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1. Introduction

This compliance manual is intended to help plans examiners, inspectors, owners, designers, builders, and energy consultants comply with and enforce California's *2016 Building Energy Efficiency Standards* (Energy Standards) for low-rise residential buildings. The lighting and domestic hot water requirements in this compliance manual also apply to high-rise residential buildings. The manual is written as a reference and an instructional guide and can be helpful for anyone that is directly or indirectly involved in the design and construction of energy-efficient low-rise residential buildings.

The compliance manual has nine chapters:

Chapter 1 introduces the Energy Standards and discusses the application and scope of the Standards for low-rise residences.

Chapter 2 reviews the compliance and enforcement process, including design and preparation of compliance documentation through field verification and diagnostic testing.

Chapter 3 addresses the requirements for the building envelope.

Chapter 4 covers the requirements for heating, ventilation, and air-conditioning (HVAC) systems.

Chapter 5 covers the water heating systems requirements, including the requirements for swimming pool systems.

Chapter 6 addresses the requirements for hardwired interior lighting and for outdoor lighting permanently attached to the building.

Chapter 7 addresses the solar-ready requirements for low-rise residential buildings .

Chapter 8 covers the performance approach to compliance.

Chapter 9 covers additions, alterations, and repairs.

1.1 Related Documents

This compliance manual is intended to supplement four other related documents that are available from the California Energy Commission. These are as follows:

- A. *The 2016 Building Energy Efficiency Standards, Title 24, Part 6* (Energy Standards). This compliance manual supplements and explains California's energy efficiency standards for buildings; it does not replace them. Readers should have a copy of the Energy Standards to refer to while reading this manual as well as a copy of the *2016 Reference Appendices*.
- B. 2016 Reference Appendices – The reference appendices have three main subsections: Reference Joint Appendices, Reference Residential Appendices, and Reference Nonresidential Appendices:
 1. The 2016 Reference Joint Appendices contain information common to both residential and nonresidential buildings including, but not limited to, definitions, climate zone listings, weather data, assembly properties, and compliance documentation registration procedures.
 2. The 2016 Reference Residential Appendices contain information for residential buildings only. The Reference Residential Appendices contain Home Energy Rating System (HERS) field verification and/or diagnostic testing procedures for

HVAC equipment, air distribution ducts, and quality insulation installation. .

3. The 2016 Reference Nonresidential Appendices contain information for nonresidential buildings only. The reference nonresidential appendices contain HERS field verification and/or diagnostic testing procedures for HVAC equipment and air distribution ducts, acceptance testing procedures, and luminaire power default values.
- C. *The 2016 Residential Alternative Calculation Method (ACMs or Compliance Software) Approval Manual. The 2016 Residential ACM Approval Manual* describes the process for certifying and decertifying the compliance software programs.
- D. *The 2016 Residential Alternative Calculation Method Reference Manual* lays out the technical rules for implementing the 2016 performance compliance path in software programs.

Material from related documents is not repeated in this compliance manual; rather, it is referenced. If you are using the electronic version of this compliance manual, there are hyperlinks throughout the manual that will take you directly to the document that is referenced.

1.2 The Technical Chapters

Each of the five technical chapters (Chapters 3 through 7) begins with an overview, followed by a presentation of a specific topic in each subsection. For the building envelope, subsections include fenestration, opaque surfaces (walls, floors, and roofs), air leakage and infiltration, radiant barriers, cool roofs, and HERS quality insulation installation (QII) verification. For HVAC, the subsections include heating equipment, cooling equipment, ducts, and HERS field verification and diagnostic testing. For water heating, subsections include equipment efficiencies and distribution systems. Lighting subsections include high efficacy lighting, LED lighting, switching devices and controls, and recessed luminaires. Mandatory measures and prescriptive requirements (defined in Section 1.6 of this chapter) are described within each subsection or component. Chapter 8 describes the computer performance approach. Chapter 9 covers requirements for additions and alterations. Chapter 2, although not a technical chapter, covers important compliance and enforcement topics.

Each technical chapter or subsection also has a *compliance options* section. The *compliance options* section includes information on how to design a building that goes beyond the *prescriptive* energy efficiency requirements and *mandatory* energy efficiency measures. Compliance options are used for compliance credit through the performance approach. There are also *design recommendations* for which no compliance credit is offered. However, following the recommendations will significantly impact building energy use or peak demand.

Table 1-1: Compliance Options vs. Design Recommendations

<i>Compliance Options</i>	<i>Design Recommendations, such as on-site generation</i>
Credit offered through the performance approach	No credit, but may still impact energy or demand.

1.3 Why California Needs Building Energy Efficiency Standards

Energy efficiency reduces energy costs, increases reliability and availability of electricity, improves building occupant comfort, and reduces impacts to the environment, making the Energy Standards important and necessary for California’s energy future.

1.3.1 Energy Savings

Reducing energy use benefits everyone. Homeowners save money, Californians have a more secure and healthy economy, the environment is less negatively impacted, and the state electrical system can operate in a more stable manner. The 2016 Energy Standards (for both residential and nonresidential buildings) are expected to reduce the growth in electricity use and reduce the growth in natural gas use.

1.3.2 Electricity Reliability and Demand

Buildings are one of the major contributors to electricity demand. During the 2000/2001 California electricity crisis and the East Coast blackout in the summer of 2003, Energy Commission staff learned that the electric distribution network is fragile and system overloads caused by excessive demand from buildings can create unstable conditions. Furthermore, resulting blackouts can seriously disrupt business and cost the economy billions of dollars.

Since the California electricity crisis, the Energy Commission has placed increasing emphasis on demand reduction.

1.3.3 Comfort

Comfort is an important benefit of energy-efficient homes. Energy-efficient houses are well-insulated, are less drafty, and use high-performance windows and/or shading to reduce solar gains and heat loss. Poorly designed building envelopes result in houses that are less comfortable. Even with oversized heating and cooling systems, comfort cannot be achieved in older, poorly insulated and leaky homes.

1.3.4 Economics

For the homeowner, energy efficiency helps to ensure that a home is affordable both now and into the future. Banks and other financial institutions recognize the impact of energy efficiency through energy-efficient mortgages; they look at the total cost of owning the home, including paying the utility bills. If the utility bills are lower, lenders can qualify borrowers for a larger loan.

From a larger perspective, the less California depends on depletable fossil resources such as natural gas, coal, and oil, the stronger and more stable the economy will remain in the face of energy cost increases. A cost-effective investment in energy efficiency helps everyone. In many ways, it is far more cost effective for the people of California to invest in saving energy than it is to invest in building new power plants.

1.3.5 Environment

In many parts of the world, energy use has led to oil spills, acid rain, smog, and other forms of environmental pollution that have ruined the natural beauty people seek to enjoy. California is not immune to these problems, but appliance standards, building standards, and utility programs that promote efficiency and conservation help maintain environmental quality. Other benefits include reduced destruction of natural habitats, which helps protect animals, plants, and natural systems.

1.3.6 Global Warming

Burning fossil fuels contributes greatly to global warming; carbon dioxide is being added to an atmosphere already containing 35 percent more than it did two centuries ago. Carbon dioxide and other greenhouse gases create an insulating layer around the earth that leads to global climate change. Energy Commission research shows that most sectors of the state economy face significant risk from climate change, including water resources (from reduced snowpack), agriculture, forests, and the natural habitats of several indigenous plants and animals.

Scientists recommend that actions be taken to reduce emissions of carbon dioxide and other greenhouse gases. While adding scrubbers to power plants and catalytic converters to cars reduces other emissions, they do not limit the carbon dioxide emitted into the atmosphere. Using energy efficiently is a far-reaching strategy that can make an important contribution to reducing greenhouse gases.

The National Academy of Sciences has urged the United States to follow California's lead on such efforts, saying that conservation and efficiency should be the chief element in energy and global warming policy. Its first efficiency recommendation was simple: Adopt nationwide energy-efficient building codes. Energy conservation will not only increase comfort levels and save homeowners money, it will play a vital role in creating and maintaining a healthy environment.

The Energy Standards are expected to have a significant impact on reducing greenhouse gas and other air emissions. Carbon dioxide (CO₂), one of the more prevalent greenhouse gases, would be reduced.

1.3.7 The Warren-Alquist Act

Section 25402 of the Public Resources Code

Section 25402 of the California Public Resources Code (the Code) authorizes the Energy Commission to develop and maintain Energy Standards for new buildings. This section of the code, commonly referred to as the Warren-Alquist Act (the act), is direction from the Legislature on the development of Energy Standards in California.

The act created the Energy Commission in 1974 and gave it authority to develop and maintain building energy efficiency standards for new buildings. The act directs the Energy Commission to “prescribe, by regulation, lighting, insulation, climate control system, and other building design and construction standards which increase the efficiency in the use of energy for new residential and new nonresidential buildings.”

The act also requires that the Energy Standards be cost-effective “when taken in their entirety and amortized over the economic life of the structure,” and it requires that the Energy Commission periodically update the Standards and develop manuals to support them. The act directs local building permit jurisdictions to withhold permits until the building satisfies the Energy Standards.

The Public Resources Code was amended through Senate Bill 5X (Sher, Chapter 7, Statutes of 2001) expands the authority of the Energy Commission to develop and maintain standards for outdoor lighting and signs.

1.4 What's New for 2016

The most significant changes in the *2016 Building Energy Efficiency Standards* affecting residential buildings include the new requirements for high-performance insulation within walls and attics. Other changes for residential buildings include:

1.4.1 Mandatory Measures:

1. Insulation in roof/ceiling construction must be at least R-22 (maximum U-factor of 0.043) (§150.0(a)1).
2. New duct total leakage reduced to 5 percent or less (§150.0(m)11B1).
3. All installed air-conditioner and heat pump systems shall be equipped with liquid line filter driers as specified by manufacturer's instructions (§150.0(h)3B).
4. Storage hot water heaters no longer need to be externally wrapped (§150.0(j)1).
5. All luminaires must be "high-efficacy" (§150.0(k)1A).
6. Isolation valves must be installed on instantaneous water heaters that have a minimum input of 6.8 kBTU/hr (§110.3(c)7).

1.4.2 Prescriptive Compliance:

1. Increased flexibility for envelope compliance (§150.1(c)).
2. Increased roof assembly requirements to include insulation installed either above or below roof deck (§150.1(c)1A).
3. Requirements for water-heating systems in single-family and multifamily buildings have been updated and more options have been added (§150.1(c)8).
4. High-performance attics and ducts in conditioned spaces have been added as option for a space-conditioning distribution system (§150.1(c)9).
5. If a whole house fan (WHF) is required, it must comply with a total air flow of at least 1.5 CFM/ft² and have 1 square foot of attic vent free area for each 750 CFM (§150.1(c)12).

1.4.3 Performance Compliance:

All compliance software programs that are approved by the Energy Commission must use a single interpretation of the performance compliance rules that the Energy Commission has integrated into the public domain software. More information is available in the *2016 Residential ACM Approval Manual* and the *2016 Residential ACM Reference Manual*.

1.4.4 Additions and Alterations:

1. Changes to the prescriptive requirements for the building envelope (specifically wall insulation) for additions (§150.2(a)1).
2. With alterations, the prescriptive requirements for mechanical cooling, water heating, and lighting have been revised (§150.2(b)).
3. More detailed information on additions and alterations in Chapter 9.

1.5 Scope and Application

1.5.1 Building Types

Though the Energy Standards apply to both nonresidential and residential buildings, this compliance manual addresses only the requirements for low-rise residential buildings. A companion compliance manual addresses the requirements for nonresidential buildings, including hotels, motels, and high-rise residential buildings that are four stories or more in height.

- A. **Mixed Low-Rise Residential and Nonresidential Occupancies.** When a building includes both low-rise residential and nonresidential occupancies, the requirements are different depending upon the percentages of the conditioned floor that is occupied by each occupancy type:
1. **Minor Occupancy** (Exception 1 to §100.0(f)). When a residential occupancy occurs in the same building as a nonresidential occupancy, and if one of the occupancies is less than 20 percent of the total conditioned floor area, the smaller occupancy is considered a “minor” occupancy. Under this scenario, optionally, the entire building may be treated as if it is the major occupancy for envelope, HVAC, and water heating. Lighting requirements in §140.6 through §140.8 or §150.0(k) must be met for each occupancy separately. The mandatory measures applicable to the minor occupancy, if different from the major occupancy, would still apply.
 2. **Mixed Occupancy.** When residential occupancy is mixed with a nonresidential occupancy, and if neither occupancy is less than 20 percent of the total conditioned floor area, these occupancies fall under different sets of standards and must be considered separately. Two compliance submittals must be prepared, each using the calculations and forms of the respective standards. Separate compliance for each occupancy, to the respective standards, is an option when one of the occupancies is a minor occupancy, as discussed in the paragraph above.
- B. **The three-story** designation relates to multifamily buildings, since all single-family homes fall under the low-rise residential requirements regardless of the number of stories. An apartment building with three or fewer habitable stories falls under the low-rise residential standards while an apartment building that has more than three habitable stories falls under the nonresidential standards. High-rise residential dwelling units must still comply with the lighting and water heating requirements for low-rise residential buildings; for example, the *Nonresidential Compliance Manual* makes reference to Chapters 5 and 6 of this document.

In multifamily buildings, lighting in common areas is subject to all nonresidential requirements if the common area conditioned floor area (CFA) exceeds 20 percent of the building CFA. Where the common area does not exceed 20 percent of the building CFA, lighting must meet mandatory requirements – a choice of high-efficacy lighting or automatic controls. (See §150.0(k)12.)

- C. The definition of **a habitable story** in the California Building Code (CBC) is used with the Energy Standards. Mezzanines are not counted as separate habitable stories, nor are minor conditioned spaces such as an enclosed entry stair that leads to an apartment or dwelling unit on the next floor. A habitable story is one that contains space in which people may live or work in reasonable comfort and that has at least 50 percent of its volume above grade.

- D. **Live/work buildings** are a special case since they combine residential and nonresidential uses within individual units. Such buildings are a common form of new construction in San Francisco and some other urban areas of the state. Even though live/work spaces may be used for an office or a studio, they are typically heated and/or cooled like a residential building. For this reason the residential standards are more suitable and the Energy Commission has made this determination: Either the low-rise or high-rise residential standards apply, depending on the number of habitable stories.

However, lighting in designated workspaces in live/work lofts must comply with the nonresidential prescriptive lighting requirements. See Chapter 5 of the *Nonresidential Compliance Manual* and §140.6 for more information.

Table 1-2: Building Types Covered by the Low-Rise Residential and Nonresidential Standards

Low-Rise Residential Standards (covered in this compliance manual)	Nonresidential Standards (covered by Nonresidential Compliance Manual)
All low-rise residential occupancies including single-family homes, duplexes, garden apartments, and other housing types with three or fewer habitable stories.	All nonresidential CBC occupancies (Group A, B, E, F, H, M, S, or U), as well as high-rise residential (Groups R-1 and R-2 with four or more habitable stories), and all hotel and motel occupancies.
<p>Includes:</p> <p>All single-family dwellings of any number of stories (Group R-3)</p> <p>All duplex (two-dwelling) buildings of any number of stories (Group R-3)</p> <p>All multifamily buildings with three or fewer habitable stories (Groups R-1 and R-2)</p> <p>Additions and alterations to all of the above buildings.</p> <p>Lighting requirements for living quarters in high-rise multifamily buildings (more than three stories) and water heating requirements for high-rise multifamily buildings (more than three stories)</p>	<p>Includes:</p> <p>Offices</p> <p>Retail and wholesale stores</p> <p>Grocery stores</p> <p>Restaurants</p> <p>Assembly and conference areas</p> <p>Industrial work buildings</p> <p>Commercial or industrial storage</p> <p>Schools and churches</p> <p>Theaters</p> <p>Hotels and motels</p> <p>Apartment and multifamily buildings with four or more habitable stories (envelope and HVAC requirements)</p> <p>Long-term care facilities (group R-2) with four or more habitable stories</p> <p>Dormitories or other congregate residences, or any building with dormitory-style sleeping quarters, with six or more "guest rooms"</p> <p>Private garages, carports, sheds, and agricultural buildings.</p>

1.5.2 Explanation of Terms

The term building type refers to the classification of buildings defined by the *CBC* and applicable to the requirements of the *Building Energy Efficiency Standards*. This manual is concerned with the Energy Standards that apply to all low-rise residential buildings, which includes all single-family residential and multifamily buildings with three or fewer habitable stories in the entire building. A multifamily building with four or more habitable stories is under the scope of the nonresidential requirements, but the dwelling units must meet the lighting, water heating, and setback thermostat requirements for low-rise residential

buildings. A multifamily building contains multiple dwelling units that share common walls (single-family attached) and may also share common floors or ceilings (apartments).

All residential buildings not in the above low-rise category are covered in the 2016 edition of the Energy Commission's *Nonresidential Compliance Manual*. (See Parts 1.1 and 1.2.)

- A. A **single-family building** is a single dwelling unit of occupancy group R-3, as defined in the *CBC*, that stands separate from other dwelling units but may have an attached garage.
- B. A **multifamily building** is a dwelling unit of occupancy group R, as defined in the *CBC*; that shares a common wall and/or floor/ceiling with at least one other dwelling unit. (See Chapter 8 for more information on multifamily energy compliance.) A single-family attached building is a dwelling unit of occupancy group R that shares a common wall with another dwelling unit.
- C. An **addition** to an existing building increases both the conditioned floor area and volume of a building, which can be new construction or added space conditioning to an existing unconditioned space. See Chapter 9 for more information on energy compliance of additions.
- D. An **existing building** is: "...a building erected prior to the adoption of [the current] code, or one for which a legal building permit has been issued." (*CBC*, Part 2)

1.5.3 Building Orientation

Building orientation can affect the energy use of a building, particularly in cooling-dominated climate zones with a high amount of west-facing glass. Some prescriptive requirements and performance modeling inputs for compliance with the Energy Standards require a description of the building orientation.

- A. East-Facing
"East-facing is oriented to within 45 degrees of true east, including 45°0'0" south of east (SE), but excluding 45°0'0" north of east (NE)." (§100.1)
- B. North-Facing
"North-facing is oriented to within 45 degrees of true north, including 45°0'0" east of north (NE), but excluding 45°0'0" west of north (NW)." (§100.1)
- C. South-Facing
"South-facing is oriented to within 45 degrees of true south, including 45°0'0" west of south (SW), but excluding 45°0'0" east of south (SE)." (§100.1)
- D. West-Facing
"West-facing is oriented to within 45 degrees of true west, including 45°0'0" due north of west (NW) but excluding 45°0'0" south of west (SW)." (§100.1)

1.5.4 Historical Buildings

Exception 1 to §100.0(a)

Exception 1 to §100.0(a) states that qualified historic buildings, as regulated in the California Historical Building Code (Title 24, Part 8) or California Building Code, Title 24, Part 2, Volume I, Chapter 34, Division II are not covered by the Building Energy Efficiency Standards. Section 140.6(a)3 clarifies that lighting systems in qualified historic buildings are exempt from the lighting power allowances only if they consist solely of historical lighting components or replicas of historical lighting components. If lighting systems in qualified historic buildings contain some historical lighting components or replicas of historical components, combined with other lighting components, only those historical or historical replica components are exempt. All other lighting systems in qualified historic buildings must comply with the *Building Energy Efficiency Standards*.

The California Historical Building Code (CHBC) Section 8-102.1.1 specifies that all non-historical additions must comply with the regular code for new construction, including the *Building Energy Efficiency Standards*. CHBC Section 8-901.5 specifies that when new or replacement mechanical, plumbing, and electrical (including lighting) equipment or appliances are added to historic buildings, they should comply with the *Building Energy Efficiency Standards*, including the *Appliance Efficiency Regulations*.

The California State Historical Building Safety Board has final authority in interpreting the requirements of the CHBC and determining to what extent the requirements of the *Building Energy Efficiency Standards* apply to new and replacement equipment and other alterations to qualified historic buildings. In enacting the State Historical Building Code legislation, one of the intents of the Legislature was to encourage energy conservation in alterations to historic buildings (Health and Safety Code Section 18951).

Additional information about the CHBC can be found on the following website:

<http://www.dgs.ca.gov/dsa/AboutUs/shbsb.aspx>

Or contact the SHBSB at (916) 445-7627.

Example 1-1

Question

Are additions to historic buildings also exempt?



Answer

If the addition adjoins the qualified historic building, then the enforcement agency at its discretion may exempt those measures which they determine could damage the historical value of the building. However, “additions which are structurally separated” from the historic building are not exempt from the Energy Efficiency Standards and must comply with building codes, including the Historical Building Code, Title 24, Part 8, Section 8-704.



Source: CEC Photographer: Andersen Windows

Example 1-2**Question**

A sunspace addition is designed with no mechanical heating or cooling and a glass sliding door separating it from all existing conditioned space. Under what conditions will the Energy Standards not apply to this addition?

Answer

The mechanical and envelope requirements of the Energy Standards do not apply if a building inspector determines that the space is unconditioned. Whether conditioned or unconditioned, per §100.0(c)2, the sunspace must still comply with the applicable lighting requirements of §150.0(k). The sunspace is unconditioned if:

- The new space is not provided with heating or cooling (or supply ducts); or
- The new space can be closed off from the existing house with weather stripped doors; or
- The addition is not indirectly conditioned space.

A building official may require a sunspace to be conditioned if it appears to be habitable space, in which case the Energy Standards would apply.

1.5.5 Exempt Buildings

The following building types are exempt from the prescriptive and performance standards:

- A. Seasonally occupied agricultural housing limited by state or federal agency contract to occupancy not more than 180 days in any calendar year (Exception 1 to §100.0(e)2D); however, these buildings must comply with the applicable mandatory requirements.
- B. Low-rise residential buildings that use no energy obtained from a depletable source for either lighting or water heating and obtain space heat from wood heating or other nonmechanical system: however, these buildings must comply with the applicable mandatory requirements.
- C. Based on discretion of building officials, temporary buildings, temporary outdoor lighting or temporary lighting in an unconditioned building, or structures erected in response to a natural disaster (Exception 2 to §100.0(a)). These buildings may also be exempt from the mandatory and prescriptive requirements of the Energy Standards.

1.5.6 Building Systems Covered

The low-rise residential standards affect the design of the building envelope; the heating, ventilation and air-conditioning (HVAC) system; the water heating system; and the lighting system. The Energy Standards do not apply to residential appliances (*Appliance Efficiency Regulations* may apply), elevators or dumbwaiters, or portable lighting systems that are plugged into a wall outlet. Only hardwired lighting is regulated, which includes lighting that is a permanent part of the building.

1.5.7 Additions, Alterations, and Repairs

§100.1(b)
§150.2(a)
§150.2(b)

Additions, alterations, and repairs are common construction projects for California homeowners. The Energy Standards apply to both additions and alterations, but not to repairs. See Chapter 9 for details.

- A. **Additions** are changes to an existing building that increase both conditioned floor area and volume.
- B. **Alterations**, that are not additions, are changes to the envelope, space conditioning system, water heating system or lighting system of a building.
- C. **Repairs** are the reconstruction or renewal of any part of an existing building for the purpose of its maintenance and are not under the scope of the Standards. Replacement of any component systems (such as reroofing) or equipment for which there are requirements in the Energy Standards is considered an alteration and not a repair.

Example 1-3

Question

The Energy Standards do not specify whether buildings damaged by natural disasters can be reconstructed to the original energy performance specifications. What requirements apply under these circumstances?

Answer

Buildings destroyed or damaged by natural disasters must comply with the energy code requirements in effect when the builder or owner applies for a permit for those portions of the building that are being rebuilt.

Example 1-4

Question

Do the Energy Standards apply to an addition to a manufactured (“mobile”) home?



Source: CEC Photographer: Brian Vahey

Answer

No. Title 25 requirements, not Title 24, govern manufactured homes, including additions to the unit. Jurisdiction in a mobile home park comes under the authority of the Department of Housing and Community Development. Jurisdiction of a mobile home on private property may come under the authority of the local building department.

Example 1-5

Question

Three stories of residential dwelling units are planned over a first story that includes retail and restaurant occupancies. Do the residential apartments need to comply with the residential standards?

Answer

Yes and No. The building envelope and HVAC equipment must comply with the nonresidential (high-rise residential) standards since the structure contains four habitable stories and, as a whole structure, is a high-rise building. The dwelling units, however, must comply with the lighting and water heating requirements for low-rise residences.

Example 1-6

Question

A four-story single-family townhouse (with no shared walls) has been constructed. Does the townhouse need to comply with the low-rise residential standards?

Answer

Yes. As a group R-3 occupancy, the low-rise residential standards apply. The building is not an apartment house (which, according to the CBC, must be at least three dwelling units).

Example 1-7

Question

A 2,100 ft² manager's residence is being constructed as part of a new 14,000 ft² conditioned warehouse building. Which Energy Standards apply?

Answer

The whole building can comply with the nonresidential standards, and the residential unit is not required to comply separately since it is a subordinate occupancy containing less than 20% of the total conditioned floor area. However, the residential dwelling unit must meet all low-rise residential mandatory measures as well as the lighting and water heating requirements.

Example 1-8

Question

Assume the same scenario as in the previous example, except that the dwelling unit is new and the remainder of the building is existing. Do the residential standards apply?

Answer

Yes. Since 100% of the addition being permitted is a low-rise residential occupancy, compliance under the residential standards is required.

Example 1-9

Question

A residence is being moved to a different location. What are the applicable compliance requirements?

Answer

Because this is an existing conditioned space, the requirements applicable to alterations would apply to any alterations being made. The building does not need to show compliance with the current Energy Standards applicable to new buildings or additions.

Example 1-10

Question

A previously conditioned retail space is remodeled to become a residential dwelling. What are the applicable compliance requirements?

Answer

The remodeled dwelling is treated as if it were previously a residential occupancy. In this case, the rules that apply to residential alterations are applied.

Example 1-11

Question

A 10,000 ft², 16-unit motel is constructed with an attached 1,950 ft² manager's residence. What are the applicable compliance requirements?



Source: <http://www2.sjsu.edu/faculty/wooda/calpark.jpeg>

Answer

The manager's unit is less than 20 percent of the total floor area, so compliance of the whole building as the predominant motel occupancy would satisfy the requirements of the Energy Standards. Either the entire building must comply with the nonresidential (high-rise residential and hotel/motel) standards; or the manager's residence must comply with the low-rise residential standards and the motel occupancy portion of the building must comply with the nonresidential standards.

Example 1-12**Question**

A subdivision of detached homes includes several unit types, each of which may be constructed in any orientation. What are the applicable compliance requirements?

Answer

The low-rise residential standards are applied to each building type. All four cardinal orientations may be shown to comply, or each individual unit in the planned orientation must comply.

Example 1-13**Question**

A four-story apartment building has three stories of apartments and a garage on the first floor. What are the applicable compliance requirements?

Answer

For compliance with the Energy Standards, the low-rise residential standards apply since the building has fewer than four habitable stories. However, for other non-energy codes and standards, this may be considered a four-story building.

Example 1-14**Question**

If in Example 1-13 above, there was a small air-conditioned elevator lobby at the garage floor, what would be applicable compliance requirements?

Answer

§100.1 defines a habitable story as a story that contains space in which people may work or live in reasonable comfort, and that has at least 50 percent of the volume therein above grade. The small elevator lobby does not meet this definition for habitable story; therefore, the low-rise residential standards still apply.

Example 1-15**Question**

If, in Example 1-13 above, there was a receptionist station in the conditioned elevator lobby at the garage floor. What would be the applicable compliance requirements?

Answer

In this case the lobby with the receptionist meets the habitable story definition of §100.1; therefore, the building must be considered a high-rise residential occupancy. The building envelope and HVAC equipment must comply with the nonresidential (high-rise residential) standards, and the dwelling units must comply with the lighting and water heating requirements for low-rise residential buildings .

1.6 Mandatory Measures and Compliance Approaches

In addition to the mandatory measures (Section 1.6.2), the Energy Standards provide two basic methods for complying with low-rise residential energy budgets: the prescriptive approach and the performance approach. The mandatory measures must be installed with

either of these approaches, but mandatory measures may be superseded by more stringent measures under either approach.

1.6.1 Approaches

- A. The **prescriptive approach**, composed of a climate zone dependent prescriptive package (Section 1.6.3), is less flexible but simpler than the performance approach. Each energy component of the proposed building must meet a prescribed minimum efficiency. The prescriptive approach offers relatively little design flexibility but is easy to use. There is some flexibility for building envelope components, such as walls, where portions of the wall that do not meet the prescriptive insulation requirement may still comply as long as they are area-weighted with the rest of the walls, and the average wall performance complies.
- B. The **performance approach** (Section 1.6.4) is more complicated but offers considerable design flexibility. The performance approach requires an approved computer software program that models a proposed building, determines the allowed energy budget, calculates the energy use of the building, and determines when it complies with the budget. Compliance options such as window orientation, shading, thermal mass, zonal control, and house configuration are all considered in the performance approach. This approach is popular with production home builders because of the flexibility and because it provides a way to find the most cost-effective solution for complying with the Energy Standards.

For additions and alterations, see Chapter 9 for details of compliance approaches that are available.

1.6.2 Mandatory Measures

With either the prescriptive or performance compliance paths, there are mandatory measures that must always be installed. Many of the mandatory measures deal with infiltration control and lighting; others require minimum insulation levels and equipment efficiency. New for the *2016 Building Energy Efficiency Standards* are mandatory measures that require higher insulation values for the building envelope, better duct sealing to limit air leakage, and high-efficacy lighting. For detailed information on these changes, see applicable sections within this manual. The minimum mandatory levels are sometimes superseded by more stringent prescriptive or performance approach requirements. For example, if mandatory measures specify R-22 ceiling insulation and the prescriptive approach, Package A, is used, then R-38 ceiling insulation (depending on climate zone) must be installed. Conversely, the mandatory measures may be of a higher efficiency than permitted under the performance approach; in these instances, the higher mandatory levels must be installed. For example, a building may comply using the performance computer modeling only R-7 insulation in a raised floor, but R-19 must be installed because that is the mandatory minimum.

1.6.3 Prescriptive Package A

§150.1(c)

The prescriptive requirements are represented in Package A. The prescriptive package is the simplest but least flexible compliance path. Package A establishes the stringency of the Energy Standards for the performance approach. Approved computer programs model a house with the features of Package A to determine the envelope, space conditioning, and water-heating budgets.

The prescriptive package is a set of predefined performance levels for various building components. Each building component must meet or exceed the minimum efficiency level specified in the package. Package A is presented in Table §150.1-A (and related footnotes) in the Energy Standards and also in Appendix B of this document. These prescriptive requirements require that ducted split-system and packaged air conditioners or heat pumps (for definition, see Reference Joint Appendix JA1) be HERS-tested to verify that they have the correct refrigerant charge.

1.6.4 Performance Approach

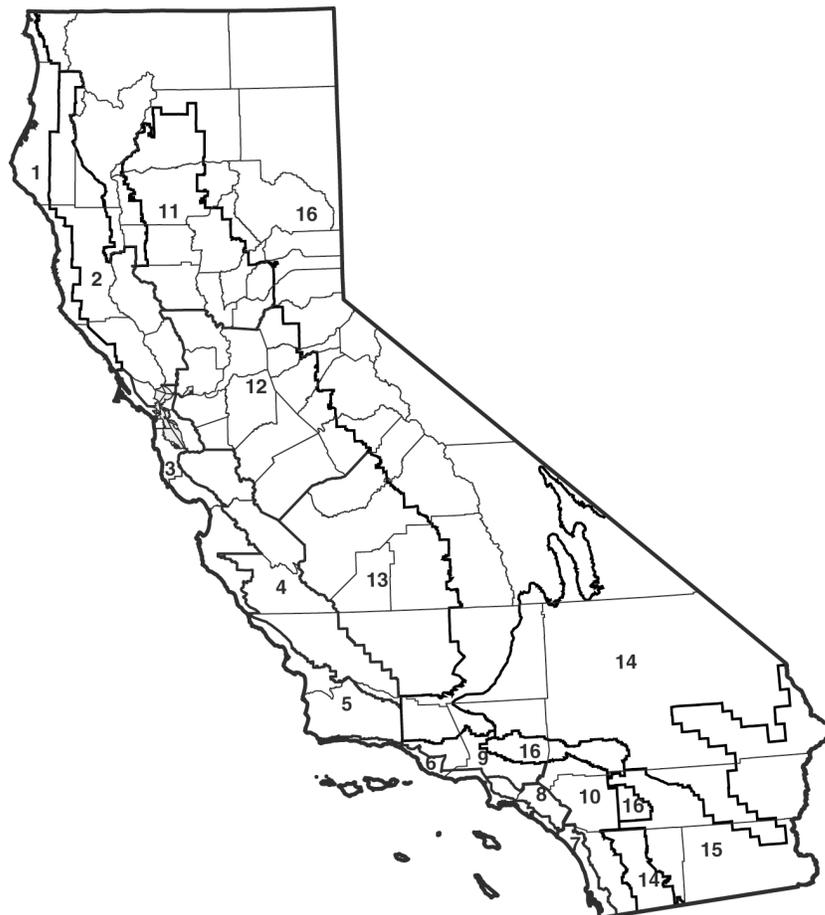
The performance approach, also known as the computer method, requires that the annual Time-Dependent Valuation (TDV) energy be calculated for the proposed building and compared to the standard TDV energy budget. TDV energy is the “currency” for the performance approach. TDV energy not only considers the type of energy that is used (electricity, gas, or propane), but when it is used. Energy saved during periods when California is likely to have a statewide system peak is worth more than energy saved at times when supply exceeds demand. Reference Joint Appendix JA3 has more information on TDV energy.

The use of Energy Commission-approved computer methods represents the most detailed and sophisticated method of compliance. While this approach requires the most effort, it also provides the greatest flexibility. The computer program automatically calculates the energy budget for space conditioning and water heating. The budget is determined from the standard design, a computer model of the building using the Package A prescriptive package. The computer software allows manipulation of the proposed building’s energy features to achieve or surpass the standard energy budget, that is, the proposed energy consumption of the building would be equal to or less than the standard energy budget. See Chapter 8 of this manual for more information on the performance method.

1.7 Climate Zones

To standardize calculations and to provide a basis for presenting the prescriptive requirements, the Energy Commission has established a set of standard climate data for each of the 16 climate zones. More information is provided in *Reference Joint Appendix JA2*, including a listing of climate zones for all California ZIP codes. *Reference Joint Appendix JA2* gives other climate information, such as design temperatures for sizing HVAC equipment. The climate zone definitions and data are the same for both the low-rise residential and the nonresidential standards.

Beginning with the 2013 Energy Standards, ZIP code boundaries have been used to define climate zone boundaries; under these rules, a given ZIP code is always located entirely within a single climate zone.

Figure 1-1: California Climate Zones

Source: California Energy Commission

1.7.1 Building Location Data

Building location data refer to specific outdoor design conditions used in calculating heating and cooling loads. Different from the climate zone used for compliance (see *Climate Zones* above), design data include the typically warmest and coolest outdoor temperatures that a building is likely to experience in an average year in a particular location.

Temperatures are from the ASHRAE publication, *SPCDX, Climatic Data for Region X - Arizona, California, Hawaii, Nevada*, May 1982 edition. (See Appendix C.) For heating, the outdoor design temperature is the Winter Median of Extremes. A higher temperature is permitted but no lower than this value. For cooling, the outdoor design temperatures must be the 1.0 percent Summer Design Dry Bulb and the 1.0 percent Wet Bulb columns.

If a building location is not listed, the local enforcement agency may determine the location for which data are available that is closest in its design characteristics to the actual building site.

1.8 Conditioned Floor Area

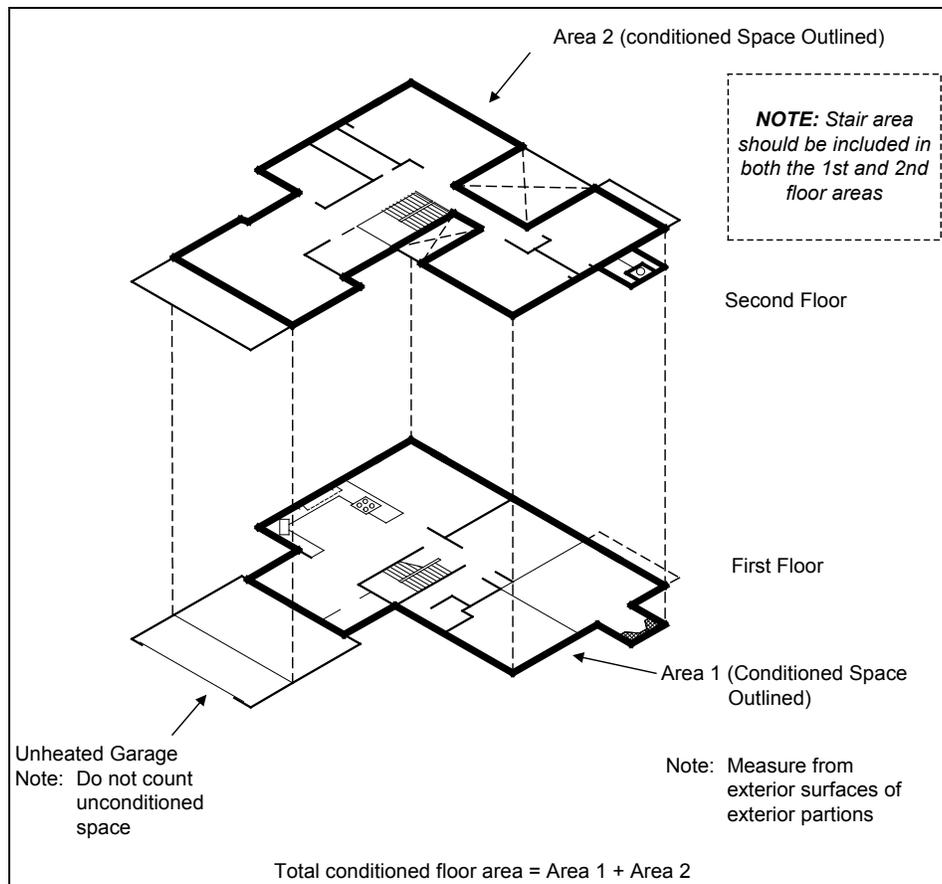
Conditioned floor area (CFA) is the total floor area (in square feet) of enclosed conditioned space on all floors of a building, as measured at the floor level of the exterior surfaces of exterior walls enclosing the conditioned space (§100.1). This term is also referred to in the Energy Standards simply as the *floor area*.

This is an important value for compliance since annual energy use is divided by this value to obtain the energy budget. In the prescriptive package, the maximum fenestration and west-facing fenestration area requirements are expressed as a percentage of this value.

CFA is calculated from the plan dimensions of the building, including the floor area of all conditioned and indirectly conditioned space on all floors. It includes lofts and mezzanines but does not include covered walkways, open roofed-over areas, porches, pipe trenches, exterior terraces or steps, chimneys, roof overhangs, or parking garages. Unheated basements or closets for central gas-forced air furnaces are also not included, unless shown to be indirectly conditioned.

The floor area of an interior stairway is determined as the CFA beneath the stairs and the tread area of the stairs themselves. See figure 1-2 below for an example of how CFA is calculated.

Figure 1-2: Total Conditioned Floor Area



1.9 Where to Get Help

The Energy Commission has several resources to help designers, builders, homeowners, and others understand and apply the Energy Standards.

1.9.1 Energy Commission Publications and Support

A. Telephone Hotline

If the information contained in the Energy Standards or this compliance manual are not sufficient to answer a specific question concerning compliance or enforcement, technical assistance is available from the Energy Standards Hotline.

You can reach the Energy Standards Hotline on weekdays from 8 a.m. – noon and 1 p.m. – 4:30 p.m.:

(800) 772-3300

(916) 654-5106

B. Publications

Publications, including the *2016 Building Energy Efficiency Standards*, the *2016 Reference Appendices*, and the *2016 Residential ACM Approval and Reference Manuals*, and others are available from the Energy Commission's website at <http://www.energy.ca.gov/title24>. Paper copies may also be ordered from:

Publications Unit

California Energy Commission

1516 Ninth Street, MS-13

Sacramento, CA 95814

(916) 654-5200

C. Blueprint

The Energy Commission publishes the *Blueprint*, a newsletter that answers questions and addresses issues related to enforcement and compliance. The *Blueprint* also provides updated information on technical assistance and computer compliance programs and lists training opportunities offered throughout the state. The *Blueprint* is available online at <http://www.energy.ca.gov/efficiency/blueprint>.

Figure 1-3: Energy Commission Blueprint Newsletter



In This Issue

- » 2016 Energy Standards Approved
- » Alpha Versions of CBECC 2016 Now Available
- » CBECC-Com Version 3c
- » Water Heater Energy Factor Reference Guide
- » CALCTP Lighting Controls Certificates of Acceptance
- » Q&A
 - Natural Ventilation
 - Bypass Ducts
 - Heat Pump Water Heating Systems

2016 Energy Standards Approved

The California Energy Commission (Energy Commission) unanimously approved the 2016 Building Energy Efficiency Standards (Energy Standards), except the nonresidential lighting alterations language, at the June 10, 2015 Business Meeting. The 2016 Energy Standards will reduce energy costs, save consumers money, and increase comfort in new and upgraded homes and other buildings.

Single family homes built with the Energy Commission's 2016 Energy Standards will use about 28 percent less energy for lighting, heating, cooling, ventilation, and water heating than those built to the 2013 Energy Standards.

The 2016 Energy Standards, which take effect on January 1, 2017, focus on three key areas: updating residential requirements to move closer to California's zero net energy goals; updating nonresidential and high-rise residential requirements; and improving the clarity and consistency of existing regulations. Based on a 30-year mortgage, the Energy Commission estimates the 2016 Energy Standards will add about \$11 per month for the average home, but will save consumers \$31 on monthly heating, cooling, and lighting bills.

In addition to simplifying the language, other major improvements include:

Residential

- » High performance attics: extra insulation at the roof deck in addition to ceiling insulation will reduce the attic temperature by 35 degrees or more on hot summer days.
- » High performance walls: builders can choose from different wall assemblies to reduce heating and cooling needs in the home year round.
- » Lighting: installation of high quality lighting with controls that nearly halve the energy required for lights in new homes.
- » Water heating: installation of tankless water heaters that reduce energy use by about 35 percent.

Nonresidential

- » Envelope: revision of envelope requirements for all nonresidential and high-rise residential buildings.
- » Lighting: update power for lights to align with the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards. This allows for the installation of newer, more efficient luminaires which are widely available and commonly used for outdoor lighting applications.
- » Elevators: require controls to shut off lights and fans when an elevator is empty. Installation of these controls enables communication with building energy management systems, allowing managers to tailor the building's energy demands and prevent waste.
- » Escalators and moving walkways: require controls on escalators and moving walkways in transit areas to run at a lower, less energy-consuming speed when not in use.
- » Windows and doors: require interlock controls that turn off cooling and heating systems if a door or window is left open for more than five minutes. This allows occupants to take advantage of outside temperatures and save on heating and cooling costs.

For more information about the 2016 Energy Standards, view the [frequently asked questions](#) and [infographic](#).

Please note that Sections 141.0(b)(2), J, K, and L, related to nonresidential lighting alterations, were not adopted at the June 10, 2015 Business Meeting. Adoption of these sec-

D. Appliance Standards

Appliances, as defined by the Energy Commission, include everything from dishwashers and refrigerators to air conditioners and boilers. The performance of some appliances, such as air conditioners, water heaters, and furnaces, is critical to the *Building Energy Efficiency Standards*. The energy efficiency of other appliances, such as refrigerators, dishwashers, and clothes dryers, is important to homeowners but does not affect the *Building Energy Efficiency Standards*, since these are considered home furnishings.

The Energy Commission has comprehensive standards that affect the performance of many appliances. *Appliance Standards* information is available from the Energy Commission website at <http://www.energy.ca.gov/appliances/>.

E. Appliance Directories

The Energy Commission publishes information on the energy efficiency of appliances. Energy Commission-approved directories can be used to determine if appliances meet

the mandatory measures and/or the prescriptive requirements. Data may also be used in performance calculations. The Energy Standards Hotline can verify certification of appliances and provide information on appropriate directories.

The complete appliance database (including manufacturer, brand codes, rated efficiencies, and so forth) can be searched from the Energy Commission's website at

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

F. Directory of Certified Insulation Materials

Manufacturers whose insulating materials are certified for sale in California are listed in the Department of Consumer Affairs's *Consumer Guide and Directory of Certified Insulation Material*. Each building department receives a copy of this directory. If an insulating product is not listed in the directory, or to purchase a directory, contact the Department of Consumer Affairs, Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal Insulation (BEARHFTI), at (916) 999-2041.

1.9.2 Training Opportunities

California utilities, organizations of energy consultants, building industry, trade associations, and organizations that serve building officials often sponsor or conduct classes on compliance and enforcement of the Energy Standards. These classes are often listed in the *Blueprint* or posted on the Energy Commission's website at <http://www.energy.ca.gov/title24>.

Energy Code Ace offers free tools, training, and resources to help identify the compliance documents, installation techniques, and standards relevant to building projects in California. Energy Code Ace resources provide fact sheets, trigger sheets and checklists to help readers understand when Title 24, Part 6 is "triggered" and how to correctly comply when it is.

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

<http://energycodeace.com/>

1.9.3 Energy Consultants

The California Association of Building Energy Consultants (CABEC) maintains a directory of consultants who provide compliance assistance. The listing is available at <http://www.cabec.org>.

1.9.4 Online Videos

The Energy Commission has a series of streaming videos that explain energy efficiency concepts and the application of the Energy Standards. These videos cover topics including plan checking, field inspection, HVAC, HERS, water heating, building envelope, and renewable energy. They can be viewed at <http://www.energyvideos.com>.

1.9.5 HERS Raters and Providers

To comply with the Energy Standards, some buildings require third-party diagnostic testing or field verification of energy-efficient systems or devices. HERS Raters are required to be hired by the builder or building owner to perform this work. Installing contractors may hire the HERS Rater for HVAC changeouts only if the homeowner agrees that the installing contractor may do so on his or her behalf. The Energy Commission approves HERS providers who train, certify, and monitor HERS Raters. For a list of the current HERS providers, please go the Energy

Commission website at <http://www.energy.ca.gov/HERS/>. To find a Rater, go to the website of the approved HERS provider available on the Energy Commission's website at the link above, or contact the Energy Standards Hotline at (800) 772-3300 (for calls within California) or (916) 654-5106 for assistance.