1. Introduction

This compliance manual is intended to help owners, designers, builders, inspectors, examiners, and energy consultants comply with and enforce California's energy efficiency 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 both 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 residential buildings.

The compliance manual has eight chapters:

- This chapter (Chapter 1) introduces the 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 design of the building envelope.
- Chapter 4 covers the requirements for HVAC systems.
- Chapter 5 covers the water heating systems requirements.
- Chapter 6 addresses the requirements for interior and for outdoor lighting permanently attached to the building.
- Chapter 7 covers the computer performance approach.
- Chapter 8 covers additions, alterations, and repairs.

1.1 Related Documents

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

- *The California 2005 Building Energy Efficiency Standards (Title 24, Part 6).* 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 Standards to refer to while reading this manual and also a copy of the Joint Appendix Manual.

- *Joint Appendices.* The joint appendices to the residential and nonresidential Alternate Calculation Method (ACM) manuals contain information that is common to both the residential and nonresidential standards.
- *Joint* Appendix I is a glossary of terms.
- *Joint* Appendix II summarizes the climate zones and design conditions in California cities.
- *Joint* Appendix III is a summary of time dependent valuation (TDV), the new currency for performance calculations.
- *Joint* Appendix IV contains thermal performance data for wall, roof and floor constructions that must be used in calculations.
- *The 2005 Residential ACM Manual.* The 2005 Residential ACM Manual is primarily a specification for computer software that is used for compliance purposes; however, the appendices contain field verification and/or diagnostic testing procedures for HVAC equipment, air distribution ducts, and insulation construction quality.

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

1.2 The Technical Chapters

Each of the four technical chapters (3 through 6) begins with an overview, which is followed by a presentation of each subsection. For the building envelope, subsections include fenestration, opaque surfaces (walls, floors, and roofs), and air leakage and infiltration. For HVAC, the subsections include heating equipment, cooling equipment, and ducts. Mandatory measures and prescriptive requirements are described within each subsection or component. Chapter 7 describes the computer performance approach. Chapter 8 covers requirements for additions and alterations.

Each chapter or subsection also has a *compliance options* section. The *compliance option*s section includes information on how to design a building that goes beyond the energy efficient prescriptive requirements and mandatory measures. Compliance options can get credit through the performance approach. There are also *design recommendations* , such as on-site generation, for which no credit is offered (but that will still significantly impact building energy use or peak demand).

Table 1-1 – Compliance Options vs. Design Recommendations

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

1.3 Why California Needs Energy Efficiency Standards

Because energy efficiency reduces energy costs, increases reliability and availability of electricity, improves building occupant comfort, and reduces impacts to the environment, standards are important and necessary for California's energy future.

Energy Savings

Reducing energy use is a benefit to all. Homeowners save money, Californians have a more secure and healthy economy, the environment is less negatively impacted, and our electrical system can operate in a more stable state. The 2005 Standards (for residential and nonresidential buildings) are expected to reduce the growth in electricity use by 478 gigawatt-hours per year (GWh/yr) and reduce the growth in gas use by 8.8 million therms per year (therms/yr). The savings attributable to new low-rise residences are 99 GWh/yr of electricity savings and 5.5 million therms. Additional savings result from the application of the Standards on building alterations. In particular, requirements for fenestration replacement and duct sealing in existing buildings are expected to save about 41 GWh/yr of electricity and 3.0 million therms/yr of gas. These savings are cumulative resulting in six times the annual saving over the three years to the next standard cycle.

Electricity Reliability and Demand

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

Since the California electricity crisis, the Energy Commission has placed more and more emphasis on demand reductions. Changes in 2001 (following the electricity crisis) reduced electricity demand by about 150 megawatts (MW) each year. The 2005 Standards are expected to reduce electric demand by another 180 MW each year. Like energy savings, demand savings accumulate each year.

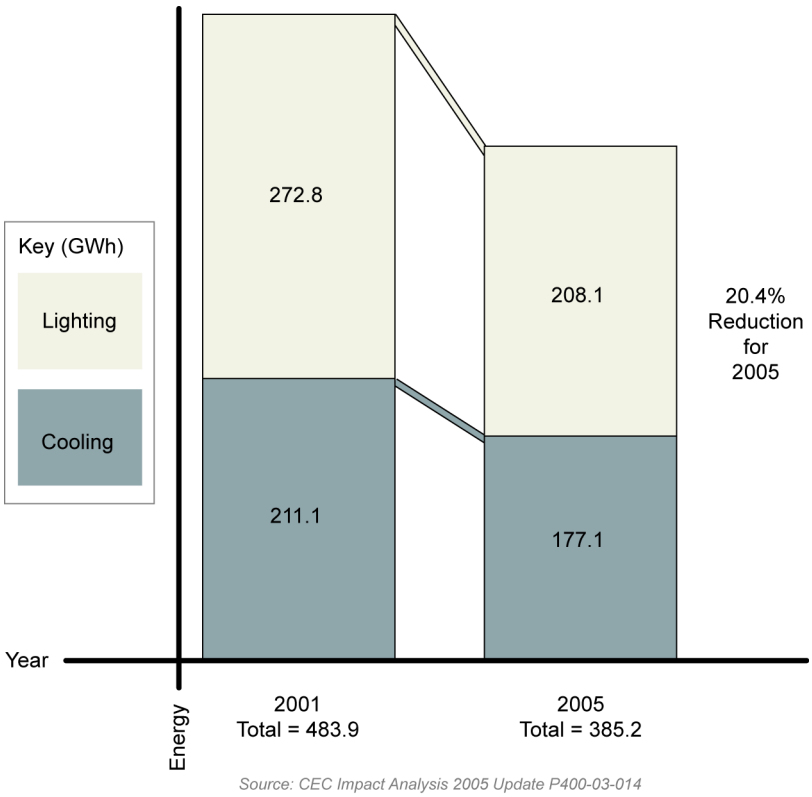


Figure 1-1 – One Year Low-Rise Residential Electricity Reduction Due to the 2005 Standards

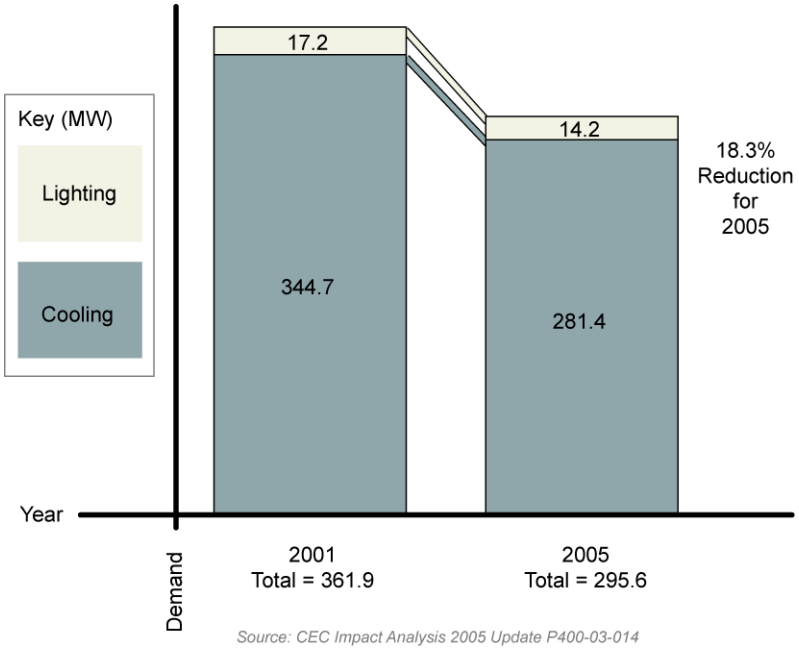


Figure 1-2 – One Year Low-Rise Residential Electric Demand Reduction Due to the 2005 Standards

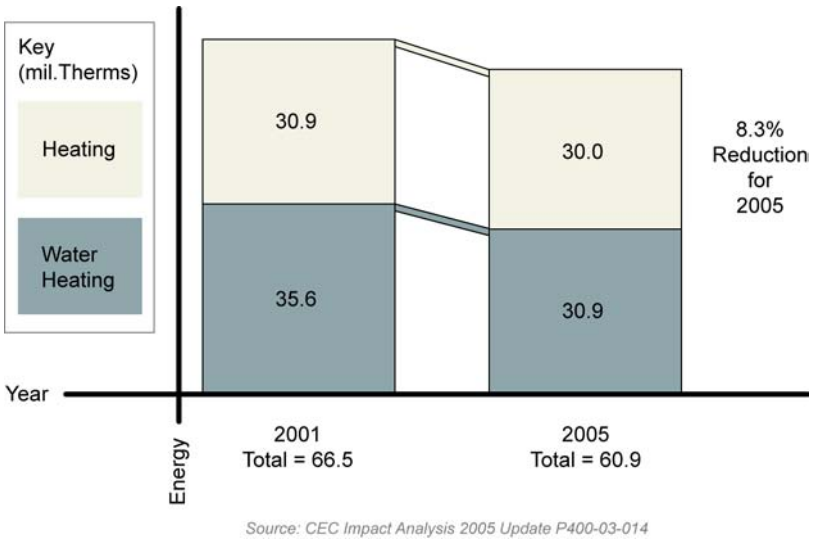


Figure 1-3 – Gas Reduction Due to the 2005 Standards

Comfort

Comfort is an important benefit of energy efficient homes. Energy efficient houses are well insulated, 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.

The Standards provide a compliance credit for properly sizing the air conditioner. This improves comfort through an even source of cooling, as opposed to an oversized air conditioner that runs for a short period of time, cools off the house and then sits idle for an extended period of time. Provided that the duct system has been properly designed and installed and has minimal leaks, a smaller air conditioner that runs for a more extended period does a better job of reducing humidity in a house; may use less energy; and creates less stress on the electrical distribution system than an oversized system.

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 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.

Environment

In many parts of the world, the use of energy 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 to maintain environmental quality. Other benefits include reduced destruction of natural habitats, which in turn helps protect animals, plants, and natural systems.

Global Warming

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

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

The National Academy of Sciences has urged the whole country to follow California's lead on such efforts, saying that conservation and efficiency should be the chief element in energy and global warming policy. Their 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 also play a vital role in creating and maintaining a healthy environment.

The Warren Alquist Act

Section 25402 of the Public Resources Code

The authority of the Energy Commission to develop and maintain energy efficiency standards for new buildings is provided in Section 25402 of the Public Resources Code. This section of the Code, commonly referred to as the Warren Alquist Act, is direction from the legislature on the development of energy efficiency standards in California.

The act created the Energy Commission in 1974 and gave it authority to develop and maintain 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 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 the Standards. Six months after publication of the manuals, the act directs local building permit jurisdictions to withhold permits until the building satisfies the Standards.

The Public Resources Code was amended through Senate Bill 5X in 2002 to expand the authority of the Energy Commission to develop and maintain standards for outdoor lighting and signs.

1.4 What's New for 2005

The most significant changes in the 2005 Building Energy Efficiency Standards include time-dependant valuation that favors peak energy saving measures over off peak measures and new federal air conditioner and water heater standards. Other changes for residential buildings include the following.

All compliance approaches:

- Time Dependent Valuation (TDV). Source energy (which has served California well) was replaced with TDV energy. TDV energy values energy savings greater during periods of peak demand, such as hot summer weekday afternoons, and values energy savings less during off peak periods. TDV gives more credit to measures such as high EER air conditioning units that are more effective during peak periods.
- Efficient lighting – high efficacy (e.g., fluorescent) in all permanent lighting or controls; high efficacy in kitchens; high efficacy or motion sensor in bathrooms, utility rooms, garages, laundry rooms; high efficacy or combined photo sensor/motion sensor for exterior lights; high efficacy or dimmer in other lighting; airtight recessed luminaries
- Third-party field verification – changes made to encourage quality installation to be field verified, including compliance credit for field-verified high quality installation of insulation; group measures requiring third-party testing and verification and improved protocols and procedures.

Prescriptive compliance:

- Duct insulation – Insulation levels depend on climate zone and range from R-4.2 to R-8
- Pipe insulation –hot water pipes ¾ inch and greater in diameter to the kitchen have to be insulated
- Replacement windows – shall be of high efficiency

- Fenestration area limit – limits the fenestration area to 20% of the conditioned floor area in all climate zones for new construction and existing homes subject to certain alterations; for new construction, limits the west facing glass to 5% of the conditioned floor area in cooling climate zones.
- Duct sealing – required when air conditioner/furnace is replaced or ducts are replaced.

Performance compliance:

- Loopholes closed – credit no longer given for reduced glazing area or using a central water heating system in multifamily buildings
- Compliance credit – high EER air conditioners, gas cooling, high quality insulation installation, properly sized air conditioners, efficient air conditioner fan motors, ducts buried in attic insulation
- Additions/Alterations – compliance credit for alterations made to an existing building receive credit only if the improved measure meets or exceeds the prescriptive requirement.

1.5 Scope and Application

1.5.1 Building Types

Though the California Standards apply to both nonresidential and residential buildings, this compliance manual only addresses 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.

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 floors falls under the low-rise residential standards while an apartment building that has more than three habitable floors 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, e.g., the *Nonresidential Compliance Manual* makes reference to Chapters 5 and 6 of this document.

A habitable floor is defined in the California Building Code (CBC) and that definition is used with the energy efficiency standards. Mezzanines are not counted as separate habitable floors – 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 humans may live or work in reasonable comfort, and that has at least 50% of its volume above grade.

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 residence. 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 floors.

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 §146 of the Standards for more information.

Explanation of Term

The term building type refers to the classification of buildings defined by the *CUBC* and applicable to the requirements of the *Energy Efficiency Standards.* This manual is concerned with the energy standards that apply to all new low-rise residential buildings, which includes all single-family dwellings and multi-family buildings with three or fewer habitable stories in the entire building. This manual does not consider standards applicable to multi- family buildings with four or more habitable stories in the entire building, hotels, motels and officially designated historical buildings. A multi-family building contains multiple dwelling units that share common walls (single family attached) and may also share common floors or ceilings (apartments).

All new residential buildings not in the above low-rise category are covered in the 2005 edition of Energy Commission's *Nonresidential Manual for Compliance with Energy Efficiency Standards* (see Parts 1.1 and 1.2).

- A single-family building is a single dwelling unit of occupancy group R-3, as defined in the *CUBC,* which stands separate and unattached from other dwelling units but may have an attached garage.
- A multi-family building is a dwelling unit of occupancy group R, as defined in the *CUBC*, that shares a common wall and/or floor/ceiling with at least one other dwelling unit. See Chapter 8 for more information on multi-family energy compliance. A single family attached building is a dwelling unit of occupancy group R that shares a common wall with another dwelling unit.
- An addition is an extension of or increase in conditioned floor area and volume of a building, which can be new construction or adding space conditioning to an existing space. See Chapter 7 for more information on energy compliance of additions.
- 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." [CUBC**,** Part II, Section 403]

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.

Includes:
• All single family dwellings of any number of stories (Group R-3)
• All duplex (two-dwelling) buildings of any number of stories (Group R-3)
• All multifamily buildings with three or fewer habitable stories (Groups R-1 and R-2)
• Additions and alterations to all of the above buildings.
• Lighting requirements for living quarters in high-rise multifamily buildings (over 3 stories) and water heating requirements for high rise multifamily buildings (over 3 stories)
	Includes:
	• Offices
	• Retail and wholesale stores
	• Grocery stores
	• Restaurants
	• Assembly and conference areas
	• Industrial work buildings
	• Commercial or industrial storage
	• Schools and churches
	• Theaters
	• Hotels and motels
	  • Apartment and multifamily buildings with four or more habitable stories (envelope and HVAC requirements)
	  • Long-term care facilities (group R-2) with four or more habitable stories
	  • Dormitories or other congregate residences, or any building with dormitory-style sleeping quarters, with six or more “guest rooms”
	  • Private garages, carports, sheds, and agricultural buildings.

1.5.2 Historical Buildings

Exception 1 to §100(a)

Exception 1 to the Standards §100(a) states that qualified historic buildings, as defined 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. Building Energy Efficiency Standards §146 (a) 5.0 clarifies that lighting systems in qualified historic buildings are exempt from the lighting power allowances only if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified historic buildings contain some historic lighting components or replicas of historic components, combined with other lighting components, only those historic or historic 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) § 102.1.1 specifies that all nonhistorical additions must comply with the regular code for new construction, including the Building Energy Efficiency Standards. CHBC § 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. It should be noted that 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 § 18951).

Additional information about the CHBC can be found on the following web site:

http://www.dsa.dgs.ca.gov/StateHistoricalBuildingSafetyBoard

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

Example 1-1

Question

Are additions to historical buildings also exempt?

Answer

If the addition adjoins the qualified historic building, then the building official at his discretion may exempt those measures, which he determines could damage the historic value of the building. However, “additions which are structurally separated” from the historical building are not exempt from the Energy Efficiency Standards and must comply with 2001 building codes (Historical Building Code, Title 24, Part 8, §8-704).

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 Standards not apply to this addition?

Source: CEC Photographer: Andersen Windows

Answer

The Standards do not apply if the space is unconditioned. The sunspace is unconditioned if:

•The new space is not provided with heating or cooling (or supply ducts);

•The new space can be closed off from the existing house with weather stripped doors; and,

•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 Standards apply.

1.5.3 Exempt Buildings

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

- Seasonally occupied agricultural housing limited by state or federal agency contract to occupancy not more than 180 days in any calendar year
- 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 non-mechanical system
- Temporary buildings, temporary outdoor lighting or temporary lighting in an unconditioned building, or structures erected in response to a natural disaster.

1.5.4 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 Standards do not apply to residential appliances (Appliance Efficiency Regulations may apply); elevators or dumbwaiters; or to 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.

1.5.5 Additions, Alterations and Repairs

§101(b)

§152 (a)

§152 (b)

Additions, alterations, and repairs are common construction projects for California homeowners. The Standards apply to both additions and alterations, but not to repairs. See Chapter 8 for details.

- Additions are changes to an existing building that increases conditioned floor area and volume.
- Alterations are changes to a building's envelope, space conditioning system, water heating system or lighting system, that are not additions.
- Repairs are the reconstruction or renewal of any part of an existing building for the purpose of its maintenance.

Example 1-3

Question

The Standards do not specify whether buildings damaged by natural disasters can be reconstructed to their 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 to rebuild for those portions of the building that are being rebuilt.

Example 1-4

Question

Do the 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 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. Should the residential apartments comply with the Residential Standards?

Answer

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. Should the townhouse 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 1,200-ft² manager's residence is being constructed as part of a new conditioned warehouse building with 14,000 ft². Which 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 10% 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 prescriptive 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?

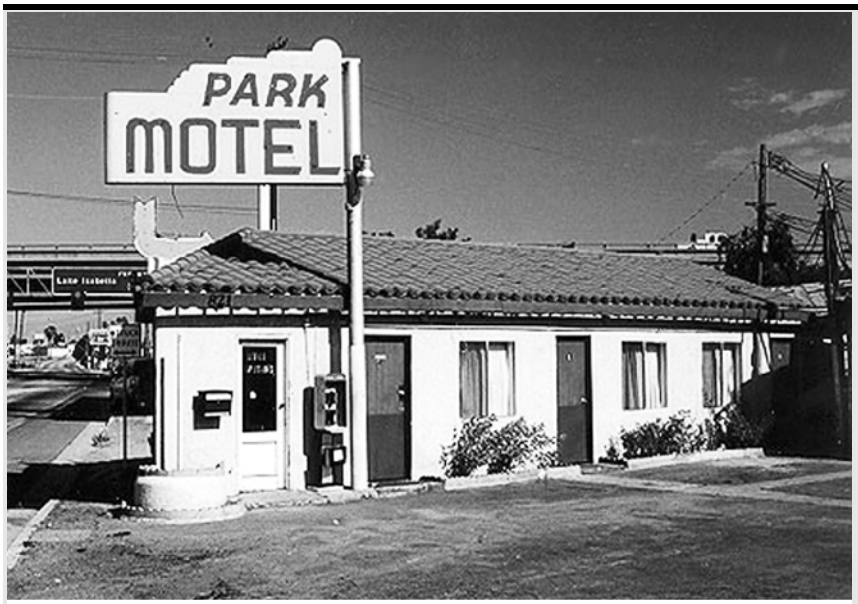
Answer

The residential 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 ft^2, 16-unit motel is constructed with an attached 950 ft^2 manager's residence. What are the applicable compliance requirements?



Source: http://www2.sisu.edu/faculty/wooda/calpark.jpeg

Answer

The manager's unit is less than 10% of the total floor area, so compliance of the whole building as the predominant motel occupancy would satisfy the requirements of the 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 its 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 Standards compliance, the low-rise residential standards apply since the building has fewer than four habitable stories. However, for the purpose of other non-energy codes and standards this may be considered a four-story building.

1.6 Mandatory Measures and Compliance Approaches

In addition to the mandatory measures (Section 1.1.6), the 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 but note that mandatory measures may be superseded by more stringent measures under the prescriptive approach.

1. The prescriptive approach (composed of several prescriptive packages) (Section 1.6.2) is the simpler. Each individual 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.
2. The performance approach (Section 1.6.3) is more complicated but offers considerable design flexibility. The performance approach requires an approved computer software program that models a proposed building, determines its allowed energy budget, calculates its energy use, 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 Standards.

For additions and alterations, see Chapter 8 for details of compliance approaches that are available.

1.6.1 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. The minimum mandatory levels are sometimes superseded by more stringent prescriptive requirements. For example, if mandatory measures specify R-19 ceiling insulation and the prescriptive approach, Package D, is used, R-30 or 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 the performance computer modeling with only R-7 insulation in a raised floor, but R-13 must be installed because that is the mandatory minimum in prescriptive Package D.

1.6.2 Prescriptive Packages

§151(f)

The prescriptive requirements are organized by packages. The prescriptive packages are the simplest and least flexible compliance path. The central prescriptive package, Package D, establishes the stringency of the Standards for the performance approach. Approved computer programs model a house with the features of Package D to determine the space conditioning and water heating budgets.

Each prescriptive package is a set of pre-defined performance levels for various building components. Each building component must meet or exceed the minimum efficiency level specified in the package. There are two packages to choose from: Package C (the all-electric house, applied to locations where natural gas is not available) and Package D. (Packages A and B were eliminated in the 2001 Standards.)

Package D and the Package D Alternative are presented in Table 151-C (and its footnotes) in the Standards (also in Appendix B of this document). Package C is presented in Table 151-B of the Standards (Appendix B of this document).

- Standard Package D. The Package D prescriptive requirements serve as the basis of the standard design in the performance approach and determine the energy budget of a proposed design. These prescriptive requirements require that split system air conditioners or heat pumps (for definition see Joint Appendix I) be diagnostically tested to verify that they have the correct refrigerant charge (or field-verified that they are equipped with a thermostatic expansion valve) and that air distribution ducts be diagnostically tested to verify that leakage does not exceed 6%.
- Alternative Package D. This is a modification to Standard Package D that does not require field verification and/or diagnostic testing. Fenestration performance and space cooling system (or in some cases the heating system) efficiency is more stringent instead. This alternative package achieves equal energy savings to Standard Package D.
- Package C. This package allows electric resistance space heat, but increases stringency for most envelope features to make up for the additional TDV energy that would be used by the electric heating systems. Electric resistance water heating may also be used with Package C if the water heater is located within the building envelope and 25% of the water heating is provided by solar or a wood stove boiler where allowed. See Section 151(f)8.

1.6.3 Performance Approach

The performance approach, also known as the computer method, requires that the annual TDV energy be calculated for the proposed house and compared to

the 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 also 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. Appendix III of the Joint Appendices 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. The budget is determined from the standard design, a computer model of the building using the Package D prescriptive package. The computer software allows manipulation of the proposed building’s energy features to achieve or do better than the energy budget.

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 *Joint* Appendix II, including a listing of climate zones for all California cities. *Joint* Appendix II 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.

Cities may occasionally straddle two climate zones. In these instances, the exact building location and correct climate zone should be verified with the building department or by the person preparing the compliance documentation before any calculations are performed. If a single building development is split by a climate zone boundary line, it must be designed to the requirements of the climate zone in which 50% or more of the dwelling units are contained.

Figure 1-4 – California Climate Zones

1.7.1 Building Location Data

Building location data refers to specific outdoor design conditions used in calculating heating and cooling loads. Different from the climate zone used for compliance (see *Climate Zone* below), design data includes the typically warmest and coolest outdoor temperatures that a building is likely to experience in an average year in its 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 is 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. [§101] This term is also referred to in the standards simply as the floor area.

This is an important value for the purpose of compliance since annual energy use is divided by this value to obtain the energy budget. In the prescriptive packages, the maximum fenestration area is 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 1-5 for an example of how CFA is calculated.

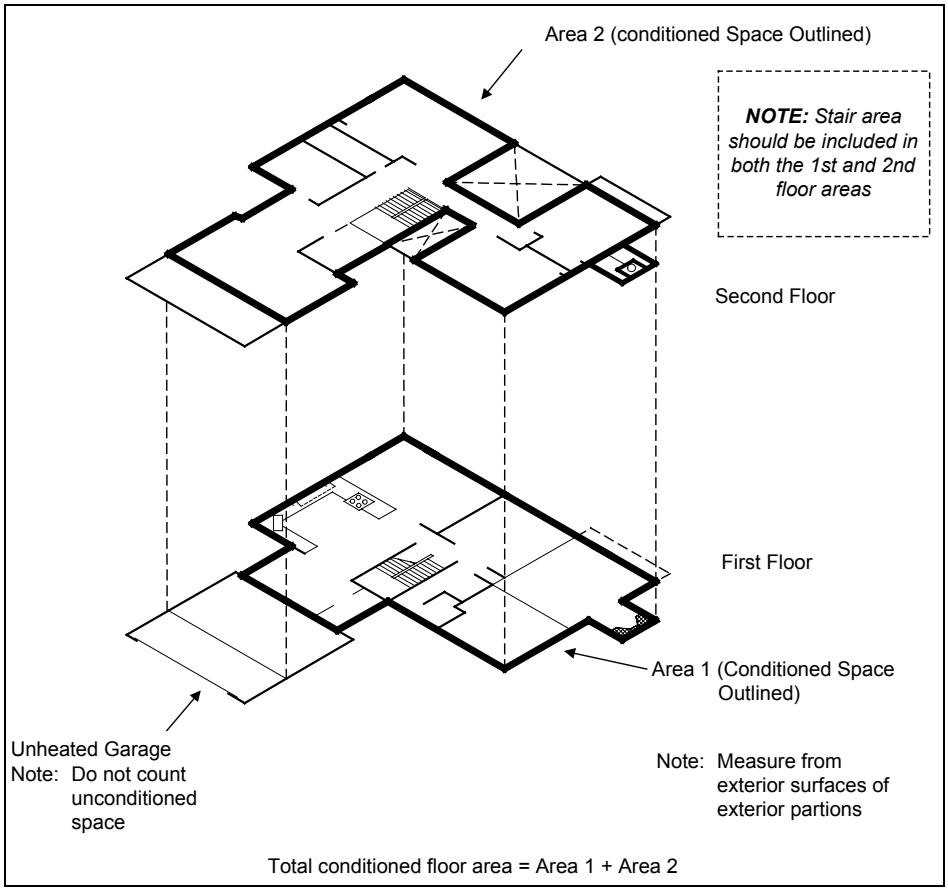


Figure 1-5 – Total Conditioned Floor Area

1.9 Where to Get Help

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

1.9.1 Energy Commission Publications and Support

Telephone Hotline

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

Your can reach the Energy Hotline on weekdays from 8:00 a.m. - noon and 1:00 p.m. – 4:30 p.m.:

(800) 772-3300
(916) 654-5106

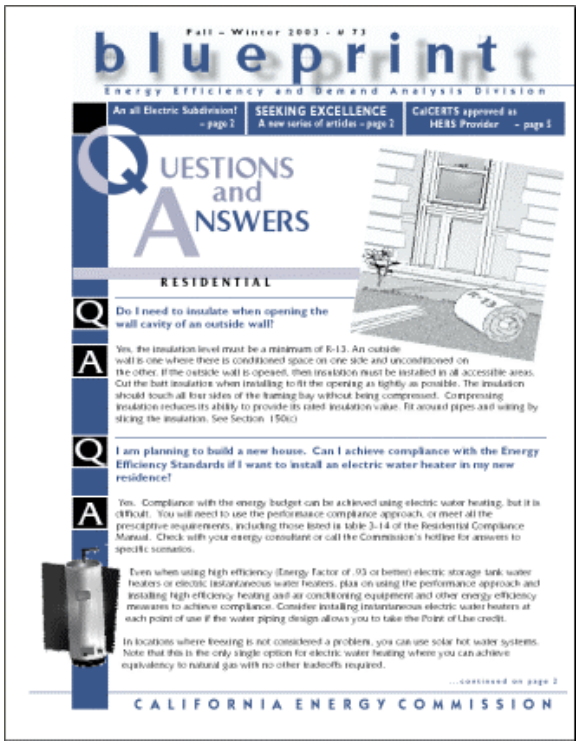
Publications

Publications including the 2005 Standards, the *Joint Appendices*, and the *2005 Residential ACM Manual* and others are available from the Energy Commission 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

Blueprint

The Energy Commission publishes the *Blueprint*, a quarterly 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 of training opportunities offered throughout the state. The *Blueprint* is available online at http://www.energy.ca.gov/title24.



Fall – Winter 2003 - # 73

blueprint

Energy Efficiency and Demand Analysis Division

An all Electric Subdivision! – page 2 | SEEKING EXCELLENCE A new series of articles – page 2 | CalCERTS approved as HERS Provider – page 3

QUESTIONS and ANSWERS

RESIDENTIAL

Q Do I need to insulate when opening the wall cavity of an outside wall?

A Yes, the insulation level must be a minimum of R-13. An outside wall is one where there is conditioned space on one side and unconditioned on the other. If the outside wall is opened, then insulation must be installed in all accessible areas. Cut the batt insulation when installing to fit the opening as tightly as possible. The insulation should touch all four sides of the framing bay without being compressed. Compressing insulation reduces its ability to provide its rated insulation value. Fit around pipes and wiring by slicing the insulation. See Section 150(c)

Q I am planning to build a new house. Can I achieve compliance with the Energy Efficiency Standards if I want to install an electric water heater in my new residence?

A Yes. Compliance with the energy budget can be achieved using electric water heating, but it is difficult. You will need to use the performance compliance approach, or meet all the prescriptive requirements, including those listed in table 3-14 of the Residential Compliance Manual. Check with your energy consultant or call the Commission's hotline for answers to specific scenarios.

Even when using high efficiency (Energy Factor of .93 or better) electric storage tank water heaters or electric instantaneous water heaters, plus on using the performance approach and installing high efficiency heating and air conditioning equipment and other energy efficiency measures to achieve compliance. Consider installing instantaneous electric water heaters at each point of use if the water piping design allows you to take the Point of Use credit.

In locations where freezing is not considered a problem, you can use solar hot water systems. Note that this is the only single option for electric water heating where you can achieve equivalency to natural gas with no other tradeoffs required.

...continued on page 2

CALIFORNIA ENERGY COMMISSION

Figure 1-6 – Energy Commission Blueprint Newsletter

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 are important to homeowners, but do not affect the building standards, since these are considered home furnishings.

The Energy Commission has comprehensive standards that affect the performance of many appliances. These are published in the Appliance Efficiency Regulations, August 2003, Publications Number P400-03-016. This document is available from the Energy Commission website at http://www.energy.ca.gov/efficiency/appliances/ or can be ordered from the Energy Commission Publications Unit (see contact information above).

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 Hotline (see above) can verify certification of appliances and provide information on appropriate directories.

The Energy Commission's website now includes references to listings of the most energy efficient appliances for several appliance types. The website address is:

http://www.energy.ca.gov/efficiency/appliances/index

The complete appliance databases can be downloaded from the Energy Commission's website at:

http://www.energy.ca.gov/efficiency/appliances/

The appliance database, as well as manufacturer/brand codes, are spreadsheet files. After downloading, these files must be decompressed and can be viewed in Excel or other compatible software.

Directory of Certified Insulation Materials

Manufacturers whose insulating materials are certified for sale in California are listed in the Department of Consumer Affair'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, Thermal Insulation Program, at (916) 574-2041.

1.9.2 Training Opportunities

If you are interested in attending a training seminar on the Standards, sign up to receive a free subscription to the *Blueprint* (see above).

Some colleges provide classes on building energy conservation and the energy standards. Information about these classes should be obtained directly from the college.

California utilities, organizations of energy consultants, building industry and trade associations, and organizations that serve building officials often sponsor or conduct classes on compliance and enforcement of the Title 24 Building Energy Efficiency Standards. These classes are often listed in the *Blueprint* or posted on the Energy Commission's website at http://www.energy.ca.gov/title24.

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 On-Line Videos

The Energy Commission has a series of streaming videos that explain energy efficiency concepts and the application of the standards. They can be viewed at http://www.energyvideos.com.

Figure 1-7 – Energy Commission Video Series
More than 100 videos produced by the Energy Commission include discussions, instructions, resources, and requirements for building residential structures.

1.9.5 HERS Raters and Providers

To achieve compliance with the standards, some buildings require third-party diagnostic testing or field verification of energy efficient systems or devices. HERS (Home Energy Rating System) raters are required to be hired by the owner to perform this work. The Energy Commission approves providers who train, certify, and monitor HERS raters. Currently, two providers are certified. To find a rater, contact the Energy Commission HOTLINE at (800) 772-3300 (for calls within California) or (916) 654-5106 or query the Energy Commission website at http://www.energy.ca.gov.

Table 1-3 – Energy Commission Video Series Titles

Area	Topic	
Plan Checking	The Plan Checking Process The Plan Checking Process – Mandatory Measures Total Energy Inspection - Pt. 1 Total Energy Inspection – Pt. 2 The Inspection Process – Foundations The Inspection Process – Framing	The Inspection Process – Final Inspection CABEC Certified Energy Analysts Water Heating Overview for Inspectors Kitchen and Bath Lighting Energy Budget vs. Mandatory Measures
HERS Providers and Raters (T-24)	Blower Door California Home Energy Efficiency Rating System	HERS Rater Code Enforcement
Space Heating and Cooling	Overview Duct Sealing Duct Design Duct Sealing with Duct Tape Energy Code Requirements HVAC Lineset Insulation TXV – Proper sizing of A/C units and ducts TXV – Proper installation of A/C units and airflow	TXV – Proper charge for A/C units TXV – Title 24 and AB 970 compliance Title 24 Zonal Control HVAC Zoning for Comfort and Energy Savings Exhaust Ventilation Systems Overview of Exhaust Ventilation Exhaust Ventilation Energy Code Requirements
Water Heating	Code: Gas Water Heaters Gas Water Heating Overview for Inspectors Overview Installation	Consumer Energy Rebate Program AB-970 Gas Tankless Water Heaters - Overview Gas Tankless Water Heaters - Installation
Building Envelope	Energy Code Requirements - Fiberglass Cellulose Insulation - Overview Cellulose Insulation - Insulating Walls Cellulose Insulation - Insulating Ceilings Fiberglass Insulation - Overview and Insulating Ceilings Fiberglass Insulation - Ceiling Insulation Details Fiberglass Insulation - Installing Ductboard Fiberglass Insulation - Insulating Walls Fiberglass Insulation - Wall Insulation Details Spray Foam Insulation Structural Insulated Panels	Fenestration - Energy Code Requirements Overview of Low-e Windows Manufacturing Low-e Glass Energy Performance Area of Glass – Impact on Compliance with Title 24 Window Sizing Window Performance Housewrap - Overview Installing an Air Barrier Air Barrier Details Energy Code Requirements Radiant Barriers - Overview Installing Flexible Radiant Barriers Installing Radiant Barrier Sheathing Radiant Barrier Energy Code Requirements
Renewable Energy	Overview of Photovoltaic Technology Installing a Photovoltaic System Renewable Energy Rebates	Renewable Energy: Wind Renewable Energy: Residential Wind Generation
Beyond the Code	Major West Coast Builder Finds Profitable New Market The Building Science of It Energy Consultants: Building Better, Selling Faster Why it is Profitable as a Marketing Strategy	Biggest Production Builder Leads the Way HVAC Diagnostics Mold in Buildings Preventing Mold in Buildings
Additions and Alterations	Perspectives on Residential Additions Title 24: Residential Additions Title 24: Residential Alterations	