Residential Lighting

Best practices in lighting design to comply with California’s Title 24 energy code
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Learning Objectives

1. Effectively apply the mandatory residential Title 24 Building Energy Efficiency Standards requirements specific to lighting.

1. Identify current lighting technologies, including LED luminaires, that are available to fulfill code requirements.

1. Access resources through utility and lighting technology training centers for continued professional development.

2. Prepare for the major lighting-related updates in the 2016 Title 24 Building Energy Efficiency Standards code.
Residential Lighting Design Guide

Provides a simplified and practical approach to lighting code compliance and design.

**Topics include:**
- Explanation of the code
- Technical guidelines
- Steps to compliance
- Lighting design examples
Compliance Requirements
Why Title 24, Part 6?

Efficiency before generation
The California Energy Commission has found energy efficiency and demand response as the preferred means of meeting the energy needs of a growing population.

![Graph showing per capita electricity sales in California and the United States from 1960 to 2008.](image)
Code Cycle Timeline

The most recent revision, the 2013 *Title 24 Building Energy Efficiency Standards* was adopted by the California Energy Commission in May 2012. Any application for a Building Permit submitted on or after July 1, 2014 must meet the 2013 standards.

The 2016 *Title 24 Building Energy Efficiency Standards* have already been approved! The new standards take effect January 1, 2017

*Note:* This presentation is not intended to be used in lieu of the *Title 24 Building Energy Efficiency Standards*. Please visit [www.energy.ca.gov/title24](http://www.energy.ca.gov/title24) to download the official *Title 24 Building Energy Efficiency Standards* as well as the *Nonresidential Compliance Manual.*
The Compliance Process

**Design**
Architects, engineers and designers must understand both the requirements and the underlying intent of the standards if they are to design buildings and systems that are inherently energy efficient and cost effective.

**Permit Application**
Design teams must make sure that the plans contain all the information that the building official will need to verify that the building or system satisfies the requirements.

**Plan Check**
The plans examiner of the local building department must verify that the building or system satisfies the requirements of the standards and that the plans (not just the compliance forms) contain the information to be verified during field inspection.

**Construction**
Contractors must carefully follow the approved plans and specifications, and the building department field inspector(s) must verify that the building or system is constructed according to the plans and specifications.

**Acceptance Commissioning**
After completion of construction, the contractor and/or the design team must properly commission the building and its systems and provide information and/or training to the building operators on maintenance and operation of the building and its equipment.

**Operation**
After occupancy, the building and its systems must be correctly operated and properly maintained.
Locally Adopted Energy Standards

Local governmental agencies, primarily cities and counties, may adopt and enforce standards for newly constructed and existing buildings that are more stringent than Title 24. These can include:

- Shorter timeframes
- Additional energy conservation measures
- More stringent energy budgets
- CALGreen or GreenPoint Rated

It is critical to check with your local building agency for additional requirements.

A list of all local ordinances exceeding the standards is located at: http://www.energy.ca.gov/title24/2013standards/ordinances/
Prescriptive vs. Performance Standards

Title 24, Part 6 compliance is achievable through two approaches:

**Prescriptive Standards**
- Simpler, but does not allow as much flexibility in design
- Each individual component of the proposed building must meet a prescribed minimum energy requirement
- Applicant needs only to show that a building meets each minimum or maximum level prescribed in the set of requirements contained in a package

**Performance Standards**
- Allows the builder more freedom, but the standards are more complex and involved
- Detailed accounting of energy trade-offs between measures is possible
- Uses Energy Commission-approved computer software to calculate energy trade-offs based on Title 24 guidelines

“Which technology is appropriate for my project?”

“What is available, and how can I piece together the building I want while complying with Title 24?”
2013 Approved Compliance Programs

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Approved versions usable for permit</th>
<th>Contact Information</th>
<th>Additional information</th>
</tr>
</thead>
</table>
| CBECC-Res            | CBECC-Res V4, as well as V3, V3b1 and V3c are valid for demonstrating compliance with the residential provisions of the 2013 California Building Energy Efficiency Standards. For new permit applications made on or after August 1, 2015, V4 must be used. Latest version of CBECC-Res and CBECC-Res Compliance Manager were approved on 5/13/2015. Please review the resolution for details of the public domain Compliance Software (CBECC-Res V4) and associated Compliance Manager (CM). | California Energy Commission Building Standards Office 1516 9th Street, MS 37 Sacramento, CA 95814 ATTN: Dee Anne Ross 916-554-6560 deeanne.ross@energy.ca.gov | CBEC-Res Website  
Approval/Expiration Dates  
FAQs  
Reported Software issues  
Support: cbec.res@gmail.com |
| EnergyPro            | Approved 05/26/2015 for compliance with the 2013 Residential Energy Efficiency Standards for newly constructed buildings and additions/alterations, Version 6.6, as well as Versions 6.3, 6.4, or 6.5 must be used. For new permit applications made on or after August 1, 2015, Version 6.6 must be used. | EnergySoft, LLC. 1025 5th Street, Suite A Novato, CA 94945-2413 415-897-6400 | EnergyPro Website  
Approval/Expiration Dates  
FAQs  
Support: support@energysoft.com |
| Right-Energy Title 24| Approved 05/26/2015 for compliance with the 2013 Residential Energy Efficiency Standards for newly constructed single family buildings. Version 1.4, as well as Versions 1.1, 1.2, or 1.3 modules of Right-Suite Universal must be used. For new permit applications made on or after August 1, 2015, Version 1.4 must be used. | Wrightsoft Corporation 131 Hartwell Avenue Lexington, MA 02421 603-226-8937 sales@wrightsoft.com | Wrightsoft Website  
Approval/Expiration Dates  
FAQs  
Support: support@wrightsoft.com |

http://www.energy.ca.gov/title24/2013standards/2013_computer_prog_list.html
Mandatory Measures

Mandatory measures required by both prescriptive and performance approaches include the following areas:

• Building envelope
• Space conditioning, water heating and plumbing
• Ducts and fans
• Pools and spas
• Fireplaces
• Lighting
What forms apply

**CF2R-LTG-1E** for single-family dwellings

**CF2R-LTG-2E** for multi-family dwellings
Concepts & Principles
Select the Appropriate Source + Luminaire + Controls (for the application)
**Terminology**

**Luminous flux**: rate of flow of visible light emitted from a light source over time, measured in lumens (lm).

**Footcandle**: equal to one lumen per square foot (1 footcandle = 10 lux).

**Illuminance**: the amount of luminous flux that covers a surface (measured in lux or footcandles).
Terminology

**Efficiency:** the ratio between the useful output of energy and the input of energy.

**Luminous Efficacy** compares the amount of light produced by a lamp (lumens), to amount of power consumed to produce it (watts).
Terminology

**Luminous Intensity:** the concentration of light emitted from a given source in a particular direction, measured in candela (cd) \((1 \text{ cd} = 1 \text{ lm per steradian})\).

*Note: color represents intensity not CCT or CRI*
# IES Illuminance Recommendations

<table>
<thead>
<tr>
<th>Category</th>
<th>Building Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (3fc)</td>
<td><strong>Public spaces</strong> (Movie theater, observatory)</td>
</tr>
<tr>
<td>B (5fc)</td>
<td><strong>Orientation for short visits</strong> (Public auditorium, night club, arcade)</td>
</tr>
<tr>
<td>C (10fc)</td>
<td><strong>Working spaces for simple visual tasks</strong> (Art gallery, restaurant, parking garage, public restroom)</td>
</tr>
<tr>
<td>D (30fc)</td>
<td><strong>Performance of visual tasks of high contrast and large size</strong> (Coliseum/arena, school gymnasium, chapel, grocery store, commercial building)</td>
</tr>
<tr>
<td>E (50fc)</td>
<td><strong>Performance of visual tasks of high contrast and small size or tasks of low contrast and large size</strong> (School, medical laboratory, computer processing office, vehicle repair center)</td>
</tr>
<tr>
<td>F (100fc)</td>
<td><strong>Performance of visual tasks of low contrast and small size</strong> (Hospital facilities, veterinary clinic)</td>
</tr>
<tr>
<td>G (800fc)</td>
<td><strong>Performance of visual tasks near threshold</strong> (Operating table)</td>
</tr>
</tbody>
</table>

*fc = footcandle
Correlated Color Temperature (CCT)

A specification of the color appearance of light emitted by a lamp, relating its color to the color of light from a source when heated to a particular temperature.

CCT rating for a lamp is a general warmth or coolness measure of its appearance.
Color Rendering Index

- Color rendering is defined as “Effect of an illuminant on the color appearance of objects by conscious or subconscious comparison with their color appearance under a reference illuminant” (CIE 17.4–1987)
- It is the only color rendering metric with wide spread acceptance
- It is calculated by comparing the color appearance of the test source to a reference source for 8 reflective samples (Score from 1–100)
- All other aspects of the source for a true comparison should be the same
**Light Output/Lumens**
Measures light output. The higher the number, the more light is emitted.
*Reported as “Total Integrated Flux (Lumens)” on LM-79 test report.*

**Watts**
Measures energy required to light the product. The lower the wattage, the less energy used.
*Reported as “Input Power (Watts)” on LM-79 report.*

**Lumens per Watt/Efficiency**
Measures efficiency. The higher the number, the more efficient the product.
*Reported as “Efficacy” on LM-79 test report.*

**IESNA LM-79-2008**
Industry standardized test procedure that measures performance qualities of LED luminaires and integral lamps. It allows for a true comparison of luminaires regardless of the light source.

**Brand & Model Number**

**Color Rendering Index (CRI)**
Measures color accuracy. Color rendition is the effect of the lamp's light spectrum on the color appearance of objects.

**Correlated Color Temperature (CCT)**
Measures light color. "Cool" colors have higher Kelvin temperatures (3600–5500K); "Warm" colors have lower color temperatures (2700–3500K).
Technology Requirements
Two Strategies, Three Main Technologies

**Sources**

**High-efficacy Luminaires**
These lighting fixtures are designed and built to operate only energy-efficient light sources, such as fluorescent T8 lamps, compact fluorescent lamps (CFLs), LEDs and high intensity discharge (HID) lamps.

**Sensors**
Occupancy/vacancy sensors and daylight sensors are all devices that automatically turn lights off (or dim them) in response to conditions that they “sense” or “see.”

**Dimmers**
Dimmers, which are already common in many residential applications, allow room occupants to lower lighting levels (and thus energy use) as desired.
High Efficacy, According to the Standards

What is never high efficacy?

- Any luminaire that does not qualify by Energy Commission definition or is not certified to the Commission
- Any luminaire containing medium screw-base socket (E24/E26)
- Any luminaire containing any line-voltage lamp socket (except GU-24 under certain conditions)
- Track lighting where track heads or lamps can be changed to a source other than LED

<table>
<thead>
<tr>
<th>Lamp Power</th>
<th>Min. System Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>5W or less</td>
<td>30 lm/W</td>
</tr>
<tr>
<td>5W – 15W</td>
<td>45 lm/W</td>
</tr>
<tr>
<td>15W – 40W</td>
<td>60 lm/W</td>
</tr>
<tr>
<td>Over 40W</td>
<td>90 lm/W</td>
</tr>
</tbody>
</table>

Efficacy = initial lumens ÷ luminaire total rated system input power

In the 2013 code: Table 150.0-A and 150.0-B and Section 150(k) 1
## High Efficacy, According to the Standards

<table>
<thead>
<tr>
<th>High Efficacy Light Sources</th>
<th>Low Efficacy Light Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminaires manufactured, designed and rated for use with only lighting technologies in this column shall be classified as high efficacy.</td>
<td>Luminaires manufactured, designed or rated for use with any of the lighting technologies in this column shall be classified as low efficacy.</td>
</tr>
<tr>
<td>• Pin-based linear fluorescent lamps or pin-based compact fluorescent lamps, provided that the ballast in the luminaire is electronic. Compact fluorescent lamps ≥ 13 watts have 4 pins for compliance with the electronic ballast requirements in §150.0(k)1D.</td>
<td>• Line-voltage lamp holders (sockets) capable of operating incandescent lamps of any type.</td>
</tr>
<tr>
<td>• Pulse-start metal halide lamps.</td>
<td>• Low-voltage lamp holders capable of operating incandescent lamps of any type.</td>
</tr>
<tr>
<td>• High pressure sodium lamps.</td>
<td>• High efficiency lamps installed in low-efficiency luminaires, including screw base compact fluorescent and screw base LED lamps.</td>
</tr>
<tr>
<td>• GU-24 sockets rated for LED lamps.</td>
<td>• Mercury vapor lamps.</td>
</tr>
<tr>
<td>• GU-24 sockets rated for compact fluorescent lamps.</td>
<td>• Track lighting or other flexible lighting system which allows the addition or relocation of luminaires without altering the wiring of the system.</td>
</tr>
<tr>
<td>• Luminaires using LED light sources which have been certified to the Commission as high efficacy in accordance with Reference Joint Appendix JA8.</td>
<td>• Luminaires using LED light sources which have not been certified to the Commission as high efficacy.</td>
</tr>
<tr>
<td>• Luminaire housings rated by the manufacturer for use with only LED light engines.</td>
<td>• Lighting systems which have modular components that allow conversion between high-efficiency and low-efficiency lighting without changing the luminaires’ housing or wiring.</td>
</tr>
<tr>
<td>• Induction lamps.</td>
<td>• Electrical boxes finished with a blank cover or where no electrical equipment has been installed, and where the electrical box can be used for a luminaire or a surface mounted ceiling fan.</td>
</tr>
</tbody>
</table>

Note: Adaptors which convert an incandescent lamp holder to a high-efficacy lamp holder shall not be used to classify a luminaire as high efficacy, even if the manufacturer declares that such adaptors as permanent.

In the 2013 code: Table 150.0-A and Section 150(k) 1
High Efficacy GU-24 Qualifications

- Factory-installed GU-24 lamp holder
- No other types of line voltage sockets in the luminaire
- Manufacturer does not provide adaptors to convert other line voltage lamp holder
- Luminaire rated only for high efficacy systems
- **NO** GU-24 low efficacy lamps
- **NO** GU-24 low efficacy luminaires
- **NO** GU-24 modular adaptors or luminaire conversions
- Quick-connects to GU-24 are allowed
- In 2008 code: no recessed downlights with GU-24 sockets that could receive a compact fluorescent lamp

In the 2013 code: Table 150-A
High-Efficacy Luminaires

Typically Compliant

- High-efficacy fixtures with electronic ballasts
- Pin-based CFL fixtures with electronic ballasts (4 pin)
- Fixtures with high-intensity discharge (HID) lamps
- Integrated LED luminaires (check efficacy, CRI and CCT)

Not Compliant

- Any fixture with incandescent replacement lamps
- Any fixture with a screw base, regardless of what source it is (even CFL or LED!)

Note: Ballast wattage is not included when determining lamp efficacy.
Appendix JA8-1

Requirements include:

**Indoor:**
- CRI 90 or above
- CCT: 2700K – 4000K

**Outdoor:**
- CCT: 2700K – 5000K

**Exception:**
Monochromatic LEDs that are only for decorative purposes

**Quality control:**
Each integral LED luminaire or LED light engine tested shall produce the same quantity and quality of light.

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**Joint Appendix JA8**

Appendix JA8 – Qualification Requirements for Residential Luminaires Using LED Light Source

To qualify as a residential high efficacy luminaire using Light Emitting Diode (LED) as the light source (as defined in IES LM-60-2008), the LED light engine (as defined in ANSI/IES RP-16-2010) used in the luminaire shall be certified to the Energy Commission according to all of the following requirements, or by a method approved by the Executive Director, if the LED light engine is inseparable from the luminaire (integral LED luminaire) then the entire luminaire shall meet the same requirements. LED light engine(s) and integral LED luminaire(s) are referred to as LED luminaire(s) below.

(a) Shall be manufactured for use in residential applications. LED luminaires not intended for use in residential applications, LED landscape luminaires, and luminaire housings not containing a light engine shall not be certified to the Energy Commission for the purpose of complying with Joint Appendix JA-8.

(b) The efficacy of the integral LED luminaire or LED light engine, when tested in accordance with IES LM-79-2008, shall be equal to or greater than the efficacies contained in TABLE JA-8.

(c) When designed or rated for outdoor use shall be capable of providing a nominal Correlated Color Temperature (CCT) that includes at least one point within the range of 2700K to 4000K for specified points, and when designed or rated for outdoor use shall be capable of providing a nominal CCT that includes at least one point within the range of 2700K to 5000K, with tolerance defined in ANSI C78.373-2008.

Exception to Section (c): Monochromatic LEDs that are only for decorative purposes

(d) Shall be capable of providing a minimum Color Rendering Index (CRI) of 80.

Exception 1 to Section (d): Monochromatic LEDs that are only for decorative purposes.

Exception 2 to Section (d): LED luminaires used for compliance with the outdoor lighting requirements in Title 24, Part 6, Section 150.009.

(e) An LED light engine shall be capable of being installed in luminaire housing without using any type of base or socket used for incandescent lamps. It may include a GU-24 or modular quick connect, but shall not include screw base sockets or adaptors of type and size E12 through E39.

(f) An LED lamp, integrated or non-integrated type in accordance with the definition in ANSI/IES RP-16-2010, shall not be certified to the Energy Commission as a high efficacy luminaire or high efficiency light engine, and shall not be classified as a high efficacy luminaire for compliance with Title 24, Part 6 of the CCR.

(g) The integral LED luminaire or LED light engine under test shall be tested in a Underwriters Laboratories (UL) type certificate test panel participating in the ISO/MIEC 17025, or the National Voluntary Laboratory Accreditation Program (NVLAP) or other laboratory accreditation body operating in accordance with ISO/MIEC 17025 and produced under an ongoing inspection program carried out by a Type A inspection body in accordance with ISO/MIEC 17020, accredited by an accreditation body operating in accordance with ISO/MIEC 17011.

(h) Each integral LED luminaire or LED light engine tested shall provide the same quantity and quality of light. An integral LED luminaire or LED light engine under test producing different Correlated Color Temperature (CCT), Color Rendering Index (CRI), total flux (per linear foot for linear systems) or other quantitative and qualitative differences in light shall be separately tested and separately certified to the Energy Commission.
Appliance Efficiency Database

http://www.appliances.energy.ca.gov/AdvancedSearch.aspx
Recessed Fixtures

Applications between conditioned and unconditioned spaces

• Approved for IC and label certifying AT according to ASTM E283

• Gasket or caulking between housing and ceiling – all air leak paths through luminaire assembly or ceiling opening must be sealed

IC applications:

• Ballasts that are rated for higher operating ranges

• Fixture configurations that limit heat to the ballast

Electronic ballasts

• Certified to the Energy Commission

• Mandated in all high-efficacy luminaires of 13W or higher

• Output frequency of no less than 20 kHz

In the 2013 code: 150(k)8 and 150(k)1 D
Recessed Luminaires

- Have a minimum rated life of 30,000 hours when operated at or below a specified maximum case temperature
- Must not exceed maximum ballast case temperature
- Have a ballast factor of not less than 0.90 for non-dimming ballasts
- Have a ballast factor of not less than 0.85 for dimming ballasts
- Allow ballast maintenance and replacement from below the ceiling without cutting holes in ceiling

**Airtight Label: ASTM E283**

The ASTM E283 label certifies a fixture as being airtight in accordance with ASTM E283 testing and Title 24.

In the 2013 code: 110.9 (f) and 150 (k)8
Indoor Vacancy Sensor Specifications

• Must be manual-on/automatic-off (can also be turned off manually)
• Time delay cannot be greater than 30 minutes
• Cannot be locked in a permanent “on” state (no “on” override)
• No more than 1 W consumed by the indicator light
• Specify with no minimum load amount

Optional features to consider
• Energy-efficient LED night-light
• Impact-resistant lens and switch

Vacancy Sensors (top to bottom): WattStopper CS-50 PIR Wall Switch Vacancy Sensor; Lutron Maestro occupancy/vacancy sensor; WattStopper CS-350-N PIR Dual Relay Wall Switch Vacancy Sensor
Dimmer Requirements

• The dimmer and all of the switches in the circuit shall have the capability of turning lighting OFF if it is ON, and turning lighting ON to the level set by the dimmer if the lighting is OFF.

• Stepped dimmers will include an off position to turn lights completely off.
Dimmer Requirements

- Comply with Title 20
- Very subtle differences in language
- The dimmer shall:
  - reduce power consumption by a minimum of 65% percent at its lowest level;
  - include an off position which produces a zero lumen output; and not consume more than 1 W per lighting dimmer switch leg when in the off position.
  - Reduce flicker through dimming range
  - For 3-way, do not override level set by dimmer and all switches should turn light off

In the 2013 code: 150 (k)   In Title 20: 1605.3 (f)
Dimmer Specifications

Specify the correct load amount

- Line voltage
- Low voltage
- 3-way dimmers (ex. hallway applications)

Pair LED luminaires and lamps carefully with dimmers, check manufacturer websites and spec sheets for compatibility

In the 2013 code: 150 (k)
Permanently Installed Night-Lights

- Shall contain only high-efficacy lamps with no line voltage lamp holder
- Shall consume no more than 5 watts
- No screw-base lamp holders
- Indicator lights that are integral to lighting controls shall consume no more than 1 watt
- Also applies to night-lights integral to permanently installed luminaires or exhaust fans

In the 2013 code: 150 (k) E
Room by Room
### 2013 Title 24 Standards by Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kitchen</strong></td>
<td>• ≥ 50% of installed wattage must be high efficacy</td>
</tr>
</tbody>
</table>
| **Bathroom**                        | • One high efficacy fixture and  
• Manual-on vacancy sensor or high efficacy for all other fixtures |
| **Garage, laundry room, utility room** | • High efficacy and  
• Manual-on vacancy sensor                                                   |
| **All other interior rooms**        | • High efficacy or  
• Manual-on vacancy sensor or  
• Dimmer                                                                      |
| **Outdoor Lighting**                | • High efficacy or  
• Low efficacy controlled by a manual on/off switch and both:  
  • Motion sensor without bypass switch and  
  • One of the following: integral photocontrol, astronomical time clock, energy management control system |
| **Common Areas**                    | • High efficacy or vacancy sensor in areas where common space ≤ 20% of floor area  
• In common areas that > 20% of floor area, occupancy responsive adaptive corridor and stairwell lighting is required |
| **Residential Parking**             | • Lots for ≤ 7 cars must comply with Outdoor Lighting requirements  
• Garages for ≤ 7 cars must comply with Garage requirements  
• Lots and garages for more than 7 vehicles must comply with Nonresidential Lighting Standards |

**COMPLIANCE REQUIREMENTS**
Kitchens: Mandatory Requirements

**Wattage**

- No limit to number of watts, but must be at least 50% high efficacy
- Quantity of fixtures is not regulated by code
- If a fixture can accept multiple lamp wattages, its wattage for the sake of code compliance is the highest re-lamping rated wattage designated by the manufacturer on a permanent, factory-installed Underwriters Laboratory label

**Lighting Controls**

- High-efficacy and low-efficacy light fixtures must be controlled separately
- Nook lighting must be on a separate switch in order to be counted as an “other space” and not part of the kitchen
- Recommended to separately switch different layers of the kitchen lighting

In the 2013 code: 150(k) 3
Kitchens: Additional Low-Efficacy Wattage

**Additional low-efficacy wattage “bonuses”**

- Up to 50 watts per dwelling in units < 2,500 sq. ft.
- Up to 100 watts per dwelling in units > 2,500 sq. ft.

**The bonuses are available if the following conditions are met:**

All lighting in the kitchen is controlled in accordance with the applicable provisions in Section 150.0(k)2, and is also controlled by vacancy sensors or dimmers.
Special Circumstances

**Appliances**
Lighting that is part of an appliance is not regulated by the code

**Blank Electrical Boxes**
Calculated and treated as 180 watts of low-efficacy lighting

**Internal Cabinet Lighting**
- Not considered part of the kitchen lighting for calculating 50%
- No more than 20W per linear foot of illuminated cabinet
- Lighting installed inside a cabinet may only be used to illuminate the inside of the cabinet
Cabinets: Measurement Methods

The length of an illuminated cabinet shall be determined using one of the following measurements, regardless of the number of shelves or the number of doors per cabinet section:

A. One horizontal length of illuminated cabinet; or
B. One vertical length, per illuminated cabinet section; or
C. No more than one vertical length per every 40 horizontal inches of illuminated cabinet.

In 2013 the code: 150(k) 4
Bathroom Requirements

**Lighting**
- At least one luminaire has to be high efficacy.

**Controls**
- Low efficacy controlled with a vacancy sensor
- High-efficacy and low-efficacy light fixtures must be controlled separately.

**Quantity**
- The quantity of light fixtures is not regulated by the code.

**Vacancy Sensor**
- Vacancy sensors must be manual on/off and automatic off
- Sensors cannot have an override allowing the light fixture to be continuously on
- The maximum time delay to turn off is 30 minutes after the last detected motion

In the 2013 code: see 150(k) 5
Bedroom Requirements

- High efficacy, vacancy sensor, or dimmer
- High-efficacy and low-efficacy light fixtures must be controlled separately
- Vacancy sensors must be manual on/off and automatic off
- Switched outlets (half-hots) do not require special controls
- Ceiling fans with incandescent light kits need one switch for the fan and one dimmer/vacancy sensor for the lights.
- High-efficacy: only one switch is needed, two are shown for flexibility

In the 2013 code: see 150(k) 7
Garages, Laundry Rooms, & Utility Rooms Requirements

**Lighting and Controls**
All lighting must be high efficacy, and shall be controlled by vacancy sensors.

**Exceptions**
- Detached storage buildings less than 1,000 square feet located on a residential site

In the 2013 code: see 150(k) 6
Living and Dining Rooms

- High efficacy, vacancy sensor, or dimmer
- Switched outlets (half-hots) do not require special controls
- Decorative option: use incandescent fixtures and dimmer(s)
- Ceiling fans with low-efficacy light kits need one switch for the fan and one dimmer/vacancy sensor for the lights (with high-efficacy kits, only one switch is needed)

In the 2013 code: see 150(k) 7
Attics and Enclosed Patios

**Attic**
- High efficacy, dimmer or vacancy sensor
- Sensors must be manual on/off and automatic off

**Enclosed Patio**
- An enclosed (unconditioned) patio is considered an “other space”
- High-efficacy and low-efficacy light fixtures MUST be controlled separately
- High efficacy, or include a dimmer or vacancy sensor

In the 2013 code: see 150(k) 7
Hallways

- High efficacy, vacancy sensor or dimmer
- Vacancy sensors must view the entire space (this application may require three-way switching as shown)
Outdoor Lighting: Requirements

**General Requirements**

- Do not apply to landscape lighting that is not attached to the building, residential parking lots, or garages for eight or more vehicles
- Must be high-efficacy, or controlled by a manual on/off switch, motion sensor, and a method automatically turn off lights during daytime
- Low-efficacy outdoor luminaires may have a temporary override switch which bypasses the motion sensing function for up to six hours provided that the override switch automatically reactivates the motion sensor
- Outdoor luminaires in or around swimming pools or water features are exempt from Title 24
- A manual off/on switch (no override to on)

**Outdoor Motion Sensors**

- Must have automatic on/off operation and photocells to keep lights off during daylight hours
- Must comply with the maximum 30-minute shut-off requirement
- Must view the space that it illuminates

**Override Switch**

Low-efficacy outdoor luminaires may have a temporary override switch which bypasses the motion sensing function for up to six hours, provided that the override switch automatically reactivates the motion sensor.

In the 2013 code: see 150(k) 9
Front Porch Lighting

• LEDs are ideal for cold outdoor environment, as CFLs often are not compatible with cold temperatures.

• LEDs’ lifespan is significantly longer than other lamp sources, requiring less maintenance.

• Although not required by the standards when using a high-efficacy fixture, including a motion sensor will provide light to occupants upon entering the space when no immediate access to a switch is available.

• For outdoor areas close to bedroom windows, high-efficacy luminaires are preferred over low-efficacy luminaires with motion sensors that may be triggered in the middle of the night.
Outdoor Spaces

• Provide adequate lighting to support the function of the space and specific tasks performed within it.

• Although not required by the standards when using a high-efficacy fixture, including a motion sensor (as shown) will provide light to occupants where there is not immediate access to a switch in a transitional space.

• Motion sensor coverage should not be too large, or lights will be triggered by street traffic or a neighbor’s motion. Most sensors have a sensitivity control to adjust the degree of motion and light that triggers them.

• In addition to the motion sensor and one of the three other lighting control options, the owner also must be provided with a manual on/off switch for low-efficacy luminaires.
Internally Illuminated Address Signs

Consume no more than 5 watts of power

OR

Comply with the nonresidential sign lighting Standards in §140.8:
- Cannot exceed 12 watts per sq. ft. internal illumination
- Cannot exceed 2.3 watts per sq. ft. external illumination

Alternatives when equipped only with one or more of the light sources
- High-pressure sodium
- Metal halide lamps (with minimum efficiency)
- Neon or cold cathode lamps (with minimum efficiency)
- Fluorescent lamps (with a minimum 80 CRI) + Electronic ballasts (minimum 20 kHz)
- Compact fluorescent lamps with no screw-base sockets
- LEDs (with minimum efficiency)
Low-rise Multi-family Common Areas

A multi-family complex consists of four or more dwelling units. A low-rise is considered a building with three or fewer stories.

If the building has more than three stories the common areas must comply with the non-residential code.

In the 2013 code: see 150(k) 9
Low-rise
Multi-family
Common Areas

In buildings where common areas constitute > 20% of the floor space:

- Lighting must comply with the non-res standards
- Lighting in corridors and stairwells **must** be controlled by occupancy sensors that reduce lighting power by at least 50%

In buildings with common areas that are ≤ 20% of the floor space:

- All hardwired lighting must be high efficacy **or** controlled by an occupancy sensor

In the 2013 code: see 150(k) 12
2013 Parking Lots and Garages

Residential Lots and Garages

- Residential standards apply to parking lots, carports and parking garages (attached and detached from dwelling unit) for **seven or fewer vehicles** per site
- Parking lots and carports must meet the residential **outdoor** lighting requirements or the non-res requirements
- Parking garages must meet the residential **indoor** lighting requirements: high efficacy and controlled by a vacancy sensor

Non-residential Lots and Garages

- Non-residential standards apply to parking lots, carports and parking garages (attached and detached from dwelling unit) for **eight or more vehicles**
- Must meet the power density limits for non-residential lighting standards
- Luminaires must be controlled by a photocontrol or time switch that turns lights off when daylight is present
- New construction or major alterations are required to comply with Backlight, Uplight, Glare ratings per IES TM-15-11
- Pole mounted luminaire > 75W and < 24 ft must include motion sensors that reduce lighting levels on vacancy.
- Other conditions apply, see sections: 110.9, 130.0, 130.2, 130.4, 140.7 & 141.0

In the 2013 code: see 150(k) 6
EXERCISE:
Making a kitchen comply with Title 24
TITLE 24 REQUIREMENT: At least 50% of the total rated lighting power in kitchens should be high-efficacy.
### Lighting Schedule 1

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>LUMINAIRE</th>
<th>LAMP</th>
<th>QTY</th>
<th>WATTS</th>
<th>TOTAL WATTS</th>
<th>EFFICACY Luminaires/Watt</th>
<th>HIGH EFFICACY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6&quot; RECESSED ADJUSTABLE DOWNLIGHT Nora Lighting HHC-8264ATF1</td>
<td>GU-24 BASE CFL MaxLife</td>
<td>4</td>
<td>26</td>
<td>104</td>
<td>63</td>
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<tr>
<td></td>
<td>4&quot; RECESSED ADJUSTABLE DOWNLIGHT Nora Lighting NL-467</td>
<td>HALOGEN MR16 Osram Sylvan</td>
<td>2</td>
<td>50</td>
<td>100</td>
<td>11</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>27&quot; UNDERCABINET DAL'S Lighting Linear Luminaire</td>
<td>HALOGEN T3s Philips</td>
<td>6</td>
<td>60</td>
<td>360</td>
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</tr>
<tr>
<td></td>
<td>TRACK SYSTEM WITH ADJUSTABLE SPOTLIGHT &amp; PENDANTS Tech Lighting Monorail System</td>
<td>HALOGEN MR16 Osram Sylvan</td>
<td>1 tracks &amp; luminaires</td>
<td>50</td>
<td>300</td>
<td>N/A</td>
<td>No</td>
</tr>
</tbody>
</table>

**NOT COMPLIANT:**

Only **12%** of the total rated lighting power is **high-efficacy**
NOT COMPLIANT:
Only 40% of the total rated lighting power is high-efficacy.
COMPLIANT: 93% of the total rated lighting power is high-efficacy
2016 Building Energy Efficiency Standards
Introducing, the All High Efficacy Home and
Welcome, Replacement Lamps.
Online Help

2013 Title 24 Residential Lighting Standards
www.energy.ca.gov/title24/2013standards

Energy Code Ace
energycodeace.com
Thank You

FOR MORE INFORMATION AND RESOURCES ABOUT TITLE 24, PART 6: cltc.ucdavis.edu/title24