can be found in the Appliance Efficiency Database at appliances.energy.ca.gov.

LIGHTING CONTROLS IN TITLE 20

Stand-alone lighting control devices have recently been adopted into Title 20. Section 1605.3 contains information on the regulation for this product category. The differentiation between “device” and “system” can help indicate whether a product needs to comply with Title 20. Systems contain two or more components. Although lighting control systems must perform the same functions as regulated devices if they are used in lieu of a stand-alone device, they are not listed in the appliances database. The following lighting controls devices commonly used in outdoor lighting applications are regulated by Title 20:

- Automatic Time-Switch Controls
- Astronomical Time-Switch Controls
- Multi-Level Astronomical Time-Switch Controls
- Outdoor Astronomical Time-Switch Controls
- Occupant Sensing Controls
- Photo Controls

Products Regulated by Title 24, Part 6

There are some lighting devices that are not currently regulated by Title 20, but must meet device performance requirements in Title 24, Part 6. For example, field assembled lighting control systems have minimum performance requirements listed in Section 110.9. With the increased use of networked lighting control systems in outdoor applications, it is important to specify controls that meet the requirements. Compliance requirements for part-night control devices are specified in Title 24, Part 6, Section 110.9(b)5, rather than Title 20. These requirements are detailed in Section 4 of this guide.
DesignLights Consortium (DLC)

The DLC is comprised of regional, state, utility, and energy efficiency programs throughout the U.S. and Canada. It provides guidance to architects, designers, builders, and commercial property owners interested in energy-efficient lighting technologies. The DLC maintains a Qualified Products List (QPL) that provides detailed information on reliable, commercially available products for the commercial sector.

In order to be listed on the QPL, a product must meet the efficacy and performance requirements set forth by the DesignLights Consortium. These requirements are generally more stringent than those of Energy Star, Title 20 or Title 24, Part 6. For this reason, the QPL is an excellent resource for finding high-performance lighting products. Lighting specifiers must still ensure that the products they select comply with both Title 20 and Title 24, Part 6 requirements.

QPL LUMINAIRES

Outdoor luminaires on the QPL include:
- Outdoor pole/arm-mounted luminaires
- Wall-mounted luminaires
- Bollards
- Parking garage luminaires
- Canopy luminaires
- Landscape/accent flood and spot luminaires
- Stairwell and passageway luminaires

California’s utility companies work closely with the DLC to specify performance specifications for lighting devices on the QPL. As a result, many utility rebates and incentives are only available for QPL products. Check with local utility representatives during project planning to see which lighting products qualify for rebates or incentives.
NEW IN 2013: AN OVERVIEW OF UPDATES

The following is an overview of the significant changes in the outdoor lighting requirements in the 2013 iteration of Title 24, Part 6:

**More retrofits must meet new-construction standards**
When alterations affect 10–50% of the luminaires in an installation, just the affected luminaires must be brought up to the new 2013 standards. When a renovation or retrofit project affects more than 50% of the luminaires in a lighting system, all the luminaires in that lighting application must comply with the 2013 standards. If any alteration increases the connected lighting load, the entire lighting system must meet the 2013 standards.

**Photocontrols AND scheduling controls required**
Under the 2008 standards, outdoor lighting had to be equipped with a photocontrol or astronomical time switch to turn OFF outdoor lighting during the day. Outdoor lighting must be separately controlled from indoor lighting. When using a photocontrol, an automatic scheduling control such as a timeclock must also be used to meet the new requirement.

**Occupancy controls required for luminaires mounted up to 24 feet above the ground**
Outdoor luminaires mounted 24 feet above the ground or lower must be equipped with lighting controls that automatically reduce lighting power 40–80% during vacant periods and automatically restore higher light levels upon occupancy.

**New control options for outdoor sales lighting**
Lighting in outdoor sales areas, including frontage, lots and canopies, may now utilize a part-night outdoor lighting control or motion sensing controls that automatically reduce lighting power 40–80% during vacant periods and automatically restore higher light levels upon occupancy. Previously, the use of automatic time switches were the only compliance option.

**Controls required for other applications**
Lighting for building facades, ornamental hardscape and outdoor dining areas must meet the same requirements as sales areas, but may use a time-based lighting control as an alternative. Previously, only facades were addressed.

**Uplight and glare limits**
The IES-standard rating system for assessing backlight, uplight and glare (BUG) has replaced the cutoff classification system used in older versions of Title 24, Part 6. Luminaires rated for use with lamps over 150 watts must comply with uplight and glare limits in certain applications.
There are two steps to complying with Title 24, Part 6:

- **Meet all mandatory requirements** by installing required devices, including controls, and ensuring that they perform all functions required by the standards.

- **Meet all prescriptive requirements** by ensuring that the actual lighting power installed in a space is less than the allowed lighting power density for that space.

Mandatory and prescriptive measures for outdoor lighting apply to hardscape areas of nonresidential sites.

### Mandatory Requirements

These measures include standards for the circuiting of electrical loads, uplight and glare control requirements for luminaires, and lighting control requirements.

### Prescriptive Requirements

The prescriptive requirements for outdoor lighting in nonresidential areas address lighting power allowances for different lighting zones (LZ1 – LZ4). The performance approach also requires these same measures.

**Curfew Dimming for Parking and Area Luminaires**

Curfew dimming technologies, such as the system installed at California State University Long Beach, present significant energy saving opportunities. Combining dimmable sources with a controller that dims based on time of night can achieve comparable energy savings to utilizing occupancy sensors. Light level reductions can be as modest as 10% or as extensive as 90%, depending on the various needs of the lighting applications.

A case study of the curfew dimming demonstration at CSU Long Beach is available at:

cltc.ucdavis.edu/publication/curfew-dimming-parking-and-area-luminaires-csu-long-beach
ADDITIONS, ALTERATIONS & REPAIRS
Section 141.0

The standards define which measures qualify as repairs and which are considered alterations. Alterations affecting more than 10% of luminaires in a hardscape area must meet Title 24 requirements for mandatory controls. Alterations to more than 50% of the luminaires must also comply with the prescriptive requirements limiting lighting power density.

Additions
New lighting additions must meet all mandatory and prescriptive measures in the same manner as new construction.

Alterations
An alteration is any change to the outdoor lighting system that does not increase the outdoor illuminated area. Not every alteration requires compliance with all of Title 24, Part 6. Also, for certain types of alterations compliance is required for specific sections of the code only.

Altering to Existing Outdoor Luminaires

<table>
<thead>
<tr>
<th>Portion of Luminaires Undergoing Alteration</th>
<th>Compliance Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 50%</td>
<td>![Mandatory Controls](130.0, 130.2, 130.4) + ![Prescriptive Requirements](LPD allowances of $140.7)</td>
</tr>
<tr>
<td>10–50%</td>
<td>![Mandatory Controls](130.0, 130.2, 130.4)</td>
</tr>
<tr>
<td>Less than 10%</td>
<td>No measures required unless the connected load is increased. If the load is increased, the requirements are the same as a retrofit that replaces more than 50% of luminaires.</td>
</tr>
</tbody>
</table>

Maintenance and Repairs
Repairs do not trigger Title 24, Part 6 compliance requirements, meaning lighting can be maintained or repaired without needing to be updated to the latest standards. Replacing lamps and ballasts in an existing outdoor luminaire or keeping the luminaire housing but adding a lower energy-consuming LED retrofit kit is considered a repair. Repairs may not include wiring alterations or increase the energy consumption of the component, system or equipment being repaired.

After the 10% trigger point has been met, changing wiring or replacing components of a system (such as an entire cobrahead or shoebox luminaire) or equipment that is regulated by Title 24, Part 6 is considered an “alteration” and not a repair.
Mandatory Requirements

Both the mandatory and prescriptive requirements for outdoor lighting apply to hardscape and the other applications listed below.

Hardscape
- Parking lots
- Site roadways
- Sidewalks
- Driveways

Other Applications
- Canopies
- Drive-up windows
- Entrances or exits

- Walkways
- Bikeways
- Plazas

- Building facades
- Outdoor dining areas
- Sales frontage and lots
REQUIRED CONTROLS

All Outdoor Lighting
Section 130.2(c)1
All outdoor lighting must be:

- Circuited and controlled independently from other electrical loads and using an automatic scheduling control.
- Equipped with photocontrol OR an astronomical time switch device that turns OFF all lighting when sufficient daylight is available.

Incandescent-compatible Luminaires
Section 130.2(a)
A motion sensor is required for any outdoor luminaire capable of operating an incandescent lamp of 100 watts or more, even if it is not currently using an incandescent lamp.

Luminaires Mounted Up to 24 ft.
Section 130.2(c)3
When mounted so the bottom of the luminaire is 24 feet above the ground or lower, luminaires must be controlled as follows:

1. Automatic 40–80% dimming required during vacant periods
   When an area is unoccupied, controls should automatically reduce the lighting power of each luminaire at least 40% but no more than 80% or provide continuous dimming through a range that includes 40–80%. When the area becomes occupied, controls should automatically increase light levels.

2. Maximum 1,500 watts of lighting power may be controlled together.

EXCEPTIONS
1. Pole-mounted luminaires with a maximum rated wattage of 75W
2. Non-pole mounted luminaires with a maximum rated wattage of 30W
3. Linear lighting with a maximum wattage of 4W per linear foot of luminaire
4. Sales frontage, lots and canopies that use a part-night control device instead of a motion sensor
5. Lighting for building facades (except for wall packs), ornamental hardscape and outdoor dining areas that use a part-night control or centralized time-based lighting control instead of a motion sensor.

Why 24 Feet?
Testing determined that 24 feet is the current maximum height at which passive infrared sensors, the most commonly available sensor technology, can maintain reliable detection levels. Luminaire mounting height is measured from the bottom of the luminous opening.

Wall Packs
Where the bottom of a wall pack is mounted 24 feet above the ground or lower, the luminaire must be controlled by a motion sensor that automatically reduces lighting power 40–80% during vacant periods.
Part-night Control Requirements

Section 110.9(b)5

A part-night lighting control is a time-based or occupancy-based device programmed to reduce or turn OFF lighting power to an outdoor luminaire for a portion of the night.

To be in compliance, part-night controls must:

1. Predict sunrise and sunset within 15 minutes
2. Keep time accurately within five minutes
3. Be able to set back or turn OFF lighting at night via a time-clock or motion sensing device
4. Time-clock controlled devices must be fully programmable by users, so lighting can be set back or turned OFF from any time at night until any time in the morning

Lighting Control Systems and Lighting Control Devices

Section 110.9

LIGHTING CONTROL SYSTEMS

Lighting control systems have two or more components. They are not required to comply with Title 20 Appliance Efficiency Regulations, but they must meet the following Title 24, Part 6 requirements:

- Indicator lights may not use more than one watt of power per light
- An installation certificate is required and must be signed by the licensee of record; this also applies to energy management control systems
- For other compliance requirements: If the control system is installed to comply with the requirements for another control device, the system must comply with all requirements of that control device

SELF-CONTAINED LIGHTING CONTROL DEVICES

A self-contained lighting control device is a single, stand-alone control device that does not require additional components or devices to function. The following lighting control devices must comply with Title 20 Appliance Efficiency Regulations:

- Time-switch lighting controls
- Automatic daylighting controls including photocontrols
- Dimmers
- Occupant sensing controls
LUMINAIRE REQUIREMENTS
Section 130.2(b)

The IES-standard BUG rating system for assessing backlight, uplight and glare has replaced the
cutoff classification system used in previous versions of Title 24, Part 6. Tables 130.2-A and
130.2-B of the standards list maximum uplight and glare lumens allowed for luminaires installed
in different outdoor lighting zones (LZ1 – LZ4). Title 24, Part 6 does not include requirements
limiting backlight.

Applications with Uplight and Glare Limits
Outdoor luminaires using lamps or light sources rated greater than 150 watts must
comply with uplight and glare limitations if installed in the following areas:

- Parking lots
- Service stations
- Building entrances
- Canopies
- Outdoor dining areas
- Outdoor sales areas

Applications without BUG Limits
Lamps and luminaires in these applications are not required to comply with BUG requirements:

- Luminaires rated at less than or equal to 150 watts
- Signs
- Building facades, public monuments, statues, and vertical surfaces of bridges
- Lighting required for health or safety
- Temporary lighting
- Replacement pole-mounted luminaires in areas where all of the following are true:
  - Connected lighting power is not increased
  - No new wiring is being installed
  - No additional poles are being added
  - Spacing between poles is greater than six times the mounting height of the existing luminaires

Raley’s replaced 16 pole-mounted metal halide cobrahead luminaires in the parking
lot of its West Sacramento store with LED luminaires from Cree. Each of the old
luminaires drew an average of 346 watts. The LED luminaire are each controlled by
a motion sensor, allowing the lights to operate in high mode (149 watts) when
the lot is in use (just 55% of the time) and in low mode (52 watts) when it is empty.
Savings total nearly 17,000 kWh annually.
The prescriptive requirements for outdoor lighting apply only to hardscape areas. A lighting installation is in compliance if its installed lighting power is less than the allowed lighting power for the site. The standards specify different lighting power allowances for different lighting zones.

**Lighting Power Allowances**

<table>
<thead>
<tr>
<th></th>
<th>LZ1</th>
<th>LZ2</th>
<th>LZ3</th>
<th>LZ4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area Wattage Allowance (AWA)</strong></td>
<td>0.035 W/ft^2</td>
<td>0.045 W/ft^2</td>
<td>0.090 W/ft^2</td>
<td>0.115 W/ft^2</td>
</tr>
<tr>
<td>The total illuminated hardscape area included in the project multiplied by the AWA for the lighting zone.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Linear Wattage Allowance (LWA)</strong></td>
<td>0.25 W/lf</td>
<td>0.45 W/lf</td>
<td>0.60 W/lf</td>
<td>0.85 W/lf</td>
</tr>
<tr>
<td>The total perimeter length of the hardscape included in the project multiplied by the LWA for the lighting zone appropriate to the project. The total hardscape perimeter does not include areas that are not illuminated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Initial Wattage Allowance (IWA)</strong></td>
<td>340 W</td>
<td>510 W</td>
<td>770 W</td>
<td>1,030 W</td>
</tr>
<tr>
<td>An additional power allowance for small sites or unusual hardscape geometries. The IWA value for the project’s lighting zone is added—only once—to the total lighting power allowance for a site.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

 Adapted from Table 140.7-A in the Standards
Planters and Small Landscape Areas

Planters and landscape areas are included in general hardscape area calculations if:

1. Less than 10 ft wide or 10 ft long
   AND
2. Bordered on at least three sides by hardscape

**NOTE:** Planters and landscape areas are excluded from general hardscape area calculations if they are greater than 10 ft in both width and length. Perimeters of excluded areas may be included in calculation of the Linear Wattage Allowance (LWA) provided the perimeter abuts the illuminated hardscape.

Calculating Allowed Lighting Power

**General Hardscape Lighting Allowance + Additional Lighting Power Allowances**

Identify which lighting zone the project falls under (LZ1 – LZ4), and if the project site is subject to any local ordinances that exceed Title 24, Part 6 requirements. Use the plan view for all area and distance measurements, unless otherwise noted:

1. **Calculate the illuminated hardscape area:** This area is square, centered on each luminaire or pole, and is 10 times the luminaire mounting height. Subtract from this any areas within the square that are within a building, obstructed by a structure, beyond the hardscape area, or beyond property lines. Also subtract any planters or landscape areas larger than 10’ x 10’.

2. **Determine the general hardscape lighting allowance:** Multiply the illuminated hardscape area (from Step 1) by the area wattage allowance (AWA) for the appropriate lighting zone (see "Lighting Power Allowances" table).

3. **Calculate the perimeter length and linear wattage allowance (LWA):**
   Multiply the hardscape perimeter by the LWA for the appropriate lighting zone (see "Lighting Power Allowances" table).

4. **Find the total general hardscape lighting allowance:** Add the allowed wattage from steps 2 and 3. This total is the general hardscape lighting allowance for the illuminated hardscape area.

5. **Add any additional lighting power allowances for specific applications:**
   Check Table 140.7-B (see appendix) for any additional lighting power allowances that apply, and add these to the sum from step 4.

6. **Add the initial wattage allowance (IWA) if needed:** If needed, the IWA for the project lighting zone (listed in "Lighting Power Allowances") can be added to the site’s total lighting power allowance—but just once for the entire site.

Calculating Actual Lighting Power

Add the wattage of all non-exempt lighting systems (including ballast, driver or transformer losses) to determine the actual installed lighting power (W) of an installation and ensure it is less than the allowed lighting power.

Additional Lighting Power Allowances

Specific outdoor lighting applications merit additional lighting power allowances. These vary depending on which lighting zone the project is associated with (see appendix).
Example Exercise: Calculating the Power Allowance for a Parking Lot

Scenario
An outdoor parking lot 10,000 ft$^2$ in size is located in a commercial area categorized as Lighting Zone 3. Two 300 W luminaires are mounted at a height of 25' in a 5' x 25' island in the middle of the lot. The parking lot has 20' x 20' landscaped areas in each corner.

What is the total power allowance for this parking lot? Does the lighting comply with Title 24, Part 6?
Steps

1. Calculate the illuminated hardscape area, remembering to subtract any landscape areas over 10’ x 10’: The illuminated area for each 25’ pole is 250’ x 250’, so it extends beyond the actual hardscape of the parking lot and encompasses the 150 ft$^2$ entrance. Because the lot is not adjacent to other hardscape on the site, use the 10,000 ft$^2$ area of the lot itself, adding the 15’ x 10’ entrance and subtracting the four 400 ft$^2$ landscaped corners of the lot:

\[
10,000 \text{ ft}^2 + 150 \text{ ft}^2 - 1,600 \text{ ft}^2 = 8,550 \text{ ft}^2
\]

2. Determine the general hardscape lighting allowance. Multiply the illuminated hardscape area (Step 1) by the AWA for LZ3 (found in Table 140.7-A):

\[
8,550 \text{ ft}^2 \times 0.09 \text{ W/ft}^2 = 770 \text{ W} \text{ (rounded from 769.5 W)}
\]

3. Calculate perimeter length and linear wattage allowance. Multiply the hardscape perimeter by the LWA (listed by lighting zone in Table 140.7-A):

\[
405 \text{ ft} \times 0.6 \text{ W/lf} = 243 \text{ W}
\]

4. Add the power allowances determined in steps 2 and 3:

\[
770 \text{ W} + 243 \text{ W} = 1,013 \text{ W}
\]

5. Add any additional lighting power allowances for specific applications:

*None are listed in Table 140.7-B for this example.*

6. Add the IWA — only once for the entire site. The IWA for a site in LZ3 is listed in Table 140.7-A as 770W:

\[
1,013 \text{ W} + 770 \text{ W} = 1,783 \text{ W}
\]

Answer

Total power allowance for this hardscape area: 1,783 W.

**YES — the lighting installation complies.** The parking lot luminaires use a total of 600 watts, which is far less than the allowed. A more energy-efficient option, such as a 110 W LED luminaire (220 W total), could further improve the energy efficiency of this installation.
OUTDOOR SIGN LIGHTING

LIGHTING CONTROL REQUIREMENTS  
Section 130.3

All Outdoor Sign Lighting  
Lighting for all outdoor signs must be equipped with:

- A photocontrol AND an automatic time-switch control
  
  OR

- An astronomical time-switch control

EXCEPTIONS  
Signs inside tunnels and large, permanently covered outdoor areas that operate 24 hours per day, 365 days per year.

Signs Illuminated Night and Day  
All outdoor signs ON during the day and night must be equipped with a control that can automatically reduce lighting power at least 65% at night. This applies to signs illuminated for more than one daylight hour in addition to nighttime hours.

EXCEPTIONS  
Signs inside tunnels and large, permanently covered outdoor areas that operate 24 hours per day, 365 days per year.

Demand Responsive Electronic Message Centers (EMCs)  
Any EMC with a connected lighting power load greater than 15 kW must have a control that can reduce lighting power by at least 30% in response to a demand response (DR) signal.

HEALTH & SAFETY EXCEPTION  
EMCs that must remain at full lighting power due to health or safety regulations are exempt and not required to respond to DR signals.
SOURCE REQUIREMENTS

Section 140.8

All internally and externally illuminated signs must use approved sources or comply with maximum lighting power limits.

Compliant Sources

Section 140.8(b)

Signs equipped strictly with one or more of the following source types do not need to adhere to allowed lighting power limits:

- **High-pressure sodium (HPS) lamps**
- **Metal halide (MH) lamps** that are pulse start or ceramic with a minimum ballast efficiency of 88% OR pulse-start MH lamps using no more than 320 watts, but not 250 W or 175 W lamps, with a minimum ballast efficiency of 80%
- **Neon or cold cathode lamps** with a minimum transformer or power supply efficiency of at least 75% for a rated output current less than 50 mA OR a minimum efficiency of 68% when the rated output current is 50 mA or greater
- **Fluorescent lighting systems** that only use lamps with a minimum CRI of 80 OR use electronic ballasts with a fundamental output frequency of at least 20 kHz
- **LEDs** with a power supply efficiency of at least 80%
- **CFLs** that do not use medium screw-base sockets

Maximum Allowed Lighting Power

Section 140.8(a)

Signs with non-compliant source types must adhere to these lighting power limits:

- **Internally Illuminated Signs:** 12 W/ft² of the illuminated sign area
  For double-faced signs, count the area of just one face.
- **Externally Illuminated Signs:** 2.3 W/ft² of the illuminated sign area
  Luminaires with permanently installed ballasts or transformers: Use the operating input wattage of the lamp/ballast or lamp/transformer combination.

Sign Alterations

Section 141.0(b)2K

Certain alterations to existing signs, whether internally or externally illuminated, require compliance with the 2013 standards for sign lighting (Section 140.8):

1. The connected lighting load is increased
2. Over 50% of the ballasts are replaced and rewired
3. The sign is relocated, either on the same site or to a new site

Sign Maintenance and Repairs

Repairs do not trigger Title 24, Part 6 requirements, as long as they do not increase energy consumption. The standards define repairs as:

1. Replacement in kind of lamps, lamp holders or lenses, or ballasts
2. Alterations caused directly by the disturbance of asbestos
Astronomical time-switch: An automatic lighting control device that switches lights ON or OFF at specified times of the day, or during astronomical events such as sunset and sunrise, to prevent energy waste during periods when daylight is available. These devices can account for geographic location and calendar date. **Multi-level astronomical time switch** controls reduce lighting power in multiple steps between full light output and the OFF setting.

Beam angle: Also referred to as beam spread. The width of the cone of light emitted from a light source, defined from the center of the beam to the angle where the intensity of light is half of its maximum. Narrow beam angles create a spotlight effect while broader beam angles spread light more evenly across a larger area.

BUG rating system: The current industry-standard rating system for measuring how much light a luminaire emits in unwanted directions, namely backlight (B), uplight (U) and glare (G). Used in conjunction with TM-15-07 measurement procedures, the BUG system aids lighting designers, engineers and others in efforts to minimize and reduce light pollution.

Building entrance way: The external area of any doorway leading in or out of a building, including overhead doors. These areas serve any doorway, set of doors (including elevator doors such as in parking garages), turnstile, or other form of doorway.

Building façade: The outdoor surfaces of a building, not including horizontal roofing, signs, and surfaces not visible from any publicly accessible viewing location.
Canopy: A permanent structure, other than a parking garage area, consisting of a roof and supporting building elements, with the area beneath at least partially open to the elements. A canopy may be freestanding or attached to surrounding structures.

Carport: A covered, open-sided structure used primarily for the purpose of parking vehicles. A carport is not a garage.

Color rendering index (CRI): The standard scale used in the lighting industry to measure how accurately a light source renders colors in comparison to an ideal source (a blackbody radiator). The maximum CRI value is 100. Lamps and luminaires with a CRI of 80 or higher provide acceptable color rendering for outdoor applications where color rendering is important.

Compact fluorescent lamp (CFL): A type of fluorescent lamp. A CFL has a ballast incorporated in its base. CFLs’ curved fluorescent tubes give them a more compact shape, allowing them to replace incandescent lamps.

Correlated color temperature (CCT): Measured in Kelvin (K), CCT describes the color appearance of light emitted from a light source. Sources with a low CCT have a warmer (more red) appearance while sources with a high CCT have a cooler (more blue) appearance. Light sources with a CCT of 2700–3000K emit incandescent-like light. Lamps with a CCT in the range of 5000–6500K emit light that more closely resembles bright daylight on a clear afternoon.

Countdown timer switch: A device that turns lighting (or other loads) ON when activated, using one or more selectable count-down time periods, and automatically turns lighting (or other loads) OFF when the selected time period has elapsed.

Daylight control: An automatic lighting control device that uses one or more photosensors to detect changes in daylight contribution and automatically adjust electrical lighting levels accordingly. A multi-level daylight control adjusts the light output (luminous flux) of the electrical lighting system in either a series of steps or by continuous dimming in response to available daylight.

Dimmer: A lighting control device that varies the light output (luminous flux) of the electrical lighting system by changing the power delivered to that system.

Dimmer, continuous: Continuous dimmers vary the luminous flux of electrical lighting systems over a continuous range, from maximum to minimum light output. Unlike step dimmers, continuous dimmers allow for subtle, granular transitions between light levels.

Dimmer, step: Step dimmers vary the luminous flux of electrical lighting systems in one or more predetermined, discrete steps between maximum and minimum light output. Changes between adjacent steps, or light levels, are visually apparent.

Efficacy, lamp: The quotient of rated initial lamp lumens and the rated lamp power (lm/W) without including auxiliaries such as ballasts, transformers, and power supplies. Efficacy indicates how much light is produced by a lamp or lighting system for the amount of power it consumes.

Electronic message centers (EMCs): Electronically controlled signs formed by a light source or lighting system that produces a pixilated image. EMCs are also commonly referred to as LED signs. Bare lamps that create linear lighting animation sequences using chaser circuits, or “charger lights,” are not considered EMCs.

Energy management control system (EMCS): A computerized control system designed to regulate a building’s energy consumption by controlling the operation of one or more energy consuming systems. Some systems log occupancy patterns and can monitor environmental and system loads in order to optimize energy usage based on occupancy, energy needs and demand response signals.

Fluorescent lamp: A low-pressure electric-discharge lamp in which a phosphor coating transforms UV energy into visible light. Fluorescent coating, including linear fluorescent luminaires, require a ballast to start and to control the electrical current. Fluorescent lamps are about 50% more efficient than incandescent lamps, and they provide uniform levels of illumination for long periods of time.
Halogen lamp: A type of lamp that uses an electrical current to heat a filament until it emits light. The filament in a halogen lamp is surrounded by halogen gas, which helps protect the lamp and redirects the light, resulting in longer lamp life, higher CCT and 25% greater efficiency than incandescent lamps.

Hardscape: Paved areas of a project site, including structural features such as curbs, plazas, entries, parking lots, site roadways, driveways, walkways, sidewalks, bikeways, water features and pools, storage or service yards, loading docks, amphitheaters, outdoor sales lots, or private monuments and statuary. Titles 24, Part 6 requirements for outdoor lighting apply only to hardscape areas, though hardscape may include planters or other small areas of landscaping.

High-intensity discharge (HID) lamps: A group of point-source, electrical gas discharge lamps with the light emitting arc contained by a secondary bulb. HID lamps include metal halide (MH) and high-pressure sodium (HPS) lamps.

High-pressure sodium (HPS) lamps: A type of lamp that uses sodium in an excited state, along with other elements, to generate light. HPS lamps produce light with a yellow or amber color and provide poor color rendering. HPS is the most prevalent type of lamp used in roadway and street lighting in California.

Illuminance: The incident luminous flux density on a differential element of surface located at a point and oriented in a particular direction (lumens per unit area).

Illumination: Light incident on a surface or the general condition of being illuminated.

Incandescent: A type of omnidirectional lamp that uses energy supplied by an electrical current to heat a filament until it emits radiation; about 90% is emitted in the form of heat while 10% is emitted as visible light.

Induction lamp: A type of lamp that emits light by sending electricity through a gas, which discharges light that is then converted into the visible spectrum by passing through white phosphor. An induction lamp uses a special ballast or a generator to create the initial electrical current, much like fluorescent lamps. Induction lamps have a long lifespan.

Lamp: The lighting industry term for an electrical light source, such as an incandescent bulb or fluorescent tube.

Light-emitting diode (LED): A type of solid-state, directional light source. LEDs are highly energy-efficient, have very long lifetimes and are compatible with lighting controls and energy management systems. LED luminaires can produce light in a variety of colors, depending on the phosphors and other materials used in their production. Color-tunable LED luminaires can emit light that varies in color. LEDs are well suited to cold temperatures but sensitive to heat.

LED lamp: An LED component, device, or package, and other optical, thermal, mechanical, and electrical (control circuitry) components with an integrated LED driver (power source) and a standardized base that is designed to connect to the branch circuit via a standardized base, lamp holder, or socket.

LED luminaire: A complete LED lighting unit consisting of a light source and driver (power source), and other components (such as optics and a heat sink) designed to distribute the light and to position and protect the light source. The LED source itself may be a component, package, device, array, module, or lamp.

Lighting control devices: Singular lighting controls that require no additional components to be fully functional and are not operated as part of a lighting control system.

Lighting control system: Technology consisting of two or more components and capable of providing full functionality for lighting control compliance.

Low-pressure sodium vapor (LPS) lamp: A lamp type that uses sodium vapor and has an outer glass vacuum envelope surrounding an inner discharge tube to provide thermal insulation. LPS lamps are slightly more efficient than high-pressure sodium (HPS) lamps. LPS lamps produce light that is somewhat more yellow or amber in color than HPS lamps, with poor color rendering, but they are favored for outdoor lighting near observatories because they contribute little light pollution along key spectra while
giving off a great deal of light along the human eye’s most sensitive color frequency.

**Lumen:** Unit of measure for the amount of light emitted by a light source. A greater number of lumens indicates greater light output.

**Luminaire:** The lighting industry term for what is also commonly referred to as a light fixture. A luminaire is a complete lighting unit, generally consisting of a housing, socket, one or more lamps or solid-state lighting arrays, a base that connects the fixture to a power source, and lighting control elements.

**Luminance:** A photometric measure of light given off of a surface in a particular direction. It is generally measured in candela per square foot or per square meter. Luminance varies with the gloss characteristics of the given surface and the direction from which the surface is viewed.

**Luminous flux:** The rate at which a light source emits visible light, measured as lumens over time. Luminous flux is how light is defined for the purposes of lighting design and illuminating engineering.

**Mesopic vision:** The human eye’s mode of visual function under transitional or intermediate levels of illumination, such as those that occur at twilight or dusk. In a sense, mesopic vision is the use of both photopic and scotopic vision. Both rod and cone cells are employed for mesopic vision, though neither function optimally under low light level conditions.

**Metal halide lamp:** A type of HID lamp that can produce white light with CRI ratings of 60–96. Full light output takes about 2–10 minutes, and color tends to shift as the lamps age. Although these lamps have poor lumen maintenance and relatively low efficacy characteristics, they produce more light than mercury vapor lamps and provide better color rendering.

**Motion sensor:** A device that automatically turns lights OFF soon after an area is vacated. “Motion sensor” applies to a device that controls outdoor lighting systems. When the device is used to control indoor lighting systems, it is called an “occupant sensor” (or an occupancy sensor, occupant-sensing device, or vacancy sensor).

**Mounting height:** The distance from the ground to the lowest point of the luminaire, including the lens.

**Mercury vapor lamp:** An older type of high-pressure HID lamp that emits a blue-green light. Sale of ballasts for these lamps has been banned in the U.S. since 2008, due to the fact that mercury vapor lamps are significantly less energy efficient than other HID sources, including metal halide and high-pressure sodium lamps.

**Occupant sensor:** A device that automatically turns lights ON when an occupant is detected and OFF soon after an area is vacated. The term occupant sensor applies to a device that controls indoor lighting systems. When used to control outdoor lighting systems, it is called a motion sensor.

**Outdoor areas:** Areas external to a building, including, but not limited to, outdoor sales frontage areas and outdoor sales lots.

**Outdoor lighting zone:** A geographic area designated by the California Energy Commission in accordance with Title 24, Part 1, Section 10-114. Lighting zones are designated LZ1, LZ2, LZ3, and LZ4. Installations in LZ1 zones must comply with the lowest lighting power allowances, to preserve dark sky areas, including wilderness preserves. Rural areas are typically designated LZ2, and urban areas are typically designated LZ3 and granted the highest lighting power allowances accordingly.

**Outdoor sales frontage:** The portion of the perimeter of an outdoor sales area immediately adjacent to a street, road, or public sidewalk.

**Outdoor sales lot:** An uncovered paved area used exclusively for the display of vehicles, equipment or other merchandise for sale. All internal and adjacent access drives, walkway areas, employee and customer parking areas, and vehicle service or storage areas are considered hardscape and not considered outdoor sales lots.
Parking lot: A type of uncovered hardscape made for the purpose of parking vehicles.

Part-night lighting control: A time-based or occupancy-based device programmed to reduce or turn OFF lighting power to an outdoor luminaire for a portion of the night.

Paved area: An area that is paved with concrete, asphalt, stone, brick, gravel, or other improved wearing surface, including curbs.

Permanently installed lighting: All luminaires attached to the inside or outside of a building site, including: flexible lighting systems and lighting attached to walls, ceilings, columns or mounted on poles, in trees, or in the ground. This does not include portable lighting or lighting installed by the manufacturer in appliances.

Photocontrol: An electrical device that detects changes in illumination levels and controls lighting load at predetermined illumination levels. Automatically turns ON luminaires at dusk and turns them OFF at dawn.

Photopic vision: Visual function under high light levels. The cone cells of the human eye are most active under photopic conditions. These photoreceptors in the eye enable color perception and greater spatial acuity.

Portable lighting: Lighting with plug-in connections for electrical power, such as movable display lighting and other lighting that is not permanently installed.

Principal viewing location: Anywhere along the adjacent highway, street, road, or sidewalk running parallel to an outdoor sales frontage.

Public monuments: Statuary, buildings, structures, and/or hardscape on public land.

Readily accessible: Capable of being reached quickly for operation, repair or inspection, without necessitating climbing, removal of obstacles or the use of special access equipment.

Repairs: Title 24, Part 6 defines repairs as reconstruction or renewal measures taken for the purpose of maintenance of any component, system or equipment of an existing building.

Sales canopy: A canopy used specifically to cover and protect an outdoor sales area.

Scotopic vision: Visual function under very low light levels. The rod cells of the human eye are activated under scotopic conditions. Scotopic vision is associated with “night vision,” though mesopic vision plays a large role. Scotopic vision is characterized by high light sensitivity (as the eyes adapt to dark conditions), poor spatial acuity, and a lack of color perception.

Stairway: One or more flights of stairs with landings and platforms connecting them to form a continuous and uninterrupted passage from one level to another. An outdoor stairway is open on at least one side, except for required structural columns, beams, handrails and guards.

Temporary lighting: Under Title 24, Part 6, lighting is considered temporary if it uses plug-in connections and does not remain in operation longer than 60 consecutive days or more than 120 days per year. Christmas tree lots, for example, frequently use temporary lighting systems.

Time switch control: Also called a timer switch or timer, this type of device automatically controls lighting based on time of day.

Vacancy sensor: An occupant sensor that requires manual activation of lighting but automatically turns lights OFF soon after an area is vacated. The device also may be called a manual-ON occupant sensor or manual-ON/automatic-OFF sensor.

Vehicle service station: A gasoline, natural gas, diesel, or other fuel dispensing station.

Watt: The unit of measure for the electrical power used by a lamp or luminaire.
COMPLIANCE DOCUMENTS

When a building permit application is submitted to a local enforcement agency, the applicant also submits plans and energy compliance documentation. Instructions for completing compliance forms are provided in Section 6.6 of the Energy Commission’s Nonresidential Compliance Manual. The Energy Commission plans to have electronic documents replace paper documents for nonresidential building projects in 2015.

The following forms are required as part of this process:

- NRCC-LTO-01-E: Outdoor Lighting
- NRCC-LTO-02-E: Outdoor Lighting Controls
- NRCC-LTO-03-E: Outdoor Lighting Power Allowances
- NRCC-LTS-01-E: Sign Lighting

NR CC – LT O – 01 – E

NR: Nonresidential
LT: Lighting
Number in Sequence
CC: Certificate of Compliance
CA: Certificate of Acceptance
CI: Certificate of Installation
E: Used by Enforcement Authority
A: Used by Acceptance Tester
O: Outdoor
I: Interior
S: Signs
Table 10-114-A: Lighting Zone Characteristics and Rules for Amendments by Local Jurisdictions

<table>
<thead>
<tr>
<th>Zone</th>
<th>Ambient Illumination</th>
<th>Statewide Default Location</th>
<th>Moving Up to Higher Zones</th>
<th>Moving Down to Lower Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td>LZ1</td>
<td>Dark</td>
<td>Government designated parks, recreation areas, and wildlife preserves. Those that are wholly contained within a higher lighting zone may be considered by the local government as part of that lighting zone.</td>
<td>A government designated park, recreation area, wildlife preserve, or portions thereof, can be designated as LZ2 or LZ3 if they are contained within such a zone.</td>
<td>Not applicable</td>
</tr>
<tr>
<td>LZ2</td>
<td>Low</td>
<td>Rural areas, as defined by the 2010 U.S. Census. Special districts within a default LZ2 zone may be designated as LZ3 or LZ4 by a local jurisdiction. Examples include special commercial districts or areas with special security considerations located within a rural area.</td>
<td>Special districts within a default LZ2 zone may be designated as LZ3 or LZ4 by a local jurisdiction. Examples include special commercial districts or areas with special security considerations located within a rural area.</td>
<td>Special districts and government designated parks within a default LZ2 zone maybe designated as LZ1 by the local jurisdiction for lower illumination standards, without any size limits.</td>
</tr>
<tr>
<td>LZ3</td>
<td>Medium</td>
<td>Urban areas, as defined by the 2010 U.S. Census. Special districts within a default LZ3 may be designated as a LZ4 by local jurisdiction for high intensity nighttime use, such as entertainment or commercial districts or areas with special security considerations requiring very high light levels.</td>
<td>Special districts within a default LZ3 may be designated as a LZ4 by local jurisdiction for high intensity nighttime use, such as entertainment or commercial districts or areas with special security considerations requiring very high light levels.</td>
<td>Special districts and government designated parks within a default LZ3 zone may be designated as LZ1 or LZ2 by the local jurisdiction, without any size limits.</td>
</tr>
<tr>
<td>LZ4</td>
<td>High</td>
<td>None</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
### Table 140.7-B: Additional Lighting Power Allowance for Specific Applications*

<table>
<thead>
<tr>
<th>Lighting Application</th>
<th>LZ1</th>
<th>LZ2</th>
<th>LZ3</th>
<th>LZ4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WATTAGE ALLOWANCE PER APPLICATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use all that apply as appropriate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Building Entrances or Exits.</strong> Allowance per door.</td>
<td>30 W</td>
<td>60 W</td>
<td>90 W</td>
<td>90 W</td>
</tr>
<tr>
<td>Luminaires qualifying for this allowance shall be within 20ft of the door.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Primary Entrances, Senior Care Facilities, Police Stations, Hospitals, Fire Stations, and Emergency Vehicle Facilities.</strong> Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100ft of the primary entrance.</td>
<td>45 W</td>
<td>80 W</td>
<td>120 W</td>
<td>130 W</td>
</tr>
<tr>
<td><strong>Drive Up Windows.</strong> Allowance per customer service location. Luminaires qualifying for this allowance shall be within 2 mounting heights of the sill of the window.</td>
<td>40 W</td>
<td>75 W</td>
<td>125 W</td>
<td>200 W</td>
</tr>
<tr>
<td><strong>Vehicle Service Station Uncovered Fuel Dispenser.</strong> Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within 2 mounting heights of the dispenser.</td>
<td>120 W</td>
<td>175 W</td>
<td>185 W</td>
<td>330 W</td>
</tr>
<tr>
<td><strong>WATTAGE ALLOWANCE PER UNIT LENGTH (W/linear ft)</strong> May be used for one or two frontage side(s) per site.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor Sales Frontage. Allowance for 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. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.</td>
<td>No Allowance</td>
<td>22.5 W/linear ft</td>
<td>36 W/linear ft</td>
<td>45 W/linear ft</td>
</tr>
<tr>
<td><strong>WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft²)</strong> May be used for any illuminated hardscape area on the site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardscape Ornamental Lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 100W or less as determined in accordance with §130(d), and shall be post-top luminaires, lanterns, pendant luminaires, or chandeliers.</td>
<td>No Allowance</td>
<td>0.02 W/ft²</td>
<td>0.04 W/ft²</td>
<td>0.06 W/ft²</td>
</tr>
<tr>
<td><strong>WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft²)</strong> Use as appropriate provided that none of the following specific applications shall be used for the same area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Facades. Only areas of building façade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the façade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.</td>
<td>No Allowance</td>
<td>0.18 W/ft²</td>
<td>0.35 W/ft²</td>
<td>0.50 W/ft²</td>
</tr>
</tbody>
</table>
### Lighting Application

<table>
<thead>
<tr>
<th>Application</th>
<th>LZ1</th>
<th>LZ2</th>
<th>LZ3</th>
<th>LZ4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outdoor Sales Lots.</strong> Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other non-sales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within 5 mounting heights of the sales lot area.</td>
<td>0.164 W/ft²</td>
<td>0.555 W/ft²</td>
<td>0.758 W/ft²</td>
<td>1.285 W/ft²</td>
</tr>
<tr>
<td><strong>Vehicle Service Station Hard scape.</strong> Allowance for the total illuminated hard scape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hard scape area and shall not be within a building, below a canopy, beyond property lines, or obstructed by a sign or other structure.</td>
<td>0.014 W/ft²</td>
<td>0.155 W/ft²</td>
<td>0.308 W/ft²</td>
<td>0.485 W/ft²</td>
</tr>
<tr>
<td><strong>Vehicle Service Station Canopies.</strong> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.</td>
<td>0.514 W/ft²</td>
<td>1.005 W/ft²</td>
<td>1.300 W/ft²</td>
<td>2.2 W/ft²</td>
</tr>
<tr>
<td><strong>Sales Canopies.</strong> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.</td>
<td>No Allowance</td>
<td>0.655 W/ft²</td>
<td>0.908 W/ft²</td>
<td>1.135 W/ft²</td>
</tr>
<tr>
<td><strong>Non-sales Canopies.</strong> Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.</td>
<td>0.084 W/ft²</td>
<td>0.205 W/ft²</td>
<td>0.408 W/ft²</td>
<td>0.585 W/ft²</td>
</tr>
<tr>
<td><strong>Guard Stations.</strong> Allowance up to 1,000 ft² per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates, and vehicle contents. Qualifying luminaires shall be within 2 mounting heights of a vehicle lane or the guardhouse.</td>
<td>0.154 W/ft²</td>
<td>0.355 W/ft²</td>
<td>0.708 W/ft²</td>
<td>0.985 W/ft²</td>
</tr>
<tr>
<td><strong>Student Pick up / Drop off Zone.</strong> Allowance for the area of the student pick up / drop off zone, with or without canopy, for preschool through 12th grade school campuses. A student pickup/drop off is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 ft, times the smaller of the actual length or 250 ft. Qualifying luminaires shall be within 2 mounting heights of the student pick up / drop off zone.</td>
<td>No Allowance</td>
<td>0.12 W/ft²</td>
<td>0.45 W/ft²</td>
<td>No Allowance</td>
</tr>
<tr>
<td><strong>Outdoor Dining.</strong> Allowance for the total illuminated hard scape of outdoor dining. Outdoor dining areas are hard scape areas used to serve and consume food and beverages. Qualifying luminaires shall be within 2 mounting heights of the hard scape area of outdoor dining.</td>
<td>0.014 W/ft²</td>
<td>0.135 W/ft²</td>
<td>0.240 W/ft²</td>
<td>0.400 W/ft²</td>
</tr>
<tr>
<td><strong>Special Security Lighting for Retail Parking and Pedestrian Hard scape.</strong> This additional allowance is for illuminated retail parking and pedestrian hard scape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.</td>
<td>0.007 W/ft²</td>
<td>0.009 W/ft²</td>
<td>0.019 W/ft²</td>
<td>No Allowance</td>
</tr>
</tbody>
</table>

*All area and distance measurements in plan view unless otherwise noted.*
CODE COMPLIANCE SUPPORT

California Advanced Lighting Control Training Program (CALCTP)
calctp.org
CALCTP educates, trains, and certifies licensed electrical contractors and state-certified general electricians in the proper installation, programming, testing, commissioning, and maintenance of advanced lighting control systems made for commercial facilities.

California Energy Commission Appliance Efficiency Database
appliances.energy.ca.gov
The Appliance Efficiency Database contains all fixtures, systems, lamps, and devices currently certified to the California Energy Commission by their manufacturers as meeting applicable efficiency standards.

California Lighting Technology Center
cltc.ucdavis.edu/title24
Part of UC Davis, CLTC conducts research, development and demonstrations of state-of-the-art outdoor lighting systems. The center offers resources and training programs on energy-efficient lighting solutions that meet or exceed Title 24, Part 6.

Energy Code Ace
energycodeace.com
This new site developed by the California Statewide Codes & Standards Program provides free tools, trainings and resources to help users comply with Title 24, Part 6.

Energy Technology Assistance Program (ETAP)
energy-solution.com/etap
The Energy Technology Assistance Program was developed by Energy Solutions to assist local governments implementing energy-efficient retrofit technologies. More than 100 local government-agencies and public educational institutions utilized ETAP resources, which were available from August 2010 through April 2012. The ETAP website provides fact sheets and case studies on outdoor lighting systems.

Illuminating Engineering Society (IES)
ies.org
The IES is the foremost authority on lighting standards and best practices for creating energy-efficient lighting. The IES also publishes Recommended Practice guides for outdoor lighting.

Title 24 Building Energy Efficiency Standards
energy.ca.gov/title24/2013standards
The 2013 Title 24 standards are available on the Energy Commission website. The standards should be the first resource for any contractor, builder, or designer seeking information on Title 24, Part 6 requirements. The Nonresidential Compliance Manual clarifies issues not addressed in the standards regarding nonresidential outdoor lighting requirements.

Energy Standards Hotline
Toll-free in California: (800) 772-3300
Title24@energy.ca.gov
For those with questions regarding Title 24 compliance, the Energy Standards Hotline is available Monday through Friday, 8 a.m. – 12 p.m. and 1 – 4:30 p.m.
CLASSES

California Center for Sustainable Energy (CCSE) Events and Workshops
energycenter.org/events

Building Operator Certification California Training Schedule
theboc.info/ca/ca-schedule.html

Building Owners and Managers Association Online Education Schedule
boma.org/education/Pages/default.aspx

California Association of Building Energy Consultants Title 24 Resources
cabec.org/title24info.php

UTILITY EDUCATION & DEMONSTRATION CENTERS

All or most of these California utility centers host Title 24 lighting classes. They also house lighting technology demonstration spaces and tool lending libraries that can provide visitors with energy and light meters, data loggers, lighting design software, lighting design manuals, and other resources.

Online calendars list training events and workshops. Some websites also provide information on utilities’ rebate and incentive programs.

Pacific Gas and Electric Company (PG&E)
pge.com
- Pacific Energy Center (PEC)
  - San Francisco
- Energy Training Center
  - Stockton

Sacramento Municipal Utility District
smud.org
- Energy & Technology Center
  - Sacramento

San Diego Gas & Electric
sdge.com
- Energy Innovation Center
  - San Diego

Southern California Edison (SCE)
sce.com
- Energy Education Centers
  - Irwindale, Tulare and on-location in other cities

MANUFACTURER TRAINING CENTERS IN CALIFORNIA

Acuity Brands
Center for Light&Space
Berkeley, CA
acuitybrands.com

Eaton’s Cooper Lighting business
Online Design Center
cooperindustries.com

Lutron
California Experience and Training Center
Irvine, CA
lutron.com
For more information and resources about Title 24, Part 6, visit the CLTC website at cltc.ucdavis.edu/title24.