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6. Residential Lighting

This chapter covers the Title 24 California Code of Regulations, Part 6 (the Energy Standards), requirements for lighting in low-rise buildings and the dwelling units in high-rise buildings. It is addressed primarily to lighting designers, electrical engineers, and enforcement agency personnel responsible for residential lighting.

6.1 Overview

For residential buildings and spaces, all of the lighting requirements are mandatory measures. There are no tradeoffs between lighting and other building features and lighting is not part of any component package under the prescriptive method.

The residential lighting Energy Standards apply only to permanently installed luminaires, including luminaires with easily interchangeable lamps, but do not apply to portable luminaires such as table lamps or freestanding floor lamps.

All section (§) and Table references in this Chapter refer to Sections and Tables contained in Title 24 California Code of Regulations, Part 6, also known as the Energy Standards or California Energy Code.

6.1.1 Significant Changes in the 2016 Energy Standards

The 2016 Energy Standards have simplified the residential lighting requirements through the following important changes:

1. All luminaires installed in residential construction must qualify as “high efficacy luminaires.” This eliminates varying requirements by room and type of controls. This also eliminates the need to calculate the wattage of low versus high efficacy luminaires in the kitchen.
2. The definition of “high efficacy luminaires” has been expanded. It includes the light sources identified as efficient in 2013 (linear fluorescent, pin based compact fluorescent, GU-24 base CFL, HID, and induction lighting), and now also includes any luminaire that contains a JA8 compliant lamp or other light source that is appropriately marked. JA8 contains requirements that ensure that light sources, including lamps and luminaires, provide sufficient color quality, life, and energy efficiency. Table 150.0-A of §150.0 contains the definition.
3. All permanently installed luminaires with interchangeable lamps must contain lamps that comply with the requirements of Joint Appendix 8 (JA8) and be appropriately marked to be considered “high efficacy luminaires.”
4. The marking “JA8-2016” is required for compliance and shall only be used on lamps that meet the requirements of Joint Appendix 8 and are listed in the Energy Commission JA8 database.
5. The marking “JA8-2016-E” indicates that in addition to the requirements above for a JA8-2016 light source, the light source has been tested to provide long life at elevated temperatures. Light sources must be marked “JA 8-2016-E” if they are to be used in enclosed or recessed luminaires.
6. Recessed downlight luminaires and enclosed luminaires are required to contain a JA8 compliant lamp that meets the elevated temperature requirement. Recessed downlight luminaires with screw based sockets are no longer permitted to be installed.

7. The builder must provide the new homeowner with a luminaire schedule (as required in Title 24 California Code of Regulations, Part 1, §10-103(b)) that includes a list of lamps installed in the luminaries so that the homeowner knows what light sources they are entitled to when they take possession of the new home.
8. Inspections for lighting are more straightforward as all luminaries have a high efficacy light source and there is a completed luminaire schedule for the inspector to review.

In addition to these changes, the 2016 Energy Standards include minor modifications to the lighting controls requirements to maintain consistency with the requirements for dimmers and/or vacancy sensors.

6.1.2 Scope and Application

The residential lighting requirements in the Energy Standards, apply to more than just single-family homes. Space types covered include:

- Single-family buildings, indoor and outdoor lighting
- Low-rise multifamily buildings (three stories or less), indoor and outdoor lighting
- High-rise multifamily residential units
- Hotel and motel guest rooms
- Outdoor lighting controlled from the inside of a high-rise multifamily unit or hotel/motel guest room
- Fire station dwelling accommodations
- Dormitory and senior housing dwelling accommodations
- Accessory buildings such as sheds or garages (U occupancy type) on residential sites

The following subchapters provide a brief introduction to how the residential lighting requirements apply in these various space types. Specific requirements are discussed in greater detail throughout this chapter.

6.1.2.1 Single-family and Low-rise Multifamily

The residential lighting requirements apply to all indoor lighting of and outdoor lighting attached to single-family buildings.

The residential lighting requirements apply to lighting within dwelling units in multifamily buildings. In addition to the residential lighting requirements, if the interior common area of a low-rise multifamily building is greater than 20 percent of the total floor area, the lighting in the common areas must comply with the nonresidential lighting standards.

A low-rise residential building is defined in §100.1(b) as a building, other than a hotel/motel, in one of the following Occupancy Groups:

- R-2, multifamily, with three stories or less; or
- R-3, single-family; or
- U-building, located on a residential site.

6.1.2.2 High-rise Multifamily

Lighting within residential units in high-rise multifamily or high-rise residential buildings is required to comply with the residential lighting requirements. Common areas in all high-rise

multifamily buildings must meet all applicable nonresidential lighting requirements. In addition, any outdoor lighting attached to a high-rise residential building controlled from within a residential unit must also meet the residential lighting requirements of the Energy Standards.

6.1.2.3 Residential Spaces in Nonresidential Buildings

In addition to typical residential units, the residential lighting requirements apply to residential spaces in nonresidential buildings. As defined in §130.0(b), the following spaces are required to comply with the residential lighting standards:

- Hotel and motel guest rooms (Note that hotel and motel guest rooms are also required to comply with the requirements in §130.1(c)8, which require captive card key or other occupant sensing controls.)
- Outdoor lighting attached to a hotel or motel that is controlled from inside the guest room.
- Fire station dwelling accommodations.
- Dormitory and senior housing dwelling accommodations.

The space types listed above are in buildings which are classified as nonresidential. All of the other space types in these nonresidential buildings are required to comply with the applicable nonresidential lighting requirements.

6.1.2.4 Outdoor

Outdoor residential lighting is sometimes subject to the residential lighting requirements, and sometimes subject to the nonresidential lighting requirements.

For example, in low-rise multifamily buildings any private patios, entrances, balconies, porches, and any parking lots or carports for fewer than eight vehicles can comply with either the residential or nonresidential Standards.

6.1.2.5 Additions and Alterations

“Additions” are treated the same as newly constructed buildings, so they must meet the applicable residential lighting requirements of §150.0(k).

For alterations, existing luminaires may stay in place but any new permanently installed luminaires shall meet the applicable requirements of §150.0(k).

6.1.3 Related Resources

There are educational resources prepared by the California Energy Commission and others that provide additional information about residential lighting. The Energy Commission educational resources webpage can be found at:

http://www.energy.ca.gov/efficiency/educational_resources.html.

The Residential Lighting Guide, which discusses best practices and lighting designs to help buildings comply with California’s Title 24 Energy Standards, is prepared by the UC Davis California Lighting Technology Center, and is available at:

<http://cltc.ucdavis.edu/title24>.

6.2 Indoor Luminaire Requirements – All High Efficacy

A “luminaire” is the lighting industry’s term for a light fixture, and is defined by §100.1 as a complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts that distribute the light, position and protect the light source and connect it to the power supply. A “lamp” is the lighting industry’s term for a light bulb or similar separable lighting component, and is defined by §100.1 as an electrical appliance that produces optical radiation for the purpose of visual illumination, designed with a base to provide an electrical connection between the lamp and a luminaire, and designed to be installed into a luminaire by means of a lamp-holder integral to the luminaire.

The 2016 Energy Standards require all permanently installed luminaires to be “high efficacy,” as specified in §150.0(k). Permanently installed lighting is defined in §100.1 and examples of permanently installed lighting include:

- Lighting attached to walls, ceilings, or columns.
- Track and flexible lighting systems.
- Lighting inside permanently installed cabinets.
- Lighting attached to the top or bottom of permanently installed cabinets.
- Lighting attached to ceiling fans.
- Lighting integral to exhaust fans.
- Lighting that is integral to garage door openers if it is designed to be used as general lighting, is switched independently from the garage door opener, and does not automatically turn off after a pre-determined amount of time.

The following are examples of what are not considered to be permanently installed lighting:

- Portable lighting as defined by §100.1 (including, but not limited to, table and freestanding floor lamps with plug-in connections).
- Lighting installed by the manufacturer in refrigerators, stoves, microwave ovens, exhaust hoods for cooking equipment, refrigerated cases, vending machines, food preparation equipment, and scientific and industrial equipment.
- Lighting in garage door openers which consists of no more than two screw-based sockets integrated into the garage door opener by the manufacturer, where the lights automatically turn on when the garage door is activated, and automatically turn off after a pre-determined amount of time.

6.2.1 High Efficacy Luminaires

“Efficacy” is a term used in the lighting industry to describe the overall effectiveness of a lamp or luminaire, including its energy efficiency (expressed as lumens/Watt). In order to simplify the residential lighting requirements, the Energy Standards define certain luminaire types as “high efficacy,” meaning that they possess a high lumens per watt efficiency and do not have any attributes that would make the light less effective or less suitable for residential illumination.

As noted above, the 2016 Energy Standards require that all permanently installed residential luminaires must be high efficacy. However, the types of luminaires that can be considered high efficacy have also been redefined.

6.2.1.1 High Efficacy Luminaires

Certain types of light sources are automatically classified as high efficacy, unless they are in recessed downlight luminaires. Luminaires in any of the following categories are automatically classified as high efficacy:

- Pin-based linear fluorescent luminaires using electronic ballasts.
- Pin-based compact fluorescent luminaires using electronic ballasts.
- Pulse-start metal halide luminaires.
- High pressure sodium luminaires.
- Luminaires with GU-24 sockets other than LEDs.
- Luminaires with hardwired high frequency generator and induction lamp.
- Inseparable SSL luminaires installed outdoors.
- Inseparable SSL luminaires with colored light sources for decorative lighting purpose.

The luminaire types listed here are the only types that are automatically classified as high efficacy. All other luminaire types must have a light source or lamp installed in them at the time of inspection that meets the requirements of Reference Joint Appendix JA8.

Note: Luminaires do not need to be shipped by manufacturers with a JA8 source installed.

6.2.1.2 High Efficacy Lighting

Luminaires not listed in the previous section must have an integral light source or removable lamp that meets the performance requirements of Reference Joint Appendix JA8. The requirements in JA8 are designed to ensure that new lighting technologies like LED provide energy efficient light, while also maintaining performance characteristics that residential customers expect. In addition to setting minimum efficacy requirements, JA8 establishes performance requirements that ensure accurate color rendition, dimmability, and reduced noise and flicker during operation.

Luminaires with integral sources, such as LED luminaires, must be certified by the Energy Commission as meeting the requirements of JA8. Luminaires that have changeable lamps (such as screw base luminaires) must be installed with lamps that have been certified by the Energy Commission as meeting the requirements of JA8. Luminaires and lamps that have been certified by the Energy Commission must be marked with "JA8-2016" or "JA8-2016-E" on the product itself. The "JA8-2016-E" marking indicates that the product meets the elevated temperature requirement of Reference Joint Appendix JA8 and is suitable for elevated temperature applications such as enclosed and recessed fixtures.

Examples of luminaires that can be classified as high efficacy by meeting the requirements of JA8 include:

- LED luminaires with integral light sources that are certified to the Energy Commission
- Screw-based luminaires with JA8-certified lamps
- Low-voltage pin-based luminaires with JA8-certified lamps

In short, almost any luminaire can be classified as high efficacy, as long as the luminaire is installed with a JA8 compliant lamp. The exception is recessed downlight luminaires in ceilings, which must meet additional requirements.

The Energy Commission maintains a database of JA8 compliant luminaires and lamps. The database can be accessed using a Quick Search Tool (<https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx>) or an Advanced Search (<https://cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx>).

Table 6-1 summarizes the requirements for residential high efficacy lighting types. As the table shows, there are three categories: luminaires automatically classified as high efficacy; luminaires that must use JA8-certified light sources or lamps; and recessed downlight luminaires in ceilings, which must meet additional requirements.

Table 6-1 - Summary of Compliant Luminaire Types

High Efficacy Luminaires*	JA8 High Efficacy Lighting – Lamps and Light Sources that must be JA8-certified	*Recessed Downlight Luminaires in Ceilings
<ul style="list-style-type: none"> • Pin-based linear fluorescent • Pin-based compact fluorescent • Pulse-start metal halide • High pressure sodium • GU-24 other than LEDs • Inseparable SSL luminaires installed outdoors • Inseparable SSL luminaires with colored light sources for decorative lighting purpose 	<ul style="list-style-type: none"> • Light sources in ceiling recessed downlight luminaires.* • LED luminaires with integral sources • Screw-based LED lamps (A-lamps, PAR lamps, etc.) • Pin-based LED lamps (MR-16, AR-111, etc.) • GU-24 based LED light source • Any source or luminaire not listed elsewhere on this table 	<ul style="list-style-type: none"> • Shall not have screw based sockets • Shall contain JA8-certified light sources • Shall meet all performance requirements in §150.0(k)1C

6.2.2 Recessed Downlight Luminaires in Ceilings

In addition to the high efficacy requirements described above, there are several additional requirements for residential downlight luminaires that are recessed in ceilings.

The first set of requirements limit the light sources and lamp types that can be used in recessed downlight luminaires. Recessed downlights:

1. Shall contain light sources that are JA8-certified.
2. Shall not contain screw based lamps.
3. Shall not contain light sources that are labeled “not for use in enclosed fixtures” or “not for use in recessed fixtures.”

In other words, all recessed downlight luminaires must contain a light source or lamp that is JA8-certified, such as an integral LED source, or LED lamp. However, screw-based lamps such as LED A-lamps or LED PAR lamps are not allowed. Pin-based lamps such as LED MR-16 lamps are allowed in recessed fixtures as long as they are JA8-certified.

In addition to the light source and lamp requirements listed above, recessed downlight luminaires in ceilings must also meet all of the following performance requirements:

1. Be listed for zero clearance insulation contact (IC) by Underwriters Laboratories or another nationally recognized testing/rating laboratory.
2. Have a label that certifies the luminaire is airtight with air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283 (exhaust fan housings are not required to be airtight).

3. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk.
4. For luminaires with hardwired ballasts or drivers, allow ballast or driver maintenance and replacement to be readily accessible to building occupants from below the ceiling without requiring the cutting of holes in the ceiling.

Luminaires that meet the first two performance attributes will typically list this information on luminaire cut sheets or packaging. Contractors are responsible for ensuring that luminaires are properly sealed, and that any ballasts or drivers are accessible.

Recessed downlight luminaires that do not meet all of these requirements cannot be used for residential lighting.

Example 6-1: Recessed downlight luminaires: fire-rated housings

Question

If a factory manufactured fire rated luminaire housing is placed over a recessed luminaire in a multifamily residential dwelling unit, is the luminaire still required to comply with the insulation contact (IC) requirements?

Answer

There are limited applications where a non-IC luminaire may be used in conjunction with a manufactured fire-rated luminaire housing in a multifamily residential dwelling unit. However, the luminaire shall still comply with all of the airtight requirements.

A non-IC luminaire may be used in a ceiling in conjunction with a fire-rated housing only if all three of the following conditions are met:

1. The multifamily dwelling unit is an occupancy type R1 or R2; and
2. The luminaire is recessed between different dwelling units that are regulated by California Building Code §712.4.1.2; and
3. The manufactured fire-rated housing is rated for a minimum of 1 hour fire in accordance with UL 263.

6.2.3 Electronic Ballasts in Luminaires

Fluorescent lamps with a power rating of 13 watts or more shall have electronic ballasts that operate the lamp at a frequency of 20 kHz or more. Most commonly available electronic ballasts meet this requirement.

If in doubt, look at the number of pins protruding from the compact fluorescent lamp base. Pin-based compact fluorescent lamps operated with electronic ballasts typically have four-pin lamp holders. Pin-based compact fluorescent lamps with two-pin lamp holders typically indicate that the ballast is magnetic. Be careful not to confuse pin-based CFL sockets with GU-24 sockets.

High intensity discharge (HID) lamps (like pulse-start metal halide or high-pressure sodium) are not required to have electronic ballasts. This requirement does not apply to HID luminaires.

6.2.4 Blank Electrical Boxes

The number of blank electrical boxes installed more than five feet above the finished floor shall not be greater than the number of bedrooms. These electrical boxes shall be served by a dimmer, a vacancy sensor, or fan speed control.

Example 6-2: Blank Electrical Boxes**Question**

Where in the house can the blank electrical boxes as specified in §150.0(k)1B be permitted to be installed?

Answer

The blank electrical boxes as specified in §150.0(k)1B can be installed anywhere within single-family buildings or dwelling units of multifamily buildings. The number of blank electrical boxes cannot be greater than the number of bedrooms.

6.2.5 Night Lights

Permanently installed night lights and night lights integral to an installed luminaire or exhaust fan shall be rated to consume no more than 5W of power per luminaire or exhaust fan, as determined by §130.0(c).

Night lights are not required to be controlled by vacancy sensors, regardless of the type of room they are located in, as specified by §150.0(k)1E.

Example 6-3: Night Lights**Question**

Where in a residential building are night lights permitted to be installed?

Answer

Since there are no location restrictions in the Energy Standards, permanently installed night lights and night lights integral to installed luminaires can be installed anywhere within single family buildings or within dwelling units of multi-family buildings.

6.2.6 Recommendations for Luminaire Specifications

It is important that luminaires are described fully in the specifications and on drawings so that contractors and subcontractors provide and install residential lighting systems that comply with the residential lighting requirements. The specifications should be clear and complete so that contractors understand what is required to comply with the Standards.

Following are a few suggestions to reduce the chance of costly change orders required to bring a non-complying building into compliance.

1. Include all applicable residential lighting requirements in the general notes on the drawings and other bid documents.
2. Include the residential lighting requirements with each luminaire listed in the lighting schedule text and details, as demonstrated in Table 6-2 below.

Table 6-2 – Sample Luminaire Specifications

Luminaire Type	Recommended Type of Notes for Luminaire Schedule
Bath Bar	Bath bar, GU-24 sockets rated for use with only LED lamps.
Ceiling fixture (i.e., for a bathroom application)	Fluorescent surface-mounted ceiling luminaire, with one F32-T8 fluorescent lamp and electronic ballast, meeting the requirements of §150.0(k).
LED Recessed Can (i.e., for a kitchen application)	LED recessed can certified by the manufacturer to the Energy Commission, housing rated only for use with LED and not containing incandescent sockets of any kind, meeting the IC, and airtight requirements of §150.0(k).
Ceiling fixture	Surface-mounted screw-base fixture, to be installed with JA8 compliant LED lamps.
Chandelier	Chandelier, installed with JA8 compliant lamps, and controlled by a dimmer switch meeting the requirements of §150.0(k) where the dimmer is certified to the Energy Commission by the manufacturer.
Vacancy Sensor (Manual-on Occupant Sensor)	Vacancy sensor certified to the Energy Commission by the manufacturer.

6.2.7 Examples for Luminaire Requirements

Example 6-4: Kitchen Alterations

Question

I am designing a residential kitchen lighting system where I plan to install six 12W LED recessed downlights, and four 24W linear fluorescent under cabinet luminaires. How many watts of incandescent lighting can I install?

Answer

None. Low efficacy luminaires are no longer allowed for residential lighting. All luminaires must meet the definitions of high efficacy luminaires as established in Table 150.0-A of the Energy Standards.

Example 6-5: Definition of high efficacy lighting

Question

I am using a screw-based luminaire that is rated to take a 60W lamp for lighting over a sink, but I plan to install a 10W LED lamp. Does this qualify as a high efficacy luminaire?

Answer

If the LED bulb is JA8-certified, and is marked “JA8-2016,” or “JA8-2016-E” then yes, that luminaire would qualify as high efficacy.

Example 6-6: Kitchens: Extraction hood lighting

Question

I am installing an extraction hood over my stove, it has lamps within it. Do these lamps have to be high efficacy?

Answer

This lighting is part of an appliance, and therefore does not have to meet the residential lighting requirements for permanently installed lighting.

Example 6-7: Fade-in lighting**Question**

I would like to use lighting with an aesthetic fade-in feature in my design. I noticed that JA8 has a start time requirement. Are fade-in lights able to qualify as high efficacy?

Answer

Yes, aesthetic fade-in is acceptable under Title 24. The test procedure for start time measures “[t]he time between the application of power to the device and the point where the light output reaches 98% of the lamp’s initial plateau.” The “initial plateau” is “[t]he point at which the average increase in the light output over time levels out (reduces in slope).”

For light sources with a fade-in feature, the light output is intentionally following a programmed fade-in curve in order to increase light output gradually. Because the light output must “level out”, the Initial Plateau for these light sources is the point in time at which there is perceived light output and the perceived light increase begins to follow the programmed fade-in curve. (Note that the programmed fade-in curve is expected to be continuously increasing as a function of time.)

This allows fade-in lighting to qualify as high efficacy.

Example 6-8: Ceiling fans with integrated lighting**Question**

Can a ceiling fan with integrated lighting be a high efficacy luminaire?

Answer

Yes. Ceiling fan light kits with integral CFL ballasts are available. Ceiling fans and light kits with screw base sockets can also be considered high efficacy if they are installed with JA8-certified light sources or lamps.

Example 6-9: Best practice for high efficacy spotlights**Question**

Are high-efficacy spotlights available, to replace halogen MR16s?

Answer

Some CFLs resemble spotlights, and manufacturers may describe them as spotlights, but they produce the same diffuse light as regular CFLs.

Metal halide spotlights with 35W T-6 high efficacy lamps are available.

MR16 LEDs can be used as spotlights but must be JA8-certified and labeled before it can be classified as high efficacy.

6.3 Indoor Lighting Controls Requirements

The use of lighting controls is an important component of the Energy Standards.

6.3.1 Requirements of Controls Devices

Manual-on/automatic-off occupant sensors (also known as vacancy sensors), motion sensors, photo-control astronomical time clock controls (used for outdoor lighting), and dimmers installed to comply with §150.0(k) must have been certified to the Energy Commission by their manufacturer, pursuant to the provisions of the Title 20 Appliance Efficiency Regulations (Title 20 California Code of Regulations, §1606), as required by §110.9.

6.3.1.1 Requirements for Dimmers

In addition to meeting the applicable requirements of the Appliance Standards, all forward phase cut dimmers must comply with NEMA SSL 7A. This designation is typically noted on equipment cut sheets or dimmer packaging and ensures compatibility with solid state lighting (including LEDs).

6.3.2 General Controls Requirements

Following are general control requirements that apply in all room types and for all luminaire types:

6.3.2.1 Readily Accessible Manual Controls

All permanently installed luminaires shall have readily accessible controls that permit the luminaires to be manually switched on and off.

6.3.2.2 Exhaust Fans

There are two options for the lighting associated with exhaust fans:

1. All lighting shall be switched separately from exhaust fans.
2. For an exhaust fan with an integral lighting system, it shall be possible for the lighting system to be manually turned on and off while allowing the fan to continue to operate for an extended period of time.

6.3.2.3 Manufacturer Instructions

All lighting controls and equipment shall be installed in accordance with the manufacturer's instructions.

6.3.2.4 Multiple Switches

This requirement applies to all 3-way, 4-way, and other lighting circuits controlled by more than one switch. A lighting circuit controlled by more than one switch where a dimmer or vacancy sensor has been installed to comply with §150.0(k) shall meet all of the following conditions:

1. No controls shall bypass the dimmer or vacancy sensor function.
2. The dimmer or vacancy sensor shall be certified to the Energy Commission that it complies with the applicable requirements of §110.9.

6.3.2.5 Lighting Control Systems and Energy Management Control Systems (EMCS)

Lighting controls may be either individual devices or systems consisting of two or more components. Lighting control systems and EMCS must meet the requirements of §110.9. There is no need for lighting control systems to be certified to the Commission. However, when installing a lighting control system, a licensee of record must sign a lighting control Certificate of Installation.

6.3.3 Spaces Required to Have Vacancy Sensors

Manual-on/automatic-off occupant sensors, also known as vacancy sensors, automatically turn lights off if an occupant forgets to turn them off when a room is unoccupied. Additionally, these sensors are required to provide the occupant with the ability to manually turn the lights:

1. Off upon leaving the room.

2. Off while still occupying a room.
3. On upon entering the room.

The manual-off feature is critical because it provides the occupants with the flexibility to control the lighting environment to their satisfaction, and results in greater energy savings by allowing the occupants to turn off the lights when they are not needed.

The Energy Standards require vacancy sensors to control at least one luminaire in the following room types:

1. Bathrooms.
2. Utility rooms.
3. Laundry rooms.
4. Garages.

If there are rooms or areas where there are safety concerns regarding the use of vacancy sensors, then the use of “dual technology” (infra-red plus ultrasonic) may be desirable, or the vacancy sensor may be staged to partially shut off the lighting before switching it off completely.

6.3.3.1 Choosing Vacancy Sensors

Vacancy sensors commonly on the market are wired in two different ways:

1. Where sensor operating current uses the load connection (two-wire connection).
2. Where sensor operating current uses a neutral connection (three-wire connection).

Some vacancy sensors using the load connection for operating current have minimum load requirements.

For example, a vacancy sensor may require that bulbs rated over 25W be installed before the sensor will work. However, if an occupant later installs a screw-in compact fluorescent lamp that is rated less than 25W, the sensor may no longer work.

Therefore, it is critical to select a sensor that has a low enough minimum load requirement to accommodate however small a load the occupant may install into the socket, or one that does not have a minimum load requirement. Sensors that have a minimum load requirement are typically designed to operate without a neutral wire in the switch box, which is a common wiring scheme in older residential units. Vacancy sensors that are designed to take advantage of the neutral wire in the switch box typically do not have a minimum load requirement and are the preferred choice for residential units.

Using vacancy sensors that use the ground wire for the operating current is not recommended. There are potential safety concerns with using the ground to carry current in residential applications.

If you are trying to control a lighting fixture from two different switches you may want to use a ceiling mounted sensor rather than a wall switch occupant sensor, or use 3-way vacancy sensors at both switch locations.

Example 6-10: Bathroom vacancy sensors--manual off

Question

Must the vacancy sensor in a bathroom provide the occupant the option of turning the light off manually?

Answer

Yes. The vacancy sensor must provide the occupant with the option to turn the lights off manually.

If an occupant forgets to turn the lights off when a room is left unoccupied, then the vacancy sensor must turn the lights off automatically within 20 Minutes. However, the occupant must also have the ability to turn the lights off upon leaving the room.

This provides occupants with the flexibility to control the lighting environment to their satisfaction, and results in greater energy savings by allowing occupants to turn off the lights when they are not needed.

Example 6-11: Can auto-on occupancy sensors be used?

Question

What are the options for using an automatic-on occupant sensor in a bathroom, garage, laundry room, or utility room?

Answer

Automatic-on occupant sensors are not allowed under the residential lighting requirements.

Example 6-12: Usage of Energy Management Control System (EMCS) for controls

Question

What is permitted for the use of Energy Management Control System (EMCS) in the controls of under-cabinet lighting?

Answer

It is allowed to use an EMCS to control under-cabinet lighting provided that the under-cabinet lighting is switched separately from other lighting systems as specified in §150.0(k)2L.

6.3.4 Luminaires Required to Have Dimmers or Vacancy Sensors

All luminaires that are installed with JA8-certified light sources are required to be controlled by either a dimmer or vacancy sensor. In addition, all blank electrical boxes more than five feet above the floor must be controlled by a dimmer, vacancy sensor, or fan speed control.

Dimmers or vacancy sensors are not required on any luminaires located in closets less than 70 square feet, or in hallways.

Although not required for all luminaires or space types, the use of dimmers and/or vacancy sensors is recommended for any application where they can provide additional energy savings or additional amenity for the homeowner or occupant.

6.3.4.1 Choosing Dimmers

It is important to correctly match the dimmer with the type of lighting load that is being dimmed. Failure to do so may result in early equipment failure, including the dimmer, transformer, ballast, or lamp.

This is especially important with LED lighting; a dimmer with the appropriate power range should be chosen to match the total wattage of lighting it controls.

As noted, all forward phase cut dimmers must comply with NEMA SSL 7A for usage with LED light source. This is to ensure compatibility between the forward phase cut dimmers and the LED light sources.

Example 6-13: Using dimmers on three-way lighting circuits

Question

In stairwells and some corridors, 3-way circuits are a common way to allow control of the lighting from either end of the space. How can I use dimmers to give a similar level of control?

Answer

In this case, the lighting must be controlled by at least one dimmer. It is functionally preferable, but not required, to have dimmers at every point. One of the switches must be a dimmer but the other may be a regular toggle switch. Alternatively, more advanced controls are available that allow dimming from both ends of the circuit.

Note that the toggles switch(es) must not allow the lighting to come on at a higher level than is set by the dimmer.

6.4 Multifamily Common Area Lighting Requirements

Common areas in multi-family buildings include areas like interior hallways, lobbies, entertainment rooms, pool houses, club houses, and laundry facilities. Lighting requirements for these spaces depend on the characteristics of the buildings, as described below.

Buildings three stories or less are classified as low-rise, and buildings four stories or more are classified as high-rise.

6.4.1 Low-Rise Multifamily

Lighting requirements in common areas of low-rise multifamily buildings depend on the percentage of the total interior common area in each building. Buildings where interior common area equals 20 percent or less to the floor area have one set of requirements, and buildings where the total interior common area is greater than 20 percent of the total floor area have different requirements.

A. If the common area equals 20 percent or less of the total building floor area

In low-rise multifamily buildings where the total interior common area in a single building is 20 percent or less of the total floor area, all permanently installed lighting in interior common areas must be high efficacy and controlled by occupancy sensors.

B. If the common area is greater than 20 percent of the total building floor area

In low-rise multifamily buildings where the total interior common area in a single building is greater than 20 percent of the total floor area, permanently installed lighting in common areas must meet the applicable nonresidential lighting requirements, and corridor and stairwell lighting must be controlled by occupant sensors.

The relevant nonresidential lighting requirements that apply in these cases are:

1. §110.9 – Mandatory Requirement for Lighting Control Devices and Systems, Ballasts, and Luminaires
2. §130.0 – Lighting Systems and Equipment, and Electrical Power Distribution Systems – General
3. §130.1 – Mandatory Indoor Lighting Controls
4. §140.6 – Prescriptive Requirements for Indoor Lighting
5. §141.0 – Additions, Alterations, and Repairs to Existing Nonresidential, High-Rise Residential, and Hotel/Motel Buildings, to Existing Outdoor Lighting, and to Internally and Externally Illuminated Signs

These sections cover allowable equipment, controls requirements for various space types, allowable lighting power densities for various space types, and requirements for additions and alterations to existing buildings. More information about the nonresidential lighting requirements that apply in these scenarios can be found in Chapter 5 of the Nonresidential Compliance Manual.

In addition to meeting the applicable nonresidential lighting requirements listed above, lighting in corridors and stairwells in these buildings must meet the following occupancy control requirements:

1. Occupancy controls must reduce stairway and corridor lighting power by at least 50 percent when the spaces are unoccupied.
2. Occupancy controls must be capable of turning stairwell and corridor lighting fully On and Off from all designated paths of ingress and egress.

The lighting of staircases and stairwells is a significant safety concern; the best way to light stairs is with directional light from above, to maximize the contrast between treads and risers.

Example 6-14: Multifamily common areas: Low rise

Question

Does the lighting for an interior common-area hallway of a low-rise residential building with a total common area of 10% of the total building area have to comply with the Residential or Nonresidential Lighting requirements?

Answer

Residential requirements only. The lighting of an interior common-area hallway of any low-rise residential building with total common area of 20% or less of the total building area must comply with only the residential lighting requirements.

Example 6-15: Egress Lighting for Common Areas in Low-rise Multifamily Buildings

Question

What is the egress lighting requirement for interior common areas in low-rise multi-family buildings?

Answer

The only requirement of the Energy Standards for egress lighting system in the interior common areas of a low-rise multi-family residential building is that all luminaires must be high efficacy. Refer to California Code of Regulations, Title 24, Part 2, Chapter 10, for emergency egress lighting requirements.

6.4.2 High-Rise Multifamily

Common areas in all high-rise multifamily buildings (four stories or greater) must meet all applicable nonresidential lighting requirements in the following sections:

1. §110.9 – Mandatory Requirement for Lighting Control Devices and Systems, Ballasts, and Luminaires.
2. §130.0 – Lighting Systems and Equipment, and Electrical Power Distribution Systems – General.
3. §130.1 – Mandatory Indoor Lighting Controls.
4. §130.4 – Lighting Control Acceptance and Installation Certificate Requirements.
5. §140.6 – Prescriptive Requirements for Indoor Lighting.
6. §141.0 – Additions, Alterations, and Repairs to Existing Nonresidential, High-Rise Residential, and Hotel/Motel Buildings, to Existing Outdoor Lighting, and to internally and Externally Illuminated Signs.

These sections cover allowable equipment, controls requirements for various space types, allowable lighting power densities for various space types, and requirements for additions and alterations to existing buildings. More information about the nonresidential lighting requirements that apply in these scenarios can be found in Chapter 5 of the Nonresidential Compliance Manual.

Dwelling units within high-rise multifamily buildings must comply with the residential lighting requirements.

Example 6-16: Multifamily common areas: High rise

Question

Does the lighting for an interior common-area hallway of a high rise residential building have to comply with the Residential or Nonresidential Lighting requirements?

Answer

The lighting of an interior common-area hallway of a high rise residential building must comply with the Nonresidential Lighting Standards. All the lighting in common areas must comply with the Nonresidential Standards; lighting inside the dwelling units must comply with the residential lighting requirements.

Hallways and stairwells are required to have partial off occupancy sensors that switch off at least half the lighting load when the hallway or stairwell is unoccupied.

6.5 Outdoor Lighting Requirements

Outdoor residential lighting is sometimes subject to the residential lighting requirements, and sometimes subject to the nonresidential lighting requirements.

6.5.1 Outdoor Luminaires

All lighting attached to the residence or to other buildings on the same lot must be high efficacy. Table 150.0-A lists all qualifying high efficacy light sources. Note that solid state lighting (SSL) luminaires installed outdoors are exempted from the general residential lighting requirement that all SSL luminaires for residential lighting must meet the requirements of Joint Appendix JA8.

6.5.2 Single-Family Outdoor Lighting

All lighting attached to the residence or to other buildings on the same lot must be high efficacy, and must be controlled by a manual ON and OFF switch and one of the following automatic control types:

1. Photocontrol and motion sensor.
2. Photocontrol and automatic time switch control.
3. Astronomical time clock control that automatically turns the outdoor lighting off during daylight hours.
4. EMCS that provides the functionality of an astronomical time clock, does not have an override or bypass switch that allows the luminaire to be always ON, and is programmed to automatically turn the outdoor lighting off during daylight hours.

Manual ON and OFF switches must not override the automatic control functions listed above, and any control that overrides the automatic controls to ON must automatically reactivate those controls within six hours.

Lighting that is not permanently attached to a building on a single-family site, such as decorative landscape lighting, is not regulated by the residential lighting requirements. However, providing high efficacy lighting and controls such as a time clock or photocontrol will help save energy and ensure that the lighting is not accidentally left on during daylight hours.

Table 6-3 Outdoor Lighting Standards for Single Family Buildings

Outdoor Lighting Requirements Res is short for Residential Standards; Nonres is short for Nonresidential Standards	
Spaces or Areas with Outdoor Lighting	Single Family Buildings
Outdoor lighting mounted to building.	Res
Private patios, entrances, balconies, and porches.	Res
Residential parking lots and carports with 8 or more vehicles per site.	Nonres
Parking garages with 8 or more vehicles.	Nonres

6.5.3 Low-Rise Multifamily Outdoor Lighting

Low-rise multifamily buildings have the option of complying with either the residential or nonresidential lighting standards for the following applications:

1. Private patios
2. Entrances
3. Balconies
4. Porches

For all other outdoor lighting applications, low-rise buildings with three units or less must comply with the residential lighting requirements, and buildings with four units or more must comply with the applicable nonresidential requirements.

Table 6-4 Outdoor Lighting Standards for Low-Rise Multifamily Buildings

Outdoor Lighting Requirements Res is short for Residential Standards; Nonres is short for Nonresidential Standards		
Spaces or Areas with Outdoor Lighting	Low-rise Multifamily Buildings	
	1-3 Dwelling Units	4 or more Dwelling Units
Private patios, entrances, balconies, and porches.	Res or Nonres (builder's option)	Res or Nonres (builder's option)
Residential parking lots and carports with less than 8 vehicles per site.	Res or Nonres (builder's option)	Res or Nonres (builder's option)
Outdoor lighting not regulated by Section 3B or 3D.	Not applicable	Nonres
Residential parking lots and carports with 8 or more vehicles per site.	Nonres	Nonres
Parking garages with 8 or more vehicles.	Nonres	Nonres

6.5.4 High-Rise Multifamily Outdoor Lighting

Any outdoor lighting attached to the building, which is controlled from within the dwelling unit, must comply with the residential requirements.

Outdoor lighting attached to the building that is not controlled from within the dwelling unit must comply with the following nonresidential requirements:

1. §110.9 – Mandatory Requirement for Lighting Control Devices and Systems, Ballasts, and Luminaires
2. §130.0 – Lighting Systems and Equipment, and Electrical Power Distribution Systems – General
3. §130.2 - Outdoor Lighting Controls and Equipment
4. §130.4 - Lighting Control Acceptance and Installation Certificate Requirements
5. §140.7 - Requirements for Outdoor Lighting
6. §141.0 – Additions, Alterations, and Repairs to Existing Nonresidential, High-Rise Residential, and Hotel/Motel Buildings, to Existing Outdoor Lighting, and to internally and Externally Illuminated Signs

For information on the nonresidential lighting requirements, see Chapter 5 of the Nonresidential Compliance Manual.

Table 6-5 Outdoor Lighting Standards for High-Rise Multifamily Buildings

Outdoor Lighting Requirements Nonres is short for Nonresidential Standards	
Spaces or areas with outdoor lighting	High-rise Multifamily Buildings (See footnote 1.)
Residential parking lots and carports with 8 or more vehicles per site.	Nonres
Parking garages with 8 or more vehicles.	Nonres

Footnote:

1. Residential Lighting Standards applies to the dwelling units;
Nonresidential Lighting Standards applies to areas outside dwelling units.

6.5.5 Internally Illuminated Signs

Internally illuminated signs shall consume no more than 5 watts of power as determined according to §130.0, or shall comply the with nonresidential sign lighting requirements in §140.8.

Example 6-17: Outdoor lighting: Glare control

Question

Are there any “cutoff” requirements for residential outdoor luminaires?

Answer

There are no “cutoff” requirements for typical residential outdoor lighting. However, residential parking lots for eight or more vehicles are required to meet the Nonresidential Standards, which do include cutoff requirements for luminaries greater than 150W. The requirement uses the Backlight, Uplight and Glare (BUG) ratings developed by the IES to define acceptable amounts of uplight and glare (there are no limits on “backlight.”) Even though not required for most residential outdoor lighting, luminaires that limit uplight are usually more efficient at providing light in the required area, so a lower wattage lamp and ballast can be used. The BUG requirements also reduce stray light and glare problems which can cause visual discomfort.

Example 6-18: Outdoor lighting: Landscape lighting

Question

I would like to install low-voltage landscape lighting in my yard. Are these required to be on a motion sensor and photocontrol?

Answer

No. Although the lighting requirements only apply to lighting that is attached to the building, it is advisable to use photocontrols or astronomical time clock controls for landscape lighting so that the lighting is not left on during daylight hours.

Example 6-19: Outdoor lighting: Patios

Question

Does outdoor lighting on the patio of a high-rise residential building have to comply with the Residential or Nonresidential Lighting Standards?

Answer

If the patio outdoor lighting is controlled from inside of the dwelling unit, it must comply with the Residential Outdoor Lighting Standards. If the patio outdoor lighting is controlled from outside of the dwelling unit, it must comply with the Nonresidential Outdoor Lighting Standards. For example, if the outdoor patio lighting is controlled by a building-wide EMCS outside of the dwelling units, it must comply with the Nonresidential Outdoor Lighting Standards.

6.6 Residential Parking Garage and Parking Lot Lighting

Residential parking garages are treated as indoor spaces, whereas residential parking lots and carports are treated as outdoor spaces. All three types of parking facilities are required to meet either the residential or the nonresidential requirements, depending on what type of building they are associated with (see the tables above for a summary of requirements.)

Private garages and carport buildings are considered to be low-rise residential buildings and have to comply with requirements of §150.0.

Regardless of the classification of the associated building, any garage, parking lot, or carport for eight or more cars must comply with all applicable nonresidential lighting requirements in §110.9, §130.0, §130.1, §130.2, §130.4, §140.6, §140.7, and §141.0.

6.6.1 Single-Family

Garages on single-family sites with space for seven cars or less must comply with the residential lighting requirements in §150.0(k), which require all luminaires to be high efficacy and that at least one luminaire in each garage to be controlled by a vacancy sensor.

Parking lots and carports on single-family sites with space for seven cars or less must comply with residential outdoor lighting requirements.

6.6.2 Low-Rise Multifamily

Parking garage lighting Standards in low-rise multifamily buildings are determined in the same manner as common area lighting Standards. Buildings where interior common area is 20 percent or less of the total building area must use the residential Standards for parking garages. Multifamily buildings with three or less stories where interior common area is greater than 20 percent of the total building area must use the nonresidential lighting requirements for parking garages.

Parking lots and carports for low-rise multifamily buildings with space for seven cars or less must install all high efficacy luminaires per §150.0(k)1A, and must additionally comply with either the residential or nonresidential lighting requirements (§150.0(k)3B).

6.6.3 High-Rise Multifamily

Garages and parking lots for high-rise multifamily buildings must comply with all applicable nonresidential lighting requirements in §110.9, §130.0, §130.1, §130.2, §130.4, §140.6, §140.7, and §141.0.

Example 6-20: Parking spaces

Question

I have a low-rise multi-family complex with a total of 20 parking spaces. However, the parking spaces are arranged throughout the site in groups of only four spaces each. Are these parking spaces required to comply with the nonresidential outdoor lighting requirements?

Answer

Yes, these spaces are required to comply with the Nonresidential Outdoor Lighting Standards. Parking lots and carports for a total of eight or more cars per site must meet the nonresidential outdoor lighting requirements, regardless of how the spaces are arranged on the site.

6.7 Additions and Alterations

Residential building additions are required to meet all mandatory requirements in §150.0. Because the residential lighting requirements are mandatory requirements, lighting in all residential building additions must meet all the applicable requirements outlined in this chapter.

For residential building alterations, any new or altered lighting systems must also meet all of the applicable requirements indicated in this chapter. Existing luminaires and lighting systems that are not altered may stay as-is.

6.8 Compliance Documentation

This section covers residential lighting compliance documentation (compliance forms) that builders must submit to the responsible code enforcement agency for compliance with the residential lighting requirements.

Because the compliance documentation for residential lighting consists primarily of a Certificate of Installation, it is not to be submitted until after the lighting project has been completed.

All of the residential lighting requirements are mandatory measures. There are no tradeoffs between lighting and other building features.

6.8.1 Certificate of Installation (CF2R-LTG)

Lighting control systems are required to comply with the Certificate of Installation (form CF2R-LTG) requirements in §130.4.

Even though the Certificate of Installation for lighting control systems is designed primarily for use as a nonresidential compliance document, it is also required whenever a lighting control system is used to comply with the residential lighting requirements.

A. Person Responsible to Submit the Certificate of Installation

The Certificate of Installation is required to be submitted by a person eligible under Division 3 of the Business and Professions Code to accept responsibility for construction for all residential lighting projects (Title 24 California Code of Regulations, Part 1, §10-103(a)3.) In this Certificate of Installation, the person accepting responsibility for the project declares that the installed residential lighting complied with all of the applicable lighting requirements.

B. Number of Certificates of Installation Required

A residential lighting project may require one, or more than one, Certificate of Installation to be submitted. For example, if one qualified person accepts responsibility for the lighting installation of an entire lighting project, only one Certificate of Installation will need to be submitted. However, if one qualified person accepts responsibility for the installation of the lighting controls, and another qualified person accepts responsibility for the installation of the luminaires, then each qualified person will need to submit a separate Certificate of Installation.

A Certificate of Installation must be submitted to the responsible code enforcement agency for any residential lighting project that is regulated by Part 6, whether that lighting project is for only one luminaire, or for the lighting of an entire building.

The Certificate of Installation for residential lighting is completed and signed by the contractor responsible for installing hard-wired lighting systems. The installer verifies compliance with the mandatory requirements for lighting, and whether high efficacy lighting and the required controls (i.e., vacancy sensors, dimmer switches) were installed.

C. Registration

New requirements for a documentation procedure called “registration” were introduced with the 2008 Energy Standards. Registration is now required for all low-rise residential buildings for which compliance requires Home Energy Rating System (HERS) field verification (see Title 20 California Code of Regulations §1670 et seq.). When registration

is required, the Certificates of Installation must be submitted electronically to an approved HERS provider data registry for registration and retention.

Registration requirements are detailed in Chapter 1 of the 2016 Residential Compliance Manual.

The builder or installing contractor responsible for the installation must provide a copy of the completed, signed, and registered Certificate(s) of Installation to the HERS rater; post a copy at the building site for review by the enforcement agency in conjunction with requests for final inspection; and provide copies of the registered Certificate(s) of Installation to the home owner.

D. Certificate of Installation Requirements in the Standards

The following is the Energy Standards' language that requires the Certificate of Installation to be submitted when a lighting control system is installed to comply with any of the residential lighting control requirements.

- §150(k)2F – Lighting controls shall comply with the applicable requirements of §110.9.
- §110.9(a)4 – Lighting Control Systems, as defined in §100.1, shall be a fully functional lighting control system complying with the applicable requirements in §110.9, and shall meet the Lighting Control Installation requirements in §130.4.
- §130.4(b) – Lighting Control Installation Certificate Requirements
To be recognized for compliance with Part 6, an Installation Certificate shall be submitted in accordance with §10-103(a) for any lighting control system, Energy Management Control System (EMCS), track lighting integral current limiter, track lighting supplementary over current protection panel, interlocked lighting system, lighting Power Adjustment Factor, or additional wattage available for a videoconference studio, in accordance with the following requirements, as applicable:
 - Certification that when a lighting control system is installed to comply with the lighting control requirements in Part 6, it complies with the applicable requirements of §110.9 and complies with Reference Nonresidential Appendix NA7.7.
 - Certification that when an EMCS is installed to function as a lighting control required by Part 6 it functionally meets all applicable requirements for each application for which it is installed, in accordance with §110.9, §130.0 through §130.5, §140.6, §140.7, and §150.0(k); and complies with Reference Nonresidential Appendix NA7.7.2.
- §150(k)2G – An EMCS may be used to comply with dimmer requirements in §150.0(k) if, at a minimum, it provides the functionality of a dimmer in accordance with §110.9, meets the installation certificate requirements in §130.4, the EMCS requirements in §130.0(e), and complies with all other applicable requirements in §150.0(k)2.
- §150(k)2H – An EMCS may be used to comply with vacancy sensor requirements in §150.0(k) if at a minimum it provides the functionality of a vacancy sensor in accordance with §110.9, meets the installation certificate requirements in §130.4, the EMCS requirements in §130.0(e), and complies with all other applicable requirements in §150.0(k)2.

- §150(k)2I – A multi-scene programmable controller may be used to comply with dimmer requirements in §150.0(k) if at a minimum it provides the functionality of a dimmer in accordance with §110.9, and complies with all other applicable requirements in §150.0(k)2.

6.8.2 Lighting Schedule Submitted to Homeowner

New to the 2016 Energy Standards, a schedule of all interior luminaires and lamps installed must be delivered to the homeowner after final inspection (Title 24 California Code of Regulations, Part 1, §10-103(b)3). In addition to a complete list of installed lighting systems, the lighting schedule should include all necessary system information for regular operations and maintenance, and references to support future upgrades to the lighting system.

6.9 For Building Officials

This section provides guidance for enforcement agency personnel, outlining what to look for on the plans, what compliance documents to expect, and high priority issues to look for on inspections.

6.9.1 Plans

A. Confirm All Specified Luminaires Are High Efficacy

All permanently installed luminaires shown on the plans and/or specifications must be high efficacy (§150.0(k)1A). Luminaires may qualify as high efficacy in one of three ways:

1. Use one of the following lighting technologies:
 - Pin-based linear fluorescent with electronic ballast.
 - Pin-based compact fluorescent with electronic ballast.
 - Pulse-start metal halide.
 - High pressure sodium.
 - GU-24 other than LEDs.
 - Induction lamp.
 - Inseparable SSL luminaires installed outdoors.
 - Inseparable SSL luminaires with colored light sources for decorative lighting.
2. Luminaires EXCEPT recessed downlights, must comply with either:
 - JA8-certified luminaires with integral light sources.
 - Luminaires installed with JA8-certified lamps at inspection.
3. Recessed downlight luminaires must comply with BOTH:
 - JA8-certified integral source or a JA8-certified lamp.
 - Must NOT contain a screw base socket.

Plans, lighting specifications, and/or notes should clearly specify how luminaires will comply.

B. Confirm All Required Controls Are Specified

Plans and specifications should clearly indicate the controls required for compliance.

Vacancy controls should be shown on plans, or described in notes or specifications, to control at least one luminaire in each of the following spaces:

- Bathrooms
- Utility Rooms
- Laundry Rooms
- Garages

Dimmers or vacancy controls should be shown on plans, or described in notes or specifications, to control all luminaires using JA8-certified changeable lamps.

Plans, lighting specifications, and/or notes should clearly identify how luminaires will comply with the controls requirements. Notes and/or control equipment specifications should include any applicable requirements for control device operation.

C. Confirm Any Applicable Outdoor and Nonresidential Lighting Standards

Where applicable, outdoor lighting shall be shown on plans or described in specifications and/or notes to be high efficacy, and to meet the control requirements of §150.0(k)3.

Plans, specifications, and notes should also describe any applicable nonresidential common area or outdoor lighting requirements that apply.

6.9.2 Compliance Documentation

Confirm that all required compliance documentation is included with the plans.

A. Certificate of Installation

The certificate of installation (CF2R-LTG) is the primary compliance documentation for residential lighting. There will be one or more CF2R-LTG forms submitted for each project. Confirm that all lighting systems and lighting controls in the project are covered by a CF2R-LTG. Confirm that all CF2R-LTG forms are registered, if required.

B. Lighting Schedule

Builders are required to submit a lighting schedule to homeowners or occupants at the time of occupancy. This lighting schedule should describe all interior luminaires and lamps installed in the home. A draft lighting schedule should be included with the plans at plan check.

C. Documentation for Control Systems

Some lighting control systems for residential lighting will also require specific compliance documentation.

6.9.3 Inspections

A. Confirm All Luminaires Are High Efficacy

Inspectors should verify that all installed luminaires are high efficacy. Luminaires are classified as high efficacy in one of three ways:

1. Use one of the following lighting technologies:
 - Pin-based linear fluorescent with electronic ballast.
 - Pin-based compact fluorescent with electronic ballast.
 - Pulse-start metal halide.

- High pressure sodium.
 - GU-24 other than LEDs.
 - Induction lamp.
 - Inseparable SSL luminaires installed outdoors.
 - Inseparable SSL luminaires with colored light sources for decorative lighting.
2. Luminaires EXCEPT recessed downlights, must comply with either:
 - JA8-certified luminaires with integral light sources.
 - Luminaires installed with JA8-certified lamps.
 3. Recessed downlight luminaires must comply with BOTH:
 - JA8-certified integral source or a JA8-certified lamp.
 - Must NOT contain a screw base socket.

Inspectors should be able to confirm that luminaires are high efficacy by a visual inspection. High efficacy luminaire types are typically recognizable and distinct from non-high efficacy luminaire types. JA8-certified luminaires and removable JA8-certified lamps must be marked with a label reading "JA8-2016" or "JA8-2016-E." The "JA8-2016-E" marking indicates those products which meet the JA8 elevated temperature requirement and are suitable for elevated temperature applications such as in enclosed fixtures or recessed downlights.

B. Confirm All Required Controls Are Installed and Functioning

Inspectors should verify that all controls are installed and functioning.

At least one luminaire in each of the following spaces must be controlled with a vacancy controls:

- Bathrooms
- Utility Rooms
- Laundry Rooms
- Garages

Dimmers or vacancy controls must control all luminaires using JA8-certified light sources.

C. Confirm Any Applicable Outdoor and Nonresidential Lighting Standards

Inspectors should verify that all outdoor lighting attached to the residence or to other buildings on the same lot are high efficacy, and are controlled by a manual ON and OFF switch and by photocell and motion sensor and one of the following automatic control types:

1. Photocontrol AND automatic time switch control.
2. Astronomical time clock controls that automatically turns the outdoor lighting off during daylight hours.
3. Energy management control system (EMCS) that functions as an astronomical time clock, does not have an override or bypass switch that allows the luminaire to be always ON, and is programmed to automatically turn the outdoor lighting off during daylight hours.

Manual ON and OFF switches must not override the automatic control functions listed above, and any control that overrides the automatic controls to ON must automatically reactivate those controls within six hours.

Lighting that is not permanently attached to a building on a single-family site, such as decorative landscape lighting, is not regulated by the residential lighting requirements.

Inspectors should also verify compliance with any applicable nonresidential common area or outdoor lighting requirements. More information on nonresidential lighting requirements can be found in the Nonresidential Compliance Manual Chapter 5 and 6.

D. Inspections for Ceiling Recessed Downlight Luminaires

Recessed downlight luminaires must be IC rated and have a gasket or caulking between the housing and ceiling to prevent the flow of heated or cooled air between conditioned and unconditioned spaces.

Luminaire must include a label certifying airtight or similar designation to show air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. The label must be clearly visible for the building inspector. The building inspector may verify the IC and ASTM E283 labels during rough inspection. If verified at final inspection, the building inspector may have to remove the trim kit to see the labels.

The ASTM E283 certification is a laboratory procedure intended to measure only leakage of the luminaire housing or, if applicable, of an airtight trim kit, and not the installation. Luminaire housings labeled as airtight, airtight ready, or other airtight designation do not establish that a luminaire has been installed airtight. The luminaire manufacturer shall provide instructions that explain the entire assembly required to achieve an airtight installation.

There are different methods used by manufacturers to meet the airtight standards. These methods include the use of caulk, or use of gaskets to reduce air leakage at the luminaire housing. The residential lighting requirements do not favor one airtight method over another.

Because luminaire housing is not always installed perfectly parallel to the ceiling surface, both methods have their benefits as follows:

1. Caulk will generally fill in and seal wide and uneven gaps. However, after the caulk dries, it may permanently attach the luminaire housing or trim to the ceiling surface. Therefore, the caulk may need to be cut away from the ceiling surface in the event that a luminaire housing or trim needs to be moved away from the ceiling.
2. Many gaskets allow the luminaire housing or trim to be readily moved away from the ceiling surface after it has been installed. However, if the gasket is too thin, or not made out of an air stopping type of material, it may not sufficiently reduce the air flow between the conditioned and unconditioned spaces. Although the Standards do not specify the type of material needed for a gasket, it is likely that an open cell type of foam, particularly if the gasket is relatively thin, will not create an airtight barrier.

The primary intent is to install a certified airtight luminaire so that it is sufficiently airtight to prevent the flow of heated or cooled air between conditioned and unconditioned spaces. All air leak paths through the luminaire assembly or through the ceiling opening must be sealed. Leak paths in the installation assembly that are not part of the ASTM E283 testing must be sealed with either a gasket or caulk.

The process for verifying an airtight installation:

1. Manufacturer specifications (a "cut sheet") of the certified airtight luminaire housing(s) and installation instructions are made available with the plans to show all components of the assembly that will be necessary to ensure there is an airtight installation consistent with §150.0(k)1C. This allows the building inspector to know what method the luminaire manufacturer specifies to achieve airtight installation, and to determine what phase of construction the building inspector should inspect the luminaire for airtight compliance.
2. One of the following primary methods is specified by the luminaire manufacturer to ensure an airtight seal of the certified airtight housing to the ceiling:
 - a. A gasket is attached to the bottom of the certified airtight housing prior to the installation of the ceiling (i.e., drywall or other ceiling materials) to create an airtight seal. The gasket may be preinstalled at the factory, or may need to be field installed. For field installed gaskets, instructions on how the gasket is to be attached shall be provided by the manufacturer. The luminaire shall be installed so that the gasket will be sufficiently compressed by the ceiling when the ceiling is installed. A gasket that is too thin will not provide an airtight seal.
 - b. A gasket is applied between the certified airtight housing and the ceiling opening after the ceiling has been installed. The gasket creates the airtight seal. The cut sheet and installation instructions for achieving the airtight conditions shall indicate how the gasket is to be attached.
 - c. Caulk is applied between the certified airtight housing and the ceiling after the ceiling has been installed. The caulk creates the airtight seal. The cut sheet or installation instructions for achieving the airtight conditions shall specify the type of caulk that must be used and how the caulk shall be applied.
 - d. A certified airtight trim kit is attached to the housing after the ceiling has been installed. The certified airtight trim kit in combination with the luminaire housing makes the manufactured luminaire airtight. Note that a decorative luminaire trim that is not ASTM E283 certified does not make the manufactured luminaire airtight. Most decorative luminaire trims are not designed to make a luminaire airtight. Rather, these trims are used to provide a finished look between the ceiling and luminaire housing, and may include a reflector, baffle, and/or lens. However, some trim kits are specifically designed to be a critical component used to make a luminaire installation airtight. These trim kits shall be certified airtight in accordance with ASTM E283. Certified airtight trim kits typically consist of a one-piece lamp-holder, reflector cone, and baffle. The cut sheet and installation instructions for achieving the airtight conditions shall show which certified airtight trim kits are designed to be installed with the luminaire housing, and how the certified airtight trim kits shall be attached. A gasket shall be installed between the certified airtight trim kit and the ceiling.
3. The following methods for ensuring an airtight seal between the certified airtight housing or certified airtight trim and the ceiling shall be field verified at different phases during construction:
 - a. A gasket attached to the bottom of the certified airtight housing shall be inspected prior to the installation of the ceiling when the rough-in electrical work is visible. The inspector shall review the cut sheet or installation instructions to make sure the housing and gasket have been installed correctly. All gaskets shall be permanently in place at the time of inspection. It is important that once the ceiling material is installed, the gasket will be in continuous, compressed contact with the backside of the ceiling and that the housing is attached securely to avoid vertical

movement. The housing shall be installed on a plane that is parallel to the ceiling plane to assure continuous compression of the gasket.

- b. A gasket applied between the certified airtight housing and the ceiling after the ceiling has been installed shall be inspected after the installation of the ceiling. The inspector shall review the cut sheet or installation instructions to make sure the housing and gasket have been installed correctly. The gasket shall be permanently in place at the time of inspection. It is important that the gasket is in continuous, compressed contact with the ceiling, and that the housing is attached securely to avoid vertical movement.
- c. Caulk applied between the certified airtight housing and the ceiling after the ceiling has been installed shall be inspected after the installation of the ceiling. The inspector shall review the cut sheet or installation instructions to make sure the housing has been installed correctly and the caulk has been applied correctly. It is important that the housing is attached securely to avoid vertical movement.
- d. A certified airtight trim kit shall be inspected after the installation of the ceiling and the installation of the trim. The inspector shall review the cut sheet or installation instructions to make sure the luminaire housing and the certified airtight trim kit have been installed correctly. It is important that the housing and the certified airtight trim kit are attached securely to avoid vertical movement. The ASTM E283 certification is a laboratory procedure where the trim kit is tested on a smooth mounting surface. However, it is common for certified airtight trim kits to be installed against a textured ceiling or other irregular ceiling surface. It is important that the gasket is in continuous, compressed contact with the ceiling and the certified airtight trim kit. Therefore, it is important to visually inspect the certified airtight trim kit and gasket next to the ceiling to assure that a continuous seal has been produced. Certified airtight trim kits may be installed on luminaire housings that may or may not be certified airtight. If the trim kit is certified airtight, it shall also have a sealed gasket between the trim kit and ceiling.

6.10 For Manufacturers – Certification to the Energy Commission

For devices to be certified to the Energy Commission (as defined in §100.1), the manufacturer must comply with the requirements of certification. Certification includes a declaration of compliance, executed under penalty of perjury of the laws of California, that the regulated device meets the requirements.

For compliance with the Appliance Efficiency Regulations (Title 20 California Code of Regulations, §1606) and the Energy Standards, the Energy Commission maintains a database of appliances, controls, and other devices that have been certified to the Energy Commission.

For compliance with the residential lighting requirements, this database includes lighting controls, and lamps and luminaires that comply with the requirements in Reference Joint Appendix JA8 in order to be classified as “high efficacy.”

Building departments, builders, contractors, and lighting designers should check the Energy Commission database to verify that a regulated device has been certified to the Energy Commission by the manufacturer of that device.

The database can be found here:

<http://energy.ca.gov/appliances/>

6.10.1 Luminaires and Lamps Complying with JA8 and JA10

The 2016 Energy Standards require all residential lighting installed to be high efficacy, and for some applications, to be JA8 compliant light sources.

Joint Appendix JA8 “Qualification Requirements for High Efficacy Light Sources,” is prepared as a technical specification with requirements for high efficacy light sources which can be luminaires and lamps. The table below provides highlights of JA8 requirements. Those who are interested in the technical aspects of high efficacy light sources should refer to Reference Joint Appendix JA8 for details.

Table 6-6: JA8 High Efficacy Light Source Requirements Highlights

METRIC	JA8 REQUIREMENTS
Light Source Type	LED, OLED Fluorescent, HID, Incandescent, Other
Product type	Omnidirectional lamp, Directional lamp, Decorative lamp, LED light engine, inseparable SSL luminaire, other
Lab accredited by NVLAP or accreditation body operating in accordance with ISO/IEC 17011?	Yes
Initial Efficacy	≥ 45 lumens/Watt
Power Factor at Full Rated Power	≥ 0.90
Start time	≤ 0.5 sec
Correlated Color Temperature (CCT)	For inseparable SSL luminaires, LED light engines and GU24 LED lamps: ≤4000 Kelvin For all other sources: ≤ 3000 Kelvin
Duv	≥-0.0033 and ≤ +0.0033
Color Rendering Index (CRI)	≥ 90
Color Rendering R9 (red)	≥ 50
Ambient or elevated temperature test for rated life, lumen maintenance, and survival rate	“Ambient” allowed only for omnidirectional lamps <10W, and decorative lamps, or labeled “not for use in enclosed fixtures,” lamps and light engines that are labeled “not for use in recessed fixtures” and “inseparable SSL luminaires.” All others must report “Elevated.”
6,000 hour lumen maintenance	≥ 86.7% or NA for integral luminaires providing TM-21 L70 projections based on light source LM80 data
LM-80 and TM-21 Projected Time to L70	≥ 25,000 hours, or N/A for light sources providing 6,000 hour lumen maintenance testing
Rated life	≥ 15,000 hours
6,000 hour survival rate	≥ 90% or NA for integral luminaires whose lumen maintenance/rated life is evaluated using light source LM-80 data.
Minimum dimming level	≤ 10%
Dimming control compatibility	At least one type must be listed
NEMA SSL 7A compatible?	If compatible with forward phase cut dimmer control, “Yes.” If not, “No.”
FLICKER: See JA10 Table 10-1 for flicker data requirements and permissible answers	<30% for frequencies of 200 Hz or below, at 100% and 20% light output
AUDIBLE NOISE: 100% light output: Audible Noise	≤ 24 dBA
20% light output: Audible Noise	≤ 24 dBA
MARKING: Marked in accordance with JA8.5	Yes. “No” allowed only for lamps and LED light engines with diameter less than 1.0” and decorative lamps with a diameter less than 2.0” ¹
¹ As stated, marking is not required for lamps and LED light engines with diameter less than 1 inch and decorative lamps with diameter less than 2 inch. However, the manufacturer of such products may opt to put a JA8 marking on these lamps and light engine products to show JA8 compliance.	

Joint Appendix JA10 “Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements,” is prepared as a supplement for the reduced flicker operation requirement of JA8. JA10 is also technical in nature and describes the test method to measure the fluctuation of light from the lighting system and process this signal to quantify flicker as a percent amplitude modulation below a given cut-off frequency. Signal processing is used to

remove high frequency components. Refer to Reference Joint Appendix JA10 for details of the test method.

6.10.2 Self-Contained Lighting Controls

Self-contained lighting controls are required to be certified to the Energy Commission by the manufacturer. A self-contained lighting control is defined in §100.1 as a unitary lighting control module that requires no additional components to be a fully functional lighting control.

Self-contained lighting control devices cannot be sold or offered for sale in California unless they have been certified to the Energy Commission according to the Title 20 Appliance Efficiency Regulations.

Figure 6-1 – Self-Contained Lighting Controls



6.10.3 Lighting Control Systems

A lighting control system is defined by §100.1 as two or more lighting control components installed to provide all of the functionality of a compliant self-contained lighting control.

Lighting control systems are not required to be Certified to the Energy Commission, but are instead required to comply with the minimum performance requirements in §110.9, and a Certificate of Installation must be submitted in accordance with the requirements in §130.4:

1. The minimum performance requirements in §110.9 require that a lighting control system functionally meet all of the requirements that a self-contained lighting control is required to meet. For example, a vacancy sensor system must functionally meet all of the requirements in the Title 20 Appliance Efficiency Regulations for a self-contained vacancy sensor.
2. A single lighting control system that is installed to provide the functionality of more than one lighting control device is required to provide all of the functionality of each respective lighting control for which it is installed.
3. Whenever a lighting control system is installed to comply with lighting control requirements in the Energy Standards, a licensee of record must submit a Certificate of Installation in accordance with the requirements in §130.4.

Specific types of lighting control systems must also meet the following requirements:

1. An Energy Management Control System (EMCS) may be used to comply with dimmer requirements if at a minimum it provides the functionality of a dimmer.
2. An EMCS may be used to comply with vacancy sensor requirements if at a minimum it provides the functionality of a vacancy sensor.

3. A multi-scene programmable controller may be used to comply with dimmer requirements if at a minimum it provides the functionality of a dimmer.
4. Lighting controls and equipment are required to be installed in accordance with the manufacturer's instructions.

6.10.4 Ballasts for Compact Fluorescent Luminaires

When used in residential recessed luminaires, all ballasts for compact fluorescent luminaires must be certified by the manufacturer to the Energy Commission according to §110.9(f), as meeting the following conditions:

1. Have a minimum rated life of 30,000 hours when operated at or below a specified maximum case temperature. This maximum ballast case temperature specified by the ballast manufacturer shall not be exceeded when tested in accordance to UL 1598 test procedure 19.15; and
2. Have a ballast factor of not less than 0.90 for non-dimming ballasts and a ballast factor of not less than 0.85 for dimming ballasts.