

Let's Talk Low-Rise and High-Rise Multifamily

Host:

Gina Rodda
Gabel Associates, LLC

Guest Speaker:

Matthew Christie
TRC Companies, Inc.



This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.



Welcome

► Welcome

- Who are we?
- Our goal today
- More about you





- What We Heard From you
- Let's Talk
- Next Steps
- Wrap Up





Recording For Future Use

This session is being recorded.

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Who Are We?



Host

Gina Rodda, Gabel Associates, LLC

gina@gabelenergy.com

Gina Rodda, our host for the Decoding Talk series, is a Certified Energy Analyst (CEA), Certified Energy Plans Examiner (CEPE) and LEED Accredited Professional (AP).

She is involved in providing residential and non-residential energy calculations for a variety of building types throughout California; an instructor of full day trainings; and host of various webinars specific to Title 24 (Part 6) Building Energy Efficiency Standards.

Gina has been in the energy modeling field since 1991, through the course of seven California building energy code cycles.



GABEL ASSOCIATES, LLC

BUILDING ENERGY ANALYSIS & ENERGY CODE COMPLIANCE



Who Are We?



Co-Host

Matthew Christie, TRC Companies, Inc.

MChristie@trcsolutions.com

Matthew Christie is a TRC Program Manager with expertise in energy efficiency and energy use reduction for the built environment using a whole-building approach. He has program management and technical experience in program design; program implementation; energy modeling and simulation; home performance energy audits; data and process analysis; and heat transfer and fluid dynamics.

Matthew is Chair of the California Association of Building Energy Consultants (CABEC) and a Certified Energy Analyst (CEA) for residential buildings.

He holds a B.A. in Physics and Mathematics from Skidmore College and an M.S. in Engineering and Energy Technologies from Dartmouth College.





Our Goal Today



Review the low-rise and high-rise multifamily requirements:

- ✦ What is difference between the two building types;
- ✦ How code requirements differ for these 2 building types;
- ✦ How to model/document multifamily construction.



We Want To Hear From You

- Welcome

▶ We Want To Hear from You

- Most common challenges
- Title 24 Part 6 CEC Documents
- Why??

- Let's Talk
- Next Steps
- Wrap Up





Our Question To You



What are your top 3 concerns regarding multi-family energy compliance (designing, modeling, verifying)?

Because 3-story and 4-story multi-family buildings are subject to a different set of code requirements as well as performance modeling protocols, compliance results for otherwise 2 similar buildings can be vastly different. This is very challenging to communicate to clients and is not rational to justify.

1. *DHW*
2. *Solar DHW*
3. *Commercial portions of ground floor*

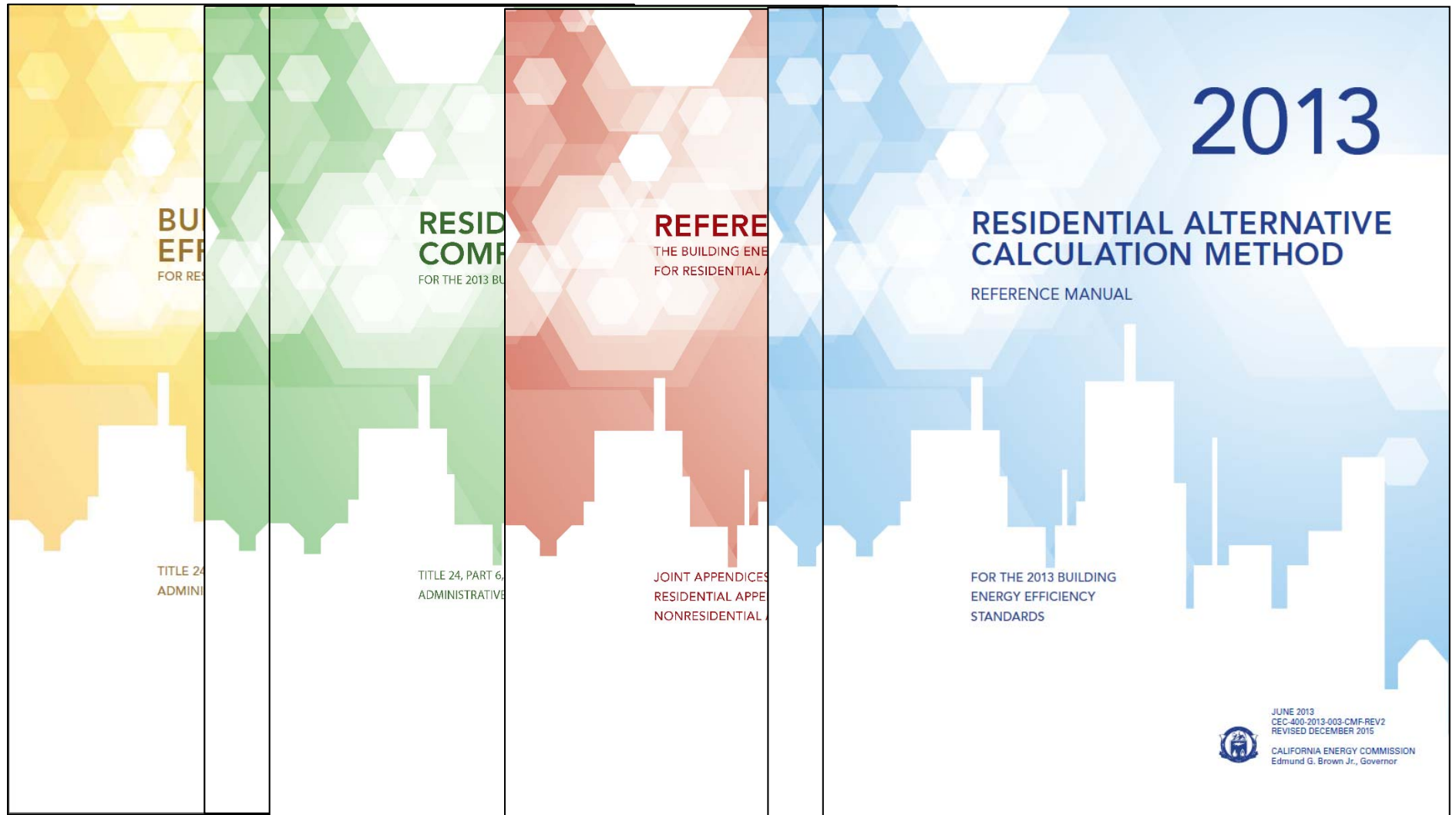
How to compare what is on the printed compliance documentation against what is shown on the plans.

Creating a model that works (clearly describes the building) and doesn't crash the computer.

What is the proper modelling of the different types of building. Can there be more than 1 way and still meet compliance?



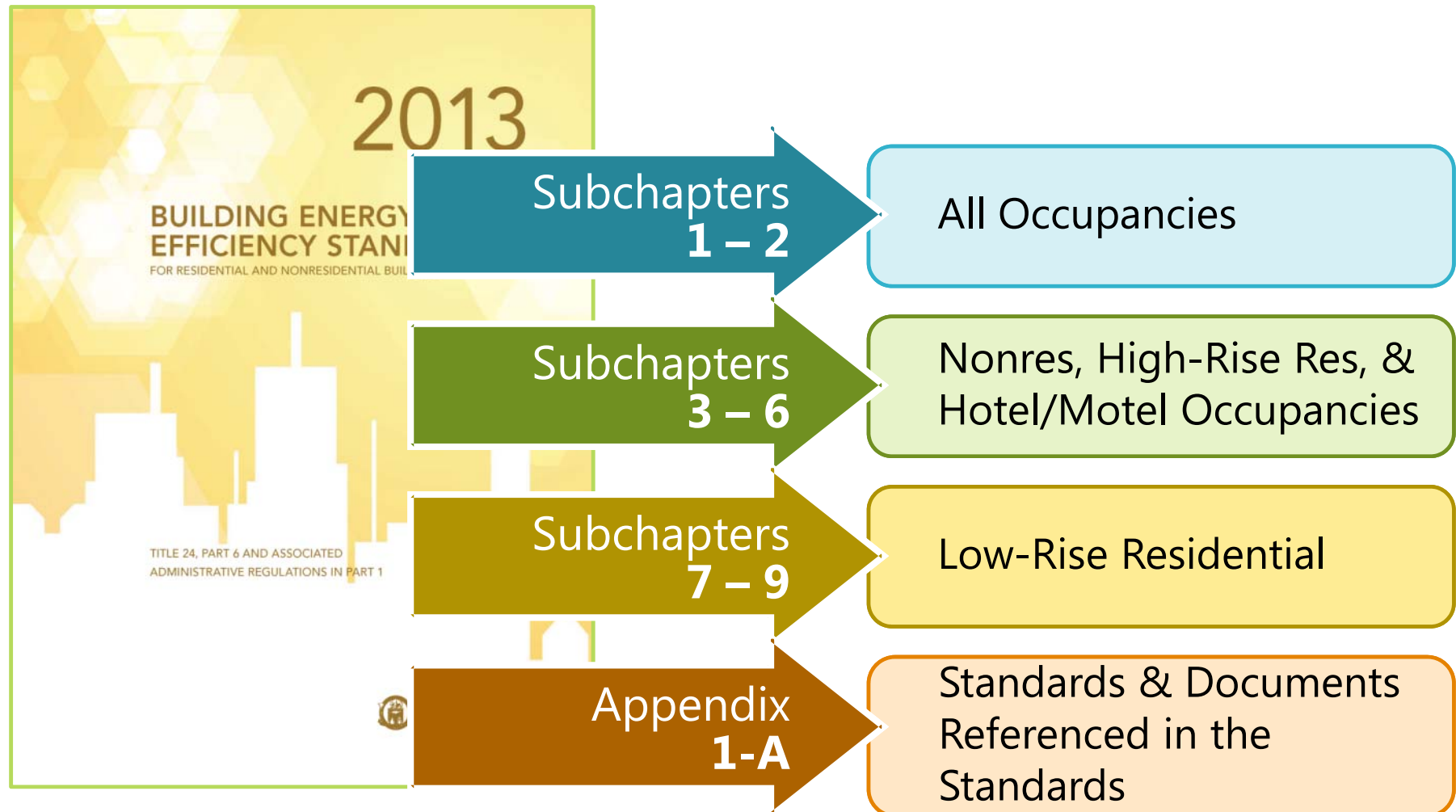
Code: 2013 CEC Documents



<http://energycodeace.com/content/reference-ace-2013-tool>



Structure/Organization of the Standards





Code: 2016 CEC Documents

**Permits pulled after
January 1, 2017**

2016
NONRESIDENTIAL
ALTERNATIVE CALCULATION
METHOD REFERENCE
MANUAL

FOR THE 2016 BUILDING
ENERGY EFFICIENCY
STANDARDS
TITLE 24, PART 4, AND ASSOCIATED
ADMINISTRATIVE REGULATIONS
IN PART 1.

JUNE 2015
CEC 400-2015-007-CMF
CALIFORNIA ENERGY COMMISSION
Edmund G. Brown, Jr., Governor

NOVEMBER 2015
CEC 400-2015-008-CMF
CALIFORNIA ENERGY COMMISSION
Edmund G. Brown, Jr., Governor

<http://www.energy.ca.gov/title24/2016standards/index.html>



California Policy Goals



- ✦ **1978:** Title 24, Part 6, California State Building Energy Efficiency Standards established; updates every 3 years
- ✦ **2006:** AB32, Global Warming Solutions Act, adopted to reduce greenhouse gas emissions
- ✦ **2008:** California Energy Action Plan adopted; efficiency 1st choice in meeting future energy needs
- ✦ **2008:** "Big Bold Strategies" adopted –
 - ✧ Nonresidential new construction: ZNE by 2030
 - ✧ Residential new construction: ZNE by 2020



Multi-Family Fact Sheet



High-Rise and Low-Rise Multifamily

Know Your Project – Key Terms

Multifamily (MF) buildings will have to comply with either residential requirements or a mix of nonresidential and residential requirements depending on the number of habitable stories in your building:

- + **Multifamily Building:** contains multiple dwelling units that share common walls (townhomes) and may also share common floors or ceilings (apartments). Hotel or motel buildings are not considered multifamily.
- + **High-Rise Residential:** all multifamily buildings with four or more habitable stories.
- + **Low-Rise Residential:** all multifamily buildings with three or fewer habitable stories.

High-Rise vs Low-Rise Multifamily

While low-rise multifamily buildings need to comply with residential requirements, several project aspects for high-rise buildings fall under the scope of other nonresidential requirements or specific high-rise residential (HRR) requirements for some prescriptive measures

Mandatory Measures All MF Buildings §110	
Low-Rise §150.0, 180-1, 190.2	High-Rise §120-141
<ul style="list-style-type: none"> + Envelope: Residential + HVAC: Residential - Including HERS measures + Water Heating: Residential - Including solar hot water and dual loop recirculation + Indoor Lighting Dwelling Units: Residential - Common areas: different options dependent on % of total conditioned floor area + Outdoor Lighting and Parking Garages: Residential - Different options dependent upon # of parking spots 	<ul style="list-style-type: none"> + Envelope: Nonresidential* + HVAC: Nonresidential - Including ventilation + Water Heating: Residential - Including solar hot water and dual loop recirculation + Indoor Lighting Dwelling Units: Residential - Common areas: Nonresidential + Outdoor Lighting: Nonresidential <p>*Section 140.3 includes specific requirements for high-rise residential</p>

Mandatory, Prescriptive, Performance

Mandatory requirements that apply to both low and high-rise multifamily buildings can be found in Section 110.0 through 110.10 of the Standards.

In addition to meeting these 'mandatory measures,' projects can choose between a prescriptive or performance compliance path. Most multifamily projects pursue the performance compliance path, which allows flexibility to trade-off performance between building systems. In order to verify compliance using the performance path, compliance software must be used to show overall project compliance.

The compliance software compares the building design to a similar building that meets the prescriptive requirements of the Standards. Mandatory measures must be met, and cannot be traded off.

- + More information can be found about the Performance and Prescriptive Compliance Approaches in the [Navigator Ace Tool](#).

Solar Ready Areas

Projects are required to either include an allocated solar ready area or show compliance with the appropriate exceptions found in Section 110.10(b)(15). A solar ready area or 'solar zone' is a section of the roof designated and reserved for the future installation of a solar electric or solar thermal system.

- + **Sizing:** The solar area shall comprise no less than 15% of the total roof area of the building (less any skylight area) and may consist of multiple sub areas provided that each subarea is at least 80 square feet with no dimension less than 5 feet.
- + **Location:** The solar area shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building, or on covered parking installed with the building project.

Section 110.10 also includes requirements for orientation, shading, structural design loads, and interconnection pathways for electrical service.

Envelope

Mandatory requirements for roofs, walls, floors and windows vary depending on construction type, and whether the project is high-rise or low-rise.

	Mandatory Envelope Requirements for Multifamily	
	Low-Rise	High-Rise
Roof		
Maximum U-factor	0.031 (wood R-30)	0.085 (metal R-19) 0.075 (WOOD R-15)
Wall		
Maximum U-factor	0.102 (2x4 R-13) 0.074 (2x6 R-19)	0.105 (metal R-13 w/ R-4) 0.110 (2x4 R-11)
Floor		
Maximum U-factor	0.037 (wood R-19)	0.269 (raised mass) 0.071 (other R-11)
Fenestration		
Maximum U-factor	0.58	NA

Detail on assemblies can be found in [Joint Appendix 4](#).

HVAC & Domestic Hot Water

There are two Energy Code Ace Trigger Sheets that go into more detail on HVAC requirements. They include requirements for new construction (new systems) as well as alterations. Low-rise projects should reference the residential sheet, and high-rise the nonresidential sheet.

- + **Residential HVAC Change-outs:** This trigger sheet covers entirely new and complete replacement HVAC systems, alterations to equipment and alterations to ductwork.
- + **Nonresidential Small Commercial HVAC Alterations:** This trigger sheet covers packaged units and split systems.

Domestic Hot Water requirements also differ based on whether the building is low-rise or high-rise:

- + **New Low-Rise MF buildings** and additions which add water heating must meet the mandatory requirements of Sections 150.0(a) and 150.0(a) regarding system design & insulation.



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- + **Mandatory pipe insulation requirements for High-Rise MF** are found in Section 120.3. Water heating systems shall have an insulation thickness corresponding to the system's fluid temperature as listed in Table 120.3-A.
- + **Both Low-Rise and High-Rise MF complying prescriptively** must meet requirements in Section 150.10-9.
 - Systems serving individual dwelling units shall be gas or propane and either a storage type water heater with an input of 75,000 Btu/hr or less or an instantaneous type water heater with an input of 200,000 Btu/hr or less. An electric resistance storage or instantaneous water heater may only be installed if natural gas is unavailable—additionally the water heater must be located within the building envelope and a solar water heating system with a solar savings fraction of 0.5 must be installed.
 - Systems serving multiple dwelling units must meet the minimum efficiency requirements of Sections 110.1 and 110.3 and have a recirculation loop equipped with an automatic control system which controls pump operation based on hot water demand and return temperature.
 - A **solar water heating system** with a minimum solar savings fraction of 0.20 in climate zones 1-9 or 0.35 in climate zones 10-16 is prescriptively required for systems serving multiple dwelling units.

Dwelling Unit Lighting (§130.0, §150.0)

Lighting requirements inside dwelling units are mandatory (rather than prescriptive) and are the same for low-rise and high-rise multifamily buildings. For a list of which spaces in high-rise residential buildings are subject to the residential lighting requirements, refer to Section 130.0(a). For a complete description of the residential lighting requirements, see Section 150.0(a) and Tables 150.0-A and 150.0-B.

Application	Fixture and Control Requirements
Bathrooms	One High Efficacy (HE) fixture AND either manual-on vacancy sensor or HE for all other fixtures
Closets < 70 R ²	High Efficacy or manual-on vacancy sensor or dimmer
Kitchens	High Efficacy for at least 50% of total rated wattage
Garages, Laundry, and Utility Rooms	High Efficacy and vacancy sensor
All other interior rooms	High Efficacy or Manual-on vacancy sensor or Dimmer

For more complete information regarding lighting requirements for dwelling units, please see our [Residential Fact Sheet on Indoor and Outdoor Lighting](#).

- + **High Efficacy Luminaires** 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.
 - Note that high efficacy lamps installed in low efficacy luminaires (e.g. screw-based CFL and LED lamps) do NOT count as high efficacy lighting.
- + **Occupancy/Vacancy sensors and daylight sensors** are all devices that automatically control lights and/or light levels in response to conditions that they "sense" or "see."
- + **Dimmers**, already common in residential applications, allow room occupants to lower lighting levels (and thus energy use) as desired.

Indoor Common Area Lighting (§130.0, §140.6, §150.0(a)(12))

For high-rise multifamily buildings, common areas must comply with the applicable nonresidential lighting standards.

For low-rise multifamily residential buildings, the requirements for indoor lighting of common areas are based on the percentage of conditioned floor area made up by these common areas. Indoor common areas with a combined floor area of:

- + **20% or less of Conditioned Floor Area** require that permanently installed lighting for these areas consist of high efficacy luminaires or be controlled by an occupant sensor.
- + **Greater than 20% of Conditioned Floor Area** will need to comply with the applicable requirements of nonresidential indoor lighting. In addition, lighting installed in corridors and stairwells shall be controlled by occupant sensors that reduce the lighting power in each space by at least 50% when unoccupied.

Lighting for Parking Lots and Carports

Requirements for outdoor lighting of parking areas are based on the vehicle capacity. Parking lots, carports, or parking garages designed for:

- + **Fewer than eight vehicles** must adhere to the basic requirements for outdoor residential lighting:
 - > High efficacy lighting with controls.
 - > Low efficacy lighting with controls.
- + **Eight or more vehicles** are required to meet the nonresidential lighting requirements, including lighting power density limits. See Sections 130.2 and 140.2 for an exhaustive list of requirements.

Additional Resources for Lighting

The following resources may be helpful in addition to the Standards language to understand the residential requirements:

- + [California Lighting Technology Center Lighting Guides](#): The CLTC has produced 2013 Title 24, Part 6 Lighting Guides for Residential Lighting and Outdoor Lighting.

Electrical Distribution (§130.5)

The 2013 Standards introduced requirements for electrical distribution in Part 6 that are relevant to nonresidential portions of a multifamily project. They can be found in Section 130.5 and include requirements for:

- + Service Metering
- + Electrical Disaggregation
- + Voltage Drop
- + Receptacle Controls

Commissioning (§120.8)

Multifamily projects that have nonresidential portions have commissioning requirements in Section 120.8, which apply to systems serving the nonresidential portions of the building.



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Commissioning



Commissioning

I am constructing a mixed occupancy building. The lower story of the building is for commercial/retail use and is 5 percent of the conditioned floor area. The remaining stories are residential and are 95 percent of the conditioned floor area. Since the building is primarily residential, does it need to be commissioned?

Yes. However, the commissioning requirements of **Section 120.8** only apply to the nonresidential portions of the building. **Section 100.0(f)** requires the space for each occupancy to meet the applicable provisions of the Energy Standards for that occupancy.

NOTE: Commissioning applies to mechanically heated or cooled nonresidential portions of newly constructed mixed occupancy buildings, regardless of the percentage of nonresidential space.

Are the commissioning requirements applicable to additions and alterations under the 2016 Energy Standards?

No. The commissioning requirements of the 2016 Energy Standards are not applicable to additions or alterations. Changes to the 2016 Energy Standards clarify the language of **Section 120.8**, and do not alter the scope. Commissioning Q&As from **Blueprint Issue 107** are still applicable to the 2016 Energy Standards.

★ Nonresidential spaces:

✧ NRCC-CXR-01-E

- Always for new construction
 - Never for additions and alterations
- ### ✧ All aspects of Cx:
- Nonresidential conditioned spaces exceed 10,000 sq. ft.
 - Never for additions and alterations

★ Residential spaces:

- ✧ No commissioning requirements



Commissioning Infographic & Fact Sheet



Building Commissioning

Commissioning in the Energy Code

Commissioning requirements for all newly constructed nonresidential buildings are included in the 2013 update to Title 24, Part 6 - California's Building Energy Efficiency Standards (Standards). Many of these requirements were moved from CalGreen (Title 24, Part 11), where commissioning was originally incorporated into state building code in 2008.

Commissioning requirements apply to all newly constructed nonresidential buildings, though the extent of the requirements depends on whether the conditioned floor area is less than 10,000 square feet or 10,000 square feet and greater.

The Standards define "newly constructed" as "a building that has never been used or occupied for any purpose" in Section 102.1.

The commissioning requirements in Part 6 do not apply to residential projects (including high-rise residential) do not apply to additions or alterations and do not apply to newly constructed nonresidential buildings that are unconditioned.

Commissioning is critical to realizing the energy savings during building operation that were intended by the building design. Closely related to acceptance testing, commissioning involves functional testing during construction, but also includes activities during design that will ensure the building systems and associated controls will meet the owner's energy and operating efficiency goals.

Title 24, Part 6 defines commissioning as, "a systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements."

Commissioning Requirements

Commissioning requirements are included in Section 120.8 of the Standards, and the table below illustrates which requirements apply based on conditioned floor area. Additional resources are listed that may provide valuable detail on how to properly implement these requirements.

Commissioning Requirements in Part 6	Conditioned Space	
	<10k ft ²	≥ 10k ft ²
OPR (§ 120.8(b))		X
BOD (§ 120.8(c))		X
Design Review (§ 120.8(d))	X	X
Commissioning in Construction Docs (§ 120.8(e))	X	X
Commissioning Plan (§ 120.8(f))		X
Functional Performance Tests (§ 120.8(g))		X
OMM Training (§ 120.8(h))		X
Commissioning Report (§ 120.8(i))		X

Table 1. Commissioning Requirements in Title 24, Part 6

Additional Resources

The following resources may be helpful in addition to the Standards language to understand the commissioning requirements:

- Building Commissioning Guide in Nonresidential Compliance Manual. This guide outlines both an intent and compliance method for each requirement in Section 120.8.

Roles and Responsibilities

Because commissioning spans the entire building delivery process from pre-design through occupancy, many parties are involved, making communication and coordination paramount. Below is a list of who may need to participate in the commissioning process, at one time or another during the project.

- Owner, owner's representative or facility operator
- Designers (architect and MEP)
- Design Reviewer (see table below)
- Plans Examiner
- General Contractor*
- Key Subcontractors (HVAC, controls, TAB, etc.)
- Acceptance Test Technician*
- Commissioning Agent*
- Building Inspector*

* These parties are generally only involved for buildings with conditioned floor area 10,000 square feet or greater when § 120.8(f) - § 120.8(i) are required.

Who is most appropriate to fill each of these roles is dependent upon the experience and expertise of the project team. There are no requirements in the Standards that designate who the Commissioning Authority must be. However, for both the Design Reviewer and Acceptance Test Technician, there are restrictions on who can fill these roles:

Building Size	< 10,000 ft ²		10,000 - 50,000 ft ²		> 50,000 ft ²	
	Complex systems in Design > 10,000 ft ²	Other	Complex systems in Design > 10,000 ft ²	Other	Complex systems in Design > 10,000 ft ²	Other
Approved Design Reviewer	Any licensed professional engineer, including the engineer of record	A licensed professional engineer in-house to the design firm but not associated with the building project, or a third party licensed engineer	A third party licensed professional engineer	A third party licensed professional engineer	A third party licensed professional engineer	A third party licensed professional engineer

Table 2. Who can act as the Design Reviewer, per § 120.8(f)

Information on becoming a certified Acceptance Test Technician can be found on the California Energy Commission's Acceptance Test Technician Certification Provider webpage.

Additional Resources

The following resources may be helpful to understand roles related to the commissioning and acceptance testing process:

- Building Commissioning Guide in Nonresidential Compliance Manual. Section 12.1 of this guide outlines roles and information on how to find a qualified Commissioning Authority.
- California Commissioning Collaborative. This organization includes a Provider List that may be valuable when searching for a Commissioning Authority.
- Section 10-10.3(a)(1). This section in the Standards indicates that the Design Reviewer must be a licensed professional engineer.

Commissioning Process

Understanding and assigning who does what and when early during the process is key to success. For all newly constructed nonresidential projects, the Standards dictate that the commissioning process starts in early design, and compliance forms verifying this must be submitted to the building department with the project's application for permit.

Additional Resources

- Energy Code Ace Commissioning Infographic. This visual provides an outline of the commissioning tasks by when they occur during a typical project delivery process.
- Energy Design Resources e-news #95. This e-news titled "Commissioning for Compliance" was issued to help practitioners understand and implement the commissioning requirements of the Standards. It includes tips and tricks and a handy graphic that shows when during project delivery the commissioning requirements should be implemented.

Functional Performance Test Procedures

Commissioning is similar to acceptance testing in that functional performance tests are performed to "demonstrate the correct installation and operation of each component, system and system-to-system interface." Section 120.8(g) says that functional testing performed to satisfy the commissioning requirements should be performed in accordance with acceptance testing procedures outlined in other sections of the Standards.

Note that the functional performance tests which are needed for commissioning are based on the systems documented in the OPR and BOD documents and may be more comprehensive than the project's required acceptance tests. A system not being included in the OPR/BOD does not exempt it from acceptance test requirements outlined in other sections of the Standards.

Additional Resources

- The following resources may be helpful to better define functional performance testing requirements:
 - Chapter 13 Acceptance Requirements in the Nonresidential Compliance Manual. An overview of acceptance testing requirements, the process and the forms are further detailed in Chapter 13. Table 13.1 includes a list of certificate of acceptance forms by building component.
 - Nonresidential Reference Appendices NA7. This Section of the Nonresidential Appendices includes test procedures, roles and responsibilities and other details related to acceptance testing.

"Simple" Systems include:
(a) Unitary or packaged equipment listed in Tables 110.2.A, 110.2.B, 110.2.C and 110.2.E that each serve one zone; OR
(b) Two-pipe, heating only systems serving one or more zones
"Complex" Systems include:
(a) Fan systems each serving multiple thermostatically controlled zones; OR
(b) Built-up air handler systems (non-unitary or non-packaged HVAC equipment); OR
(c) Hydronic or steam heating systems; OR
(d) Hydronic cooling systems

Figure 1. "Simple" vs. "Complex" HVAC Systems

Commissioning Documents

In addition to the compliance forms (see below), there are documents that are required by Section 120.8 for buildings with conditioned floor area 10,000 ft² and greater. These documents are used both to facilitate and document the commissioning activities:

- Owner's Project Requirements (OPR)
- Basis of Design (BOD)
- Commissioning Specifications
- Commissioning Plan
- Functional Performance Tests
- Operation and Maintenance Training Documents
- Commissioning Report

Additional Resources

The following resources may be helpful to produce these required documents:

- Energy Design Resources e-news #96. The Commissioning for Compliance e-news provides more pragmatic detail and tips on each document listed.
- Building Commissioning Guide in Nonresidential Compliance Manual. This guide provides an intent and compliance method for each document.
- California Commissioning Collaborative. Templates and sample documents are provided by this organization to facilitate commissioning in California.

Compliance Forms

All newly constructed nonresidential projects are required to complete the design review certificates of compliance, regardless of project size (see Table 1). At a minimum, the NRCC-CXR-01-E and NRCC-CXR-02-E must be completed. The project then uses the NRCC-CXR-03-E for "simple" HVAC systems, and the NRCC-CXR-04-E for "complex" HVAC systems (see Figure 1). The NRCC-CXR-05-E is also completed for all projects requiring compliance with Section 120.8.

Although there are no commissioning forms other than the certificates of compliance, the NRCA forms (certificates of acceptance) are used to document functional performance tests for the inspector to review.

Additional Resources

- The following resources may be helpful to prepare the project team for completing compliance forms, and the enforcement agencies for reviewing them:
 - Energy Design Resources e-news #96. This e-news includes more detail on each compliance form, including when it should be completed.
 - Building Commissioning Guide in Nonresidential Compliance Manual. Section 12.10 of this guide has detailed instructions on completing the compliance forms associated with commissioning.
 - NRCA forms. The certificates of acceptance themselves are useful to understand required documentation.

Don't Forget About CAL Green!

Title 24, Part 11 (CAL Green) also includes requirements for commissioning in Chapter 5 - Nonresidential Mandatory Measures. These requirements are complementary to the Energy Code requirements, but be sure to read through them as additional systems such as renewable energy, landscape irrigation and water reuse systems are counted here.



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Let's Talk

- Welcome
- What We Heard from You

▶ Let's Talk

- Our 4 Challenges

- Next Steps
- Wrap Up

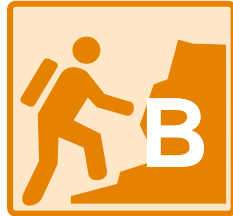




Challenges (Phase of Project)



- ✦ Challenge A:
 - ✦ Low-Rise versus High-Rise



- ✦ Challenge B:
 - ✦ Building Features



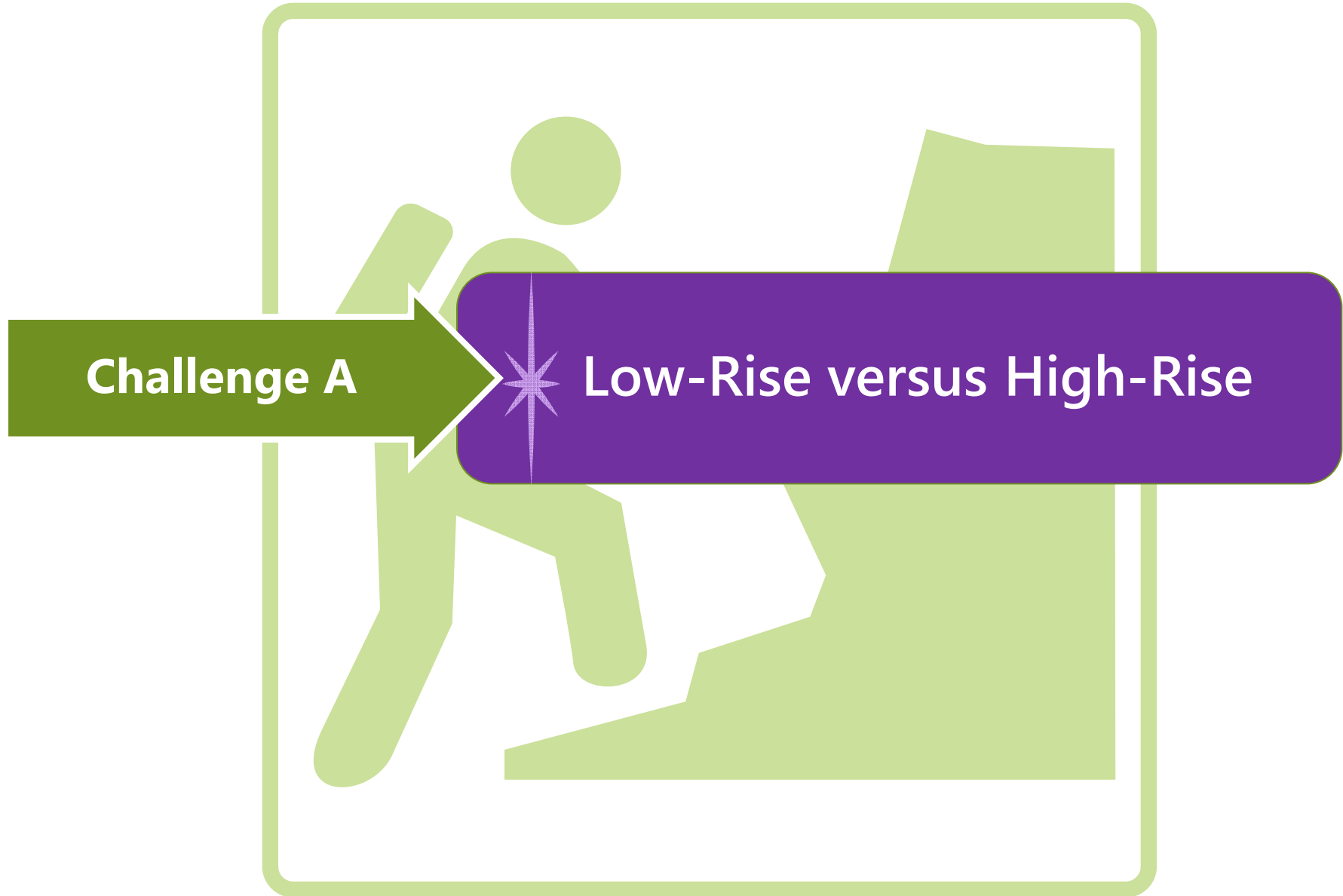
- ✦ Challenge C:
 - ✦ Documentation



- ✦ Challenge D:
 - ✦ Modeling/Documentation Challenges



Challenge A





Our Question To You



How do you prepare for designing/installing/inspecting a multi-family building?

For us as Plan Check staff is to make sure necessary documents are submitted and then comparing what is shown on the plans. If the computer run is approved, then we should make sure that the plans includes those features.

Just make sure the team is aware of the 20% solar thermal offset included in the baseline. And of the strict glazing baseline, as always.

Review plans, discuss with designer and builder.

Lay out goals for the project, regarding the efficiency (minimum, above code, exceptional), budget, standard assemblies to use, etc. Also look at res vs non-res areas, percentages, joint or separate systems etc.

thoroughly



Why Low-Rise vs High-Rise?



- ✦ The New Shorter Oxford English Dictionary defines a high-rise as "a building having many storeys".
- ✦ The International Conference on Fire Safety in High-Rise Buildings defined a high-rise as "any structure where the height can have a serious impact on evacuation"
- ✦ Most building engineers, inspectors, architects and similar professions define a high-rise as a building that is at least 75 feet tall.



Low-Rise Dwelling Units



Mandatory Measures
 Mechanical: §110.2, 110.3
 Solar Ready §110.10
§150.0
 Insulation
 HVAC (including IAQ)
 DHW Distribution
 Residential Lighting



Prescriptive Approach

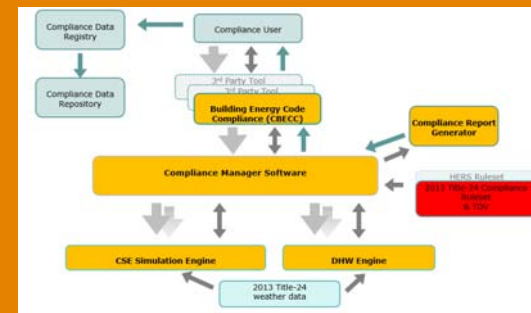
ENV §150.1	HVAC DHW Solar HW §150.1	LTG See Mandatory
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Alterations: §150.2



Performance Approach

CBECC-Res





High-Rise Dwelling Units



Mandatory Measures
 Mechanical: §110.2, 110.3
 Solar Ready: §110.10
 Mechanical (including ventilation): §120.1-120.5
 Insulation: §120.7
§150.0
 Residential Lighting



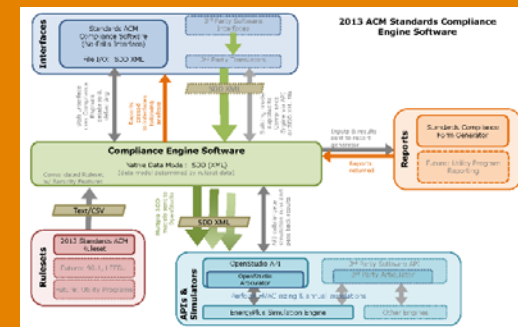
Prescriptive Approach

ENV §140.3	HVAC §140.4 DHW Solar HW §150.1	LTG See Mandatory
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Alterations: §141.0



Performance Approach CBECC-Com





Multifamily Project “Highlight”



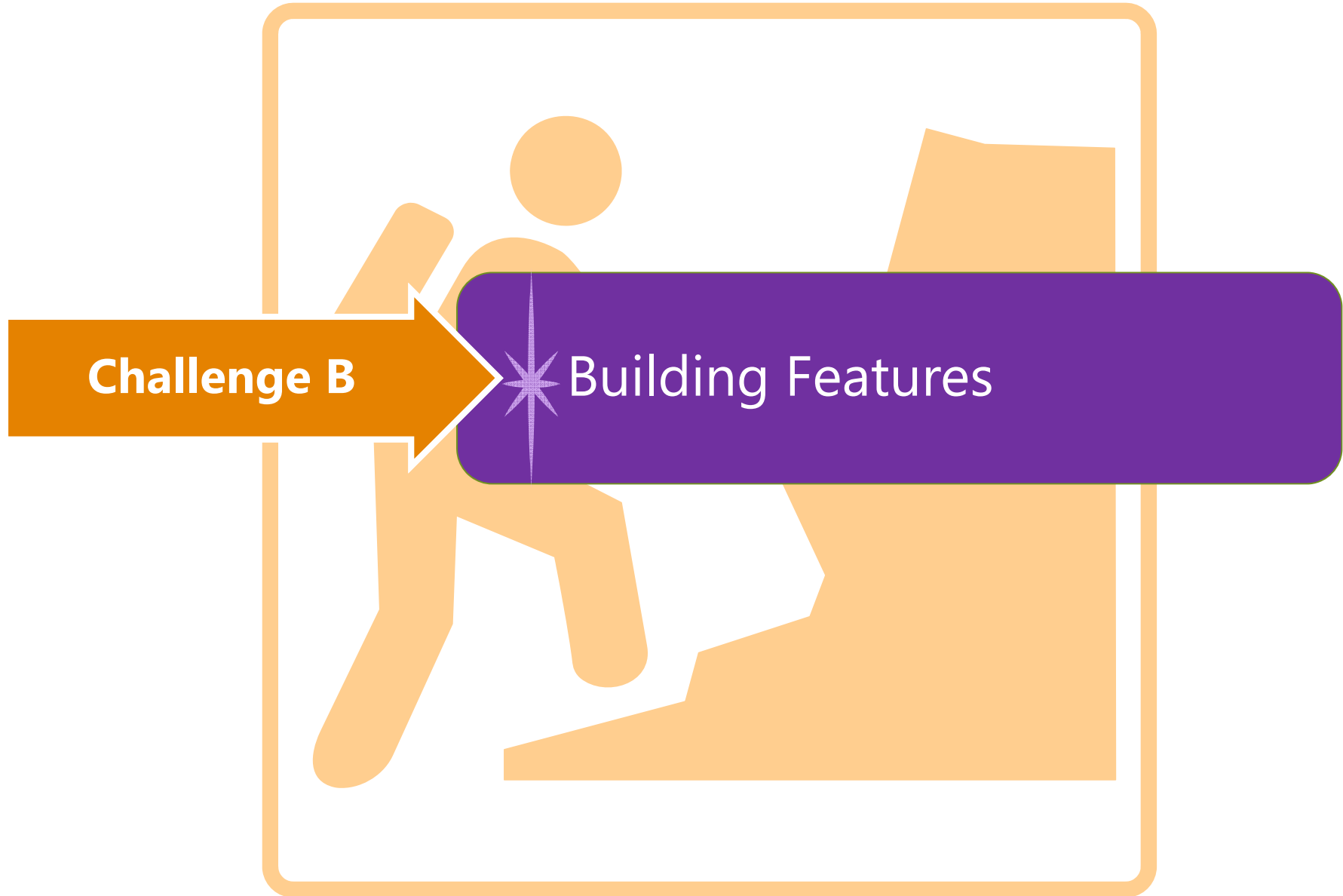
From the Files

- ◆ La Moraga Apartments – San Jose
- ◆ 29% above 2008 Title 24 Code
- ◆ Six of 3 and 4 story buildings with identical construction methods. 3 are high-rise, 3 are low rise.
- ◆ At initial permitting, 2 of the “high-rise” buildings were deemed low-rise, and sent through residential code calculations. Later, they switched back.
- ◆ **Solution?:** A lot of extra paperwork





Challenge B





Intent Behind the Code

Low-Rise vs High Rise Code



- ★ In 2007 the CPUC adopted the aspirational goals that all new construction in California be Zero-Net-Energy (ZNE); residential by 2020 and commercial by 2030.
- ★ **When does multifamily go ZNE?**
 - ✧ Low-Rise follows the residential code. Prescriptive features are typically based on single-family norms.
 - ✧ High-Rise follows the commercial code. Prescriptive features are based on commercial building norms.
- ★ Multi-family norms often do not receive direct attention



Envelope

- ▶ Walls
- ▶ Floors
- ▶ Roof
- ▶ Solar Ready



HELPING YOU PLAY YOUR CARDS RIGHT





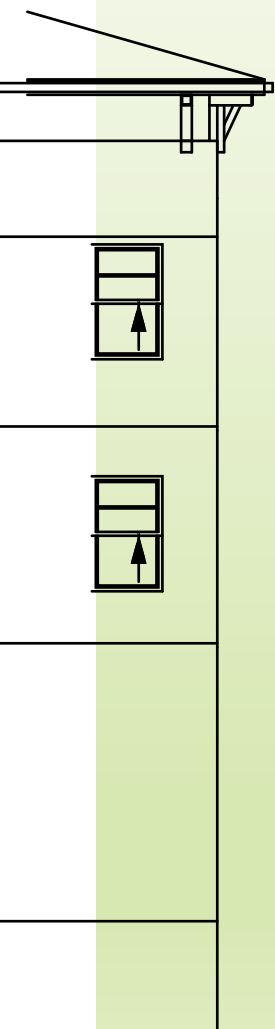
Envelope

Equipment	Dwelling Units (and NR spaces if <20% of CFA)	Nonresidential Spaces (>20% CFA)
Low-rise		
Opaque	§110.8; 150.0	§110.8; 120.7; 140.3
Fenestration	§110.6; 150.0; 150.1	§110.6; 140.3
Roof	§110.8; 150.0; 150.1	§110.8; 140.3
Solar Ready	§110.10(b) through (d)	
High-rise		
Opaque	§110.8; 120.7; 140.3	§110.8; 120.7; 140.3
Fenestration	§110.6; 140.3	§110.6; 140.3
Roof	§110.8; 140.3	§110.8; 140.3
Solar Ready	§110.10(b) through (d)	



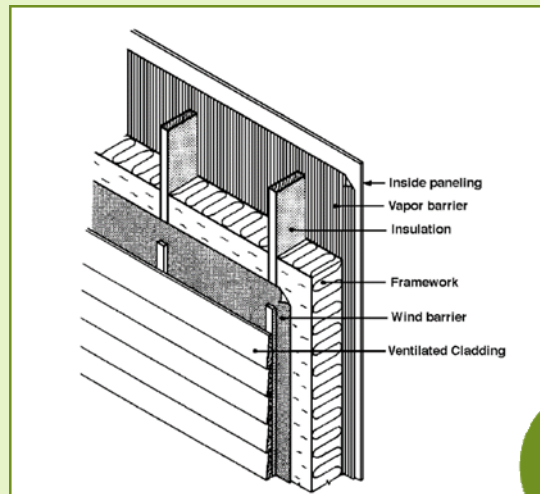
Wall: Low-Rise

2013 Wood Framed Wall



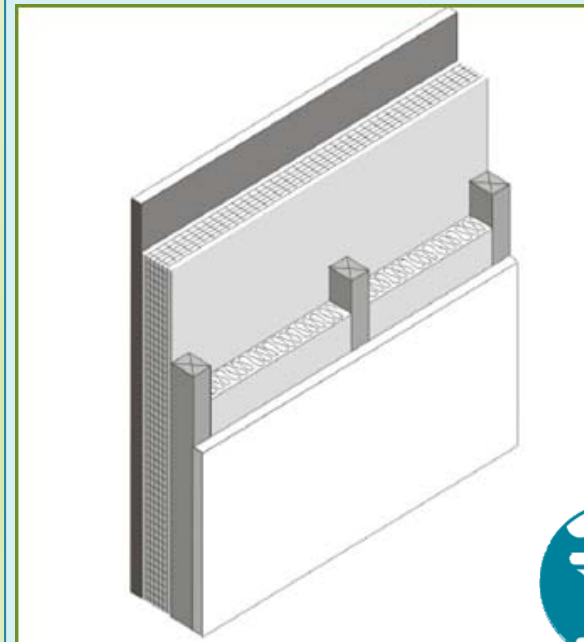
Mandatory

- ◆ U-factor = 0.102 (R-13)
OR
- ◆ U-factor = 0.074 (R-19)



Prescriptive

- ◆ U-factor = 0.065
(R-13 + R-5 continuous)



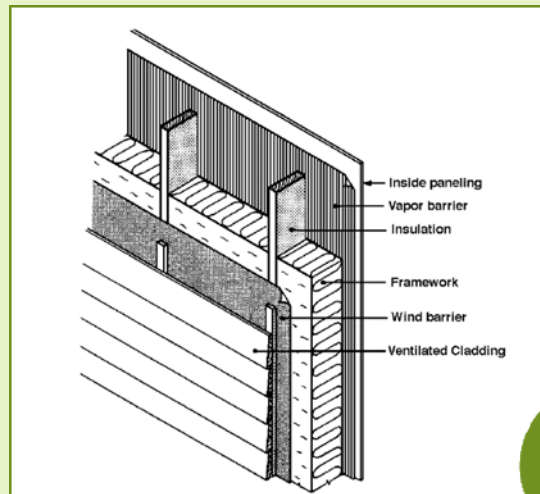


Wall: Low-Rise

2016 Wood Framed Wall

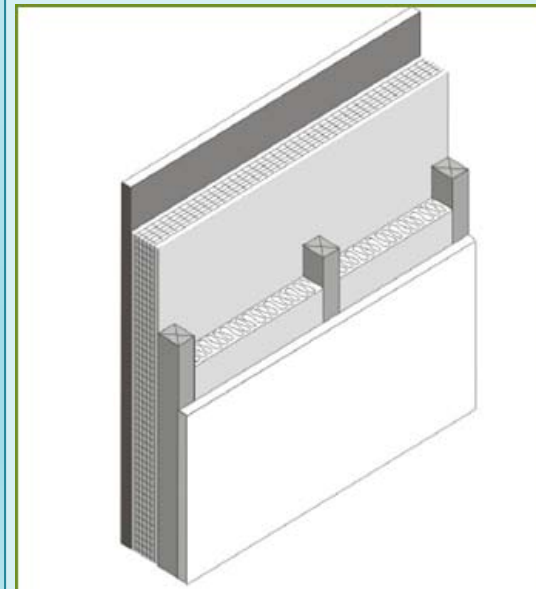
Mandatory

- ✦ U-factor = 0.102 (R-13)
OR
- ✦ U-factor = 0.074 (R-19)

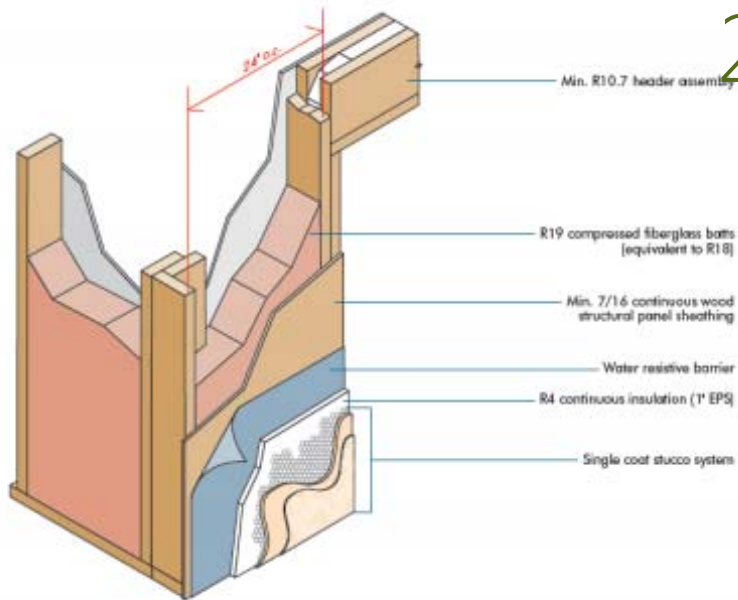


Prescriptive

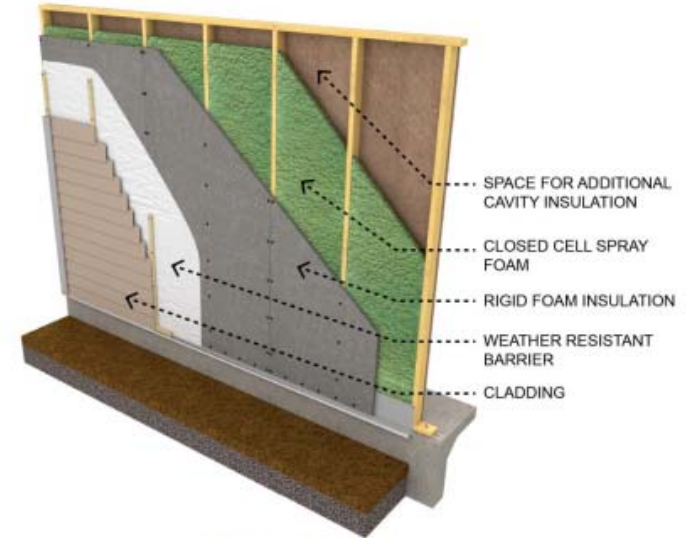
- ✦ All CZ's except #6&7:
U-factor = 0.051
(**R-19** + R-5 continuous)



2016 Framed Wall Assembly



Source: APA, The Engineered Wood Association



Source: BASF Corporation

U-factor	Framing	Stud Spacing	Cavity Insulation	Exterior Insulation	Cavity Insulation Type
0.050	2x6	24" OC	R-19	R-5 (1")	Low density fiberglass batt
0.051	2x6	16" OC	R-21	R-4 (1")	High density batt or BIB
0.049	2x6	16" OC	R-19	R-6 (1.25")	Low density fiberglass batt
0.050	2x4	16" OC	R-15	R-8 (2")	High density batt

**Multiple combinations of similar materials will achieve these same U-factors



Slide courtesy of CAHP -
Master Builder
Advanced Home Design
and Building Practices 2016
Code Readiness Program



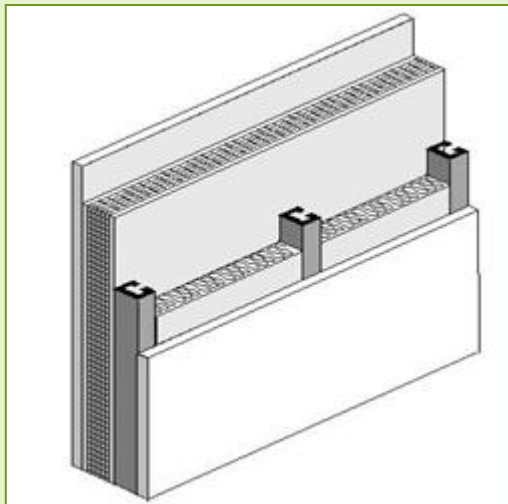
Wall – High Rise

2013 Wall



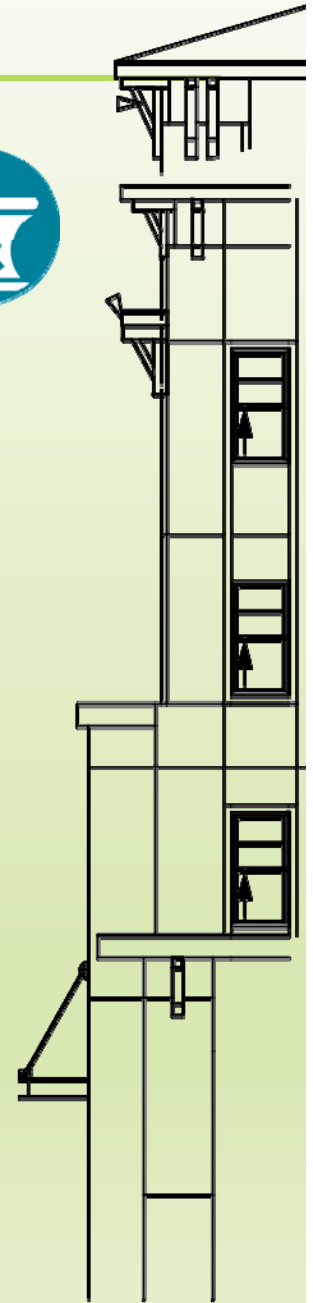
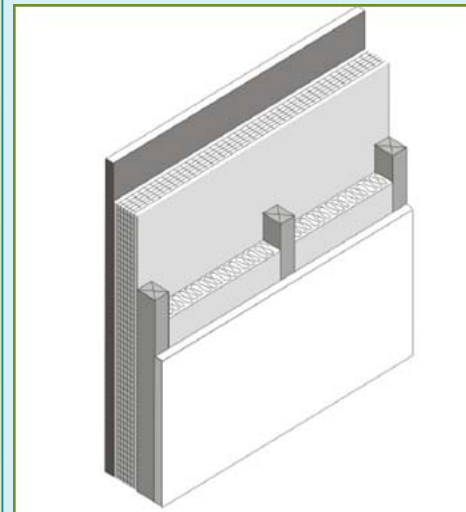
Mandatory

- ★ Wood: U-factor = 0.110
 - ◇ R-13
- ★ Metal: U-factor = 0.105
 - ◇ R-13 + R-4



Prescriptive: CZ3

- ★ Wood: U-factor = 0.059
 - ◇ R-21 + R-2
- ★ Metal: U-factor = 0.105
 - ◇ R-13 + R-4 continuous





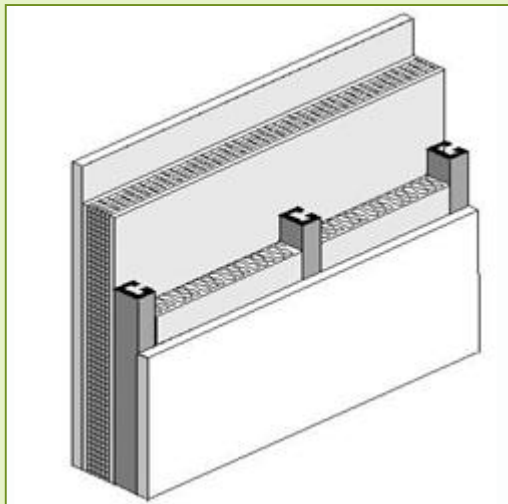
Wall – High Rise

2016 Wall



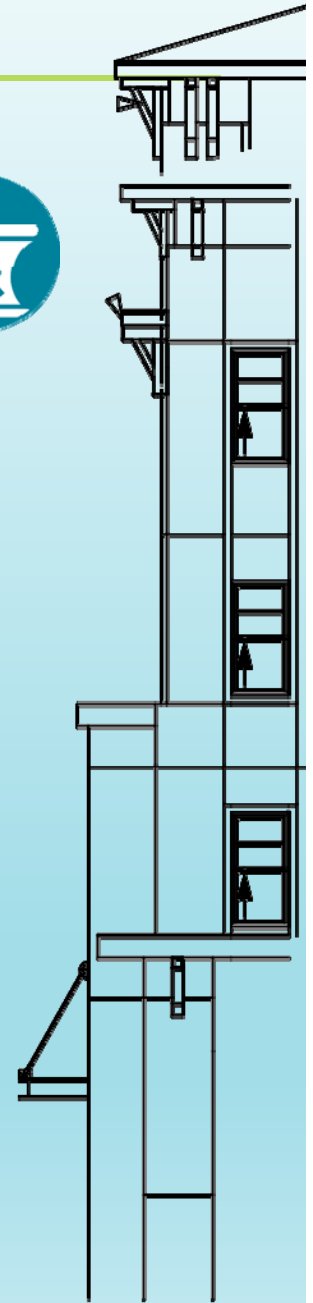
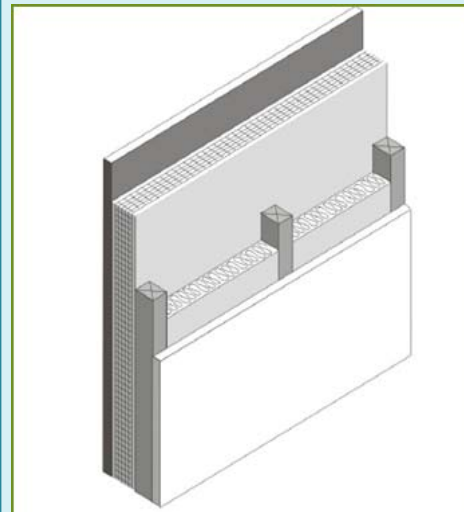
Mandatory

- ★ Wood: U-factor = 0.110
 - ◇ R-13
- ★ **Metal: U-factor = 0.151**
 - ◇ **8" wall with R-19**



Prescriptive: CZ3

- ★ Wood: U-factor = 0.059
 - ◇ R-21 + R-2
- ★ Metal: U-factor = **0.069**
 - ◇ **R-21 + R-7** continuous





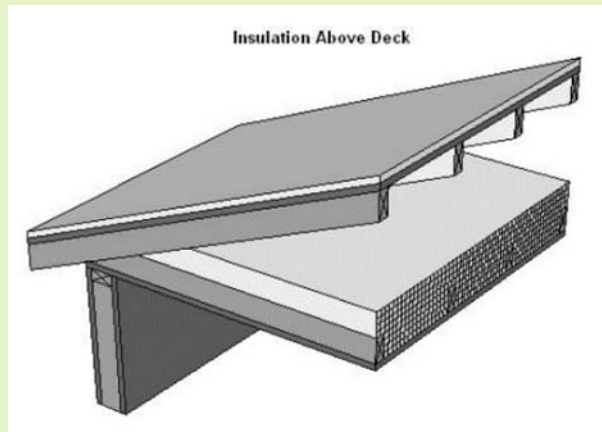
Roof – LowRise

2013 and 2016



Mandatory

- ★ 2013: U-factor: 0.031
- ✧ Attic: R-30



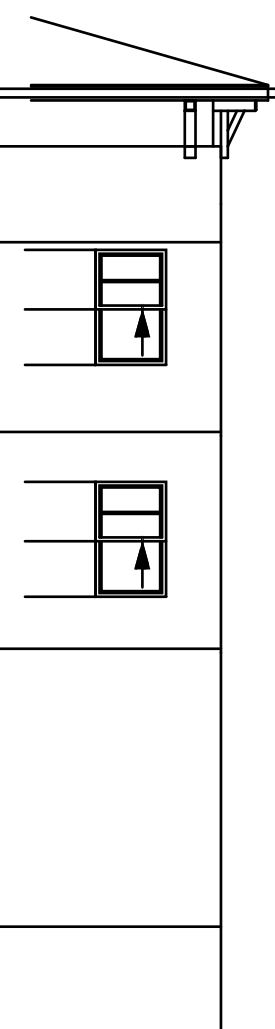
- ★ 2016: U-factor = **0.043**
- ✧ Attic: **R-22**



Prescriptive

2013

- ★ CZ 1, 11-16: U-Factor = 0.025
 - ✧ Attic: R-38
- ★ CZ 2-10: U-factor = 0.031
 - ✧ Attic: R-30
- ★ Ducts and air handler in conditioned space
- ★ 2016: Option C
 - ✧ **No change**





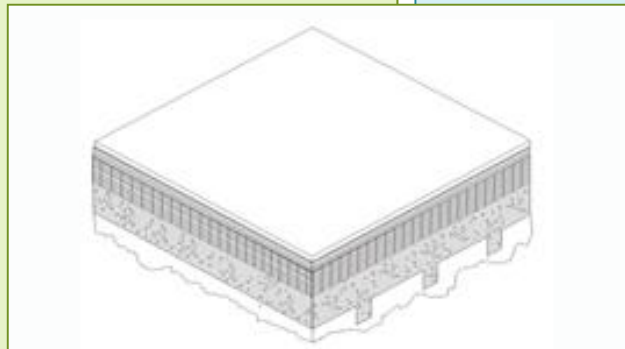
Roof – High Rise

2013 and 2016



Mandatory

- ◆ 2013: U-factor = 0.075
 - ◇ 4" concrete
 - R-10 + fireproofing



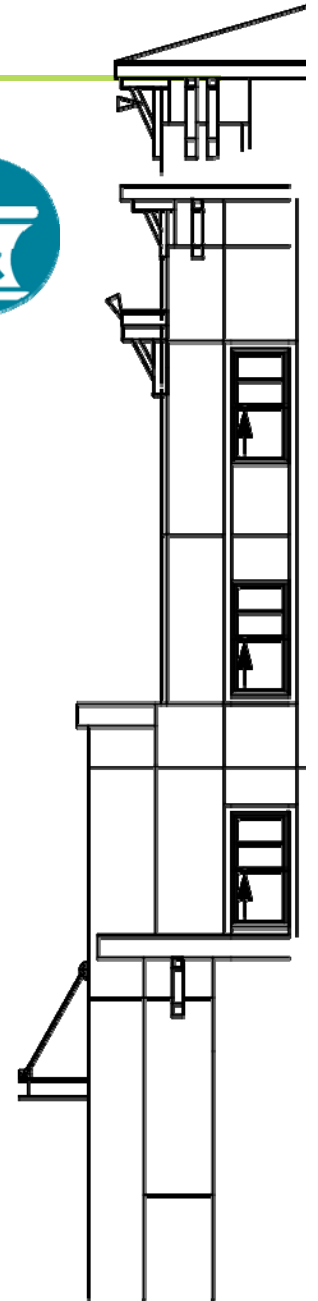
- ◆ 2016: **No Change**



Prescriptive: CZ3

- ◆ 2013: U-factor = 0.039
 - ◇ 4" concrete
 - R-22 + fireproofing

- ◆ 2016: U-factor = **0.034**
 - ◇ 4" concrete
 - **R-25** + fireproofing





Multi Family: Solar Ready



2013: 15% of total roof area

★ Building 10 stories or less

✧ *Exceptions:*

- PV system=1 watt per ft² of roof area
- Solar hot water system with solar savings fraction (SSF):
 - 20% = CZ1 through 9
 - 35% = CZ 10-16
- 50% *potential* solar zone area provided

■ Multifamily exception only:

- *Demand response thermostats*
- *High efficacy lights at kitchen, bathrooms (with vacancy sensor), utility rooms, garages and outside (with occupancy and photo sensor)*
- *Every room has a switched receptacle*



Multifamily: Solar Ready §110.10



2016: Revised Exception

- Multifamily exception only:
 - *Install a dishwasher that meets or exceeds the ENERGY STAR Program requirements with either a refrigerator that meets or exceeds the ENERGY STAR Program requirements or a whole house fan driven by an electronically commutated motor; **or***
 - *Install a home automation system capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals; **or***
 - *Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system in compliance with the California Plumbing Code and any applicable local ordinances; **or***
 - *Install a rainwater catchment system designed to comply with the California Plumbing Code and any applicable local ordinances, and that uses rainwater flowing from at least 65 percent of the available roof area.*



Floor

2013 and 2016 (no change)



Mandatory

- ◆ Wood: U-factor = 0.037
 - ◇ R-19
- ◆ Mass: U-factor = 0.269
 - ◇ no insulation

↑
Low-Rise

High-Rise
↓

- ◆ Wood: U-factor = 0.071
 - ◇ R-11
- ◆ Mass: U-factor = 0.269
 - ◇ no insulation

Prescriptive: CZ3

- ◆ Wood: U-factor = 0.037
 - ◇ R-19
- ◆ Mass: U-factor = 0.269
 - ◇ no insulation

↑
Low-Rise

High-Rise
↓

- ◆ Wood: U-factor = 0.039
 - ◇ R-25
- ◆ Mass: U-factor = 0.058
 - ◇ R-15





Fenestration – LowRise

2013 and 2016 (no change)



Mandatory

- ◆ 2013: U-factor
 - ◇ Weighted value of 0.58

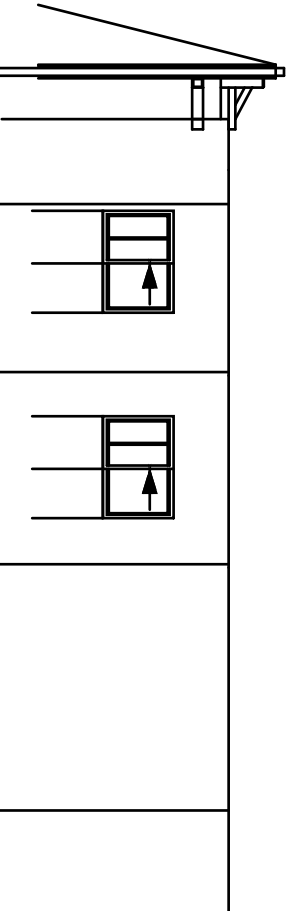


- ◆ 2016: No Change



Prescriptive

- ◆ 2013
 - ◇ U-factor = 0.32
 - ◇ SHGC:
 - CZ 2,4,6-16 = 0.25
 - CZ 1,3,5 = N/A
 - ◇ Max. area: 20% CFA
 - ◇ Max. west facing
 - CZ 2,4,6-16 = 5%
 - CZ 1,3,5 = N/A
- ◆ 2016
 - ◇ No Change





Fenestration – High Rise

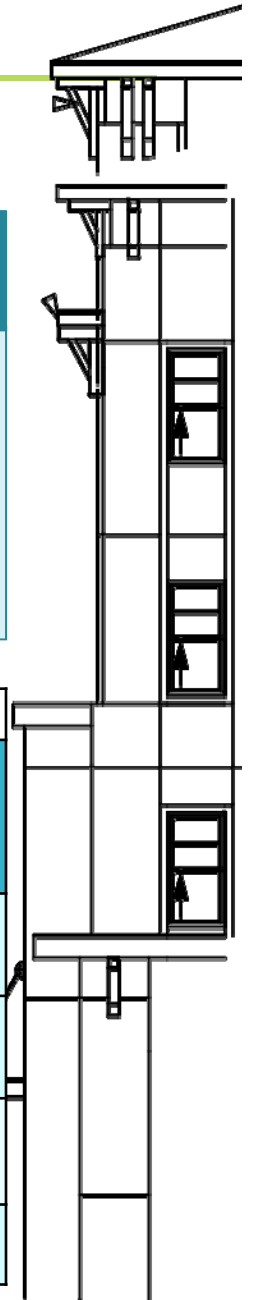


2013 and 2016 (no change)

2013 Prescriptive

- ◆ U-factor and SHGC Methods
- ◆ Default Tables 110.6-A/B
- ◆ NA6 COG formula: less than 1,000 sq. ft. site built fenestration
- ◆ NFRC label certificate (CMA or traditional)

		All Climate Zones					
		Fixed Window	Operable Window	Curtainwall or Storefront	Glazed Doors		
Fenestration	Vertical	Area-Weighted Performance Rating	Max U-factor	0.36	0.46	0.41	0.45
			Max RSHGC	0.25	0.22	0.26	0.23
		Area-Weighted Performance Rating	Min VT	0.42	0.32	0.46	0.17
		Maximum WWR%	40%				





Mechanical

- ▶ HVAC
- ▶ DHW
- ▶ HERS



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Mechanical

Equipment	Dwelling Units	Nonresidential Spaces
Low-rise		
HVAC	§110.2(a); 150.0(h)(i); 150.1(c)	§110.2(a); 120.2; 120.5; 140.4
IAQ	§150.0(o)	§120.1
DHW (same)	§110.3; 150.0(n)	§110.3; 140.5
High-rise		
HVAC	§110.2(a); 120.2(c); 140.4	§110.2(a); 120.2; 120.5; 140.4
IAQ	§120.1	§120.1
DHW (same)	§110.3; 150.0(n)	§110.3; 140.5
Distribution	Dwelling Units	Nonresidential Spaces
Low-rise		
HVAC	§120.3; 150.0(i)(m)	§120.3; 120.4;
DHW (same)	§110.3(c)5; 150.0(j)(n)	§120.3; 120.4;
High-rise		
HVAC	§110.3(c)5; 120.3; 120.4;	§120.3; 120.4;
DHW (same)	§110.3(c)5; 150.0(j)(n)	§120.3; 120.4;



2013 and 2016 HVAC: Low-Rise

HVAC Alterations

Split Systems and Packaged Systems	Mandatory Measures					Prescriptive Requirements	
	Setback Thermostat §110.2(c) §150.2(b)F	Cooling Load Calcs §150.0(h), §150.2(b)1C	Heating Load Calcs §150.0(h), §150.2(b)1C	HERS: Duct Seal and Test §150.0 (m)1-3 & 11 §150.2(b)1C,D, & E	HERS: Cooling Coil Airflow and Fan Watt Draw §150.0(m)12, 13 & 15 §150.2 (b)1C, D	Duct Insulation §150.1(c)9 §150.2(b)1D	HERS: Refrigerant Charge §150.1(c)7 A §150.2(b)1 F
Change this (and nothing else)							
Whole split or packaged system (no ducts added or replaced)	YES	no	no ^A	YES ^B	no	no	YES ^{C, D}
Evaporator coil (cooling coil), condenser coil, or outdoor condensing unit	YES	no	no ^A	YES ^B	no	no	YES ^{C, D}
Furnace (air handler)	YES	no	no ^A	YES ^B	no	no	YES ^{C, D}
Compressor, refrigerant metering device	YES	no	no ^A	no	no	no	YES ^{C, D}
Some ducts	no	maybe ^E	maybe ^{A, E}	YES ^B	no	YES ^F	no
"All new" ducts ^G	no	maybe ^E	maybe ^{A, E}	YES ^H	YES ^I	YES ^F	no
Whole split or packaged system and all new ducts	YES	YES ^E	YES ^{A, E}	YES ^H	YES ^I	YES ^F	YES ^{C, D}

NOTE:

- Replacing the blower wheel fan is considered a repair and does NOT trigger the Standards.
- All new HVAC equipment must meet minimum federal efficiency requirements
- Cooling line insulation is triggered if the line set (cooling system, suction line) is replaced or repaired. Line sets ≤1.5" in diameter must have 0.5" thick insulation.

- ^A Heating equipment must meet CBC minimum capacity requirements.
- ^B Unless exceptions apply, duct systems must be sealed and verified if >40 feet of ducts in unconditioned space. Duct system leakage must be ≤15% in total, or ≤10% to the outside. Or, if unable to meet the sealing requirements, all accessible leaks must be sealed and verified by a HERS rater.
- ^C HERS verification of refrigerant charge is required in **climate zones 2 and 8-15 only** when a refrigerant containing component of an air conditioner or heat pump is replaced or installed in an existing building.
- ^D Although there are no commercially available HVAC systems with approved Charge Indicator Display (CID) devices at the time of publication (July 2014) the Standards do allow use of a CEC-approved CID should such equipment become available during the 2013 code cycle.
- ^E Cooling and heating load calculations are required when ducts are added to **serve new conditioned space**, such as an addition.
- ^F When adding or replacing >40 feet of ducts in unconditioned space: CZ 1-10 and 12-13: R-6; CZ 11 and 14-16: R-8. HERS verification is required for insulated ducts in conditioned space. Mandatory duct insulation requirements (R-6) apply to all new or replacement ducts (not existing or unaltered ducts).
- ^G The system is considered to have "all new" ducts when 75% or more of the ducts are new material and up to 25% reused parts from the existing duct system (e.g., registers, grilles, boots, air handler, coil, plenums, duct material) if the reused parts are accessible and can be sealed to prevent leakage.
- ^H In all climate zones, when new duct systems are installed in unconditioned space, leakage must be ≤6% of the air handler airflow.
- ^I When new duct systems are installed, cooling coil airflow must be >350 CFM per ton, and fan watt draw must be ≤0.58W/CFM. Alternatively, the system can meet the requirements in Table 150.0-C or Table 150.0-D (Return Duct Sizing and Filter Sizing).

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This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

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HERS Mandatory/Prescriptive/Performance

HERS-verified Measure	Mandatory	Prescriptive	(if credit taken) Performance
Mechanical			
Duct sealing (maximum leakage)	X ^A		
Indoor air quality ventilation (based on ASHRAE Standard 62.2)	X		
Refrigerant charge or Installation of a charge indicator display		CZ 2, 8-15	CZ 1, 3-7, 16
Duct design (reduced surface area, high insulation, and duct location)			X
Ducts entirely in conditioned space			X
Low leakage ducts entirely in conditioned space			X
Ducts <12 feet outside conditioned space			X
Low leakage air handlers			X
Cooling coil air flow and air handler fan watt draw AND/OR Verified return duct design and air filter device	X		
High SEER			X
High EER			X
Photovoltaic (PV) system capacity to qualify for PV rebate via New Solar Home Partnership			X
Central fan integrated ventilation cooling systems		Optional ^B	
Zonal control			X
Evaporatively cooled condensers			X
Ice storage air conditioners			X
Plumbing			
Pipe insulation			X
Verified design (parallel piping, compact design, point of use)			X
Multi family recirculation loops			X
Envelope			
Quality insulation installation (QII)			X ^C
Building envelope sealing			X
HERS verified pre-existing conditions			X

HERS Verified Measures

- ✦ Triggers HERS registration
- ✦ Triggers ALL forms to be HERS registered
- ✦ Triggers HERS rater for verification of applicable features



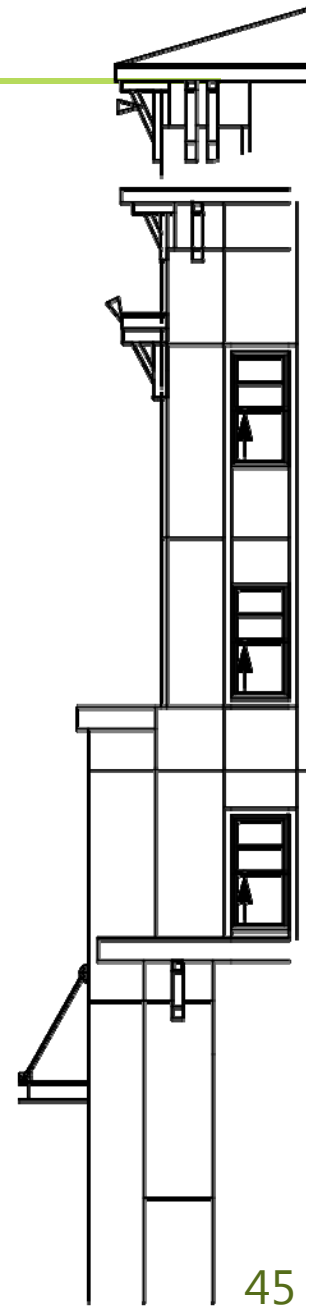
2013 and 2016 HVAC: High-Rise

Small Commercial HVAC Alterations

Packaged Units — Single-zone, Constant Air Volume (CAV) — and Split Systems														
Change this (and nothing else)	Mandatory Measures								Prescriptive Requirements					
	Tstat §110.2(c) §120.2 (a), (b), (c) & (e)	Supply & Exhaust Dampers (ventilation provided by HVAC) §120.2(f)	Min. Cooling Efficiency §110.2(a)	Min. Heating Efficiency §110.2(a)	Ventilation Calcs (NRCC-MCH-03-E) §120.1	Demand Control Ventilation ^A §120.1(c) 3 & 4	Duct Insulation §120.4	Demand Shed Controls ^B §120.2	Cooling Load Calcs §140.4(b)	Heating Load Calcs §140.4(b)	Equipment Sizing (per load calcs) §140.4(a)	Fan Power ^C §140.4(c)	Economizer ^D §140.4(e)	Duct Seal & Test ^E §140.4(l), 140.9(b)2E
Whole Pkg Unit Or split system NO DUCTS	YES	YES	YES	YES	YES	YES ^A	NO	YES ^B	YES	YES	YES	YES ^C	YES ^D	YES ^E
Cooling Coil of Packaged System	YES	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES ^E
Split System, Outdoor Unit	YES	NO	YES	YES ^F	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES
Split System, Indoor Unit	YES	NO	YES	YES ^F	NO	NO	NO	NO	NO	NO	YES	NO	NO	YES
Ductwork ^G	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	YES ^E
≥75% new ducts and Whole Pkg Unit and Split System	YES	YES	YES	YES	YES	YES ^A	YES	YES ^B	YES	YES	YES	YES ^C	YES ^D	YES ^E

NOTE: + For Nonresidential HVAC systems, a change in blower motor, compressor, condenser coil, or plenum is considered a repair and does not trigger the Title 24, Part 6 Standards.

^A If system is single-zone with any controls or multi-zone with direct digital control, and has airside economizer, and serves a high-density space (≥25 people per 1,000 ft²)
^B Only required if the altered unit has direct digital controls (DDC) to the zone level.
^C If total system fan power is >25 hp
^D If >54,000 Btu/h cooling capacity (4.5 tons)
^E If CAV single-zone system and serves <5,000 ft conditioned floor area and >25% duct surface in unconditioned space including under a roof that does not meet current prescriptive insulation requirements.
^F If split system operates as a heat pump, heating efficiency must meet mandatory requirements in §110.2.
^G Check with your local building department to see if changes to duct work only will require a permit.





2013 and 2016 Plumbing



Individual DHW

2013: (1) gas or propane tank water heater with an input of 75,000 Btu per hour or less

For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used

2016: (1) gas or propane tankless water heater with an input of 200,000 Btu per hour or less; EF = 0.82

Central DHW

2013 and 2016: A water heating recirculation loop that is equipped with an automatic control system that controls the recirculation pump operation based on measurement of hot water demand and hot water return temperature and has two recirculation loops each serving half of the building; and

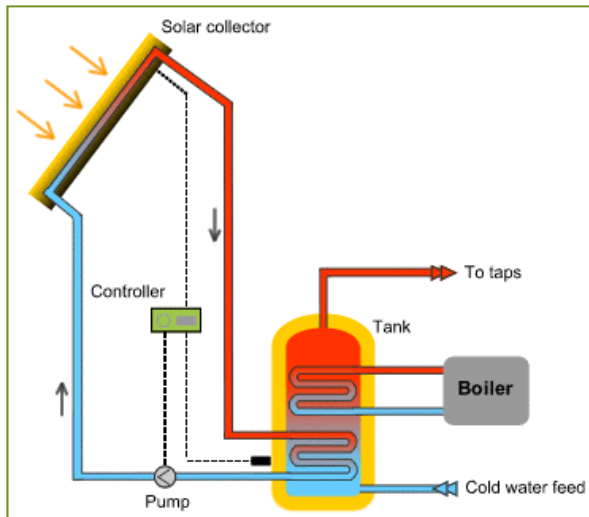
- ✧ EXCEPTION to Section 150.1(c)8Cii: Buildings with eight or fewer dwelling units are exempt from the requirement for two recirculation loops.

A solar water-heating with a minimum solar savings fraction of:

0.20 in Climate Zones 1 through 9

0.35 in Climate Zones 10 through 16.

The solar savings fraction shall be determined using a calculation method approved by the Commission.





Lighting

- ▶ **JA8**
- ▶ **Indoor**
- ▶ **Outdoor**



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Lighting

Fixtures	Dwelling Units	Indoor Nonresidential	Outdoor
Low-rise	§150.0(k)1-8	Common ≤20% of CFA: §150.0(k)12 Common >20% of CFA: NR Lighting	7 parking spots or less: §150.0(k)9A or NR lighting 8 parking spots or more: §140.7 (alterations: §141.0)
High-rise	§150.0(k)1-8	§140.6 (alterations: §141.0)	§140.7 (alterations: §141.0)
Controls	Dwelling Units	Indoor Nonresidential	Outdoor
Low-rise	§150.0(k)1-8	§130.0, §130.1 and §130.4	7 parking spots or less: §150.0(k)9A or NR lighting 8 parking spots or more: §130.2 (alterations: §141.0)
High-rise	§150.0(k)1-8	§130.0, §130.1 and §130.4	§130.2 (alterations: §141.0)



2013 Dwelling Unit Lighting: §130.0(b)



Bathroom	<ul style="list-style-type: none">• One high efficacy fixture and• Manual-on vacancy sensor or high efficacy for all other fixtures
Kitchen	<ul style="list-style-type: none">• 50% high efficacy (or more) wattage• 50% low efficacy (or less) wattage (switched separately from high efficacy)
All other interior rooms	<ul style="list-style-type: none">• High efficacy or• Manual-on vacancy sensor or• Dimmer

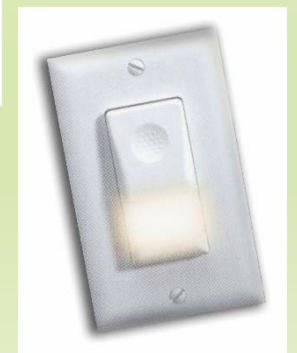
Sources

- ✦ **High-efficacy luminaires** 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.



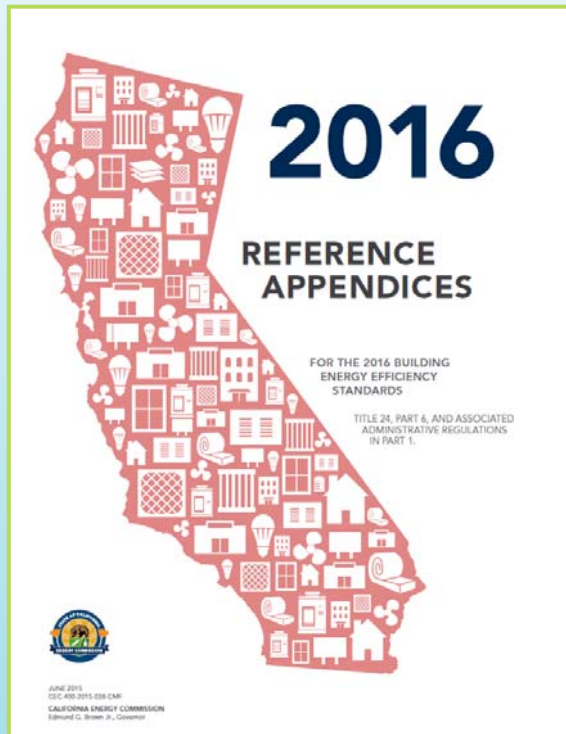
Controls

- ✦ **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**, which are already common in many residential applications, allow room occupants to lower lighting levels (and thus energy use) as desired.





"CLTC: What's New in the 2016 Code"



"JA8-2016" or "JA8-2016-E"

JA8 compliance markings are located on the lamp bulb or base. **This will be required for all LED lamp types**, and anything else not considered "high efficacy" per Table 150.0-A:

- The marking "JA8-2016-E" indicates that the light source has been tested to provide long life at elevated temperatures in addition to the requirements listed for JA8-2016 and may be used in enclosed and recessed luminaires.

Table 150.0-A: High efficacy includes fluorescent with electronic ballast

Appendix JA8: Qualification Requirements for High Efficacy Light Sources – Partial List

Specification	Requirement
Initial Efficacy	≥ 45 lumens/Watt
Power Factor at Full Rated Power	≥ 0.90
Correlated Color Temperature (CCT)	For inseparable SSL luminaires, LED light engines and GU24 LED lamps, ≤4000 Kelvin. For all other sources, ≤3000 Kelvin.
Color Rendering Index (CRI)	≥90
R9	≥50
Rated Life	≥ 15,000 hours
Minimum Dimming Level	≤10%
Flicker	<30% for frequencies of 200 Hz or below, at 100% and 20% light output.

This table contains a partial list of requirements. Additional qualification requirements may be found in JAB.

A list of compliant products may be found at <https://cacertappliances.energy.ca.gov>



“CLTC: What’s New in the 2016 Code”

LIGHTING BEST PRACTICES



WHAT'S NEW IN THE 2016 CODE?
RESIDENTIAL LIGHTING

Changes to mandatory lighting requirements in California's 2016 Building Energy Efficiency Standards

California's new code, the 2016 Energy Efficiency Standards, took effect on January 1, 2016. The 2016 focus on several key areas to improve the energy efficiency of newly constructed buildings, additions and existing buildings. The most significant change is the implementation of advanced lighting controls for new homes. The California Energy Commission estimates that the 2016 standards will save approximately 240 gigawatt-hours by saving electricity and reduce greenhouse gas emissions by 100,000 metric tons. This is the equivalent of saving 100,000 Gallons of gasoline each year.

These standards represent a major step towards meeting California's residential Zero Net Energy (ZNE) goal by 2020. Applications have been approved to cover private and public homes, and for 2016 code improvements slated for 2018 code. This subject offers an overview of important requirements and updates to the 2016 residential lighting energy efficiency code.

MAJOR CHANGES

- ALL HIGH EFFICACY LIGHTING**
Indoor and outdoor lighting for new homes must be high efficiency.
- JAS UPDATED**
2016 Appendix JAS regulates new commercial requirements for more types of residential high efficiency lamps and luminaires. In the 2013 Standards, JAS regulated only compact fluorescent lamps.
- SIMPLIFIED CONTROL REQUIREMENTS**
Lighting control requirements for interior spaces are now similar. Control requirements for closets, secondary bedrooms, and utility rooms are now simplified, not the same.

For more information, visit the website: www.clctc.org or call 916.735.2222. For more information, visit the website: www.energy.ca.gov/title24/2016standards or contact the author: info@clctc.org. Title 24 Energy Efficiency Standards, Division 9, Appendix JAS, and the Residential Code are referenced.

CALIFORNIA LIGHTING TECHNOLOGY CENTER · UNIVERSITY OF CALIFORNIA, DAVIS · CLTC

Lighting Controls

2016 Indoor Residential Lighting Requirements: Spaces & Lighting Controls

Residential Space	Manual ON / OFF Controls	Vacancy Sensor or Dimmer ¹	Separate Switching: Exhaust Fans	Separate Switching: Undercabinet Lighting
Hallways & Closets ²		Not required		
Kitchens		Based on installed luminaire or lamp type ³	Exhaust fans must be switched separate from lighting or utilize a device where lighting can be turned OFF while the fan is running. Excludes kitchen exhaust hoods.	Undercabinet lighting must be switched separate from all other lighting.
Bathrooms	Required for all spaces	At least one luminaire controlled by a vacancy sensor and all other based on installed lamp or luminaire type	Exhaust fans must be switched separate from lighting or utilize a device where lighting can be turned OFF while the fan is running. Excludes kitchen exhaust hoods.	Undercabinet lighting must be switched separate from all other lighting.
Laundry Rooms / Utility Rooms				
Garage				
All Other		Based on installed luminaire or lamp type ³		

¹ May be achieved with an EMCS or programmable scene controller with required functionality.

² Closets less than 70ft². For all other closets, requirements based on installed lamp or luminaire type.

³ See page 3 for a list of requirements by lamp and luminaire type.

“Installed luminaire or lamp type”:

JA8-2016/JA8-2016-E (all LED) will require a dimmer or vacancy sensor.

High efficacy per Table 150.0-A (no LED) allowed just an on/off switch.



Multifamily Project “Highlight”



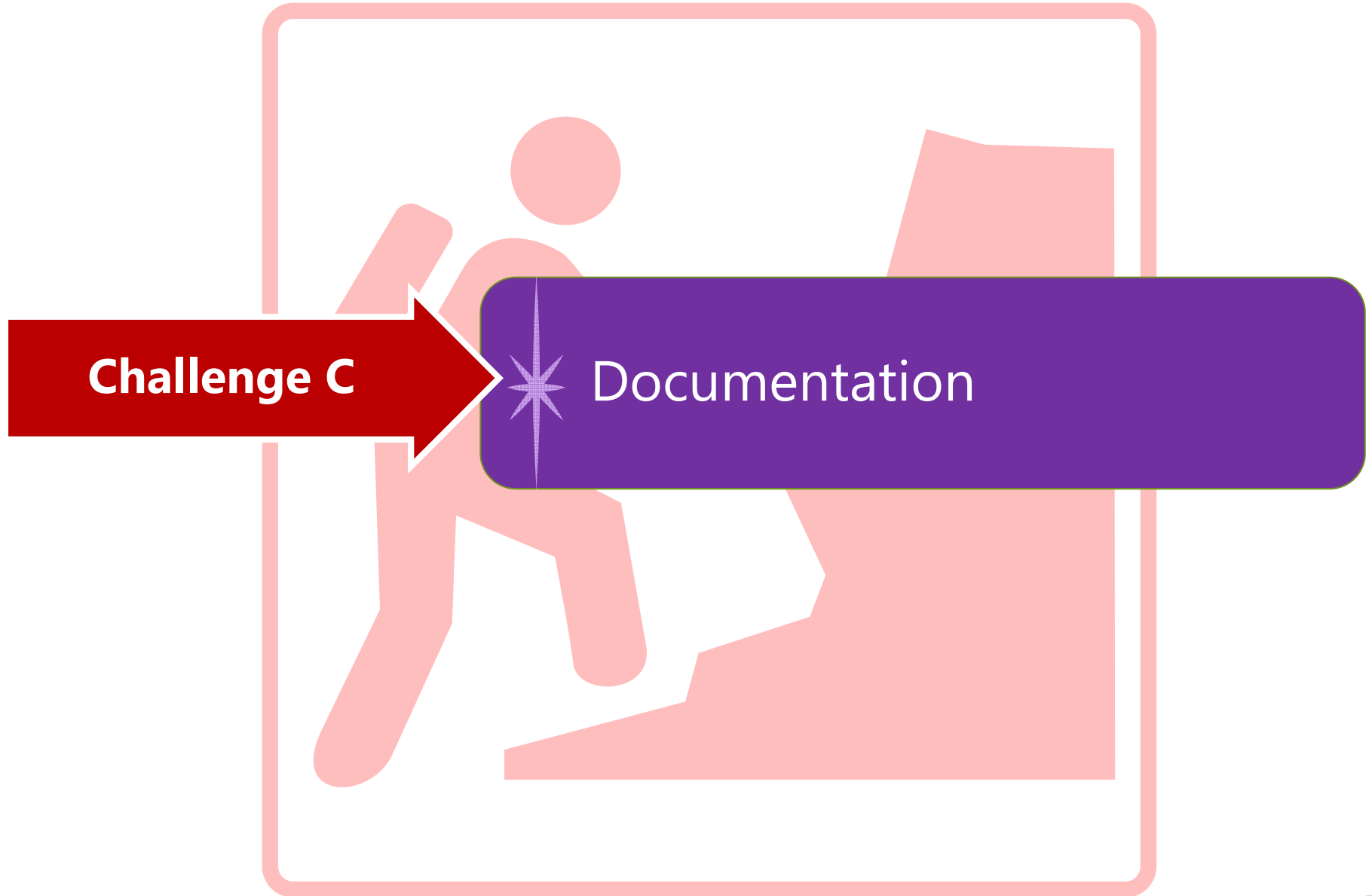
From the Files

- ✦ NW Land Park Bungalows and Villas, Sacramento
- ✦ 19% above 2013 Title 24 Code
- ✦ *Ductless* mini-splits on all floors except the top floor with *ducted* mini-splits
- ✦ **Solution?:** Zonal modeling with two systems.
- ✦ However, with a ‘standard’ system, the project would have been ~33% above 2013 Title 24 Code due to a high quality envelope





Challenge C





Forms

Building Type	Envelope	HVAC	DHW	Lighting
Low-rise Dwelling units	CF1R-PRF	CF1R-PRF	CF1R-PRF	N/A
Conditioned NR spaces	NRCC-PRF; NRCC-ENV	NRCC-PRF; NRCC-MCH	NRCC-PRF; NRCC-PLB	NRCC-PRF; NRCC-LTI/LTO/LTS
Unconditioned NR spaces	N/A	N/A	N/A	NRCC-LTI/LTO/LTS
High-rise Dwelling units	NRCC-PRF	NRCC-PRF	NRCC-PRF	N/A
Conditioned NR spaces	NRCC-PRF; NRCC-ENV	NRCC-PRF; NRCC-MCH	NRCC-PRF; NRCC-PLB	NRCC-PRF; NRCC-LTI/LTO/LTS
Unconditioned NR spaces	N/A	N/A	N/A	NRCC-LTI/LTO/LTS
Other Forms	Design Review	Electrical	Solar Ready	Parking Garage
Low-rise	NRCC-CXR if mixed use	N/A	CF1R-SRA	NRCC-PRC-02-E
High-rise	NRCC-CXR if mixed use	NRCC-ELC	NRCC-SRA	NRCC-PRC-02-E

BOLD: Performance form



2013 and 2016 Forms Conventions



Document Category

PRF = Performance approach	ENV = Envelope
NCB = New construction & additions >1,000 ft ²	MCH = Mechanical
ADD = Additions (≤ 1,000 ft ²)	LTG = Lighting
ALT = Alterations	PLB = Plumbing (DHW)
EXC = Existing Conditions	PHV = Photovoltaic
SRA = Solar Ready	WKS = Worksheet

(Residential)
Compliance Form

CF1R-ALT-01-E

Document Type

Certificates of...

1R = Compliance

2R = Installation

3R = HERS Verification

Primary user

E = Enforcement agency

H = HERS

CERTIFICATE OF COMPLIANCE - RESIDENTIAL PERFORMANCE COMPLIANCE METHOD

CF1R-PRF-01-E

Project Name: Lowrise Multi-Family Example

Calculation Date/Time: 09:45, Thu, Aug 13, 2015

Page 1 of 9

Calculation Description: Title 24 Analysis

Input File Name: MF Example.xml

GENERAL INFORMATION				
01	Project Name	Lowrise Multi-Family Example		
02	Calculation Description	Title 24 Analysis		
03	Project Location	7188 Pleasant Way		
04	City	Rocklin	05	Standards Version
				Compliance 2015
06	Zip Code	90000	07	Compliance Manager Version
				BEMCmpMgr 2013-4 (744)
08	Climate Zone	CZ11	09	Software Version
				EnergyPro 6.6
10	Building Type	Multifamily	11	Front Orientation (deg/Cardinal)
				0
12	Project Scope	Newly Constructed	13	Number of Dwelling Units
				10
14	Total Cond. Floor Area (ft ²)	8000	15	Number of Zones
				2
16	Slab Area (ft ²)	4000	17	Number of Stories
				2
18	Addition Cond. Floor Area	N/A	19	Natural Gas Available
				Yes
20	Addition Slab Area (ft ²)	N/A	21	Glazing Percentage (%)
				11.1%

COMPLIANCE RESULTS	
01	Building Complies with Computer Performance
02	This building incorporates features that require field testing and/or verification by a certified HERS rater under the supervision of a CEC-approved HERS provider.
03	This building incorporates one or more Special Features shown below

ENERGY USE SUMMARY				
04	05	06	07	08
Energy Use (kTDV/ft ² -yr)	Standard Design	Proposed Design	Compliance Margin	Percent Improvement
Space Heating	7.95	7.00	0.95	11.9%
Space Cooling	42.19	43.48	-1.29	-3.1%
IAQ Ventilation	2.71	2.71	0.00	0.0%
Water Heating	17.33	14.46	2.87	16.6%
Photovoltaic Offset	---	-7.45	7.45	---
Compliance Energy Total	70.18	60.20	9.98	14.2%

Registration Number:

CA Building Energy Efficiency Standards - 2013 Residential Compliance

Registration Date/Time:

Report Version - CF1R-08062015-744

HERS Provider:

Report Generated at: 2015-08-13 09:46:12

CERTIFICATE OF COMPLIANCE - RESIDENTIAL PERFORMANCE COMPLIANCE METHOD

CF1R-PRF-01-E

Project Name: Lowrise Multi-Family Example

Calculation Date/Time: 09:45, Thu, Aug 13, 2015

Page 2 of 9

Calculation Description: Title 24 Analysis

Input File Name: MF Example.xml

REQUIRED SPECIAL FEATURES
The following are features that must be installed as condition for meeting the modeled energy performance for this computer analysis.
<ul style="list-style-type: none"> PV System: 2.0 kW

HERS FEATURE SUMMARY
The following is a summary of the features that must be field-verified by a certified HERS Rater as a condition for meeting the modeled energy performance for this computer analysis. Additional detail is provided in the building components tables below.
<ul style="list-style-type: none"> Building-level Verifications: <ul style="list-style-type: none"> IAQ mechanical ventilation Cooling System Verifications: <ul style="list-style-type: none"> Minimum Airflow Verified EER Verified SEER Refrigerant Charge Fan Efficacy Watts/CFM HVAC Distribution System Verifications: <ul style="list-style-type: none"> Duct Sealing Ducts located entirely in conditioned space Domestic Hot Water System Verifications: <ul style="list-style-type: none"> -- None --

ENERGY DESIGN RATING				
This is the sum of the annual TDV energy consumption for energy use components included in the performance compliance approach for the Standard Design Building (Energy Budget) and the annual TDV energy consumption for lighting and components not regulated by Title 24, Part 6 (such as domestic appliances and consumer electronics) and accounting for the annual TDV energy offset by an on-site renewable energy system.				
	Reference Energy Use	Energy Design Rating	Margin	Percent Improvement
Total Energy (kTDV/f2-yr)*	148.60	138.62	9.98	6.7%

* includes calculated Appliances and Miscellaneous Energy Use (AMEU)

BUILDING - FEATURES INFORMATION						
01	02	03	04	05	06	07
Project Name	Conditioned Floor Area (sft)	Number of Dwelling Units	Number of Bedrooms	Number of Zones	Number of Ventilation Cooling Systems	Number of Water Heating Systems
Lowrise Multi-Family Example	8000	10	20	2	0	1



2013 and 2016 Forms Conventions



Document Category

PRF = Performance approach	ENV = Envelope
CXR = Design Review	MCH = Mechanical
LTI = Indoor Lighting	ELC = Electrical
LTO = Outdoor Lighting	PLB = Plumbing (DHW)
LTS = Sign Lighting	PRC = Covered Process
SRA = Solar Ready	STC = Solar Thermal

Nonresidential

NR CC - PRF - 01 - E

Document Type

Certificates of...
CC = Compliance
CI = Installation
CA = Acceptance
CV = Verification

Primary user

E = Enforcement agency
H = HERS Rater
F = Field Technician
(Contractor)
A = Acceptance Test Tech

Project Name:	Sample High Rise	NRCC-PRF-01-E	Page 1 of 15
Project Address:		Calculation Date/Time:	21:12, Mon, Mar 28, 2016
Compliance Scope:	NewEnvelope	Input File Name:	15515-GR v6.7 1.29.16.xml

A. PROJECT GENERAL INFORMATION					
1.	Project Location (city)	- specify -	7.	# of dwelling units	150
2.	CA Zip Code		8.	Standards Version	Compliance2015
3.	Climate Zone	4	9.	Compliance Software (version)	EnergyPro 6.7
4.	Total Conditioned Floor Area	216,339 ft ²	10.	Building Orientation (deg)	(N) 0 deg
5.	Total Unconditioned Floor Area	174,274 ft ²	11.	Permitted Scope of Work	NewEnvelope
6.	# of Stories (Habitable Above Grade)	7	12.	Building Type(s)	High-Rise Residential

B. COMPLIANCE RESULTS FOR PERFORMANCE COMPONENTS					§ 140.1
BUILDING COMPLIES					
1. Energy Component	2. Standard Design (TDV)	3. Proposed Design (TDV)	4. Compliance Margin (TDV)	5. Percent Better than Standard	
Space Heating	15.1	12.7	2.4	15.9%	
Space Cooling	19.8	18.9	0.9	4.5%	
Indoor Fans	13.6	13.0	0.6	4.4%	
Heat Rejection	1.6	1.5	0.1	6.3%	
Pumps & Misc.	4.6	4.7	-0.1	-2.2%	
Domestic Hot Water	--	--	--	--	
Indoor Lighting	39.1	39.1	--	0.0%	
COMPLIANCE TOTAL	93.8	89.9	3.9	4.2%	
Receptacle	38.3	38.3	0.0	0.0%	
Process	--	--	--	--	
Process Ltg	--	--	--	--	
TOTAL	132.1	128.2	3.9	3.0%	

Project Name:	Sample High Rise	NRCC-PRF-01-E	Page 2 of 15
Project Address:		Calculation Date/Time:	21:12, Mon, Mar 28, 2016
Compliance Scope:	NewEnvelope	Input File Name:	15515-GR v6.7 1.29.16.xml

C. PRIORITY PLAN CHECK/ INSPECTION ITEMS (in order of highest to lowest TDV energy savings)

1st	Space Heating: Check envelope and mechanical	<p style="text-align: center;">Compliance Margin By Energy Component (from Table B column 4)</p> <p style="text-align: center;"> Space Heating Space Cooling Indoor Fans Heat Rejection Domestic Hot Water Indoor Lighting Pumps & Misc. </p> <p style="text-align: center;"> Penalty Energy Credit </p>
2nd	Space Cooling: Check envelope and mechanical	
3rd	Indoor Fans: Check envelope and mechanical	
4th	Heat Rejection: Check envelope and mechanical	
5th	Domestic Hot Water: Check mechanical	
6th	Indoor Lighting: Check lighting	
7th	Pumps & Misc.: Check mechanical	

D. EXCEPTIONAL CONDITIONS
The project shows partial compliance, using envelope-only compliance. The building must show either lighting and mechanical partial compliance or full new building compliance before operation.
The project shows partial compliance, either envelope only or mechanical only, excluding lighting systems. The building must show partial compliance including lighting or full new building compliance or show prescriptive lighting compliance before operation
The building does not include service water heating. Verify that service water heating is not required and is not included in the design.

E. HERS VERIFICATION
This Section Does Not Apply

F. ADDITIONAL REMARKS
None Provided



Construction: **CF2R/NRCI**

Certificate of Installation



- ✦ Provided by installing contractor or General Contractor during construction.
- ✦ Reviewed by building inspector.
- ✦ Then provided to building owner.

Mandatory Measures found within these forms.



Inspection/Verification: CF3R/NRCV

Certificate of Verification



- ★ Provided by HERS rater.
- ★ Made available BEFORE building inspector arrives for final then provided to building owner.



Building Inspection: **NRCA**

Certificate of Acceptance



- ✦ Provided by installing contractor or Acceptance Test Technician.
- ✦ Made available BEFORE building inspector arrives for final then provided to building owner.



Multifamily Project “Highlight”

From the Files



- ✦ Carmel Lofts – Sunnyvale
- ✦ 33% above 2008 Title 24 Code
- ✦ Identical units were modeled using “vertical multipliers”
- ✦ The HERS Registry does not correctly interpret the use of the vertical multiplier and therefore did not include a placeholder for some duct-leakage testing results
- ✦ **Solution?:** Have the Rater upload for units they could, and submit the remaining units to incentive program staff



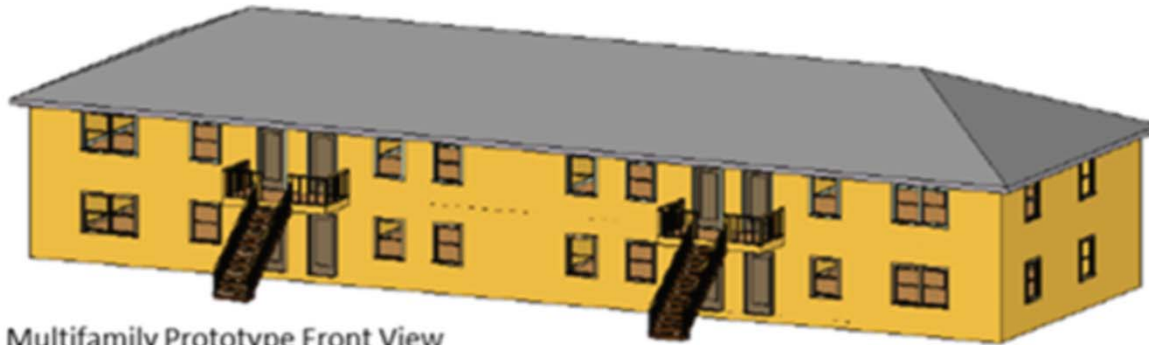
Challenge D

Challenge D

Modeling Challenges

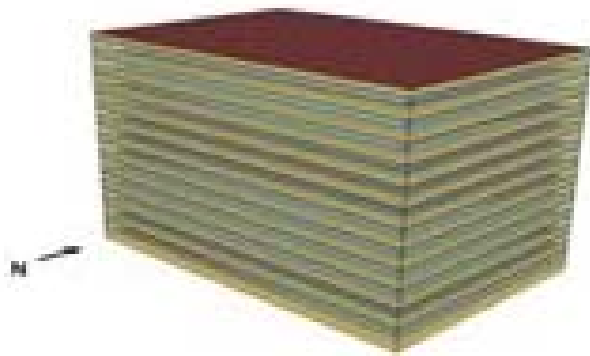


What's Baseline?



Multifamily Prototype Front View

- ✦ CBECC-res
 - ✧ 3-story max, no corridors, exterior stairs;
 - ✧ Envelope meeting prescriptive;
 - ✧ HVAC: Split DX, ducts and air handler in conditioned space;
 - ✧ DHW: If central, solar hot water system.



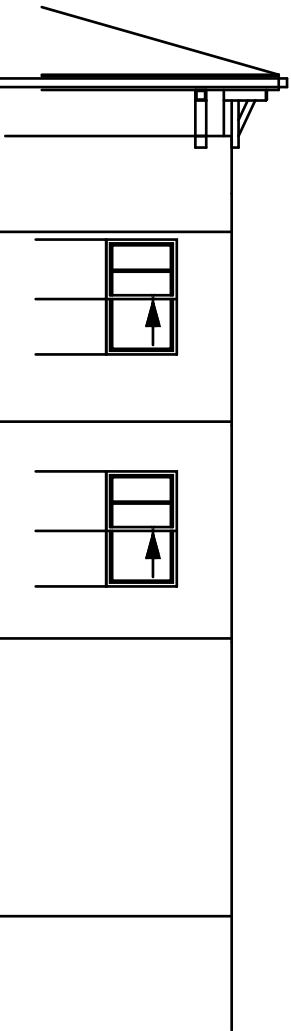
- ✦ CBECC-com
 - ✧ Same # of stories;
 - ✧ Envelope meeting prescriptive (If more than 40% WWR then fenestration evenly divided among all orientations at 40% WWR);
 - ✧ HVAC: Central plant with 4 pipe fan coil;
 - ✧ DHW: Central with solar hot water system.



2013 and 2016 Low-Rise: Modeling

Challenges

- ◆ Gina's challenges





2013 and 2016 Low-Rise: Modeling



Is that a floor or a loft?

- ✦ You have 3 floors, and a loft...but when you try and model the loft, the software will not run saying you now have a high rise residential project..what do you do?

General Lighting Mechanical Schedules Dwelling Units

Zone Details

Name:

Zone Type:

Occupancy:

90.1 Ltg Occupancy:

of Floors:

Envelope Status:

Lighting Status:

Year Built:

Rotation:

Building Story: loft modeled as "3"

North, East, South West

Display Perimeter: feet feet

Select the Building Story

4 of 4

Name
Floor 1
Floor 2
Floor 3
loft modeled as "3"

Name:

Floor Multiplier:

Ceiling Height: feet

Floor Elevation: feet

Floor to Floor Height: feet

Window Head Height: feet

✦ Fake it

- Model the 3rd floor twice.



2013 and 2016 Low-Rise: Modeling



Where do the unconditioned Nonresidential spaces go?

- ✦ You have a 3 story multi family building with an unconditioned lobby, how do you model that space?
 - ✦ Fake it
 - Model the lobby as a garage (so that you can model demising walls).

General | Lighting | Mechanical | Schedules | Dwelling Units

Zone Details

Name:	<input type="text" value="Unconditioned"/>
Zone Type:	<input type="text" value="Res Garage"/> ▾
Occupancy:	<input type="text" value="Multi-Family"/> ▾





2013 and 2016 Low-Rise: Modeling



Where do the conditioned Nonresidential spaces go?

★ Your building has a conditioned meeting space that exceeds 20% of the total conditioned floor area, how do you account for the this space?



✧ Fake it

- Model residential walls to the space as “next to different dwelling unit” then model those spaces in CBECC-com (envelope, lighting, HVAC and DHW)

Name:

Area: ft²


Surface Type:

New Assembly:  

Floor Elevation: feet

Next to a different dwelling unit Next to Residential Attic

Adjacent To:





2013 and 2016 Low-Rise: Modeling



How do I model PV for a building deciding to use all electric resistance DHW?

✦ Your client will be covering the roof with PV, and are choosing to not connect to natural gas available at the street and use electric resistance DHW, this will work right?

✦ DON'T fake it

■ Principal heating source is not a choice, but a limitation of the site.

Principal Heating Source

- Natural Gas
- Propane
- Electric (Natural Gas Available)
- Electric (No Natural Gas Available)

ENERGY USE SUMMARY				
04	05	06	07	08
Energy Use (KTDV/ft ² -yr)	Standard Design	Proposed Design	Compliance Margin	Percent Improvement
Space Heating	7.85	6.91	0.94	12.0%
Space Cooling	42.88	44.09	-1.21	-2.8%
IAQ Ventilation	2.71	2.71	0.00	0.0%
Water Heating	26.35	49.32	-22.97	-87.2%
Photovoltaic Offset	----	-7.72	7.72	----
Compliance Energy Total	79.79	95.31	-15.52	-19.5%

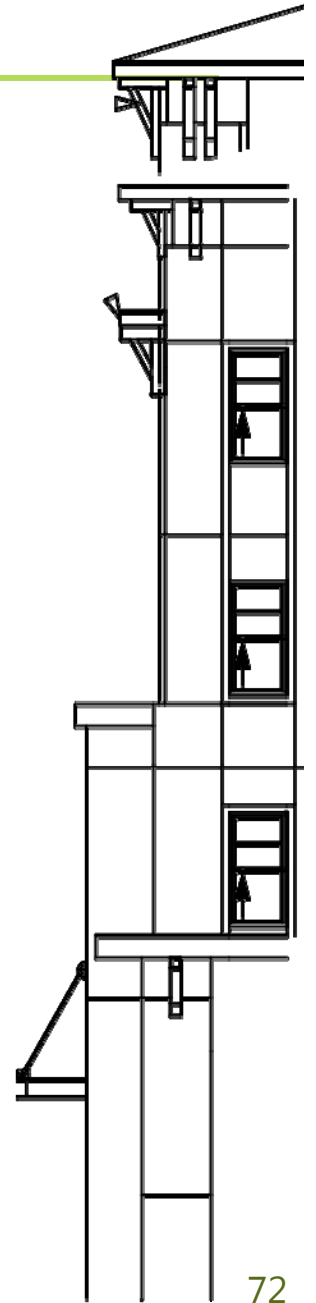


2013 and 2016 High-Rise: Modeling

Challenges



- ◆ Gina's challenges





2013 and 2016 High-Rise: Modeling



How do I model PV for a building deciding to use all electric resistance DHW?

✦ Your client will be covering the roof with PV, and are choosing to not connect to natural gas available at the street and use electric resistance DHW, this will work right?

✦ You can't

- PV is not an allowance under the nonresidential standards

Month	Production (kWh)	Demand (kW)	Cost
Jan	0	0.0	\$0
Feb	0	0.0	\$0
Mar	0	0.0	\$0
Apr	0	0.0	\$0
May	0	0.0	\$0
Jun	0	0.0	\$0
Jul	0	0.0	\$0
Aug	0	0.0	\$0
Sep	0	0.0	\$0
Oct	0	0.0	\$0
Nov	0	0.0	\$0
Total:	0.0	0.0	\$0



2013 and 2016 High-Rise: Modeling



Get the BHP for the supply fans, NOT plate HP. It is sometimes a struggle to get from the mechanical designer, but worth it to the fan energy TDV.

VRF is modeled how?

- ✦ A VRF system is being used for the dwelling units, amazingly high efficiencies and low fan power values, you've got it made!
 - ✦ Err, not really
 - VRF is not supported currently by CBECC-com (hopefully soon!) and must be modeled as minimum efficiency split DX using the indoor fan CFM and BHP.
 - Don't forget about ventilation system!



2013 and 2016 High-Rise: Modeling



What is intermittent versus continuous fan power?

- ✦ Wow, selecting this one feature makes my building pass by a mile!
 - ✦ Err, it depends
 - Intermittent can be used for dwelling units only IF the ventilation is not being supplied through the HVAC unit (but as a separate fan system in which it should be modeled as exhaust fan)
 - Cannot be used for ANY nonresidential spaces.

Heating Cooling Controls Outdoor Air Fans Evaporative Cool

Fan Operation: Intermittent

Cycle System on at Night to Meet Loads

Maximum Humidity: 100 %

Exhaust Fan

Type: General

Quantity: 1 CO Sensors

Flow Control: Constant Flow Constant Speed Fan

Fan Control: Constant Volume

Fan Type: Centrifugal Air Foil

Configuration: Blow-Through

Design Airflow: 100 cfm

Minimum Airflow: 0 cfm

Design Power: 0.0200 hp

Drive Efficiency: 100 %

Input as Watts 25 watts



2013 and 2016 High-Rise: Modeling



But I don't want any AC!

✦ A ducted furnace is being installed, but no cooling. YEAH, credit for no AC!

✦ NO

- You must model a "default" AC system (BTUH and minimum efficiencies) and it must be sized properly.

Sized just right (per load calculations)

Calculation	Heating	Cooling	Lighting	Process Ltg	Receptacle	Fans	Heat Rejection	Pumps	Process	DHW	Total
Standard	14.43	20.10	39.06	0.00	38.25	13.62	1.67	4.89	0.00	1.91	133.94
Proposed	11.00	24.84	39.06	0.00	38.25	15.44	0.00	0.00	0.00	2.56	131.15

2.08%

Smallest BTUH and CFM possible since I have no cooling

Calculation	Heating	Cooling	Lighting	Process Ltg	Receptacle	Fans	Heat Rejection	Pumps	Process	DHW	Total
Standard	14.43	20.10	39.06	0.00	38.25	13.62	1.67	4.89	0.00	1.91	133.94
Proposed	13.17	10.31	39.06	0.00	38.25	9.58	0.00	0.00	0.00	2.56	112.95

15.7%



Multifamily Project “Highlight”

From the Files



- ✦ Cathedral Gardens – Oakland
- ✦ 50% above 2008 Title 24 Code
- ✦ 3 buildings – 2 high-rise (4 stories each), 1 low-rise (3 stories)
- ✦ 1 single shared system for heating and water heating
- ✦ No-cooling
- ✦ **Solution?:** Three separate models. Each with space heating sized from the central system based on % of total square footage for each bldg.



Next Steps

- Welcome
- What We Heard from You
- Let's Talk

▶ Next Steps

- Best Practices
- Help?!

- Wrap Up





Our Question To You



If you could wave your magic wand, multi-family documentation for Title 24 Part 6 would include _____ to make your job easier?

The compliance percentage, adjusted, really big on the first page. Better graphs of energy use. Clients seriously can't even find the % passing in the reports!

single source of info for various utility rebate modeling requirements-links to the current requirements for each utility.

Consistency between low rise and high rise. not going to 2 compliance manuals. an interface that only allows inputs to information that will impact that project type.

Top ten list of things the builder/architect/developer, should know about meeting energy code compliance for their project.

Descriptions of how to model all unusual existing conditions in each piece of software.



HELP



Where to get help

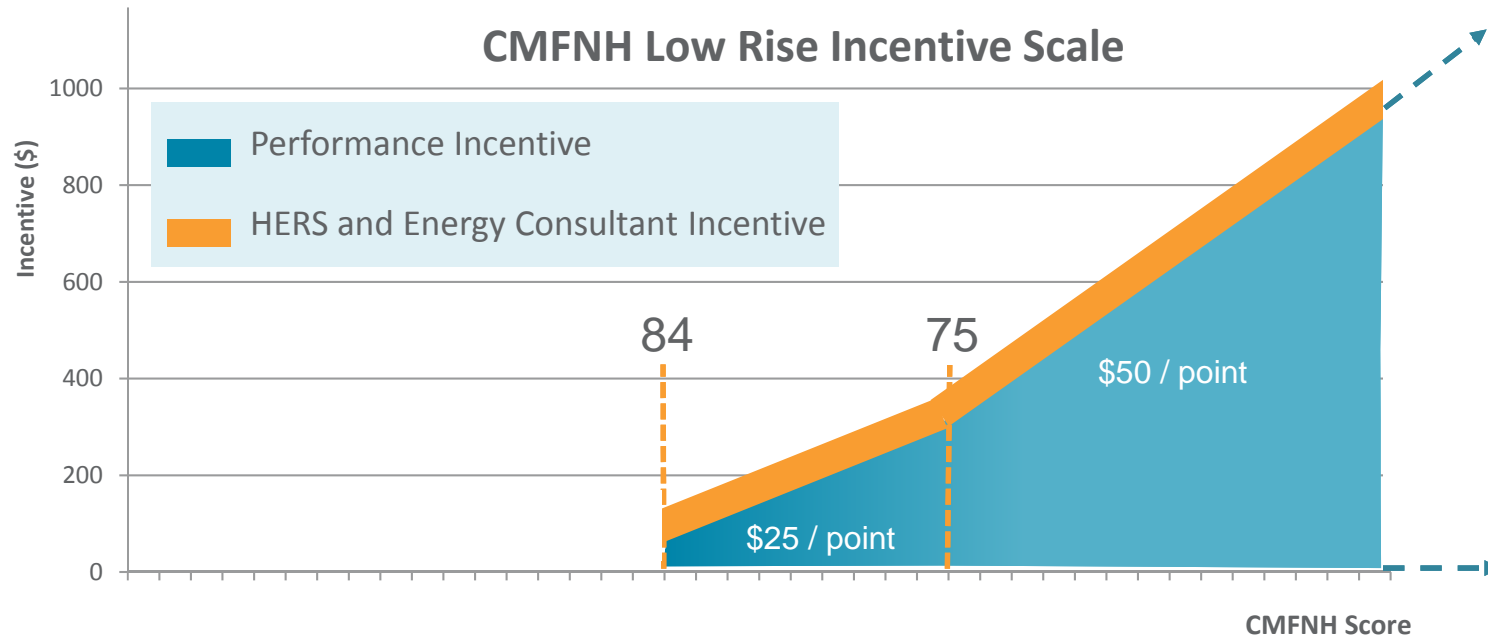
- ✦ Incentive Programs: CMFNH (PG&E) & CAHP-MF (SDG&E, SCG, SCE)
 - ✧ Cash Incentives
 - ✧ Energy Design Assistance
 - ✧ Project Roundtables
 - ✧ Educational Opportunities
 - ✧ Program Coordination
- ✦ <http://cmfnh.com>, <http://cahp-pge.com>
- ✦ TCAC, Regional Energy Networks, municipal utilities, Green Point Rated, LEED, NSHP
- ✦ ZNE Projects can receive extra support



HELP



Incentive (per unit)	Low Rise (1 - 3 stories)	High Rise (4+ stories)
Performance (issued to developer)	<ul style="list-style-type: none"> – \$75 base incentive: Meet 15% better than 2013 standards OR a CMFNH Score of 84 – \$25 per CMFNH point down to 75 – \$50 per CMFNH point below 75 	<ul style="list-style-type: none"> – \$150 for 15% – \$400 for 30%
Energy Consultant	– \$50 (200 unit limit)	
HERS (issued to developer)	– \$60 (200 unit limit)	





HELP



Where else to get help

- ◆ California Association of Building Energy Consultants
 - ◇ Education & Training – Title 24 Code, building science and energy modeling
 - ◇ Certified Energy Analyst certification
 - ◇ Information Network
 - ◇ Code related advocacy



- ◆ www.cabec.org
- ◆ 2016 CABEC Conference – April 28-30, Squaw Creek Resort, Tahoe



A new website developed by the Statewide Codes & Standards Program to help you meet the requirements of Title 24, Part 6

We offer **FREE**



A variety of tools to help you identify the forms, installation techniques, and building energy standards relevant to building projects in California



Classroom and online trainings on Title 24, Part 6.



Fact Sheets, Trigger Sheets, Checklists, and FAQs to help you understand when Title 24, Part 6 is "triggered" and how to correctly comply when it is



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Wrap Up

- Welcome
- What We Heard from You
- Let's Talk
- Next Steps

► Wrap Up

- Thank you!
- Questions?
- CEUs





Thank you!

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HELPING YOU PLAY YOUR CARDS RIGHT

High-Rise and Low-Rise Multifamily

Know Your Project – Key Terms

Multifamily (MF) buildings will have to comply with either residential requirements or a mix of nonresidential and residential requirements depending on the number of habitable stories in your building:

- ✦ **Multifamily Building:** contains multiple dwelling units that share common walls (townhomes) and may also share common floors or ceilings (apartments). Hotel or motel buildings are not considered multifamily.
- ✦ **High-Rise Residential:** all multifamily buildings with four or more habitable stories.
- ✦ **Low-Rise Residential:** all multifamily buildings with three or fewer habitable stories.

High-Rise vs Low-Rise Multifamily

While low-rise multifamily buildings need to comply with residential requirements, several project aspects for high-rise buildings fall under the scope of either nonresidential requirements or specific high-rise residential (HRR) requirements for some prescriptive measures

Mandatory Measures All MF Buildings §110	
Low-Rise §150.0, 150.1, 150.2	High-Rise §120-141
<ul style="list-style-type: none"> ✦ Envelope: Residential ✦ HVAC: Residential ○ including HERS measures ✦ Water Heating: Residential ○ including solar hot water and dual loop recirculation ✦ Indoor Lighting Dwelling Units: Residential ○ Common areas: different options dependent on % of total conditioned floor area ✦ Outdoor Lighting and Parking Garages: Residential ○ Different options dependent upon # of parking spots 	<ul style="list-style-type: none"> ✦ Envelope: Nonresidential* ✦ HVAC: Nonresidential ○ including ventilation ✦ Water Heating: Residential ○ including solar hot water and dual loop recirculation ✦ Indoor Lighting Dwelling Units: Residential ○ Common areas: Nonresidential ✦ Outdoor Lighting: Nonresidential <p>*Section 140.3 includes specific requirements for high-rise residential</p>

Mandatory, Prescriptive, Performance

Mandatory requirements that apply to both low and high-rise multifamily buildings can be found in [Section 110.0 through 110.10](#) of the Standards.

In addition to meeting these “mandatory measures,” projects can choose between a prescriptive or performance compliance path. Most multifamily projects pursue the performance compliance path, which allows flexibility to trade-off performance between building systems. In order to verify compliance using the performance path, compliance software must be used to show overall project compliance.

The compliance software compares the building design to a similar building that meets the prescriptive requirements of the Standards. Mandatory measures must be met, and cannot be traded off.

- ✦ More information can be found about the Performance and Prescriptive Compliance Approaches in the [Navigator Ace Tool](#).

Solar Ready Areas

Projects are required to either include an allocated solar ready area or show compliance with the appropriate exceptions found in [Section 110.10\(b\)1B](#). A solar ready area or “solar zone” is a section of the roof designated and reserved for the future installation of a solar electric or solar thermal system.

- ✦ **Sizing:** The solar area shall comprise *no less* than 15% of the total roof area of the building (less any skylight area) and may consist of multiple sub areas provided that each subarea is at least 80 square feet with no dimension less than 5 feet.
- ✦ **Location:** The solar area shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet of the building, or on covered parking installed with the building project.

[Section 110.10](#) also includes requirements for orientation, shading, structural design loads, and interconnection pathways for electrical service.

Envelope

Mandatory requirements for roofs, walls, floors and windows vary depending on construction type, and whether the project is high-rise or low-rise.

Mandatory Envelope Requirements for Multifamily

	Low-Rise	High-Rise
Roof		
Maximum U-factor	0.031 (wood R-30)	0.098 (metal R-19) 0.075 (wood R-13)
Wall		
Maximum U-factor	0.102 (2x4 R-13) 0.074 (2x6 R-19)	0.105 (metal R-13 w/ R-4) 0.110 (2x4 R-11)
Floor		
Maximum U-factor	0.037 (wood R-19)	0.269 (raised mass) 0.071 (other R-11)
Fenestration		
Maximum U-factor	0.58	NA

Detail on assemblies can be found in [Joint Appendix 4](#).

HVAC & Domestic Hot Water

There are two Energy Code Ace Trigger Sheets that go into more detail on HVAC requirements. They include requirements for new construction (new systems) as well as alterations. Low-rise projects should reference the residential sheet, and high-rise the nonresidential sheet.

- ✦ **Residential HVAC Change-outs:** This trigger sheet covers entirely new and complete replacement HVAC systems, alterations to equipment and alterations to ductwork.
- ✦ **Nonresidential Small Commercial HVAC Alterations:** This trigger sheet covers packaged units and split systems.

Domestic Hot Water requirements also differ based on whether the building is low-rise or high-rise:

- ✦ **New Low-Rise MF buildings** and additions which add water heating must meet the mandatory requirements of [Sections 150.0\(n\)](#) and [150.0\(j\)](#) regarding system design & insulation.

- ★ **Mandatory pipe insulation requirements for High-Rise MF** are found in [Section 120.3](#). Water heating systems shall have an insulation thickness corresponding to the system's fluid temperature as listed in [Table 120.3-A](#).
- ★ **Both Low-Rise and High-Rise MF complying prescriptively** must meet requirements in [Section 150.1\(c\)8](#):
 - ✦ Systems serving individual dwelling units shall be gas or propane and either a storage type water heater with an input of 75,000 Btu/hr or less or an instantaneous type water heater with an input of 200,000 Btu/hr or less. An electric resistance storage or instantaneous water heater may only be installed if natural gas is unavailable—additionally the water heater must be located within the building envelope and a solar water heating system with a solar savings fraction of 0.5 must be installed.
 - ✦ Systems serving multiple dwelling units must meet the minimum efficiency requirements of [Sections 110.1](#) and [110.3](#) and have a recirculation loop equipped with an automatic control system which controls pump operation based on hot water demand and return temperature.
 - ✦ A **solar water heating system** with a minimum solar savings fraction of 0.20 in climate zones 1-9 or 0.35 in climate zones 10-16 is prescriptively required for systems serving multiple dwelling units.

Dwelling Unit Lighting (§130.0, §150.0)

Lighting requirements inside dwelling units are mandatory (rather than prescriptive) and are the same for low-rise and high-rise multifamily buildings. For a list of which spaces in high-rise residential buildings are subject to the residential lighting requirements, refer to [Section 130.0\(b\)](#). For a complete description of the residential lighting requirements, see [Section 150.0\(k\)](#) and [Tables 150.0-A](#) and [150.0-B](#).

Application	Fixture and Control Requirements
Bathrooms	One High Efficacy (HE) fixture AND either manual-on vacancy sensor or HE for all other fixtures
Closets ≥ 70 ft ²	High Efficacy or manual-on vacancy sensor or dimmer
Kitchens	High Efficacy for at least 50% of total rated wattage
Garages, Laundry, and Utility Rooms	High Efficacy and vacancy sensor
All other interior rooms	High Efficacy or Manual-on vacancy sensor or Dimmer
For more complete information regarding lighting requirements for dwelling units, please see our Residential Fact Sheet on Indoor and Outdoor Lighting	

- ★ **High Efficacy Luminaires** 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.
 - ✦ Note that high efficacy lamps installed in low efficacy luminaires (e.g. screw-based CFL and LED lamps) do NOT count as high efficacy lighting.
- ★ **Occupancy/Vacancy sensors and daylight sensors** are all devices that automatically control lights and/or light levels in response to conditions that they “sense” or “see.”
- ★ **Dimmers**, already common in residential applications, allow room occupants to lower lighting levels (and thus energy use) as desired.

Indoor Common Area Lighting (§130.0, §140.6, §150.0(k)12)

For high-rise multifamily buildings, common areas must comply with the applicable nonresidential lighting standards.

For low-rise multifamily residential buildings, the requirements for indoor lighting of common areas are based on the percentage of conditioned floor area made up by these common areas. Indoor common areas with a combined floor area of:

- ★ **20% or less of Conditioned Floor Area** require that permanently installed lighting for these areas consist of high efficacy luminaires or be controlled by an occupant sensor.
- ★ **Greater than 20% of Conditioned Floor Area** will need to comply with the applicable requirements of nonresidential indoor lighting. In addition, lighting installed in corridors and stairwells shall be controlled by occupant sensors that reduce the lighting power in each space by at least 50% when unoccupied.

Lighting for Parking Lots and Carports

Requirements for outdoor lighting of parking areas are based on the vehicle capacity. Parking lots, carports, or parking garages designed for:

- ★ **Fewer than eight vehicles** must adhere to the basic requirements for outdoor residential lighting:
 - ✦ High efficacy lighting OR
 - ✦ Low efficacy lighting with controls.
- ★ **Eight or more vehicles** are required to meet the nonresidential lighting requirements, including lighting power density limits. See [Sections 130.2](#) and [140.7](#) for an exhaustive list of requirements.

Additional Resources for Lighting

The following resources may be helpful in addition to the Standards language to understand the residential requirements:

- ★ [California Lighting Technology Center Lighting Guides](#): The CLTC has produced 2013 Title 24, Part 6 Lighting Guides for Residential Lighting and Outdoor Lighting.

Electrical Distribution (§130.5)

The 2013 Standards introduced requirements for electrical distribution in Part 6 that are relevant to nonresidential portions of a multifamily project. They can be found in [Section 130.5](#) and include requirements for:

- ★ Service Metering
- ★ Electrical Disaggregation
- ★ Voltage Drop
- ★ Receptacle Controls

Commissioning (§120.8)

Multifamily projects that have nonresidential portions have commissioning requirements in [Section 120.8](#), which apply to systems serving the nonresidential portions of the building.



What's New with 2016 Nonresidential Code?

Overview

Changes to the nonresidential requirements in the [2016 Building Energy Efficiency Standards \(Energy Standards\)](#) largely follow ASHRAE 90.1 national standards and include energy conservation measures related to the building systems shown in Figure 1. The standards have been adopted, and once approved, will be implemented for projects permitted on or after January 1, 2017. For more detailed information, see the [CEC FAQ Sheet](#).

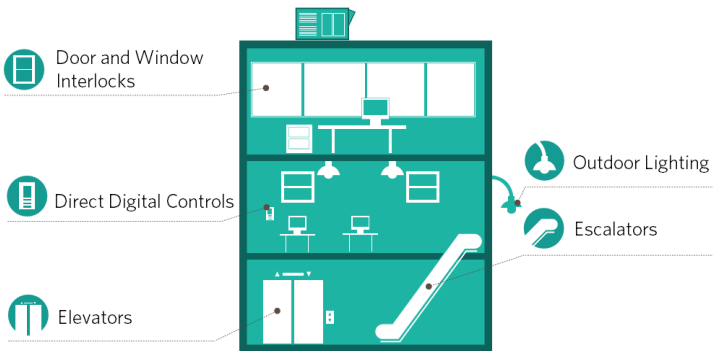


Figure 1: 2016 Energy Standards Update Infographic by CEC

In addition, the 2016 Energy Standards have set out to simplify and clarify several areas that were new in the 2013 Energy Standards, which were identified during the public comment period as needing clarification.

Compliance Tools

The Compliance Manuals and other related manuals are being updated to reflect the adopted 2016 Energy Standards and are planned to be available in early 2016 on the [CEC's website](#).

In addition, Energy Code Ace is working with the California Energy Commission (CEC) to produce a suite of 2016 Energy Standards Application Guides, which will provide project examples and other information that may be helpful in applying the energy code requirements. Look for these and other new tools, training and resources on [EnergyCodeAce.com](#) during the summer of 2016.

CBECC-Com, the state-funded nonresidential computer simulation tool, has been updated for the 2016 Energy Standards as well. A certified version is publicly available for [free download](#) now. This was developed early in order to give users time to utilize the software prior to the January 2017 implementation date.

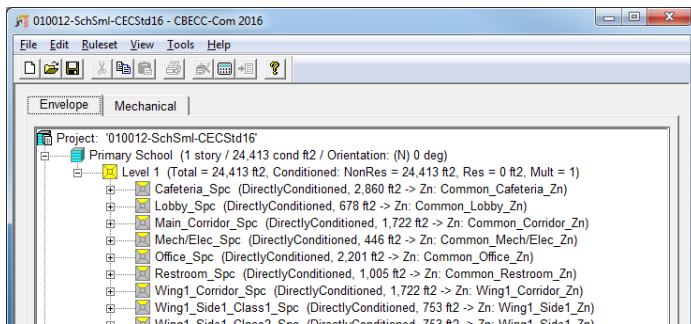


Figure 2: CBECC-Com 2016 Interface

Envelope Highlights

Prescriptive insulation requirements for roofs and ceilings have become more stringent under the 2016 Energy Standards. Additionally, prescriptive insulation requirements have become more stringent for metal and wood-framed walls in certain climate zones.

Mandatory Measures – Section 120.7

Wall Insulation levels have been changed to the following:

- ★ Metal framed: U-factor = 0.151 (R-13 w/R-2)
- ★ Metal demising: U-factor = 0.151 (R-13 w/R-2)

All other mandatory insulation levels are unchanged. Additional exceptions apply for dedicated data centers.

Prescriptive Measures – Section 140.3

- ★ Prescriptive envelope requirements in Table 140.3-B have been updated for Nonresidential buildings.
- ★ Prescriptive envelope requirements in Table 140.3-C have been updated for High-Rise Residential and Hotel/Motels.
- ★ The prescriptive Roof/Ceiling Insulation Tradeoff for Aged Solar Reflectance Table 140.3 has been updated as shown below. Requirements apply to roof replacements as well as new installations.

Table 140.3 Nonresidential Roof U-Factor			
Aged Solar Reflectance	Metal Building	Wood Framed and Other	
	All Zones	Zones 6 & 7	All other Zones
0.62-0.56	0.038	0.045	0.032
0.55-0.46	0.035	0.042	0.030
0.45-0.36	0.033	0.039	0.029
0.35-0.25	0.031	0.037	0.028

Process Equipment Highlights

New to the 2016 Energy Standards are mandatory energy saving requirements for escalators and elevators. Acceptance testing will be required for controls requirements.

Escalators and Moving Walkways – Section 120.6(g)

- ★ Escalators and moving walkways will be required to run at lower speeds when unoccupied (and thus a lower energy consuming state) while not in use in high traffic areas like airports, hotels, and transportation function areas.

Elevators – Section 120.6(f)

- ★ Energy efficient lighting: Lighting Power Density (LPD) of 0.6 w/ft² maximum
- ★ Energy efficient fans: Ventilation fans for cabs without space conditioning shall not exceed 0.33 w/cfm
- ★ Automatic shut-off controls on cab lighting and fans after 15 minutes of no service (stopped, unoccupied with doors closed)
- ★ Lighting and ventilation must be operational during emergency stop situations while occupied with passengers.

Mechanical Highlights

Mandatory Equipment Efficiencies – Section 110.2

Mandatory equipment efficiencies for air conditioning units have increased as of 1/1/2016. Chiller and DX equipment efficiencies have become more stringent.

Economizers – Section 120.2 (i)

New mandatory requirements for Fault Detection and Diagnostics (FDD) on all economizers installed on new air-cooled packaged DX units with cooling capacity of 54,000 Btu/hr or greater. Stand alone or integrated FDD accepted per Section 120.2(i) of the 2016 Energy Standards.

HVAC System Controls - Sections 120.2 & 140.4

- ✦ **Mandatory Direct Digital Controls (DDC):** DDC shall be applied per Section 120.2(j) of the 2016 Energy Standards, Table A for new construction, additions, and alterations. Control logic must be capable of monitoring several points including fan pressure, pump pressure, heating and cooling, have optimum start/stop controls, and perform automatic information transfer among other requirements.
- ✦ **Mandatory Optimum Start/Stop Controls:** The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy. Additional requirements for mass radiant floor slab systems. Requirements per Section 120.2 (k) of the 2016 Energy Standards.
- ✦ **Prescriptive HVAC Shut-off Sensors for Windows and Doors:** If windows or doors are left open for more than five minutes, sensors will adjust thermostats to disable the HVAC equipment by resetting the temperature setpoint to 55°F for mechanical heating and 90°F for mechanical cooling. Exemptions for doors with automatic closers or any space without thermostatic controls. Requirements per Section 140.4 (n) of the 2016 Energy Standards.

Commissioning Highlights

A few important clarifications were made to the commissioning requirements in Section 120.8 of the 2016 Energy Standards:

- ✦ Commissioning is required for all new buildings with nonresidential conditioned space, including nonresidential spaces in hotel/motel and high-rise residential buildings. The Owner's Project Requirements (OPR) must include building envelope performance expectations under the 2016 Energy Standards.
- ✦ Section 10-103 in Part 1 specifies that the Design Reviewer may be a licensed architect or licensed contractor in addition to a professional engineer.

Indoor Lighting Highlights

The interior lighting mandatory and prescriptive measures, as well as updates to the calculation methodologies are included below.

Prescriptive Calculation Methodology – Section 140.6

- ✦ **Complete Building Method:** Allowed Lighting Power Densities are reduced by 0.1 or less for half of building types listed in Table 140.6-B.
- ✦ **Area Category Method:** Allowed Lighting Power Densities are reduced by 0.2 or less for a third of functional areas in Table 140.6-C.
- ✦ **Tailored Method:** Lighting Power Density Values updated per Table 140.6-G. Allowances in Table 140.6-D remain unchanged.

Indoor Lighting Controls – Sections 130.1 & 140.6

- ✦ **Mandatory Shut-OFF Controls:** Additional exception of 0.1 w/ft² for egress in any building.
- ✦ **Mandatory Multi-level Controls:** Enclosed areas 100 ft² or greater with a general lighting load greater than 0.5 w/ft² must have multi-level controls as shown in Table 130.1-A. Some exceptions apply for classrooms, public restrooms, and areas with one luminaire.
- ✦ **Mandatory Partial-ON Occupancy Sensor:** For areas requiring occupant sensing controls per Section 130.1(c)5 of the Standards (offices ≤ 250 ft², multipurpose rooms < 1,000 ft², classrooms, and conference rooms), and multilevel controls per Section 130.1(b) of the 2016 Energy Standards, the occupant sensing controls shall function as partial-ON (for 50-70% of controlled power) OR vacancy sensor (only manual ON). Where no multi-level controls are required per Section 130.1(b) of the 2016 Energy Standards, an automatic full-on occupancy sensor is acceptable.
- ✦ **Control Credits:** Power Adjustment Factors (PAF) listed in Table 140.6-A have been updated and the following options have been added:
 - ✦ Institutional Tuning: Limits maximum output or power draw of controlled lighting to 85% or less of full light output/draw.
 - ✦ Daylight dimming plus OFF control: Turns lighting completely OFF when daylight in the daylit zone is greater than 150% of general lighting system at full power.

Lighting Alterations

The lighting alterations language for the prescriptive approach is included in the following sections. Lamp replacements or ballast replacements alone are not considered lighting alterations, provided that replacement lamps and/or ballasts are installed and powered without modifying the luminaire.

Entire Luminaire Alterations – Section 141.2I

Lighting shall meet the lighting power allowance in Section 140.6 of the 2016 Energy Standards and altered permanently installed luminaires shall meet the applicable requirements in Table 141.0-E if the following options occur:

- ✦ Removing/reinstalling 10% or more of the existing luminaires (if there are more than 2) in a space, or
- ✦ Replacing or adding entire luminaires, or
- ✦ Adding, removing, or replacing walls or ceilings along with lighting redesign (changing the area or space type)

When replacing existing luminaires and the alteration is not in conjunction with adding, removing or replacing walls or ceilings, the new luminaires must:

- ✦ Reduce rated power by 50% for office, retail and hotel occupancies and 35% for all others, compared to the original luminaires, at full light output, and
- ✦ Meet all the requirements in Sections listed in Lighting Alterations (see list below)

Luminaire Component Modifications – Section 141.2J

Definition: Alterations that replace the ballasts or drivers and the associated lamps in the luminaire, or permanently change the light source or the optical system of the luminaire.



Lighting Alterations (cont.)

Modifying the components of fewer than 70 existing luminaires on a single floor or within a tenant space within a year, does not trigger code. If there are 70 or more modifications per year on a single floor or tenant space, then the project needs to meet one of the following criteria:

- ✦ Meet lighting power allowance in Section 140.6 of the 2016 Energy Standards, and comply with Table 141.0-E or
- ✦ Reduce rated power by 50% for office, retail and hotel occupancies and 35% for all others, compared to the original luminaires, at full light output, and meet the requirements in Lighting Alterations Sections List.

In addition, the modification should not prevent or disable multi-level, shut-off, or daylight controls.

Lighting Wiring Alterations – Section 141.0(b)2K

Definition: Alterations that add a circuit feeding luminaires, that replace, modify or relocate wiring between a switch or panelboard and luminaires, or replace lighting control panels, panelboards, or branch circuit wiring.

Wiring alterations (unless strictly to add lighting controls) in each enclosed space shall meet the requirements in the following sections:

- ✦ Lighting Power Allowance in Section 140.6
- ✦ Section 130.1 (a) 1, 2 and 3
- ✦ Section 130.1 (c)1A through C
- ✦ Section 130.1 (c)3 and Section 130.1 (c)4

And meet the following criteria:

- ✦ Each enclosed space must be wired to create a min. of one step between 30-70% of the lighting power or meet Section 130.1(c)4 of the 2016 Energy Standards.
- ✦ For each enclosed space where alterations include 10 or more luminaires that provide general lighting and are located in the primary sidelit daylit or skylit daylit zone, also meet the requirements of Section 130.1(d) of the 2016 Energy Standards.

Exceptions for all lighting alterations:

- ✦ Alterations that would cause the disturbance of asbestos.
- ✦ Alterations affecting two or fewer luminaires in an enclosed space.
- ✦ Lighting control acceptance testing (per Section 130.4 of the 2016 Energy Standards) is not required for alterations of a total of 20 or fewer controlled luminaires.

Control Requirements	Lighting power <85% of allowance	Lighting power is >85% of allowance
Section 130.1 (a)1,2 and 3 Area controls	Yes	Yes
Section 130.1 (b) Multi-level controls*	For each space, min. one step between 30-70% or meet 130.1 (b)	Yes
Section 130.1 (c) Shut-off Controls	Yes	Yes
Section 130.1 (d) auto daylight controls	Not Required	Yes
Section 130.1 (e) Demand Responsive Controls	Not Required	Yes

*The 2016 Energy Standards now allow A/B or checkerboard switching. The previously required multilevel lighting per luminaire is no longer applicable.

Lighting Alterations Sections List:

- ✦ Section 130.1 (a) 1, 2 and 3
- ✦ Section 130.1 (c)1A through C
- ✦ Section 130.1 (c)2 through Section 130.1(c)6A
- ✦ Section 130.1 (c)7B (for parking garages only)

Outdoor Lighting Highlights

- ✦ **Outdoor Lighting Zone 0:** New lighting zone added for undeveloped areas of state or national parks. No continuous hardscape lighting allowed. A single luminaire of 15 watts or less may be installed in certain areas.
- ✦ **Hardscape Lighting Power:** Several reductions in lighting allowances have been included in Table 140.7-A, for each lighting zone (LZ). Additional wattage allowances are applicable for instances where hardscape is more than 50% concrete in LZ2 and LZ3.
- ✦ **Specific Applications in Lighting Power:** Lighting power allowances for building entrances/exits for LZs 1-4 have been reduced (Table 140.7-B). Lighting for ATM machines is now 250 watts for the first ATM and 70 watts for each additional machine, across all LZs.
- ✦ **Motion Sensors:** Motion sensor capabilities must be able to reduce lighting power of each luminaire by at least 40% but not exceeding 90%. Sales lots and sales canopies are no longer exceptions under Section 130.2(c)3 of the 2016 Energy Standards.

Outdoor Lighting Alterations Section 141.0(b)2L

Alterations to existing outdoor lighting shall meet the mandatory requirements in the following sections in the 2016 Energy Standards:

- ✦ Section 130.0
- ✦ Section 130.2(a) and (b)
- ✦ Section 130.4

For alterations that increase the connecting lighting load:

- ✦ Added or altered luminaires must meet the applicable requirements in 2016 Energy Standards of Section 130.2(c) and the requirements of Section 140.7 for general hardscape lighting or for the specific lighting applications contained the alterations.

For alterations that do not increase the connecting lighting load but where the greater of 5 luminaires or 10% of existing luminaires are replaced, the following requirements apply:

- ✦ Parking lots/ outdoor sales lots: For replacement of luminaires mounted 24 ft or less above the ground, alteration must comply with Section 130.2(c)1 and Section 130.2(c)3 of the 2016 Energy Standards.
- ✦ For all other applications (except parking lots/outdoor sales lots) and where the replacement luminaires are mounted above 24 ft (parking lots & sales areas), alteration must comply with Section 130.2(c)1 and either Section 130.2(c)2 or be controlled by lighting controls (motion sensors) that automatically reduce power by ≥40% when unoccupied.

For alterations that do not increase the connecting lighting load but where the greater of 5 luminaires or 50% of existing luminaires are replaced, the following requirements apply:

- ✦ Must meet all above requirements for 10% replacement
- ✦ Section 140.7 (except when alterations reduce power consumption by 40% compared to the original luminaires)

Exceptions for all lighting alterations:

- ✦ Lighting control acceptance testing (per Section 130.4 of the 2016 Energy Standards) is not required for alterations of a total of 20 or fewer controlled luminaires.

Overview

The [2016 update to the Residential Building Energy Efficiency Standards](#) (Energy Standards) requires new and altered homes to become more efficient in several ways to create energy and environmental savings for Californians. See Figure 1 below for building systems that include updates under the new 2016 Energy Standards.

The 2016 Energy Standards have been adopted, and once approved, will be implemented for projects permitted on or after January 1, 2017. For more detailed information, see the [CEC FAQ Sheet](#).



Figure 1: [Title 24, Part 6 2016 Update Infographic by CEC](#)

Statewide Savings

The incremental changes to California's energy code mean big savings across the state for ratepayers. Per the California Energy Commission (CEC), new residential requirements for the 2016 code cycle mean real savings for homeowners—around \$7,400 over a 30 year mortgage. A single family home that meets the 2016 standards could see 28% more energy savings in regulated loads than those built under the 2013 Energy Standards. See the [Adoption Hearing Presentation](#) for more 2016 Energy Standards energy impacts.

California's Energy Goals

[California's Energy Efficiency Strategic Plan](#) describes energy efficiency as the "least cost, most reliable, and most environmentally sensitive resource, and minimizes our contribution to climate change."

The Strategic Plan goes on to outline four "Big Bold Strategies" to guide the market transformation necessary to meet the State's energy goals. A short description of the "Big Bold Strategies" and overview of the Strategic Plan is included in a summary [Fact Sheet](#).

Energy codes and standards is one of six themes identified in the Energy Efficiency Strategic Plan to achieve the Big Bold Strategy related to residential construction. The Strategic Plan describes the role of codes and standards as:

"Adopt aggressive and progressive minimum energy codes and standards for buildings and plug loads, effective code compliance and enforcement, and parallel, tiered voluntary energy efficiency standards that pull the market along and set a higher bar for subsequent standards."

The updates made to the Energy Standards described in this fact sheet are meant to take action on the codes and standards theme outlined in the Strategic Plan.

Envelope Highlights

Mandatory Measures §150.0

There are several new thresholds for mandatory envelope requirements including:

- ✦ Ceiling/Roof insulation maximum = 0.043 U-factor (R-22 wood framing)
- ✦ Non-framed (mass) wall maximum = 0.102 U-factor
 - ✧ Equivalency to R-13 wood framing
- ✦ Maximum fenestration U-factor = 0.58 (same as 2013)
 - ✧ New exception allows for 30 sqft for dual glazed greenhouse windows
- ✦ Doors (including pet doors) must meet maximum 0.3 cfm/ft² air leakage

Prescriptive High Performance Walls §150.1

In Climate Zones 1-5 & 8-16, above grade framed wall assemblies must not exceed a maximum U-factor of 0.051:

- ✦ 2x6 @ 16" OC framing—R19 cavity + R5 continuous
- ✦ 2x4 @ 16" OC framing—R15 cavity + R8 continuous

In Climate Zones 6 & 7, the maximum U-Factor is 0.065

Prescriptive High Performance Attics §150.1

There are three options that may be used to comply:

- ✦ Option A: Ducts and air handler may be located in the attic
 - ✧ Install attic radiant barrier (Zones 2-15)
 - ✧ Install R-38 insulation at ceiling (R-30 in zones 3 & 5-7)
 - ✧ Install continuous roof deck insulation (Zones 4 & 8-16)
 - R-6 with air space above insulation/ R-8 with no space
- ✦ Option B: Ducts and air handler may be located in the attic
 - ✧ Install attic radiant barrier (Zones 2,3 & 5-7)
 - ✧ Install R-38 insulation at ceiling (R-30 in Zones 3 & 5-7)
 - ✧ Install below roof deck insulation (at rafter) (Zones 4 & 8-16)
 - R-13 with air space above insulation/ R-18 with no space
- ✦ Option C: Ducts and air handler must be located in conditioned space
 - ✧ Install attic radiant barrier (Zones 2-15)
 - ✧ Install R-38 insulation at ceiling (R-30 in Zones 3 & 5-7)

Prescriptive Additions §150.2

There are several options that allow for extensions of existing wood-framed walls to retain the same dimensions.

- ✦ Install R-15 in 2x4 framing
- ✦ Install R-19 in a 2x6 framing

Mechanical Highlights

Updates were made to both mandatory and prescriptive HVAC requirements under the 2016 Standards:

Mandatory Measures §150.0(m)

- ✦ All ducts in conditioned spaces must include R-4.2 insulation.
- ✦ Duct leakage requirement has been reduced to 5% maximum for single family homes.

Prescriptive Measures §150.1

- ✦ High performance attics with ducts in attic (options A and B)
 - ✦ R-8 duct insulation in Zones 1-2, 4, 8-16
 - ✦ R-6 duct insulation in Zones 3, and 5-7
- ✦ High performance attics with ducts in conditioned space (option C)
 - ✦ R-6 in all zones
- ✦ Whole house fans must supply 1.5 cfm/sf (reduced from 2 cfm/sf). Attic vent area also reduced to 1 sf/ 750 cfm of airflow.

Domestic Hot Water Highlights

Increased Prescriptive Efficiency for Water Heaters (3 options) §150.1(c)8

1. Tankless (gas or propane): minimum energy factor of 0.82
2. Tank ≤ 55 gal (gas or propane): minimum energy factor of 0.60. Additional HERS verification: HERS verified Quality Insulation Installation (QII) and either HERS verified compact hot water distribution system or HERS verified DHW pipe insulation required.
3. Tank ≥ 55 gal (gas or propane): minimum energy factor of 0.76. Additional HERS verification: HERS verified compact hot water distribution system or HERS verified DHW pipe insulation required.

Prescriptive Isolation Valves §110.3(c)7

- ✦ Instantaneous water heaters with an input rating of 6.8kBtu/hr (2 kW) or greater need an isolation valve on cold water supply and hot water leaving water heater.
- ✦ Each valve needs a hose bibb or other fitting allowing for flushing the water heater when the valves are closed.

Mandatory Water Heater Pipe Insulation §150.2(b)1G

- ✦ For water heater replacements, install piping insulation per mandatory measures and insulate all existing accessible piping.

Onsite Renewable Systems Highlights

The compliance credit for installing PV systems is only available if the project meets the following conditions:

- ✓ The Performance Approach is used
- ✓ The project is in Climate Zones 1-5, 8-16
- ✓ The system is ≥ 2 kWdc* for Single Family
- ✓ The system is ≥ 1 kWdc* for Multi Family
- ✓ The amount of credit will depend upon the Climate Zone and the Conditioned Floor Area of the dwelling.

Note: Taking the PV system credit does not require HERS verification unless getting a rebate from the New Solar Homes Partnership (NSHP).

Lighting Highlights

Mandatory High Efficacy Lighting §150.0(k)



High efficacy lighting is essential to reducing energy load in homes and dwelling units, and the 2016 Standards makes it mandatory that all residential lighting be high efficacy. The Standards do not allow trade-offs between lighting and other features when using the Performance Method.

These mandatory requirements apply to permanently installed light fixtures, including screw-based which must contain JA8 compliant

lamps. Table 150.0-A summarized below, lists light source technologies qualified as high efficacy.

Table 150.0-A: High Efficacy Light Sources	
✦	Pin-based linear or compact fluorescent lamps light sources using electronic ballasts
✦	Pulse-start metal halide lamps
✦	High pressure sodium lamps
✦	GU-24 sockets containing light sources other than LEDs
✦	Inseparable SSL luminaires that are installed outdoors
✦	Inseparable SSL luminaires containing colored light sources that are installed to provide decorative lighting

Light sources not listed in Table 150.0-A above may be certified to the CEC as high efficacy in accordance with Joint Appendix 8 (JA8).

JA8 compliant light sources must be marked as "JA8-2016" or "JA8-2016-E." "JA8-2016-E" designates light sources that have passed the Elevated Temperature Life Test and are deemed appropriate for use in enclosed luminaires.

JA8 compliant light sources shown in the table below must be controlled by vacancy sensors or dimmers (exceptions for closets <70 SF and hallways, §150.0(k)2K).

Table 150.0-A & JA8: High Efficacy Light Sources	
✦	Light sources in ceiling recessed downlight luminaires
✦	LED luminaires with integral sources
✦	Pin-based LED lamps (MR-16, AR-111, etc.)
✦	GU-24 based LED light source

Screw Based Luminaires §150.0(k)G

- ✦ Screw based luminaires must contain JA8 compliant light sources.
- ✦ Recessed downlight luminaires in ceilings must not contain screw-based sockets.
- ✦ Incandescent sources are prohibited from having a GU-24 base (per Title 20 Section 1605.3(k)).

Blank Electrical Boxes §150.0(k)B

- ✦ The number of blank electrical boxes more than 5 feet above the finished floor shall not be greater than the number of bedrooms.
- ✦ Additionally, these electrical boxes must be served by a dimmer, vacancy sensor, or fan speed control.

Bathrooms, Garages, Laundry Rooms, and Utility Rooms §150.0(k)2J

- ✦ At least one fixture must be controlled by a vacancy sensor.

Under Cabinet Lighting §150.0(k)2L

- ✦ Any under cabinet lighting (including kitchen) must be switched separately from other lighting systems.

Outdoor Lighting §150.0(k)3

- ✦ Must be high efficacy like indoor lighting.
- ✦ Must include manual on/off switch and one of the following:
 - ✦ Photocontrol and motion sensor
 - ✦ Photocontrol and automatic time switch control
 - ✦ Astronomical time switch control
 - ✦ Energy Management Control System

WHAT'S NEW IN THE 2016 CODE?

NONRESIDENTIAL LIGHTING

Changes to mandatory lighting requirements in California's 2016 Building Energy Efficiency Standards

California's new nonresidential Building Energy Efficiency Standards take effect on January 1, 2017. The 2016 Standards focus on several key areas to improve the energy efficiency of newly constructed buildings, additions and alterations to existing buildings. California's Standards now align with ASHRAE 90.1 2013 standards and include more stringent lighting power density limits for many indoor and outdoor spaces. Updates enhance and simplify many aspects of the 2013 requirements including indoor lighting control requirements for new construction and alterations. This publication offers an overview of important updates contained in the 2016 nonresidential lighting energy efficiency standards.

MAJOR CHANGES



REDUCTION TO LIGHTING POWER DENSITY VALUES

Lighting power density allotments have been reduced for many indoor and outdoor spaces including spaces in auditoriums, libraries, and schools. Reductions affect building, area and tailored methods of compliance.



UPDATED POWER ADJUSTMENT FACTORS

The 2016 Standards contain two new power adjustment factors (PAF) that address institutional tuning and daylight harvesting. Three other PAF have been eliminated.



MULTILEVEL LIGHTING & OCCUPANCY CONTROLS

Multilevel lighting control requirements have been simplified. In addition, spaces that utilize certain types of occupancy controls are no longer required to also include multilevel control. Other occupancy control requirements are now to apply in practice.



ALTERATIONS

The line between maintenance and retrofit has been redrawn. More projects are now exempt from alteration requirements. Those that are required to comply now have more options including some with reduced control requirements.

This guide is not intended to be used in lieu of California's Building Energy Efficiency Standards, and it is not a substitute for the code itself. Please visit energy.ca.gov/title24/2016standards to download the official 2016 Title 24 Building Energy Efficiency Standards, Errata, Reference Appendices, and the Nonresidential Compliance Manual.

INDOOR LIGHTING REQUIREMENTS

While the new Title 24 nonresidential standards contain many important updates, changes to the lighting requirements are minimal in most regards. In general, power density allotments have been reduced to reflect efficacy improvements and the increased prevalence of LED lighting in commercial buildings. For new construction, most lighting control requirements remain unchanged as compared to the 2013 Standards. For alterations, the path to compliance has become less complex. The following information details the major mandatory and prescriptive lighting requirements and critical changes between the 2013 and 2016 iterations of Title 24, Part 6.

Lighting Power Allowances

For many spaces, the allowed lighting power density has been reduced. Reductions affect projects using any of the three compliance methods: area category, complete building or tailored. Indoors, buildings such as auditoriums, libraries, schools, restaurants and medical buildings are most affected. For those using the tailored method to determine allowed lighting power, significant changes affect all space types.

Power Adjustment Factors

Two new PAF have been added to the Standards that encourage the use of institutional tuning and daylight harvesting control systems.

Now, projects may gain a 10% lighting power allowance credit for implementing institutional tuning. In daylit areas, the credit is reduced to 5%. Institutional tuning is a control strategy that sets the maximum output of a lighting system to less than full output (less than 100%). In many cases, lighting systems are designed to initially deliver more light than is needed because, over time, the light output will decrease. With tuning, the system can be set to deliver the right amount of light and use less energy. As light levels decrease over time, tuning adjustments can be made to increase output.

The second new PAF addresses daylight harvesting control systems that fully extinguish all the lighting when sufficient daylight is available. Projects may gain a 10% credit for this strategy when applied to luminaires in a skylit or primary sidelit daylit zone.

Three PAFs included in the 2013 Standards have been eliminated because the control strategies are now mandatory under **§130.1**.

- Partial-ON occupancy sensors in spaces less than or equal to 250ft²
- Manual dimming or multiscene programmable dimming controls
- Credits for a combination of these measures

Lighting Power Density Updates 2013 to 2016: Area Category Method

Primary Function Area	Allowed Lighting Power Density (W / ft ²)		
	2016	Δ	
Auditorium Area	1.4 ³	↓ 0.1	
Convention, Conference, Multipurpose and Meeting Center Areas	1.2 ³	↓ 0.2	
Dining Area	1.0 ³	↓ 0.1	
Electrical, Mechanical, Telephone Rooms	0.55 ²	↓ 0.15	
Exhibit, Museum Areas	1.8	↓ 0.2	
Financial Transaction Area	1.0 ³	↓ 0.2	
Hotel Function Area	1.4 ³	↓ 0.1	
Kitchen, Food Preparation Areas	1.2	↓ 0.4	
Laundry Area	0.70	↓ 0.2	
Library Area, Reading Areas	1.1 ³	↓ 0.1	
Lobby Area	Hotel Lobby	0.95 ³	↓ 0.15
	Main Entry Lobby	0.95 ³	↓ 0.55
Locker/Dressing Room	0.70	↓ 0.1	
Lounge Area	0.90 ³	↓ 0.2	
Malls and Atria	0.95 ³	↓ 0.25	
Transportation Function Area	Concourse & Baggage	0.50	—
	Ticketing	1.0	—
Waiting Area	0.80 ³	↓ 0.3	
All Other Areas	0.50	↓ 0.1	

Footnotes for **Table 140.6-C**: See **Section 140.6(c)2** for an explanation of additional lighting power available for specialized task work, ornamental, precision, accent, display, decorative, and white boards and chalk boards, in accordance with the footnotes in this table. The smallest of the added lighting power listed in each footnote below, or the actual design wattage, may be added to the allowed lighting power only when using the Area Category Method of compliance.

² Specialized task work	0.50 W/ft ²
³ Ornamental lighting as defined in Section 100.1 and in accordance with Section 140.6(c)2 .	0.50 W/ft ²

Based on Table 140.6-C in the standards

Lighting Power Density Adjustment Factors (PAF)

Type of Control	Type of Area	Factor
a. To qualify for any of the Power Adjustment Factors in this table, the installation shall comply with the applicable requirements in Section 140.6(a)2 b. Only one PAF may be used for each qualifying luminaire unless combined below c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF		
Daylight Dimming plus OFF Control*	Luminaires in skylit daylit zone or primary sidelit daylit zone	0.10
Occupant Sensing Controls in Large Open Plan Offices	In open plan offices > 250ft ² one sensor controlling an area that is:	No larger than 125ft ²
		From 126 to 250ft ²
		From 251 to 500ft ²
Institutional Tuning*	Luminaires in non-daylit areas: Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.	0.10
	Luminaires in daylit areas: Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.	0.05
Demand Responsive Control	All building types less than 10,000 sq. ft. Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF.	0.05

* New for 2016

Table 140.6-A in the Standards

Lighting Controls

Mandatory lighting control requirements contain minor revisions throughout, which are designed to make requirements more consistent and easier to apply in practice. In particular, updates make occupant sensing controls more consistent in where they are required and how they are expected to perform.

MULTILEVEL LIGHTING CONTROLS

Multilevel lighting requirements are now simpler and easier to apply. The number of mandatory control steps is still based on the light source type per **Table 130.1-A**, however, the explicit requirement to also utilize manual dimming, tuning, lumen maintenance, automatic daylighting or demand response has been eliminated. Now, if multilevel lighting is required, multilevel controls need only allow the user to activate all the required control steps. If the lighting is dimmable, the multilevel control must be a dimmer that allows this function plus manual ON and OFF.

Two new exceptions to multilevel lighting requirements have also been added. Public restrooms and areas that are required to utilize full or partial-OFF occupancy sensors are now exempt from multilevel requirements contained in **§130.1(b)**.

OCCUPANCY CONTROLS

Various occupancy sensor control requirements have been clarified and expanded in the 2016 Standards. Performance requirements for partial-ON and partial-OFF occupancy control strategies are now specified based on the areas where the controls are installed.

As with the 2013 Standards, occupancy controls must shut OFF all the lighting in:

- Offices 250ft² or smaller
- Multipurpose rooms less than 1000ft²
- All classrooms, and all conference rooms

However, now the Standards also specify how the lighting in these spaces can be activated by the occupancy sensor. For spaces that also require multilevel lighting controls, sensors must act as a partial-ON device or a vacancy sensor. The partial-ON strategy may only automatically activate between 50 and 70% of the controlled lighting. For areas not required to have multilevel controls, the sensor may be a traditional, auto-ON occupancy sensor, a vacancy sensor, or employ a partial-ON strategy.



In addition, language pertaining to the potential use of a partial-ON control strategy has been removed from [§130.1\(c\)6](#) and [§130.1\(c\)7](#). The 2013 Standards used the term partial-ON/OFF occupancy control when, in practice, partial-OFF was the intended strategy. This ambiguity has been removed and the term partial-OFF used throughout. All other requirements contained in [§130.1\(c\)6](#) and [§130.1\(c\)7](#) are unchanged.

DAYLIGHT HARVESTING & DEMAND RESPONSE

All automatic daylighting control requirements are unchanged from 2013. Demand response control requirements are also, essentially, unchanged from 2013, with only minor clarifications added to the 2016 code.

Emergency & Egress Lighting

Requirements have been updated to allow a small portion of lighting to operate continuously if it is noted for use along a building's means of egress. Up to 0.2 W/ft² of lighting in any area is now exempt from area control requirements if it meets the egress definition. Previously, the exemption only applied to office spaces during occupied hours. Multilevel control requirements still apply in accordance with [§130.1\(b\)](#). Up to 0.1 W/ft² is also exempt from automatic shutoff control requirements. Previously, only 0.05 W/ft² was exempt.

In addition, a luminaire or lighting system is exempt from shut-OFF control requirements if it is designed only for emergency use, is connected to an emergency power supply, and functions only when normal power is absent. This exemption is new for 2016. However, if egress lighting falls within a daylit zone, automatic daylighting controls are still required as are demand response controls under most circumstances.

Acceptance Test Requirements

Acceptance tests for institutional tuning controls and "Daylight Dimming plus OFF" PAFs have been added to the Standards. These tests are designed to ensure that systems claiming these PAF meet the specific performance criteria required under [Section 140.6](#).

Institutional tuning controls tests are documented on a new compliance form, [NRCA-LTI-05-A](#). Test results for "Daylight Dimming plus OFF" are documented on the existing, automatic daylighting controls compliance form, [NRCA-LTI-03-A](#).

All lighting controls acceptance tests must be conducted by a Certified Lighting Controls Acceptance Test Technician, a requirement that went into effect with the 2013 Standards. Technicians are required to recertify their credential to ensure they are up to date with the new 2016 requirements.

To learn more about Lighting Control Acceptance Testing, please visit energy.ca.gov/title24/attcp.

INDOOR LIGHTING ALTERATIONS

Requirements for indoor lighting alterations (**§141.0(b)2I-J**) have been simplified, reorganized and renamed. Indoor lighting alterations are now categorized into three types of projects, listed in the table to the right, and outdoor requirements are now listed under **§141.0(b)2L**. Two types of projects remain exempt from lighting alteration requirements: those that may disturb asbestos during construction and those that address only two or fewer luminaires in an enclosed space.

Compliance Threshold

For indoor luminaire component modifications, the threshold for compliance has been raised. This change allows a larger portion of maintenance projects to avoid additional lighting control and power density requirements intended for larger system retrofits. Previously, projects that addressed 40 or more luminaires or 10% of luminaires in a space were regulated under the Standards. This threshold is now 70 luminaires or 10% per year. Thresholds for the replacement of existing luminaires or addition of new luminaries remains at 10%. Most types of wiring alterations must comply with **§141.0(b)2K** regardless of their size, however, projects that only add lighting controls to an existing system are exempt.

Lighting Control Requirements

A new compliance path has been added for alterations. Now, when existing luminaires are replaced with new luminaires and no changes are made to walls or ceilings, a project may bypass additional multilevel and some occupancy control requirements by installing new products that achieve a minimum of 35% power reduction as compared to the luminaires they replaced. For hotel, office and retail occupancies, the reduction must be at least 50%.

For all other types of projects and luminaire replacements not able to meet these power reduction thresholds, controls requirements are nearly identical to 2013 requirements. Per **Table 141.0-E**, alterations with over 85% of the power allowance must meet most control requirements in Section 130.1, but those with 85% or less are exempt from daylighting and demand response control requirements.

One additional control requirement has been simplified. Lighting retrofit projects that are able to reduce the total input power to 85% or less of that allowed now must only include multilevel controls with one control step between 30% and 70% of

Indoor Lighting Alterations

Alteration	Scope of Work
Entire Luminaire Alterations (§141.0(b)2I.)	<ul style="list-style-type: none"> Remove & reinstall existing luminaires Remove existing luminaires, replace with new Add new luminaires Adding, removing, or replacing ceiling or walls along with any redesign of the lighting system
Luminaire Component Modifications (§141.0(b)2J.)	<ul style="list-style-type: none"> Lamp and ballast/driver replacement Permanently changing the light source type in an existing luminaire Changes to the luminaire's optical system
Lighting Wiring Alterations (§141.0(b)2K.)	<ul style="list-style-type: none"> New circuits Replace, modify, or relocate wiring between a switch and a luminaire Replace, modify or relocate wiring between a panelboard and a luminaire Replacement of existing lighting control panels, panelboards, or branch circuiting with new

What is considered a building 'Space' under the new Standards?

For complete luminaire and wiring alterations, the compliance threshold applies to the 'enclosed space', a space substantially surrounded by walls, ceilings or roofs, fenestration, floors or ground.

For component modifications, the compliance threshold applies to any single building floor, or if there are multiple tenants on the floor, the individual tenant space.

full power. This requirement now applies to the enclosed space and not to each luminaire. As such, projects may meet this requirement by switching alternate luminaires in the space, for example. Under the 2013 Standards, the number of control steps was based on source type and could include up to four steps or require continuous dimming. Note, this is still a requirement for projects over the 85% threshold.

LIGHTING WIRING ALTERATIONS

Controls requirements for lighting wiring alterations have been reduced in the new Standards. Projects are no longer required to meet the full suite of multilevel, automatic daylighting and demand response control requirements. Area controls are always required and lighting wiring alterations must meet the lighting power allowances provided in [§140.6](#).

Under the 2016 Standards:

- **Multilevel Controls**—
only one control step for the enclosed space as a whole between 30 and 70%
- **Automatic Daylighting Controls**—
only required if alteration affects 10 or more luminaires in a primary sidelit or skylit daylit zone
- **Demand Response Controls**—
no longer required

Lamp and Ballast / Driver Replacements

Ballast or driver replacements are not regulated by the Standards. Lamp replacements only or ballast/driver replacements only are both considered exceptions to [§141.0\(b\)2J](#). However, a complete lamp and ballast/driver retrofit completed as a single project is considered a regulated alteration under the 2016 Standards and must meet lighting power density requirements in [§140.6](#) and controls requirements per [§141.0\(b\)2J](#).

Acceptance Testing

Indoor lighting alterations must comply with acceptance test requirements contained in [§130.4](#). When a project adds lighting controls to control 20 or few luminaires in total, the project is exempt. As an example, a project that adds three occupancy sensors with each controlling five luminaires, is exempt from acceptance test requirements. However, a project that adds three occupancy sensors with each controlling 10 luminaires is not. This exemption is new for 2016.

OUTDOOR LIGHTING REQUIREMENTS

Allowed Lighting Power

Lighting power allowances (LPA) for outdoor spaces have been reduced for hardscapes and building entrances or exits. Reductions range from 11–56% for general hardscape lighting with the most significant reductions affecting linear and area wattage allowances for Zones 1–4. In

addition, ATM, tunnel and bridge lighting are no longer exempted from LPA calculations. Values for all outdoor areas in Lighting Zones 0–4 are shown in [Tables 140.7-A](#) and [140.7-B](#) of the Standards. Values have been lowered to reflect the industry shift to LED lighting as the basis of design.

Outdoor Power Allowance Updates – 2013 to 2016

Type of Power Allowance	Lighting Zone 0	Lighting Zone 1		Lighting Zone 2 ¹		Lighting Zone 3 ¹		Lighting Zone 4	
Area Wattage Allowance (AWA)	No allowance	0.02 W/ft ²	↓42%	0.03 W/ft ²	↓33%	0.04 W/ft ²	↓35%	0.05 W/ft ²	↓56%
Linear Wattage Allowance (LWA)		0.15 W/lf	↓40%	0.25 W/lf	↓44%	0.35 W/lf	↓41%	0.45 W/lf	↓47%
Initial Wattage Allowance (IWA)		340W	No Change	450W	↓11%	520W	↓32%	640W	↓37%

¹ For lighting Zone 2 and 3, where greater than 50% of the paved surface of a parking lot is finished with concrete, the AWA for that area shall be 0.035 W/ft² for Lighting Zone 2 and 0.040 W/ft² for Lighting Zone 3, and the LWA for both lighting zones shall be 0.70 W/lf. This does not extend beyond the parking lot, and does not include any other General Hardscape areas.

Based on Table 140.7-A in the standards

In addition, **Table 140.7-A** has been modified to incorporate the new requirements of the recently revised Illuminating Energy Society of North America (IES) document RP-20-2014, Parking Lot Lighting Recommended Practice.

Lighting Zone 0

Requirements for Lighting Zone 0 have been added to the Standards. Lighting Zone 0 is designated specifically for undeveloped areas in parks and preserves, where no continuous lighting is intended.

While continuous lighting in Zone 0 is now explicitly prohibited, sites may utilize a single luminaire of 15W or less at entrances to parking lots, trail heads, or other areas in order to safely illuminate site facilities. In addition, luminaires installed in Lighting Zone 0 cannot exceed the maximum zonal lumen limits for Uplight and Glare specified in **Table 130.2-A** and **130.2-B** of the Standards.

Lighting Controls

Outdoor lighting controls requirements have changed, expanding to include more provisions for outdoor sales canopies and outdoor sales lots, which were previously exempted from occupancy-based dimming controls requirements contained in **§130.2(c)3**.

Outdoor controls must turn off all the lighting during the day and reduce or fully extinguish it at night when its not needed. These requirements are unchanged from the 2013 Standards and two types of control are required to achieve these goals. A photocontrol or astronomical time-switch is required to turn lights OFF during the day. At night, a motion sensor or time-based control is also required. The specific types of allowed devices are dependent on the mounting height of the luminaire.

Motion sensors in outdoor areas work well as a partial-OFF device, meaning they turn off only a portion of the lights at night. This saves energy and maintains a low light level for safety and wayfinding.

Automatic Lighting Controls for Outdoor Luminaires Mounted at 24 feet or Less from Grade

	NEW CONSTRUCTION	ALTERATIONS	
	All Regulated Projects	Connected Lighting Load is Increased Any Size Project	Connected Lighting Load is not Increased Greater of 5 Luminaires or 10% affected
Outdoor Sales Frontage	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Part-night control or motion sensor 	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Part-night control or motion sensor 	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Motion sensor or lighting must be independently controlled from all other lighting by a time-switch
Outdoor Sales Lots			<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Part-night control or motion sensor
Parking Lots			
Building Facades*	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • One of following: <ul style="list-style-type: none"> • Part-night control • Motion sensor • Centralized, time-based control system 	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • One of following: <ul style="list-style-type: none"> • Part-night control • Motion sensor • Centralized, time-based control system 	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Motion sensor or lighting must be independently controlled from all other lighting by a time-switch
Ornamental Hardscape			
Outdoor Dining			
All Other General Hardscape	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Part-night control or motion sensor 	<ul style="list-style-type: none"> • Photocontrol or outdoor astronomical time-switch • Part-night control or motion sensor 	

* Wallpacks mounted to building facades must use motion sensors.



For certain outdoor luminaires mounted 24 feet or less above the ground, motion sensors or other occupancy-based controls are required as part of the night time control strategy. All incandescent luminaires must be controlled by a motion sensor. For all other luminaires mounted over 24 feet, motion sensors are not explicitly required. The table on the previous page details the various control requirements for luminaires mounted 24 feet or below based on the type of outdoor area.

The maximum dimming permitted as part of an active motion controlled lighting system has increased from 80% to 90%. In addition, outdoor lighting is no longer required to be separately circuited from other lighting, only separately controlled.

All outdoor lighting control provisions may be found in [§130.2](#) of the Standards.

Acceptance Test Requirements

In conjunction with these changes, acceptance test requirements and procedures for many types of outdoor automatic shut-OFF controls have been clarified and/or expanded. Specific functional tests for photocontrols, astronomical timeswitch controls and part-night controls are now available. Information on the updated requirements may be found in [Nonresidential Appendix 7, Section 8 \(NA7.8\)](#).

Lastly, an alteration project where lighting controls are added to control 20 or fewer luminaires in total is now exempt from acceptance testing requirements contained in [§130.4](#).

Outdoor Alterations

Requirements for outdoor lighting alterations are now more detailed and specific to the type of outdoor space. Previously, any project that met compliance thresholds was required to address all lighting control provisions contained in [§130.2](#). Now, only the altered or new luminaires must comply, and the minimum threshold for projects that do not increase the connected lighting load has been raised to the greater of five luminaires or 10%. Under the 2013 Standards, small projects that addressed 1–4 luminaires were expected to comply with the full suite of controls requirements. This is no longer the case.

As with the 2013 Standards, when 50% or more luminaires are being replaced, the project must comply with lighting power and other requirements contained in [§140.7](#). Under the new Standards, an exception to this rule has been added. If the new luminaires have at least 40% lower power consumption, the alteration is not required to comply with [§140.7](#).

ABOUT THE CALIFORNIA LIGHTING TECHNOLOGY CENTER: *The California Lighting Technology Center was created in 2003 by the California Energy Commission in collaboration with the U.S. Department of Energy and the National Electrical Manufacturers Association. Part of the Department of Design at the University of California, Davis, CLTC is dedicated to accelerating the development and deployment of energy-efficient lighting and daylighting technologies.*

ABOUT ENERGY CODE ACE: *Developed and provided by the California Statewide Codes & Standards Program, Energy Code Ace offers free energy code training, tools and resources for those who need to understand and meet the requirements of Title 24, Part 6 and Title 20. The program aims to advance the adoption and effective implementation of energy efficiency measures and building practices to lock in long-term energy savings. For more information, visit energycodeace.com.*





WHAT'S NEW IN THE 2016 CODE? RESIDENTIAL LIGHTING

Changes to mandatory lighting requirements in California's 2016 Building Energy Efficiency Standards

California's new residential Building Energy Efficiency Standards take effect on January 1, 2017. The 2016 Standards focus on several key areas to improve the energy efficiency of newly constructed buildings, additions and alterations to existing buildings. The most significant efficiency improvements address attics, walls, water heating and lighting. The California Energy Commission estimates that the 2016 standards will deliver approximately 281 gigawatt-hours of electricity savings annually and reduce statewide greenhouse gas emissions by 160,000 metric tons. This is enough electricity to power 500,000 California homes each year.

These standards represent a major step towards meeting California's residential Zero Net Energy (ZNE) goal by the year 2020. Updates enhance and simplify previous requirements and lay the foundation for additional efficiency improvements slated for 2019 code. This publication offers an overview of important requirements and major updates to the 2016 residential lighting energy efficiency code.

MAJOR CHANGES



ALL HIGH EFFICACY LIGHTING

Indoor and outdoor lighting for new homes must be high efficacy.



JA8 UPDATED

Joint Appendix JA8 regulations now contain requirements for more types of residential high efficacy lamps and luminaires. In the 2013 Standards, JA8 regulations only applied to LED sources.



SIMPLIFIED CONTROL REQUIREMENTS

Lighting control requirements for indoor spaces are now simpler. Control requirements are based, in nearly all cases, on the type of lamp or luminaire installed, not the space.

This guide is not intended to be used in lieu of California's Building Energy Efficiency Standards, and it is not a substitute for the code itself. Please visit energy.ca.gov/title24/2016standards to download the official 2016 Title 24 Building Energy Efficiency Standards, Errata, Reference Appendices, and the Nonresidential Compliance Manual.

INDOOR LIGHTING REQUIREMENTS

High Efficacy Lighting

New regulations require that lighting in new homes be high efficacy, while also expanding the types of lighting that qualify as high efficacy. This change eliminates most space by space requirements and ensures that a variety of lighting technologies and techniques are available to builders and contractors. This also removes the need for calculating the wattage of low versus high efficacy luminaires in kitchens.

JAB COMPLIANT LAMPS & LUMINAIRES

The definition of “high efficacy luminaires” includes all light sources identified as “efficient” under the 2013 Standards. This includes linear fluorescent, pin based compact fluorescent, GU-24 base CFL, HID, and induction. High efficacy products include any luminaire that contains a JAB-compliant lamp or other light source. In other words, any luminaire can qualify as high efficacy as long as it meets the requirements of **Section 150.0 (k)** and **Joint Appendix JAB**. Manufacturers must test their products at an accredited test laboratory and submit the results to the California Energy Commission to gain JAB certification. A list of compliant products may be found at <https://cacertappliances.energy.ca.gov>.

Appendix JAB: Qualification Requirements for High Efficacy Light Sources – Partial List

Specification	Requirement
Initial Efficacy	≥ 45 lumens/Watt
Power Factor at Full Rated Power	≥ 0.90
Correlated Color Temperature (CCT)	For inseparable SSL luminaires, LED light engines and GU24 LED lamps, ≤4000 Kelvin. For all other sources, ≤3000 Kelvin.
Color Rendering Index (CRI)	≥ 90
R9	≥ 50
Rated Life	≥ 15,000 hours
Minimum Dimming Level	≤ 10%
Flicker	< 30% for frequencies of 200 Hz or below, at 100% and 20% light output.

This table contains a partial list of requirements. Additional qualification requirements may be found in JAB.

For lamps to qualify as high efficacy under JAB, they must be certified and marked as either JAB-2016 or JAB-2016-E. These markings mean the light source meets the requirements of **Joint Appendix JAB**, and the product is listed in the Energy Commission product database. Requirements assure lamps and luminaires provide high color quality, have a long life and are energy efficient.

JAB compliance markings are located on the lamp bulb or base. The marking “JAB-2016-E” indicates that the light source has been tested to provide long life at elevated temperatures in addition to the requirements listed for JAB-2016. Only “JAB-2016-E” lamps may be used in enclosed and recessed luminaires.

Construction & Inspection

The builder must now provide new homeowners with a luminaire schedule that includes a list of installed lamps and luminaires. This ensures that homeowners know what lighting products they are entitled to when they take possession of a new home.

This also makes lighting inspections much more straight forward as all luminaires are high efficacy, and there is a completed luminaire schedule for the owner.



PHOTO: CLTC, UC DAVIS



Switching Devices & Controls

Lighting control requirements for indoor spaces are now simpler. Control requirements are based, in nearly all cases, on the type of lamp or luminaire installed. Any JA8-compliant lamp or luminaire must be controlled by a vacancy sensor or dimmer. In practice, this requirement translates to any screw-base luminaire, ceiling recessed downlight, dedicated LED luminaire, or luminaire with an LED lamp. In addition, all undercabinet lighting must be switched separately from other lighting in the home.

Screw-Base Luminaires

Under the 2016 Standards, all luminaires that utilize a screw-based socket, excluding hard-wired ballasted HID, must contain lamps that comply with JA8 high efficacy requirements. All enclosed, screw-base luminaires, must utilize a compliant lamp rated for elevated temperatures. Recessed downlight luminaires with screw based sockets are no longer permitted under the 2016 Standards.

2016 Indoor Residential Lighting Requirements: Luminaires

Mandatory Measure	Screw-Base Luminaire	Pin-Base ¹ Luminaire	Recessed Downlight	Inseparable SSL ⁵ Luminaire (LED)	Night Lights ²	All Other
High Efficacy (required)	Yes—All	Yes—All	Yes—All	Yes—All	No	Yes—All
High Efficacy Qualification via JA8 lamps and luminaires³	All, excluding hard-wired ballasted HID	Only GU-24 LED lamps	All types, and certified compliant for elevated temperatures	All, except colored-decorative	No	All types
Automatic Qualification as High Efficacy: Listed in Table 150.0-A, Column 1 <i>(JA8 compliance not required)</i>	Hard-wired, ballasted HID only	All types, excluding GU-24 LED	None	Colored-decorative	No	None
Dimmer, Vacancy Control or EMCS⁴	Yes—All	Not mandatory, except for GU-24 LED	Yes—All	All, except colored-decorative	No	All
Other Requirements	Cannot be a recessed downlight	Must use an electronic ballast	Airtight, IC-rated and maintenance per § 150(k)1.C	None	Must consume 5W or less	None

¹ Excludes recessed downlights

² Permanently installed or integral to luminaire or exhaust fan

³ Enclosed luminaires must use JA8 lamps certified for use at elevated temperatures

⁴ Excludes luminaires in closets less than 70ft² and hallways

⁵ Solid-state lighting such as LED where the LED source is permanently attached to the luminaire

Control Requirements by Space

Most space-specific indoor control requirements have been eliminated with one exception. Now, at least one luminaire in the bathroom, garage, laundry room and utility room must be controlled

by a vacancy sensor or dimmer. Preset scene controllers and EMCS can take the place of dimmers as long as the functionality meets code requirements.

2016 Indoor Residential Lighting Requirements: Spaces & Lighting Controls

Residential Space	Manual ON/OFF Controls	Vacancy Sensor or Dimmer ¹	Separate Switching: Exhaust Fans	Separate Switching: Undercabinet Lighting
Hallways & Closets ²	Required for all spaces	Not required	Exhaust fans must be switched separate from lighting or utilize a device where lighting can be turned OFF while the fan is running. Excludes kitchen exhaust hoods.	Undercabinet lighting must be switched separate from all other lighting.
Kitchens		Based on installed luminaire or lamp type ³		
Bathrooms		At least one luminaire controlled by a vacancy sensor and all other based on installed lamp or luminaire type		
Laundry Rooms / Utility Rooms				
Garage				
All Other		Based on installed luminaire or lamp type ³		

¹ May be achieved with an EMCS or programmable scene controller with required functionality.

² Closets less than 70ft². For all other closets, requirements based on installed lamp or luminaire type.

³ See page 3 for a list of requirements by lamp and luminaire type.

OUTDOOR LIGHTING REQUIREMENTS

All outdoor lighting must now be high efficacy. In addition, for single family homes, lighting mounted to any building on the lot must be controlled by one of the following combinations:

1. Photocell and motion sensor
2. Photocell and time switch
3. Astronomical time clock
4. EMCS with features of astronomical time clock, does not allow the luminaire to be ON during the day, and may be programmed to automatically turn lighting OFF at night.

For low-rise, multifamily residential buildings, outdoor lighting for private patios, balconies, entrances, and porches must also meet these requirements or comply with the applicable nonresidential standards.

Requirements for carports and parking lots vary based on the number of parking spaces they contain. Carports, parking garages and parking lots with eight or more spaces must comply with the nonresidential standards. Smaller parking areas may comply with either the residential or nonresidential standards.

ABOUT THE CALIFORNIA LIGHTING TECHNOLOGY CENTER: *The California Lighting Technology Center was created in 2003 by the California Energy Commission in collaboration with the U.S. Department of Energy and the National Electrical Manufacturers Association. Part of the Department of Design at the University of California, Davis, CLTC is dedicated to accelerating the development and deployment of energy-efficient lighting and daylighting technologies.*

ABOUT ENERGY CODE ACE: *Developed and provided by the California Statewide Codes & Standards Program, Energy Code Ace offers free energy code training, tools and resources for those who need to understand and meet the requirements of Title 24, Part 6 and Title 20. The program aims to advance the adoption and effective implementation of energy efficiency measures and building practices to lock in long-term energy savings. For more information, visit energycodeace.com.*



Building Commissioning

Commissioning in the Energy Code

Commissioning requirements for all newly constructed nonresidential buildings are included in the 2013 update to Title 24, Part 6- California's Building Energy Efficiency Standards (Standards). Many of these requirements were moved from CalGreen (Title 24, Part 11), where commissioning was originally incorporated into state building code in 2008.

Commissioning requirements apply to all newly constructed nonresidential buildings, though the extent of the requirements depends on whether the conditioned floor area is less than 10,000 square feet or 10,000 square feet and greater.

The Standards define "newly constructed" as "a building that has never been used or occupied for any purpose" in [Section 100.1](#).

The commissioning requirements in Part 6 do not apply to residential projects (including high-rise residential), do not apply to additions or alterations and do not apply to newly constructed nonresidential buildings that are unconditioned.

Commissioning is critical to realizing the energy savings during building operation that were intended by the building design. Closely related to acceptance testing, commissioning involves functional testing during construction, but also includes activities during design that will ensure the building systems and associated controls will meet the owner's energy and operating efficiency goals.

Title 24, Part 6 defines commissioning as, "a systematic quality assurance process that spans the entire design and construction process, including verifying and documenting that building systems and components are planned, designed, installed, tested, operated and maintained to meet the owner's project requirements."

Commissioning Requirements

Commissioning requirements are included in [Section 120.8](#) of the Standards, and the table below illustrates which requirements apply based on conditioned floor area. Additional resources are listed that may provide valuable detail on how to properly implement these requirements.

Commissioning Requirements in Part 6	Conditioned Space	
	<10k ft ²	≥ 10k ft ²
OPR (§120.8(b))		X
BOD (§120.8(c))		X
Design Review (§120.8(d))	X	X
Commissioning in Construction Docs (§120.8(e))	X	X
Commissioning Plan (§120.8(f))		X
Functional Performance Tests (§120.8(g))		X
O&M Training (§120.8(h))		X
Commissioning Report (§120.8(i))		X

Table 1. Commissioning Requirements in Title 24, Part 6

Additional Resources

The following resources may be helpful in addition to the Standards language to understand the commissioning requirements:

- ★ [Building Commissioning Guide](#) in Nonresidential Compliance Manual: This guide outlines both an intent and compliance method for each requirement in Section 120.8.

Roles and Responsibilities

Because commissioning spans the entire building delivery process from pre-design through occupancy, many parties are involved, making communication and coordination paramount. Below is a list of who may need to participate in the commissioning process, at one time or another during the project.

- ★ Owner, owner's representative or facility operator
- ★ Designers (architect and MEP)
- ★ Design Reviewer (see table below)
- ★ Plans Examiner
- ★ General Contractor*
- ★ Key Subcontractors (HVAC, controls, TAB, etc.)*
- ★ Acceptance Test Technician*
- ★ Commissioning Agent*
- ★ Building Inspector*

* These parties are generally only involved for buildings with conditioned floor area 10,000 square feet or greater when §120.8(f) - §120.8(i) are required.

Who is most appropriate to fill each of these roles is dependent upon the experience and expertise of the project team. There are no requirements in the Standards that designate who the Commissioning Authority must be. However, for both the Design Reviewer and Acceptance Test Technician, there are restrictions on who can fill these roles.

Building Size	< 10,000 ft ²	10,000 - 50,000 ft ²	> 50,000 ft ²	Complex systems in Bldgs >10,000 ft ²
Allowed Design Reviewer	Any licensed professional engineer, including the engineer of record	A licensed professional engineer in-house to the design firm but not associated with the building project, or a third party licensed engineer	A third party licensed professional engineer	A third party licensed professional engineer

Table 2. Who can act as the Design Reviewer, per §120.8(d)

Information on becoming a certified Acceptance Test Technician can be found on the [California Energy Commission's Acceptance Test Technician Certification Provider webpage](#).

Additional Resources

The following resources may be helpful to understand roles related to the commissioning and acceptance testing process:

- ★ [Building Commissioning Guide](#) in Nonresidential Compliance Manual: Section 12.1 of this guide outlines roles and information on how to find a qualified Commissioning Authority.
- ★ [California Commissioning Collaborative](#): This organization includes a Provider List that may be valuable when searching for a Commissioning Authority.
- ★ [Section 10-103\(a\)1](#): This section in the Standards indicates that the Design Reviewer must be a licensed professional engineer.

Commissioning Process

Understanding and assigning who does what and when early during the process is key to success. For all newly constructed nonresidential projects, the Standards dictate that the commissioning process starts in early design, and compliance forms verifying this must be submitted to the building department with the project's application for permit.

Additional Resources

- ★ [Energy Code Ace Commissioning Infographic](#): This visual provides an outline of the commissioning tasks by when they occur during a typical project delivery process.
- ★ [Energy Design Resources e-news #96](#): This e-news titled [Commissioning for Compliance](#) was issued to help practitioners understand and implement the commissioning requirements of the Standards. It includes tips and tricks and a handy graphic that shows when during project delivery the commissioning requirements should be implemented.

Functional Performance Test Procedures

Commissioning is similar to acceptance testing in that functional performance tests are performed to “demonstrate the correct installation and operation of each component, system and system-to-system interface.” Section 120.8(g) says that functional testing performed to satisfy the commissioning requirements should be performed in accordance with acceptance testing procedures outlined in other sections of the Standards.

Note that the functional performance tests which are needed for commissioning are based on the systems documented in the OPR and BOD documents and may be more comprehensive than the project's required acceptance tests. A system not being included in the OPR/BOD does not exempt it from acceptance test requirements outlined in other sections of the Standards.

Additional Resources

The following resources may be helpful to better define functional performance testing requirements:

- ★ [Chapter 13 Acceptance Requirements](#) in the Nonresidential Compliance Manual: An overview of acceptance testing requirements, the process and the forms are further detailed in Chapter 13. [Table 13-1](#) includes a list of certificate of acceptance forms by building component.
- ★ [Nonresidential Reference Appendices NA7](#): This Section of the Nonresidential Appendices includes test procedures, roles and responsibilities and other details related to acceptance testing.

“Simple” Systems include:

- Unitary or packaged equipment listed in Tables 110.2-A, 110.2-B, 110.2-C and 110.2-E that each serve one zone; OR
- Two-pipe, heating only systems serving one or more zones

“Complex” Systems include:

- Fan systems each serving multiple thermostatically controlled zones; OR
- Built-up air handler systems (non-unitary or non-packaged HVAC equipment); OR
- Hydronic or steam heating systems; OR
- Hydronic cooling systems

Figure 1. “Simple” vs. “Complex” HVAC Systems

Commissioning Documents

In addition to the compliance forms (see below), there are documents that are required by Section 120.8 for buildings with conditioned floor area 10,000 sf and greater. These documents are used both to facilitate and document the commissioning activities:

- ★ Owner's Project Requirements (OPR)
- ★ Basis of Design (BOD)
- ★ Commissioning Specifications
- ★ Commissioning Plan
- ★ Functional Performance Tests
- ★ Operation and Maintenance Training Documents
- ★ Commissioning Report

Additional Resources

The following resources may be helpful to produce these required documents:

- ★ [Energy Design Resources e-news #96](#): The [Commissioning for Compliance e-news](#) provides more pragmatic detail and tips on each document listed.
- ★ [Building Commissioning Guide](#) in Nonresidential Compliance Manual: This guide provides an intent and compliance method for each document.
- ★ [California Commissioning Collaborative](#): Templates and sample documents are provided by this organization to facilitate commissioning in California.

Compliance Forms

All newly constructed nonresidential projects are required to complete the design review certificates of compliance, regardless of project size (See Table 1). At a minimum, the [NRCC-CXR-01-E](#) and [NRCC-CXR-02-E](#) must be completed. The project then uses the [NRCC-CXR-03-E](#) for “simple” HVAC systems, and the [NRCC-CXR-04-E](#) for “complex” HVAC systems (See Figure 1). The [NRCC-CXR-05-E](#) is also completed for all projects requiring compliance with Section 120.8.

Although there are no commissioning forms other than the certificates of compliance, the NRCA forms (certificates of acceptance) are used to document functional performance tests for the inspector to review.

Additional Resources

The following resources may be helpful to prepare the project team for completing compliance forms, and the enforcement agencies for reviewing them:

- ★ [Energy Design Resources e-news #96](#): This e-news includes more detail on each compliance form, including when it should be completed.
- ★ [Building Commissioning Guide](#) in Nonresidential Compliance Manual: Section 12.10 of this guide has detailed instructions on completing the compliance forms associated with commissioning.
- ★ [NRCA forms](#): The certificates of acceptance themselves are useful to understand required documentation.

Don't Forget About CALGreen!

Title 24, Part 11 (CALGreen) also includes requirements for commissioning in Chapter 5- Nonresidential Mandatory Measures. These requirements are complimentary to the Energy Code requirements, but be sure to read through them as additional systems such as renewable energy, landscape irrigation and water reuse systems are covered here

