



design brief

OUTDOOR LIGHTING & TITLE 24

Summary

The California Energy Commission (CEC) introduced new Outdoor Lighting Standards in 2005 to conserve energy and reduce electricity peak demand. The Outdoor Lighting Standards regulate lighting power, controls, and allowed lighting fixture types. Illuminated signs are also covered by the Standards.

This design brief aims to explain the 2005 Outdoor Lighting Standards and discuss some energy efficient compliance strategies. First, the design brief illustrates which lighting applications are regulated by the Standards, and which applications are not. Next, the brief describes applicable lighting technologies, such as controls and cutoff luminaires that are mandatory for certain outdoor lighting applications. Third, concepts such as Lighting Zones and power limits are introduced. The design brief next describes how the Outdoor Lighting Standards address alterations and additions as well as special security needs. Finally, the design brief takes a look at how signs are addressed by the new Standards.

By the end of this design brief, the reader should understand how to comply with the 2005 Title 24 Outdoor Lighting Standards through good outdoor lighting design.

Introduction

Evolution of the Standards

In 1977, the Warren-Alquist Act created the CEC to reduce energy consumption in the State of California. The following year, the CEC adopted the first requirements for low-rise residential and

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Figure 1: Standards Timeline

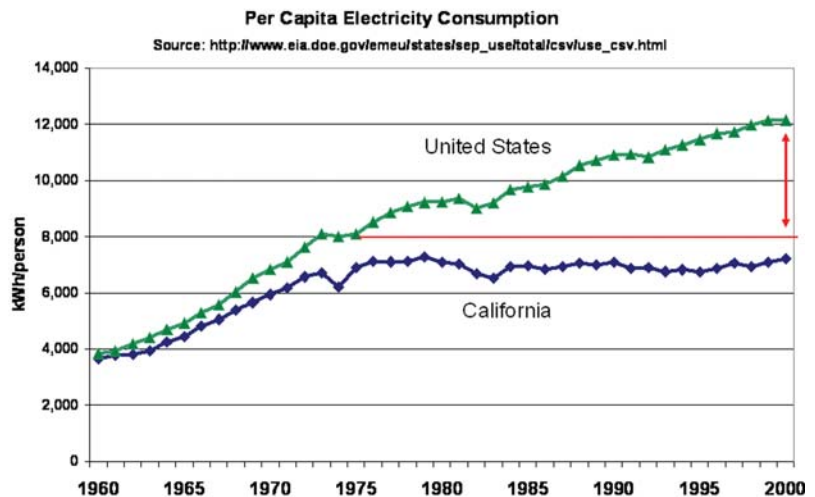


Source: Architectural Energy Corporation

nonresidential buildings based largely on ASHRAE 90-75. These Standards sought measures that would be both cost effective and result in long-term energy savings. The Standards have been continually updated since their inception through an open and public process. In April of 2001, in response to the 2000-2001 energy crises, the California Legislature passed Senate Bill 5X which directed the CEC to adopt Outdoor Lighting Standards that were technologically feasible and cost-effective. In 2005, these Standards became effective.

To date, California's building efficiency Standards (including appliance Standards) have saved more than \$56 billion in electricity and natural gas, and it is estimated the Standards will save an additional \$23 billion by 2013.¹ These savings have contributed to California's success in maintaining a relatively constant per capita electricity consumption since the late 1970's, as shown in Figure 2. The new Outdoor Lighting Standards are expected to save more than 17 GWh in the first year, and the savings are expected to increase each year thereafter.

Figure 2: History of Per Capita Electricity Consumption in California and US



Benefits

Outdoor lighting accounts for more than 3,000 GWh of annual electric energy use in California.² The Outdoor Lighting Standards are expected to reduce outdoor lighting energy by 30% by decreasing lighting power and requiring controls. Reduced consumption also creates spillover benefits by reducing air, water, and soil pollutants resulting from energy generation.

The Outdoor Lighting Standards will also inadvertently generate other non-energy benefits such as the reduction of light trespass and light pollution. Light trespass is defined as unwanted light from a neighboring property that is becoming an increasing nuisance. Potential sources of light trespass include street lighting, security lighting, sports lighting, billboards, and signs. Light pollution is light that is directed or reflected to the sky, creating a glowing effect that inhibits visibility beyond the immediate area.

Which Lighting Applications are Regulated

Table 1 provides a summary of lighting applications that are regulated by the Outdoor Lighting Standards, and a summary of lighting applications that are not. Details may be found in Section 147 of the Standards for general outdoor lighting applications and in Section 148 for outdoor signs. The Standards are available for free at www.energy.ca.gov/title24.

Controls

Basic Functions

All permanently installed outdoor lighting regulated by the Outdoor Lighting Standards requires either photocontrol or an astronomical time switch that automatically turns off the outdoor lighting when daylight is available, except in those areas that require illumination during daylight hours such as parking garages and tunnels. See Section 132 of the Standards for the full list of exceptions.

Figure 3: DPN Photocontrol



This standard twist-lock DPN (Part Night) photocontrol turns one or more lights on at dusk and off at dawn on the first night, but every night thereafter the lights are turned off exactly halfway through the night. The DPN automatically keeps track of the times of dusk and dawn as they change throughout the year, always turning the lights off halfway between dusk and dawn. The energy savings provided by half-night operation will quickly pay for this handy little device.

Source: American Electric Lighting
www.americanelectriclighting.com

Table 1: Regulated and Non-Regulated Applications

Regulated	Non-regulated
Automotive hardscape <ul style="list-style-type: none"> ■ parking lots* ■ driveways* ■ site roads* ■ vehicle service stations 	Temporary outdoor lighting
Pedestrian hardscape <ul style="list-style-type: none"> ■ plazas* ■ sidewalks* ■ walkways* ■ bikeways* 	Lighting required/regulated by <ul style="list-style-type: none"> ■ Federal Aviation Administration ■ Coast Guard Lighting for public streets, roadways, highways, and traffic signage, including lighting for driveway entrances occurring in the public right-of-way
Building entrances & facades*	Sports/athletic fields & children's playgrounds
Outdoor sales <ul style="list-style-type: none"> ■ lots* ■ frontage 	Industrial sites
Canopies <ul style="list-style-type: none"> ■ service stations ■ sales ■ non-sales 	Automated teller machines, including site area identified by the California Financial Code
Ornamental lighting	Public monuments, including flag illumination
Drive-up windows	Lighting used in or around swimming pools or water features
Guarded facilities	Tunnels, bridges, stairs, & ramps
Outdoor dining	Landscape lighting
Signs	Decorative gas lighting
	Theatrical lighting (Stage film & video production)
	Lighting required by a health or life safety statute, ordinance, or regulation, including but not limited to, emergency lighting

**Lighting tradeoffs are allowed between the indicated lighting applications.*

For certain applications, including building facades, parking lots, garages, and sales and non-sales canopies with two or more luminaires there is an additional requirement. An automatic time switch control is required that can reduce the amount of light below full power, allowing a reduction in light when, for example, a business is closed but some light is still desired for security or other purposes. This control must be able to automatically reduce lighting power within the range of 50% to 80%, in addition to being able to turn lights completely off if they are not needed. There are a few exceptions described in Section 132 of the Standards where this multi-level control capability is not required, such as lighting for facilities that are designed to operate continuously and therefore have constant lighting requirements.

Astronomical Time Switches

Section 119 of the Standards describes the following requirements for outdoor astronomical time switch controls used to control outdoor lighting. These controllers shall:

- Contain at least 2 separately programmable channels per function area
- Have the ability to independently offset the on and off times for each channel by 0 to 99 minutes before or after sunrise or sunset
- Have sunrise and sunset prediction accuracy within +/- 15 minutes and timekeeping accuracy within 5 minutes per year
- Store time zone, longitude, and latitude in non-volatile memory
- Display date/time, sunrise time, and sunset time
- Have an automatic daylight savings time adjustment
- Be capable of different programming schedules for weekdays and weekends
- Have program backup capabilities to prevent loss of the device's program and time setting for at least 10 hours if power is interrupted

Figure 4: Astronomical Time Switch



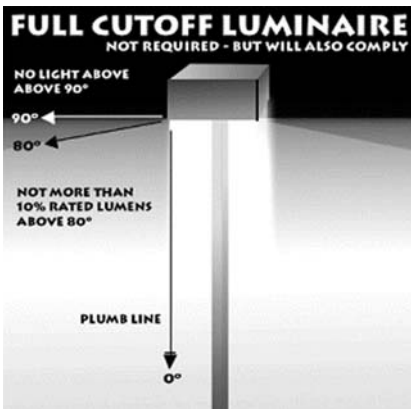
Source: HPM Controls,
<http://www.hpmcontrols.com.au>

Figure 5: Motion Sensor



Source: WattStopper,
<http://www.wattstopper.com>

Figure 6: Cutoff Luminaire



Source: Nonresidential Compliance Manual For
California's 2005 Energy Efficiency Standards,
www.energy.ca.gov/title24/

Motion Sensors

A motion sensor is a device that automatically switches off lighting soon after an area is vacated. Luminaires with lamp wattages greater than 100 must be either high efficacy, i.e. at least 60 lumens per watt, or controlled by a motion sensor. This requirement will have the greatest impact on fixtures designed for mercury vapor lamps and high wattage incandescent lamps. Most linear fluorescent, metal halide, and high-pressure sodium lamps have a lamp efficacy greater than 60 lumens per watt and will easily comply.

Certification

Photocontrols, astronomical time switches, and automatic controls must be certified by the CEC. The designer is responsible for the specification of products that are certified. All automatic outdoor lighting control devices must be certified by the manufacturer before they can be installed in a building. All certified devices are listed in the Directory of Automatic Lighting Control Devices.³ Contact the Energy Hotline at 1-900-772-3300 to obtain more information.

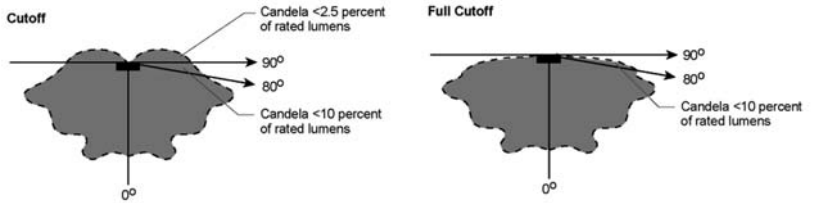
Cutoff Luminaires

The new Standards require cutoff luminaires in several applications for lamp wattages greater than 175 watts.

Cutoff luminaires are designed to minimize wasted light distribution above the horizontal plane of the luminaire. In order to qualify as a cutoff luminaire, the light output extending above the horizon (90° above nadir⁴) can be no greater than 2.5% while the light output at or above a vertical angle of 80° above nadir can be no greater than 10%. Nadir is the direction of straight down, as would be indicated by a plumb line. The cutoff luminaires requirement applies to lamps rated greater than 175 watts in hardscape areas, building entrances, sales and non-sales canopies, outdoor dining, and outdoor sales areas. Although not the intent of the Standards, cutoff luminaires reduce light pollution and potentially hazardous glare by focusing light downward onto the surfaces that they were intended to illuminate.

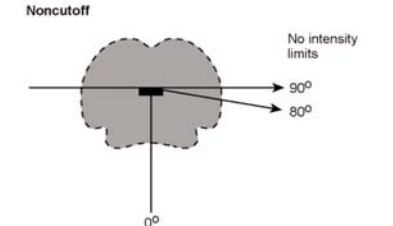
A photometric test report noting any tilt or other non-level mounting condition of the installed luminaire must be used to verify the luminaire’s cutoff classification. This information can be requested from the manufacturer, who might be able to provide a photometric report indicating the maximum tilt that will comply with the Standards. Otherwise, to factor a non-level mounting condition into the photometric report, use a protractor to draw a line at the installed angle on the cut sheet.

Figure 7: Classification of Cutoff Luminaires

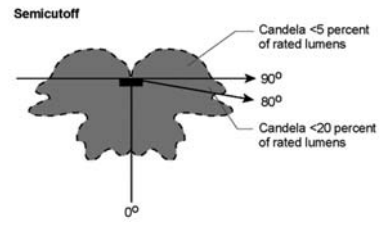


A cutoff luminaire sends most of its light below the horizontal, yet may still cause glare from high angle light. Light intensities above horizontal are limited to 2.5% of lamp lumens

A full cutoff luminaire directs all of its light below the horizontal. This type of distribution helps to minimize light trespass and pollution while reducing glare.



A non-cutoff luminaire distributes light in all directions and may be completely uncontrolled.



A semi-cutoff luminaire provides some optical control but still distributes a lot of light above the horizontal. Light intensities of up to 5% of lamp lumens may be emitted upward

Source: Architectural Energy Corporation

Outdoor Lighting Zones

Why?

The Outdoor Lighting Zones use surrounding lighting conditions to determine the appropriate allowable lighting power. This lighting power varies as a result of sensory adaptation. In areas of lower surrounding light intensity, the eye has adapted to the darker conditions and requires less light to see properly. The CEC defines the Lighting Zone boundaries based on the urban and rural boundaries of the U.S. Census Bureau.

What Are They?

Lighting Zone 1 – Darkest Ambient Illumination

Government designated parks, recreation areas, and wildlife preserves. Those parks, like neighborhood parks that are entirely contained within a higher Lighting Zone may be considered as part of that Lighting Zone by the local government.

Lighting Zone 2 – Low Ambient Illumination

Rural areas as defined by the 2000 U.S. Census. Roadways may be lighted according to typical residential standards.

Lighting Zone 3 – Medium Ambient Illumination

Urban areas as defined by the 2000 U.S. Census. Roadways may be lighted according to typical traffic route standards. The majority of outdoor lighting building permits being applied for are in Lighting Zone 3.

Lighting Zone 4 – High Ambient Illumination

The CEC has not specified a default for Lighting Zone 4. Local jurisdictions may designate Lighting Zone 3 areas as Lighting Zone 4 based on high intensity nighttime use.

Example

Q: How do I identify my Lighting Zone?

A: It's best to check with the local jurisdiction first. The local jurisdiction will know if the property is in a government-designated park, recreation area, or wildlife preserve.

Next you can consult the US Census Web site to determine if the zone is contained within a rural or urban census tract.⁵ By altering the BOUNDARIES input to include only "2000 Urban Areas" and altering the FEATURES input to include "National Park" and "Other Park" you can quickly access the information you need. The site also provides the option of searching by zip code for increased accuracy.

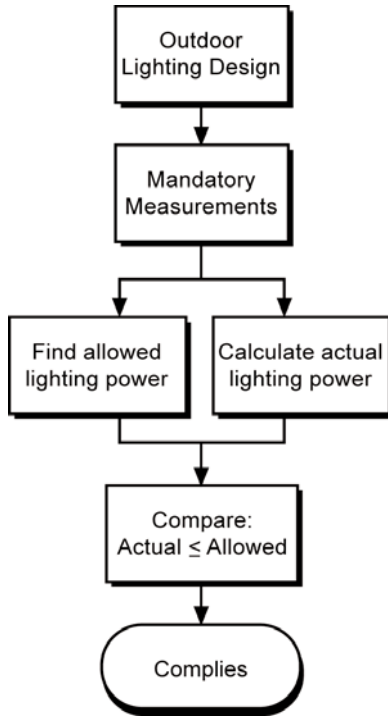
Finally, check the CEC's Web site to determine if the property is within the physical boundaries of a Lighting Zone that has been changed through a local jurisdiction adoption process.⁶

If a local jurisdiction says that the Lighting Zone of a particular property has been changed, but that change is not listed on the CEC Website, then the change is not yet effective.

Reclassification by Local Jurisdiction

The CEC sets statewide default Lighting Zones. However, local jurisdictions (usually city or county) may change the zones to better represent local conditions. Local governments may classify a portion of Lighting Zones 2 or 3 as Lighting Zones 1 or 4. The local jurisdiction may also classify a portion of Lighting Zone 3 as Lighting Zone 2 or even Lighting Zone 1. When a local jurisdiction adopts changes to the Lighting Zone boundaries, it must follow a public process that allows for formal public notification, review, and comment regarding the proposed change. The local jurisdiction must also provide the CEC with detailed information about the new Lighting Zone boundaries and submit justification to show that the new Lighting Zones are consistent with the Standards. The CEC has the authority to deny Lighting Zone changes if it determines the changes to be inconsistent with the specification of the Standards.

Figure 8: Lighting Compliance



Source: Nonresidential Compliance Manual For California's 2005 Energy Efficiency Standards, www.energy.ca.gov/title24/

Power Limits

The first step in determining the power allowance is to identify the lighting application and whether it is general or specific (see Table 2). Those applications that fit into the general category qualify for tradeoffs. Applications that fit into the specific category are “use-it-or-lose-it” and cannot be traded off.

Table 2: General and Specific Applications

General	Specific
Automotive hardscape* <ul style="list-style-type: none"> ■ parking lots ■ driveways ■ site roads 	Building facades
Pedestrian hardscape* <ul style="list-style-type: none"> ■ plazas ■ sidewalks ■ walkways ■ bikeways 	Outdoor sales frontage
Building entrances without canopy	Gas stations
Outdoor sales lots	Canopies
	Ornamental lighting
	Drive-up windows
	Guarded facilities
	Outdoor dining

**Hardscape is defined as an area whose surface has been enhanced to accommodate parking or travel. Such enhancements can include gravel, pavers, asphalt, cement, or other pervious or non-pervious materials.*

General

The Outdoor Lighting Standards regulate maximum lighting power limits for general site illumination that include the following areas: hardscape for automotive vehicular use including parking lots, driveways, and site roads; hardscape for pedestrian use including plazas, sidewalks, walkways, and bikeways; building entrances (without canopy); and outdoor sales lots.

A single lighting budget may be used for general site illumination applications and tradeoffs can be made. Other outdoor lighting applications are considered specific applications and do not allow for tradeoffs. The area of general illumination for a site may not include the areas for specific applications.

The allowed lighting power for general site illumination is calculated by determining the area or length of each lighting application and multiplying this area or length by the lighting power allowance. These allowances are listed in Table 147-A of the Standards and repeated here in Table 3.

Figure 9: Parking Lot Lighting



“Shoe Box” pole lights help improve system efficiency by shining the light downward where it is needed.

Source: American Electric Lighting, www.americanelectricleighting.com

Table 3: General Site Illumination Lighting Power Density Values (Table 147-A in the Standards)

Application	Area	Zone 1	Zone 2	Zone 3	Zone 4
Hardscape for automotive vehicular use: parking lots, driveways, and site roads	Method i: Actual paved area plus 5 foot perimeter of adjacent unpaved land. Includes planters and landscaped areas less than 10 feet wide enclosed on at least three sides by hardscape.	0.05 W/ft ²	0.08 W/ft ²	0.15 W/ft ²	0.19 W/ft ²
Hardscape for pedestrian use: plazas, sidewalks, walkways, and bikeways	Method i: Actual paved area plus 5 foot perimeter of adjacent unpaved land. Shall include all continuous paved area before including adjacent grounds.	0.06 W/ft ²	0.09 W/ft ²	0.17 W/ft ²	0.21 W/ft ²
Hardscape for driveways, site roads, sidewalks, walkways, and bikeways	Method ii: 25 foot wide path incorporating as much of the paved area of the site roadway, driveway, sidewalk, walkway, or bikeway as possible.	1.0 W/lf	1.5 W/lf	4.0 W/lf	5.0 W/lf
Building entrances without canopies	Width of doors plus 3 feet on either side times a distance of 18 feet outwards	0.35 W/ft ²	0.50 W/ft ²	0.70 W/ft ²	1.00 W/ft ²
Outdoor sales lot	Actual portion of uncovered outdoor sales lot used exclusively for display of vehicles or other merchandise for sale. All adjacent access drives, walkways, customer parking areas, vehicle service or storage areas that are not surrounded on at least three sides by sales areas are considered hardscape.	0.35 W/ft ²	0.70 W/ft ²	1.25 W/ft ²	2.00 W/ft ²

The Standards provide instructions on how to calculate the illuminated area, which at the upper limit is considered to be the area that falls within a square with the lighting fixture located in the center. The length of each side of that square is six times the luminaire mounting height. This area calculation must leave out any area that is within a building, under a canopy, beyond property lines, or obstructed by a sign or structure.

Parking Lots and Pedestrian Plazas

At a minimum, the illuminated area is the actual paved area that is illuminated. However, some non-paved areas can also be included. Planter boxes and other landscaped areas are considered illuminated areas as long as they are less than 10 feet wide and enclosed on at least three sides by the paved area. In addition, up to five feet of adjacent unpaved land can be included.

Parking lot luminaire light distribution should also generally be symmetrical, usually a square or circular shape. At the edge of the parking lot, forward-throw optics can be used to project light toward the center of the parking lot while minimizing the amount of wasted light that escapes the intended area of illumination. Metal halide, high-pressure sodium (HPS), and induction lamps ranging from 70 to 400 watts are recommended for this application.

Pedestrian plaza luminaires are similar to parking lot luminaires, but typically smaller in size and intensity. Reflective luminaires with metal halide, HPS, induction, or compact fluorescent lamps ranging from 26 to 100 watts are recommended for this application.

White light sources such as metal halide, induction, and compact fluorescent lamps are recommended over high-pressure sodium lamps due to the greater portion of energy emitted in the blue-green wavelengths of the spectrum that tend to enhance peripheral vision in conditions of low nighttime illumination.

Roadways, Driveways, Sidewalks, Walkways, and Bikeways

The maximum allowed illuminated area may be determined by either of the following methods:

- *Method 1:* The illuminated area may include the actual hardscape plus 5 feet on either side of the centerline path of travel.
- *Method 2:* The illuminated area may include a 25 foot wide area running along the axis of the path of travel. The allowed lighting power is calculated as the length of the centerline of the path multiplied by the allowed power per unit length.

Luminaires in these areas are intended to provide low-glare lighting to enhance nighttime visibility for motorists and pedestrians. Horizontal and vertical light distribution, pole height, pole spacing, and glare potential should all be considered when selecting the appropriate luminaires.

At night, peripheral vision, contrast detection, and motion sensitivity are key concerns for outdoor lighting related to security and roadway vision. For this application, using blue-rich lighting to preferentially stimulate the rods may be important. This suggests that metal halide lamps may be better suited for peripheral detection under street and roadway lighting than high-pressure sodium lamps.

Example

Q: I understand that stairs, along with tunnels and bridges, are exempt from outdoor lighting power limits, but what if a lighting fixture illuminates both the stairs and the surrounding hardscape?

A: What must be considered in this case is where the majority of the light from each luminaire falls. If the majority of the light falls on the stairs, then that luminaire it is indeed exempt. However, if most of the light falls on regular hardscape, then that luminaire is not exempt and must be included in the actual lighting power calculation.

Figure 10: Sidewalks



Source: PSE&G,
www.pseg.com

In certain instances, such as wildlife preserves and astronomical observatories, the use of metal halide lamps have been found to be disruptive.

Increasing Efficiency for Compliance

If the lighting power allowances are insufficient to meet design goals when using moderately efficient lighting technologies, it may still be possible to achieve compliance by increasing the efficiency of the specified fixtures. Lighting technologies such as pulse-start metal halide lamps and/or HPS lamps are capable of producing more light while consuming less power compared to other technologies. Using cutoff luminaires rather than full cutoff luminaires is another method of increasing illumination without increasing energy usage.

Specific Lighting Applications

Specific lighting application allowances are listed in Table 4 (Title 24 Standards Table 147-B). Each of these specific lighting application shall comply with the Standards independently, as tradeoffs are not permitted between specific lighting applications and general site illumination. In other words, these are “use it or lose it” allowances.

The allowed lighting power for specific lighting applications is the smaller of the product of the area of each lighting application and the allowed power density from Table 4, and the actual power used to illuminate the area. Luminaires qualifying for these allowances shall not be used to determine allowed lighting power for general site illumination or any other specific application.

Table 4: Specific Application Lighting Power Densities (Table 147-B in the Standards)

Application	Zone 1	Zone 2	Zone 3	Zone 4
Building facades	Not allowed	0.18 W/ft ²	0.35 W/ft ²	0.50 W/ft ²
Outdoor sale frontage	Not allowed	22.5 W/lf	38.5 W/lf	55.00 W/lf
Gas station	0.70 W/ft ²	1.15 W/ft ²	1.45 W/ft ²	2.40 W/ft ²
Gas station hardscape	0.05 W/ft ²	0.20 W/ft ²	0.40 W/ft ²	0.60 W/ft ²
All other sales canopies	Not allowed	0.70 W/ft ²	1.00 W/ft ²	1.25 W/ft ²
Non-sales canopies	0.12 W/ft ²	0.25 W/ft ²	0.50 W/ft ²	0.70 W/ft ²
Ornamental lighting	Not allowed	0.01 W/ft ²	0.02 W/ft ²	0.04 W/ft ²
Drive-up windows	0.12 W/ft ²	0.25 W/ft ²	0.50 W/ft ²	0.70 W/ft ²
Guarded facilities	0.19 W/ft ²	0.40 W/ft ²	0.80 W/ft ²	1.10 W/ft ²
Outdoor dining	0.05 W/ft ²	0.18 W/ft ²	0.35 W/ft ²	0.55 W/ft ²

Building Façades

A building façade is the exterior surface of a building, not including horizontal roofing, signs, and surfaces not visible from any reasonable viewing location. Building façades are architectural features that may be illuminated by flood lights, sconces, or other lighting attached to the building. Building façade lighting is not permitted in Lighting Zone 1.

Only the actual illuminated façade area may be counted when calculating the allowance for façade lighting. Façade orientations and façade areas that are not illuminated due to lighting obstructions shall not be included.

General site illumination and/or lighting for other specific applications can be attached to the side of a building without being considered façade lighting. However, each luminaire can only be assigned to one specific lighting application. Unshielded wallpacks mounted on the sides of a building are not considered façade lighting, since most of the light emitted by these fixtures will land on areas other than the building façade.

Ground-mounted and building-mounted uplight luminaires must be designed so that the light emitted will be directed at the building façade. This can be accomplished with precise beam spread selection, louvers, and shielding, as well as carefully selected mounting locations. Metal halide, PAR metal halide, HPS, compact fluorescent, induction, and LED lamps are recommended for this application. Furthermore, the luminaires should be designed to shed water and resist ice buildup. Luminaires should aim downward towards the façade, either recessed in soffits or arm mounted.

Sales Frontage

The portion of an outdoor sales lot along the street may qualify for additional lighting power over that allowed for general site illumination. This additional allowance is intended to accommodate the retailer's need to showcase merchandise for passing motorists.

The allowed lighting power for outdoor sales frontage is the smaller of the product of the frontage (in feet) and the allowed lighting power density per foot from Table 4, and the actual power used to illuminate the frontage.

Figure 11: Building Façade



Source: Nonresidential Compliance Manual For California's 2005 Energy Efficiency Standards, www.energy.ca.gov/title24/

Unshielded wallpacks mounted on the sides of buildings are not considered façade lighting since the majority of light emitted by these fixtures does not serve to illuminate the facade. Wallpacks are not only an expensive way to provide outdoor lighting, but are also an ineffective means towards this end.

Sales frontage is the unobstructed area immediately adjacent to the principal viewing location. A corner sales lot may include both sides provided that a principal viewing location exists for each side. Measured in plan view, only sections of the outdoor sales area that are along the frontage and are within three mounting heights of frontage luminaires are eligible for this power allowance. When using the sales frontage allowance, the area within three mounting heights may not be counted as part of the outdoor sales lot in the general site lighting calculation. Luminaires qualifying for this allowance must be located in plan view between the principal viewing location and the frontage outdoor sales area.

Light Vehicle Service Stations (Gas Stations)

The allowed lighting power density for vehicle service stations is the same whether or not they have a canopy. If a canopy exists, then the relevant lighting area is the horizontal projection of the canopy (or the canopy drip line). If a canopy does not exist, the lighting area is 500 ft² per double sided fuel dispenser and 250 ft² per single sided fuel dispenser. The lighting power allowance is listed in Table 4. Luminaires qualifying for this allowance cannot be used to determine the lighting power allowance for general site illumination or other specific lighting applications.

Service station hardscape is the paved area surrounding the fuel dispensers that is not part of the fuel dispenser area. The lighting power allowance for service station hardscape is listed in Table 6. Luminaires qualifying for this allowance cannot be used to determine the lighting power allowance for general site illumination or other specific lighting applications.

As a general recommendation, these luminaires should have a flat lens and either be completely recessed in the canopy or surface mounted. Induction lamps and metal halide lamps below 150 watts are recommended for canopy lighting. Lamp housing should be designed to minimize insect infiltration and plastic lenses should be UV resistant.

Example

Q: We have been commissioned to design the lighting of a natural gas/biodiesel fueling station in San Francisco. Would this application be covered by Title 24? If so, what is the lighting power density allowance? There are canopies over each row of pumps.

A: While this guide has made reference to such sites as “gas stations,” the exact phrase used in the Standards is “vehicle service station.” Yes, a natural gas/biodiesel fueling station would fall under this category.

Located in San Francisco, your site would most likely be classified as Lighting Zone 3. According to Table 147-B in the Standards, the lighting allowance is 1.45 W/ft² for area under the canopies and 0.40 W/ft² for illuminated hardscape areas beyond the canopy. Since these are specific applications, you will either use or lose these allowances.

Canopies

Canopies are permanent structures consisting of a roof and supporting elements. The space beneath a canopy must be at least partially open, otherwise it is considered a building. A canopy may have conditioned space above it, for example, when the first floor of a building is set back.

The lighting power allowance for a canopy is dependent upon its purpose. Service station canopies were addressed in the previous section and must be treated separately. The two types of canopies addressed in this section are those used for sales and those that are not used for sales. Non-sales canopies include covered entrances to hotels, office buildings, convention centers, and other buildings. Sales canopies cover and protect outdoor sales areas including garden centers, automobile sales lots, and other outdoor markets with permanent roofs. The lighting power allowances for these two canopy types are listed in Table 4.

Luminaires for sales and non-sales canopies are usually recessed into the canopies or overhangs. Induction lamps and metal halide lamps below 150 watts are recommended for canopy lighting. Lamp housings should be designed to minimize insect infiltration and plastic lenses should be UV resistant.

Figure 12: Canopies



Source: Architectural Energy Corporation
Photographer: Tom Bergstrom

Figure 13: Drive-Up Windows



Source: Architectural Energy Corporation
Photographer: Tom Bergstrom

Ornamental Lighting

Ornamental lighting includes post-top luminaires, lanterns, pendant luminaires, chandeliers, and marquee lighting. The lighting power allowance is based on the area of the site external to the buildings. Luminaires used for ornamental lighting shall have a rated wattage, as listed on a permanent factory-installed label, of 100 watts or less and are defined in Section 101 as post-top luminaires, lanterns, pendant luminaires, chandeliers, and marquee lighting. The lighting power allowances for ornamental lighting are listed in Table 4.

Drive-Up Windows

Drive-up windows are common for fast food restaurants, banks, and parking lot entrances. In order to qualify as a drive-up window, someone must be working behind the 'window'. Automatic ticket dispensers in parking lots do not qualify. The lighting area of a drive-up window is the width of the window plus 6 feet (3 feet on each side) multiplied by a maximum distance of 30 feet outward from the window. The distance from the window may not extend beyond the property line or further than 4 feet past the edge of the paving. Luminaires qualifying for this drive-up window allowance shall not be used to determine the allowed lighting power for general illumination. Drive-up windows shall comply independently of other lighting applications, as tradeoffs are not permitted with other specific lighting applications or general site illumination. The lighting power allowances for drive-up windows are listed in Table 4.

Example

Q: I'm designing a bank that has a drive up window with an automated teller machine (ATM). How do the outdoor lighting standards apply?

A: Lighting for ATMs is not regulated by Title 24, as noted in Table 1, and instead must meet requirements of the California Financial Code. That code defines minimum illumination levels as well as the extent of area surrounding the ATM that is regulated. That area must be indicated on the plans and subtracted from the site area when performing Title 24 outdoor lighting compliance calculations. Luminaires that direct more than half of their light into the ATM area are not counted in the actual lighting power calculation for Title 24 compliance. However, if the majority of light from a luminaire falls outside the ATM area, then that luminaire must be included in the actual power total. See the California Financial Code sections 13020, 13040, and 13041 for more details.

Guarded Facilities

The lighting power allowance for gated communities and other guarded facilities must be calculated based on the entrance driveway, gatehouse, and guardhouse indoor areas.

The guarded facility area includes the guardhouse indoor area plus the product of the entrance width of 24 feet and length of 80 feet, up to the property boundaries. Luminaires qualifying for this guarded facility allowance shall not be used to determine the allowed lighting power for general illumination. The lighting power allowances for guarded facilities are listed in Table 4.

Figure 14: Outdoor Dining



Source: Architectural Energy Corporation
Photographer: Tom Bergstrom

Example

Q: We are in the process of a major retrofit/renovation project at Big Sur National Park. We are curious as to the lighting power allowance for the ranger station at the entrance to the campsite. The station is a five foot by five foot square. This is where visitors pay for camp sites.

A: This is considered a guarded facility, since the ranger has the authority to stop and inspect. The lighting area includes the interior of the guardhouse and a 25 foot wide by 80 foot long entrance way. The total area, therefore, would be 2025 ft².

As the ranger station is located in Lighting Zone 1, the lighting power allowance is 0.19 W/ft² according to Table 147-B. The total wattage allowed for this specific application would be 384.75 watts.

Outdoor Dining

Outdoor dining areas are limited to uncovered hardscape areas used to serve and consume food and beverages. If the outdoor dining area is covered, then the allowance is based on a non-sales canopy. Luminaires qualifying for this allowance shall not be used to determine allowed lighting power for general illumination. The lighting power allowances for outdoor dining are listed in Table 4.

Alterations and Additions

Additions to existing outdoor lighting systems face the same requirements as new systems. For alterations to existing outdoor lighting, the lighting power requirements will be triggered when the alteration increases the connected lighting load or replaces more than 50% of the existing luminaires. Lighting alterations generally refer to replacement of the entire luminaire, which includes the housing, lamps, ballasts, and louvers or lenses. Simply replacing lamps and ballasts in an existing fixture is not considered a lighting alteration.

Replacing or installing new wiring generally represents a lighting alteration and lighting control requirements may apply. The CEC's Nonresidential Compliance Manual provides details.

Example

Q: We have been having a lot of trouble with our aluminum wiring. It has come to pass that we need to change it all out and put in copper. At the same time, we are going to go ahead and increase the capacity of the wires even though we don't plan to increase our load. Do we have to comply with Title 24?

A: The lighting power requirements do not apply unless you plan to change more than 50% of your luminaires or increase your load. However, the multi-level switching requirements may apply depending on the lighting application.

Security

The general outdoor lighting power allowances should be adequate to permit lighting designs that deliver appropriate light levels as recommended by the Illumination Engineering Society of North America (IESNA). Minimum safety requirements have already been taken into consideration. However, the Standards include a method to increase allowed lighting power for cases where local ordinances or other special security requirements require higher illuminance levels.

Often times, high light levels will create a mis-adaptation of the eye at night and will have negative consequences for safety and security. The eye will take significantly longer to adjust from dark to bright and from bright to dark resulting in higher susceptibility to accidents. Bright light sources can also cause a debilitating glare.

Adjustments

Local Ordinance Adjustments

Lighting power adjustments specified in Table 5 may be used when higher light levels are required by law through an officially adopted local ordinance and when the allowed lighting power density is inadequate to provide the required higher lighting levels using efficient lighting technologies (such as pulse start metal halide, fluorescent T8 and T5 sources, or high pressure sodium lighting systems). These adjustments apply to generic site illumination and several specific

At night, peripheral vision, contrast detection, and motion sensitivity are key concerns for security lighting and roadway vision. In this instance, the use of blue-rich lighting to preferentially stimulate the rods may be important. This suggests that metal halide lamps would be better suited for peripheral detection under street and roadway lighting than high-pressure sodium lamps (Advanced Lighting Guidelines, NBI).

applications such as parking lots, site roadways, driveways, sidewalks, walkways, and bikeways.

The lighting power densities in Table 5 are based on “average” footcandle levels. If the local ordinance is based on “minimum” footcandle levels, the “average” footcandle level must be increased by a factor of two. For example, if a local ordinance calls for “minimum” of one footcandle level, then instead of using one footcandle level at 0.07 W/ft², use two footcandle levels at 0.12 W/ft². If multiplying the “average” footcandle level results in a value that is greater than four footcandles, simply extrapolate the 0.25 W/ft² value of the average four-footcandle level. For example, a “minimum” of three footcandles is equivalent to six “average” footcandles. Extrapolating for 0.25 W/ft² results in 0.38 W/ft².

Table 5: Adjustments to Light Levels

Required Light Levels by Law (average horizontal footcandles)	Allowed Lighting Power Density (W/ft ²)
0.5	0.05
1.0	0.07
1.5	0.10
2.0	0.12
3.0	0.19
4.0 or greater	0.25

Security Adjustments

Lighting power adjustments may be used when higher light levels are required due to special security requirements. When a security adjustment is used, the areas affected shall be considered special applications and no tradeoffs are permitted. The area of security lighting is omitted from the general site illumination area and is treated as a use-it-or-lose-it allowance. The following three cases may utilize the security adjustment:

- For retail parking lots in Lightings Zones 1, 2, and 3, the lighting power allowance from Table 6 may be increased by 25%.

- For hardscape areas (plazas, pedestrian ways, parking, or roadways) within 100 feet of the entrance for senior housing facilities, the lighting power allowance from Table 6 may be increased by 25%.
- For parking lots and walkways within 60 feet of building entrances for law enforcement, fire, ambulance, and emergency vehicle facilities, the lighting power allowance from Table 6 may be doubled. This adjustment does not apply to general commercial facilities where occasional emergency vehicle use could occur.

Signs

The energy requirements for signs apply to all internally and externally illuminated signs, whether they are located indoors or outdoors. The Standards are the same throughout the state, independent of outdoor Lighting Zones, and compliance can be achieved using either the component performance approach or the prescriptive approach. The component performance approach sets power limits on signage while the prescriptive approach requires efficient lighting sources.

Signs that are excluded from the Standards include unfiltered signs, traffic signs, and exit signs.⁷ An unfiltered sign is one that has exposed light sources, such as a typical neon sign or a sign consisting of an array of individual lamps.

Component Performance Approach

Internally Illuminated Signs

For internally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and a lighting power density of 12 W/ft². For double-faced signs, only the area of a single face shall be used to determine the allowed lighting power. For signs where lamps are isolated by an opaque divider and for irregularly shaped signs where the faces are not parallel and the lamps are shielded by an opaque divider so that only one sign face is illuminated, the total area of all sign faces can be used to determine the allowed lighting power.

Most signs should be turned off after prime hours of use so that they do not contribute to light pollution or light trespass.

Externally Illuminated Signs

For externally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and a lighting power density of 2.3 watts per square foot. Only areas of externally lighted signs that are illuminated by one or more luminaires without obstruction shall be considered in the calculation.

Luminaires specifically designed for signs should be equipped with symmetric reflectors to evenly illuminate the sign surface. Compact fluorescent, T-8 or T-5 fluorescent, metal halide, or LED lamps are recommended for sign illumination. All of these lamps are capable of incorporating a dimming ballast for sign brightness customization. Externally mounted signage luminaires should be mounted at the top of the sign and aimed downward to reduce light pollution.

Prescriptive Approach

The prescriptive approach utilizes specific energy efficient technologies and requires that a sign be illuminated with one or more of the following light sources, or that all light sources be powered by electronic ballasts with a fundamental output frequency not less than 20 kHz.

- High pressure sodium
- Pulse start and ceramic metal halide
- Neon
- Cold cathode
- Light emitting diodes
- Barrier coat rare earth phosphor fluorescent lamps (includes most T8 and T5 lamps)
- Compact fluorescent lamps that do not contain a medium-base socket (E24/E26)

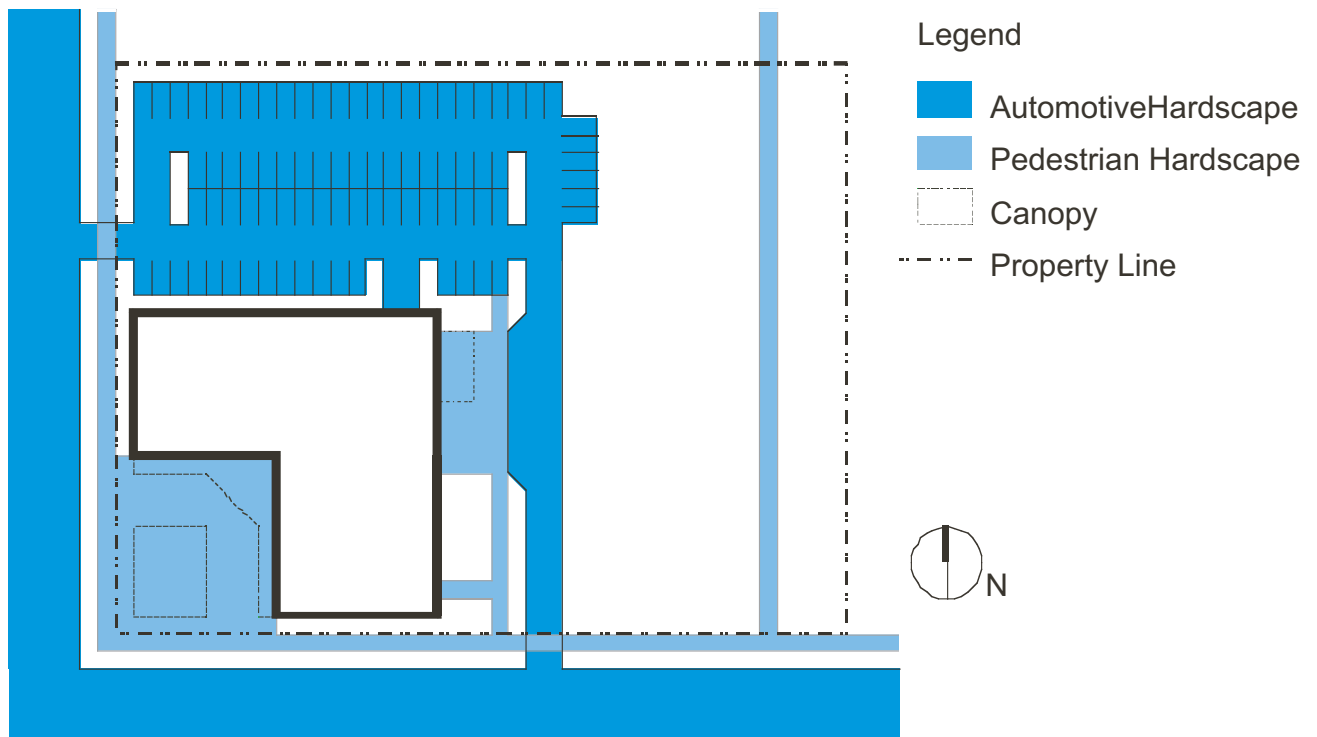
Sign Additions or Alterations

All new signs must meet the sign energy Standards according to the component performance approach or the prescriptive approach. This applies to signs that are installed in conjunction with alterations to existing interiors and alterations to existing outdoor lighting systems.

Existing indoor and outdoor signs that are altered and either increase the connected lighting load, result in replacement and rewiring of more than 50% of the ballasts, or result in relocation of the sign to a different location on the same site or on a different site shall meet the sign energy Standards. The replacement of parts in an existing sign, such as lamps, sign face, or ballasts, is not considered an alteration if the sign does not require rewiring or if the part replacement does not coincide with the sign relocation.

Example Application

Figure 23: Example Application of Outdoor Lighting Standards



Source: Architectural Energy Corporation

Description

A hotel with a lobby and restaurant on the ground floor is situated on a corner lot next to a creek. This hotel is located in an urban area classified as Lighting Zone 3.

The building has an “L” shape enclosing a pedestrian plaza on the southwest corner. The main entrance canopy runs along the two sides of the building that face this plaza. A second entrance canopy is located on the east side of the building. In the center of the plaza is a covered outdoor dining area/bar on the southeast corner of the lot.

Automotive access is both from the south and the west, with the parking lot located at the north end of the site. A loading dock ramp is also located on the north side of the building.

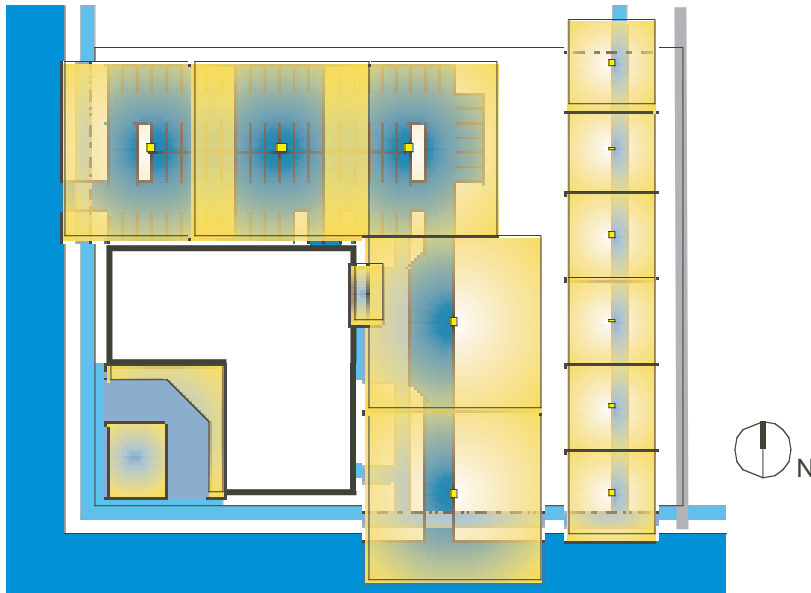
The hotel is required to maintain a bicycle/walking path on the east side of the site located adjacent to the creek. The path is on hotel property, but there is a public easement. Public sidewalks are located on the south and west sides, just outside of the property line.

Lighting Design

The lighting design consists of 20 foot tall pole mounted luminaires in the parking lot and along the roadway access from the south, a total of five. The pedestrian/bicycle path is illuminated by 10 foot tall pole mounted luminaires positioned at 60 foot intervals along the west side of the path, a total of six. Luminaires are also mounted under the canopies. Some of these luminaires are intended to light the area under the canopies while others are intended to light the surrounding pedestrian areas.

Illuminated Area

Figure 24: Illustration of Illuminated Areas



Source: Architectural Energy Corporation

In order to determine the lighting power allowance, the illuminated area must first be determined. The Standards define illuminated area as a square centered around each luminaire with a dimension equal to six times the luminaire mounting height. The lighted area under a canopy is the horizontal projection of the canopy. Figure 24 shows the lighted areas highlighted in yellow.

A lighting application must be within an illuminated area to qualify for an allowance, e.g. an allowance in an unlighted portion of a parking lot may not be used for lighted portions of the parking lot. In this example, the entire parking lot, vehicular access road to the south, and pedestrian/bike path to the east are all completely within lighted areas because the proposed luminaires provide full coverage. However, there are some pedestrian areas within the plaza on the southwest corner and on the east side of the building that fall outside the reach of any proposed luminaires and are not within the illuminated area. Therefore, these areas may not be counted when determining the lighting power allowance. The non-lighted pedestrian areas are the blue areas within the property lines, shown in Figure 24.

General Site Illumination Applications

The next step in the process is to identify the appropriate lighting applications from Table 147-A, and then determine the corresponding areas for each of the identified applications. In the proposed plan, there are two general site illumination applications from Table 147-A: pedestrian hardscape and vehicular hardscape.

The area of the parking lot extends to the boundaries of the paved lot plus an additional five feet beyond the paved area, including landscaped areas that are bounded on at least three sides by hardscape and no more than 10 feet wide. Therefore, the area of landscaped islands in the middle of the parking lot is included in the calculation. Also included are the landscaped “peninsulas.” However, other landscaped area must be excluded from the area calculation even though it may fall within the reach of the luminaires. The landscaped “cutouts” at the corner of the parking lot are bounded on only two sides and cannot be included in the application area. For this example, the paved parking area totals 29,000 ft². The landscaped islands and peninsulas add another 1,020 ft². Finally, there is 260 linear feet of perimeter where the application area can be extended 5 feet into the adjacent area. This perimeter allowance adds 1,300 ft², bringing the total application area for the parking lot to 31,320 ft². The power allowance for vehicular hardscape in Lighting Zone 3 is 0.15 W/ft², and the total allowance for this application is 4,698 watts. Note that the perimeter along the north side of the parking lot cannot be included because it falls outside of the illuminated area covered by the proposed luminaires.

For the driveways there are two options for calculating the allowed power. The first method is simply to use the actual paved area plus five feet on each side. The second method is based on the length of the driveway, with the power allowance expressed in watts per linear foot (W/lf). In this example, the first method results in an application area of 6,600 ft². The power allowance for vehicular hardscape in Lighting Zone 3 is 0.15 W/ft², equal to 990 watts total for this application. The allowance under the second method is 4 W/lf and the driveway length is 190 ft, leading to a total allowance of 760 watts. Clearly, the first method is more generous in this case.

The bicycle path is the third general site illumination application in this example, and the two compliance options are identical to the driveway case. The bicycle path is 320 feet long and 10 feet wide. The application area under the first compliance method is 6,400 feet, equal to the width plus five feet on either side times the length. The resulting power allowance is 1,088 watts, based on an allowance of 0.17 W/ft² for pedestrian hardscape. Under the second method, the allowed power is 1,280 watts, using the allowance of 4 W/lf times the length of the path. For the bike path, the second method provides a higher power allowance.

Since tradeoffs are allowed among general site lighting applications, the total allowance for combined power in the parking lot, driveway and bicycle path is 6,968 watts (4,698+990+1,280). The Standards allow the actual installed lighting power in any one of the these applications to exceed its individual limit as long as the total power for the three applications falls within the combined limit.

Table 6: Example Lighting Power Allowance Calculations for General Lighting Applications

Application	Category	Size	Unit Power Allowance	Total Power Allowance
Parking Lot	Hardscape for automotive vehicular use	31,320 ft ²	0.15 W/ft ²	4,698 watts
Driveways	Method 1: Hardscape for automotive vehicular use	6,600 ft ²	0.15 W/ft ²	990 watts
	Method 2: Hardscape for driveways, site roads, sidewalks and bikeways	190 ft	4 W/lf	760 watts
Bicycle path	Method 1: Hardscape for pedestrian use	6,400 ft ²	0.17 W/ft ²	1,088 watts
	Method 2: Hardscape for driveways, site roads, sidewalks and bikeways	320 ft	4 W/lf	1,280 watts
Total Allowance (using Method 1 for Driveways and Method 2 for Bicycle Path)				6,968 watts

Specific Applications

This example includes three specific lighting applications: the two entrance canopies and the covered outdoor dining area. Specific lighting applications are those listed in Table 147-B of the Standards, and these applications differ from the general illumination applications because the power allowance applies to only the luminaires used for the specific application. Tradeoffs with other illuminated areas are not allowed.

The area for use in the calculation is simply the area under the canopy, bounded by the “drip-line.” The appropriate lighting power category from Table 147-B is “non-sales canopies” for each of the three cases in this example. One of the other categories in Table 147-B is called “Outdoor Dining,” but that category applies only to uncovered dining areas. Therefore, our covered outdoor dining area fits in the “non-sales canopies” category.

For each of the three canopy areas, the allowance is 0.50 W/ft². The power for luminaires in each of these areas must not exceed their individual limits. The allowance is equal to the following:

- Up to 1,000 watts for the 2,000 ft² covered dining area
- Up to 1,000 watts for the 2,000 ft² canopy along the south-west plaza
- Up to 400 watts for the 800 ft² canopy on the east side

FOR MORE INFORMATION

James Benya, Lisa Heschong, Terry McGowan, Naomi Miller, and Francis Rubinstein, *Advanced Lighting Guidelines* (White Salmon, WA: New Buildings Institute Inc., 2003), www.newbuildings.org/lighting.htm

California Energy Commission. California's 2005 Building Energy Efficiency Standards, www.energy.ca.gov/title24/2005standards

California Energy Commission. Nonresidential Compliance Manual for California's 2005 Building Energy Efficiency Standards, www.energy.ca.gov/title24/2005standards/nonresidential_manual.html

NOTES

- 1 <http://www.energy.ca.gov/title24/>
- 2 2003, Outdoor Lighting Baseline Assessment produced by RLW Analytics for the Energy Commission Public Interest Energy Research Program.
- 3 <http://www.energy.ca.gov/appliances/appliance/>
- 4 Nadir is in a direction straight down, as would be indicated by a plumb line. Ninety degrees above nadir is horizontal. Eighty degrees above nadir is 10 degrees below horizontal.
- 5 http://factfinder.census.gov/servlet/AdvancedGeoSearchMapFramesetServlet?_lang=en&_command=getPlacenames
- 6 http://www.energy.ca.gov/title24/2005standards/outdoor_lighting/index.html
- 7 Exit signs shall meet the requirements of the Appliance Efficiency Regulations.



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