REVISION RECORD FOR THE STATE OF CALIFORNIA

SUPPLEMENT

January 1, 2009

2007 Title 24, Part 6, California Energy Code

PLEASE NOTE: The date of this Supplement is for identification purposes only.
See the History Note Appendix for the adoption and effective dates of the provisions.

It is suggested that the section number as well as the page number be checked when inserting this material and removing the superseded material. In case of doubt, rely on the section numbers rather than the page numbers because the section numbers must run consecutively.

It is further suggested that the material be retained with this revision record sheet so that the prior wording of any section can be easily ascertained.

Please keep the removed pages with this revision page for future reference.

Note

Due to the fact that the application date for a building permit establishes the California Building Standards Code provisions that are effective at the local level, which apply to the plans, specifications, and construction for that permit, it is strongly recommended that the removed pages be retained for historical reference.

Remove Existing Pages	Insert New Pages
v and vi	v and vi
ix through 100	ix through 112

Item No. 5560S001

CALIFORNIA CODE OF REGULATIONS, TITLE 24

California Agency Information Contact List

California Energy Commission

Energy Hotline . . . . . (800) 772-3300
Building Efficiency Standards
Appliance Efficiency Standards
Compliance Manual/Forms

California State Lands Commission

Marine Oil Terminals. . . . . (562) 499-6317

California State Library

Construction Standards. . . . . (916) 445-9604

Corrections Standards Authority

Local Adult Jail Standards . . . . . (916) 324-1914
Local Juvenile Facility Standards . . . . . (916) 324-1914

Department of Consumer Affairs—Acupuncture Board

Office Standards . . . . . (916) 445-3021

Department of Consumer Affairs—Board of Pharmacy

Pharmacy Standards . . . . . (916) 574-7900

Department of Consumer Affairs—Bureau of Barbering and Cosmetology

Barber and Beauty Shop and
College Standards . . . . . (916) 952-5210

Department of Consumer Affairs—Bureau of Home Furnishings and Thermal Insulation

Insulation Testing Standards . . . . . (916) 574-2041

Department of Consumer Affairs—Structural Pest Control Board

Structural Standards . . . . . (800) 737-8188

Department of Consumer Affairs—Veterinary Medical Board

Veterinary Hospital Standards . . . . . (916) 263-2610

Department of Food and Agriculture

Meat & Poultry Packing Plant Standards . . . (916) 654-0509
Dairy Standards . . . . . (916) 654-0773

Department of Health Services

Organized Camps Standards . . . . . (916) 449-5661
Public Swimming Pools Standards . . . . . (916) 449-5661
Asbestos Standards. . . . . (510) 620-2874

Department of Housing and Community Development

Residential—Hotels, Motels, Apartments
Single-Family Dwellings . . . . . (916) 445-9471
Permanent Structures in Mobilehome
and Special Occupancy Parks . . . . . (916) 445-0481
Factory-Built Housing, Manufactured
Housing and Commercial Modular . . . . (916) 445-3338
Mobile Homes—Permits & Inspections
Northern Region. . . . . (916) 255-2501
Southern Region. . . . . (951) 782-4420
Employee Housing Standards . . . . . (916) 445-9471

Department of Water Resources

Gray Water Installations Standards. . . . . (916) 651-9667

Division of the State Architect—Access Compliance

Access Compliance Standards . . . . . (916) 445-8100

Division of the State Architect—Structural Safety

Public Schools Standards. . . . . (916) 445-8100
Essential Services Building Standards . . . . (916) 445-8100

Division of the State Architect—State Historical Building Safety Board

Alternative Building Standards. . . . . (916) 445-8100

Office of Statewide Health Planning and Development

Hospital Standards . . . . . (916) 440-8409
Skilled Nursing Facility Standards . . . . . (916) 440-8409
Clinic Standards . . . . . (916) 440-8409

Office of the State Fire Marshal

Code Development and Analysis . . . . . (916) 445-8200
Fire Safety Standards. . . . . (916) 445-8200
Fireplace Standards . . . . . (916) 445-8200
Day Care Centers Standards . . . . . (916) 445-8200
Exit Standards . . . . . (916) 445-8200

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SUBCHAPTER 1

ALL OCCUPANCIES—GENERAL PROVISIONS

SECTION 100
SCOPE

(a) **Buildings covered.** The provisions of Title 24, Part 6, apply to all buildings:

1. That are of Occupancy Group A, B, E, F, H, M, R, S or U; and
2. For which an application for a building permit or renewal of an existing permit is filed (or is required by law to be filed) on or after the effective date of the provisions, or which are constructed by a governmental agency; and
3. That are:

   A. Unconditioned, indirectly or directly conditioned by mechanical heating or mechanical cooling or process spaces; or

   B. Low-rise residential buildings that are heated with a wood heater or another nonmechanical heating system.

   Exception 1 to Section 100(a): Qualified historic buildings as regulated by the *California Historic Building Code* (Title 24, Part 8).

   Exception 2 to Section 100(a): Building departments, at their discretion, may exempt temporary buildings, temporary outdoor lighting or temporary lighting in an unconditioned building, or structures erected in response to a natural disaster. Temporary buildings or structures shall be completely removed upon the expiration of the time limit stated in the permit.

(b) **Parts of buildings regulated.** The provisions of Title 24, Part 6, apply to the building envelope, space-conditioning systems, water-heating systems and indoor lighting systems of buildings, and outdoor lighting systems and signs located either indoors or outdoors that are covered by Section 100(a) as set forth in Table 100-A.

(c) **Floors and habitable stories.**

1. Only habitable floors that have at least 50 percent of their volume above grade as defined in the CBC shall be counted in determining how many habitable stories a building has.
2. All conditioned space in a floor shall comply with Title 24, Part 6, whether or not the floor is above grade and whether or not it is habitable. All unconditioned space in a floor shall comply with the lighting requirements of Title 24, Part 6, whether or not the floor is above grade and whether or not it is habitable.

(d) **Outdoor lighting and indoor and outdoor signs.** The provisions of Title 24, Part 6, apply to outdoor lighting systems and to signs located either indoors or outdoors as set forth in Table 100-A.

(e) **Sections applicable to particular buildings.** Table 100-A and this subsection list the provisions of Title 24, Part 6, that are applicable to different types of buildings covered by Section 100(a).

1. **All buildings.** Sections 100 through 119 apply to all buildings.

   Exception to Section 100(e)1: Spaces or requirements not listed in Table 100-A.

2. **Newly constructed buildings.**

   A. **All newly constructed buildings.** Sections 110 through 119 apply to all newly constructed buildings within the scope of Section 100(a). In addition, newly constructed buildings shall meet the requirements of B, C or D, as applicable.

   B. **Nonresidential, high-rise residential and hotel/motel buildings that are mechanically heated or mechanically cooled.**

      i. **Sections applicable.** Sections 120 through 148 apply to newly constructed nonresidential buildings, high-rise residential buildings and hotels/motels that are mechanically heated or mechanically cooled.

      ii. **Compliance approaches.** In order to comply with Title 24, Part 6, newly constructed nonresidential buildings, high-rise residential buildings and hotels/motels that are mechanically heated or mechanically cooled must meet the requirements of:

         a. Mandatory measures: The applicable provisions of Sections 120 through 139; and

         b. Either:

            Performance approach: Section 141; or

            Prescriptive approach: Sections 142 through 148.

   C. **Unconditioned nonresidential buildings and process spaces.** Sections 119, 130 through 134, 143(c), 146, 147 and 148 apply to all newly constructed unconditioned buildings and process spaces within the scope of Section 100(a).

   D. **Low-rise residential buildings.**

      i. **Sections applicable.** Sections 150 through 151 apply to newly constructed low-rise residential buildings.

      ii. **Compliance approaches.** To comply with Title 24, Part 6, newly constructed low-rise residential buildings must meet the requirements of:

         a. Mandatory measures: The applicable provisions of Sections 110 through 119, and 150; and

b. Either:

Performance approach: Section 151(a) through (e); or

Prescriptive approach: Sections 151(a) and (f).

Exception 1 to Section 100(e)2Diib: Seasonally occupied agricultural housing limited by state or federal agency contract to occupancy not more than 180 days in any calendar year.

Exception 2 to Section 100(e)2Diib: Low-rise residential buildings that are heated with a wood heater or another nonmechanical heating system and that use no energy obtained from depletable sources for lighting or water heating.

3. **New construction in existing buildings.**

A. **Nonresidential, high-rise residential and hotel/motel buildings.** Section 149 applies to new construction in existing buildings that will be nonresidential, high-rise residential and hotel/motel occupancies.

B. **Low-rise residential buildings.** Section 152 applies to new construction in existing buildings that will be low-rise residential occupancies.

4. **Installation of insulation in existing buildings.** Section 118(d) applies to buildings in which insulation is being installed in existing attics, or on existing water heaters or existing space conditioning ducts.

5. **Outdoor lighting.** Sections 119, 130, 132, 134, 147 and 150 apply to newly constructed outdoor lighting systems, and Section 149 applies to outdoor lighting additions and alterations.

6. **Signs.** Sections 130, 133 and 148 apply to newly constructed signs located either indoors or outdoors, and Section 149 applies to sign alterations located either indoors or outdoors.

(f) **Mixed occupancy.** When a building is designed and constructed for more than one type of occupancy (residential and nonresidential), the space for each occupancy shall meet the provisions of Title 24, Part 6, applicable to that occupancy.

Exception to Section 100(f): If one occupancy constitutes at least 80 percent of the conditioned floor area of the building, the entire building envelope, HVAC and water heating may comply with the provisions of Title 24, Part 6 applicable to that occupancy, provided that the applicable lighting requirements in Sections 146 through 148 or 150(k) are met for each occupancy and space and mandatory measures in Sections 110 through 139 and 150 are met for each occupancy and space.

TABLE 100-A—APPLICATION OF STANDARDS

OCCUPANCIES	APPLICATION	MANDATORY	PRESCRIPTIVE	PERFORMANCE	ADDITIONS/ALTERATIONS
General Provisions		100, 101, 102, 110, 111			
Nonresidential, High-rise Residential and Hotels/Motels	General	140	142	141	149
	Envelope (conditioned)	116, 117, 118	143		
	Envelope (unconditioned, process spaces)		143(c)		
	HVAC (conditioned)	112, 115, 120-125	144		
	Water Heating (conditioned)	113, 123	145		
	Indoor Lighting (conditioned, process spaces)	119, 130, 131, 134	143(c), 146		
	Indoor Lighting (unconditioned)	119, 130, 131, 134	143(c), 146	N.A.	
	Outdoor Lighting	119, 130, 132, 134	147		
Refrigerated Warehouse	Envelope and HVAC	126	N.A.		
Signs	Indoor and Outdoor	130, 133	148		
Low-rise Residential	General	150	151(a,f)	151(a-e)	152
	Envelope (conditioned)	116, 117, 118, 150(a-g, 1)			
	HVAC (conditioned)	112, 115, 150(h, i, m, o)			
	Water heating (conditioned)	113, 150(j, n)			
	Indoor Lighting (conditioned, unconditioned and parking garages)	119, 150(k)			
	Outdoor Lighting	119, 150(k)			
	Pool and Spa systems	114, 150(p)	N.A.	N.A.	N.A.

(g) **Administrative requirements.** Administrative requirements relating to permit requirements, enforcement by the Commission, locally adopted energy standards, interpretations, claims of exemption, approved calculation methods, rights of appeal, and certification and labeling requirements of fenestration products and roofing products are specified in California Code of Regulations, Title 24, Part 1, Sections 10-101 to 10-114.

(h) **Certification requirements for manufactured devices.** Title 24, Part 6, limits the installation of the following manufactured devices to those that have been certified by their manufacturer to meet or exceed minimum specifications or efficiencies by the Commission.

1. Central air-conditioning heat pumps and other central air conditioners (Sections 111 and 112).
2. Combination equipment: space heating and cooling, or space heating and water heating [Section 112(a)3].
3. Fenestration products (Section 116).
4. Fluorescent lamp ballasts (Section 111).
5. Gas space heaters (Sections 111 and 112).
6. Insulating materials and roofing products (Section 118).
7. Lighting control devices and lighting control systems (Section 119).
8. Oil fired storage water heaters (Section 113).
9. Other heating and cooling equipment (Sections 111 and 112).
10. Plumbing fittings (Section 111).
11. Pool heaters (Section 114).
12. Refrigerators, refrigerator-freezers and freezers (Section 111).
13. Room air conditioners (Section 111).
14. Slab floor perimeter insulation [Section 150(1)].
15. Water heaters (Section 113).
16. Track lighting integral current limiter (Section 119(l)).
17. High efficacy LED light sources (Section 119(m)).
18. Ballasts for residential recessed luminaires (Section 119(n)).
19. Dimmable fluorescent ballasts for power adjustment factors (Section 119(o)).

The certification status of any such manufactured device may be confirmed only by reference to:

1. A directory published or approved by the Commission; or
2. A copy of the application for certification from the manufacturer and the letter of acceptance from the Commission staff; or
3. Written confirmation from the publisher of a Commission-approved directory that a device has been certified; or
4. A Commission-approved label on the device.

Note: Title 24, Part 6, does not require a builder, designer, owner, operator or enforcing agency to test any certified device to determine its compliance with minimum specifications or efficiencies adopted by the Commission.

SECTION 101
DEFINITIONS AND RULES OF CONSTRUCTION

(a) **Rules of Construction.**

1. Where the context requires, the singular includes the plural and the plural includes the singular.
2. The use of "and" in a conjunctive provision means that all elements in the provision must be complied with or must exist to make the provision applicable. Where compliance with one or more elements suffices, or where existence of one or more elements makes the provision applicable, "or" (rather than "and/or") is used.
3. "Shall" is mandatory and "may" is permissive.

(b) **Definitions.** Terms, phrases, words and their derivatives in Title 24, Part 6, shall be defined as specified in Section 101. Terms, phrases, words and their derivatives not found in Section 101 shall be defined as specified in Title 24, Part 2, Chapter 2 of the California Code of Regulations. Terms, phrases, words and their derivatives not found in either Title 24, Part 6, or Chapter 2 shall be defined as specified in Title 24, Part 2, Chapter 2 of the *California Building Code.* Where terms, phrases, words and their derivatives are not defined in any of the references above, they shall be defined as specified in *Webster's Third New International Dictionary of the English Language, Unabridged* (1987 edition), unless the context requires otherwise.

ACCA is the Air-Conditioning Contractors of America.

ACCA MANUAL J is the Air-Conditioning Contractors of America document entitled "Manual J-Residential Load Calculation, Eighth Edition." (2003)

ACCEPTANCE REQUIREMENTS FOR CODE COMPLIANCE is a description of test procedures in the Reference Nonresidential Appendices that includes equipment and systems to be tested, functions to be tested, conditions under which the test shall be performed, the scope of the tests, results to be obtained and measurable criteria for acceptable performance.

ACCENT (LIGHT) is a directional luminaire designed to highlight or spotlight objects. It can be recessed, surface mounted, or mounted to a pendant, stem or track.

ACCESSIBLE is having access thereto, but which first may require removal or opening of access panels, doors or similar obstructions.

ADDITION is any change to a building that increases conditioned floor area and conditioned volume. See also, "newly conditioned space." Addition is also any change that increases the floor area or volume of an unconditioned building of an occupancy group or type regulated by Part 6. Addition is also any change that increases the illuminated area of an outdoor lighting application regulated by Part 6.

AGRICULTURAL BUILDING is a structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. It is not a structure that is a place of human habitation, a place of employment where agricultural products are processed, treated or packaged, or a place used by the public.

AIR-TO-AIR HEAT EXCHANGER is a device which will reduce the heat losses or gains that occur when a building is mechanically ventilated, by transferring heat between the conditioned air being exhausted and outside air being supplied.

ALTERATION is any change to a building's water-heating system, space-conditioning system, lighting system or envelope that is not an addition. Alteration is also any change that is regulated by Part 6 to an outdoor lighting system that is not an addition. Alteration is also any change that is regulated by Part 6 to signs located either indoors or outdoors.

ALTERED COMPONENT is a component that has undergone an alteration and is subject to all applicable Standards requirements.

ALTERNATIVE CALCULATION METHODS (ACMs) are the Commission's Public Domain Computer Programs, one of the Commission's Simplified Calculation Methods or any other calculation method approved by the Commission. ACMs are also referred to as compliance software.

ALTERNATIVE CALCULATION METHODS APPROVAL MANUAL is the document that specifies the procedures and tests required for approval of Alternative Calculation Methods.

ANNUAL FUEL UTILIZATION EFFICIENCY (AFUE) is a measure of the percentage of heat from the combustion of gas or oil which is transferred to the space being heated during a year, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 112.

ANNUNCIATED is a type of visual signaling device that indicates the on, off, or other status of a load.

ANSI is the American National Standards Institute.

ANSI C82.6-2005 is the American National Standards Institute document entitled "Ballasts for High-Intensity Discharge Lamps – Methods of Measurement." (ANSI C82.6-2005)

ANSI Z21.10.3 is the American National Standards Institute document entitled "Gas Water Heaters, Volume I, Storage Water Heaters with input ratings above 75,000 Btu per hour," 2001. (ANSI Z21.10.3-2001)

ANSI Z21.13 is the American National Standards Institute document entitled "Gas-Fired Low Pressure Steam and Hot Water Boilers," 2000. (ANSI Z21.13-2000).

ANSI Z21.40.4 is the American National Standards Institute document entitled "Performance Testing and Rating of Gas-Fired, Air Conditioning and Heat Pump Appliances," 1996. (ANSI Z21.40.4-1996)

ANSI Z21.47 is the American National Standards Institute document entitled "Gas-Fired Central Furnaces," 2001. (ANSI Z21.47-2001)

ANSI Z83.8 is the American National Standards Institute document entitled "Gas Unit Heaters and Gas-Fired Duct Furnaces," 2002. (ANSI Z83.8-2002)

APPLIANCE EFFICIENCY REGULATIONS are the regulations in Title 20, Sections 1601 et seq. of the California Code of Regulations.

APPROVED BY THE COMMISSION means approval under Section 25402.1 of the Public Resources Code.

APPROVED CALCULATION METHOD (See "alternative calculation methods.")

ARI is the Air-conditioning and Refrigeration Institute.

ARI 210/240 is the Air-conditioning and Refrigeration Institute document entitled "Unitary Air-Conditioning and Air-Source Heat Pump Equipment," 2003. (ARI 210/240-2003)

ARI 310/380 is the Air-conditioning and Refrigeration Institute document entitled "Packaged Terminal Air-Conditioners and Heat Pumps," 1993. (ARI 310/380-93)

ARI 320 is the Air-conditioning and Refrigeration Institute document entitled "Water-Source Heat Pumps," 1998. (ARI 320-98)

ARI 325 is the Air-conditioning and Refrigeration Institute document entitled "Ground Water-Source Heat Pumps," 1998. (ARI 325-98)

ARI 340/360 is the Air-conditioning and Refrigeration Institute document entitled "Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment," 2000. (ARI 340/360-2000)

ARI 365 is the Air-conditioning and Refrigeration Institute document entitled, "Commercial and Industrial Unitary Air-Conditioning Condensing Units," 2002. (ARI 365-2002)

ARI 460 is the Air-conditioning and Refrigeration Institute document entitled "Remote Mechanical-Draft Air-Cooled Refrigerant Condensers," 2000. (ARI 460-2000)

ARI 550/590 is the Air-conditioning and Refrigeration Institute document entitled "Standard for Water Chilling Packages Using the Vapor Compression Cycle," 1998. (ARI 550/590-98)

ARI 560 is the Air-conditioning and Refrigeration Institute document entitled "Absorption Water Chilling and Water Heating Packages," 2000. (ARI 560-2000)

ASHRAE is the American Society of Heating, Refrigerating and Air-conditioning Engineers.

ASHRAE CLIMATIC DATA FOR REGION X is the American Society of Heating, Refrigerating and Air-conditioning Engineers document entitled "ASHRAE Climatic Data for Region X, Arizona, California, Hawaii and Nevada," Publication SPCDX, 1982 and "Supplement," 1994.

ASHRAE HANDBOOK, APPLICATIONS VOLUME is the American Society of Heating, Refrigerating and Air-conditioning Engineers document entitled "ASHRAE Handbook: Heating, Ventilating, and Air-Conditioning Applications." (2003)

ASHRAE HANDBOOK, EQUIPMENT VOLUME is the American Society of Heating, Refrigerating and Air-conditioning Engineers document entitled "ASHRAE Handbook: Heating, Ventilating, and Air-conditioning Systems and Equipment." (2000)

ASHRAE HANDBOOK, FUNDAMENTALS VOLUME is the American Society of Heating, Refrigerating and Air-conditioning Engineers document entitled "ASHRAE Handbook: Fundamentals." (2005)

ASHRAE STANDARD 55 is the American Society of Heating, Refrigerating and Air-conditioning Engineers document entitled "Thermal Environmental Conditions for Human Occupancy," 2004. (ASHRAE Standard 55-2004)

ASHRAE STANDARD 62.2 is the American Society of Heating, Refrigerating and Air-Conditioning Engineers document entitled "Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings," 2007 (ASHRAE Standard 62.2-2007).

ASME is the American Society of Mechanical Engineers.

ASTM is the American Society for Testing and Materials.

ASTM C 55 is the American Society for Testing and Materials document entitled "Standard Specification for Concrete Brick," 2001. (ASTM C 55-01)

ASTM C 177 is the American Society for Testing and Materials document entitled "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus," 1997. (ASTM C 177-97)

ASTM C 272 is the American Society for Testing and Materials document entitled "Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions," 2001. (ASTM C 272-01)

ASTM C 335 is the American Society for Testing and Materials document entitled "Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation," 1995. (ASTM C 335-95)

ASTM C 518 is the American Society for Testing and Materials document entitled "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus," 2002. (ASTM C 518-02)

ASTM C 731 is the American Society for Testing and Materials document entitled "Standard Test Method for Extrudability, After Package Aging of Latex Sealants," 2000. (ASTM C 731-00)

ASTM C 732 is the American Society for Testing and Materials document entitled "Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants," 2001. (ASTM C 732-01)

ASTM C 836 is the American Society of Testing and Materials document entitled, "Standard Specification for High solids Content, cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course," 2005. (ASTM C 836-05)

ASTM C 1167 is the American Society for Testing and Materials document entitled "Standard Specification for Clay Roof Tiles," 1996. (ASTM C 1167-96)

ASTM C 1371 is the American Society for Testing and Materials document entitled "Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers," 1998. (ASTM C 1371-98)

ASTM C 1583 is the American Society of Testing and Materials document entitled, "Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension" Pull-off Method)," 2004. (ASTM C 1583-04)

ASTM D 522 is the American Society of Testing and Materials document entitled, "Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings," 2001. [ASTM D 522-93a (2001)]

ASTM D 822 is the American Society of Testing and Materials document entitled, "Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings," 2001. (ASTM D 822-01)

ASTM D 1003 is the American Society for Testing and Materials document entitled "Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics," 2000. (ANSI/ASTM D 1003-00)

ASTM D 1653 is the American Society of Testing and Materials document entitled, "Standard Test Methods for Water Vapor Transmission of Organic Coating Films," 2003. (ASTM D 1653-03)

ASTM D 2370 is the American Society of Testing and Materials document entitled, "Standard Test Method for Tensile Properties of Organic Coatings," 2002. [ASTM D 2370-98 (2002)]

ASTM D 2824 is the American Society of Testing and Materials document entitled "Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered, Asbestos Fibered, and Fibered without Asbestos," 2002. (ASTM D 2824-02)

ASTM D 3468 is the American Society of Testing and Materials document entitled, "Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing," 1999. (ASTM D 3468-99)

ASTM D 3805 is the American Society of Testing and Materials document entitled "Standard Guide for Application of Aluminum-Pigmented Asphalt Roof Coatings," 1997. [ASTM D 3805-97 (reapproved 2003)]

ASTM D 5870 is the American Society of Testing and Materials document entitled, "Standard Practice for Calculating Property Retention Index of Plastics," 2003. [ASTM D 5870-95 (2003)]

ASTM D 6083 is the American Society of Testing and Materials document entitled, "Standard Specification for Liquid Applied Acrylic Coating Used in Roofing," 2005. (ASTM D 6083-05e1)

ASTM D 6694 is the American Society of Testing and Materials document entitled, "Standard Specification for Liquid-Applied Silicone Coating Used in Spray Polyurethane Foam Roofing," 2001. (ASTM D 6694-01)

ASTM D 6848 is the American Society of Testing and Materials document entitled "Standard Specification for Aluminum-Pigmented Emulsified Asphalt Used as a Protective Coating for Roofing," 2002. (ASTM D 6848-02)

ASTM D 4798 is the American Society for Testing and Materials document entitled "Standard Test Method for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method)," 2001. (ASTM D 4798-01)

ASTM E 96 is the American Society for Testing and Materials document entitled "Standard Test Methods for Water Vapor Transmission of Materials," 2000. (ASTM E 96-00)

ASTM E 283 is the American Society for Testing and Materials document entitled "Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen," 1991. [ASTM E 283-91(1999)]

ASTM E 408 is the American Society for Testing and Materials document entitled, "Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques," 1971. [ASTM E 408-71(2002)]

AUTOMATIC is capable of operating without human intervention.

AUTOMATIC MULTILEVEL DAYLIGHTING CONTROL is a multilevel lighting control that automatically reduces lighting in multiple steps or continuous dimming in response to available daylight. This control uses one or more photosensors to detect changes in daylight illumination and then change the electric lighting level in response to the daylight changes.

AUTOMATED TELLER MACHINE (ATM) is any electronic information processing device which accepts or dispenses currency in connection with a credit, deposit or convenience account without involvement by a clerk.

AUTOMATIC TIME SWITCH CONTROL DEVICES are devices capable of automatically turning loads off and on based on time schedules.

BATHROOM (See "residential space type.")

BELOW-GRADE WALL is the portion of a wall, enclosing conditioned space, that is below the grade line.

BUILDING is any structure or space covered by Section 100 of the Building Energy Efficiency Standards.

BUILDING ENVELOPE is the ensemble of exterior and demising partitions of a building that enclose conditioned space.

CALL CENTER is a phone center that handles large number of phone calls including but not limited to help desk, customer and sales support, technical support, emergency response, telephone answering service, and inbound and outbound telemarketing.

CAPTIVE-KEY OVERRIDE is a type of lighting control in which the key that activates the override cannot be released when the lights are in the on position.

CENTRAL FAN-INTEGRATED VENTILATION SYSTEM is a central forced air heating and/or cooling system which is intended to operate on a regular basis to bring in outdoor ventilation air and/or distribute air around the home for comfort and ventilation even when heating and cooling are not needed.

CERTIFYING ORGANIZATION is an independent organization recognized by the Commission to certify manufactured devices for performance values in accordance with procedures adopted by the Commission.

CHANDELIER is a ceiling-mounted, close-to-ceiling, or suspended decorative luminaire that uses glass, crystal, ornamental metals or other decorative material and that typically is used in hotel/motels, restaurants or churches as a significant element in the interior architecture.

CLIMATE ZONES are the 16 geographic areas of California for which the commission has established typical weather data, prescriptive packages and energy budgets. Climate zone boundary descriptions are in the document "California Climate Zone Descriptions" (July 1995), incorporated herein by reference. Figure 101-A is an approximate map of the 16 climate zones.

CLOSED-CIRCUIT COOLING TOWER is a closed-circuit cooling tower that utilizes indirect contact between a heated fluid, typically water or glycol, and the cooling atmosphere to transfer the source heat load indirectly to the air, essentially combining a heat exchanger and cooling tower into one relatively compact device.

CODES,CALIFORNIA HISTORICAL BUILDING CODE is the *California Historical Building Code*, California Code of Regulations, Title 24, Part 8 and Part 2 (Chapter 34).

CODES, CBC is the 2007 *California Building Code*.

CODES, CEC is the 2007 *California Electric Code*.

CODES, CMC is the 2007 *California Mechanical Code*.

CODES, CPC is the 2007 *California Plumbing Code*.

COEFFICIENT OF PERFORMANCE (COP), COOLING, is the ratio of the rate of net heat removal to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 112.

COEFFICIENT OF PERFORMANCE (COP), HEATING, is the ratio of the rate of net heat output to the rate of total energy input, calculated under designated operating conditions and expressed in consistent units, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 112.

COEFFICIENT OF PERFORMANCE (COP), HEAT PUMP is the ratio of the rate of useful heat output delivered by the complete heat pump unit (exclusive of supplementary heating) to the corresponding rate of energy input, in consistent units and as determined using the applicable test method in Appliance Efficiency Regulations or Section 112.

COMBUSTION EFFICIENCY is a measure of the percentage of heat from the combustion of gas or oil that is transferred to the medium being heated or lost as jacket loss.

COMMISSION is the California State Energy Resources Conservation and Development Commission.

CONDITIONED FLOOR AREA (CFA) is the 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.

CONDITIONED SPACE is space in a building that is either directly conditioned or indirectly conditioned.

CONDITIONED SPACE, DIRECTLY is an enclosed space that is provided with wood heating, is provided with mechanical heating that has a capacity exceeding 10 Btu/hr-ft^2) or is provided with mechanical cooling that has a capacity exceeding 5 Btu/hr-ft^2, unless the space-conditioning system is designed for a process space. (See "Process space".)

CONDITIONED SPACE, INDIRECTLY is enclosed space, including, but not limited to, unconditioned volume in atria, that (1) is not directly conditioned space; and (2) either (a) has a thermal transmittance area product (UA) to directly conditioned space exceeding that to the outdoors or to unconditioned space and does not have fixed vents or openings to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

CONDITIONED VOLUME is the total volume (in cubic feet) of the conditioned space within a building.

CONTINUOUS DIMMING (See "dimming, continuous.")

COOL ROOF is a roofing material with high thermal emittance and high solar reflectance, or low thermal emittance and exceptionally high solar reflectance as specified in Section 118 (i) that reduces heat gain through the roof.

COOLING EQUIPMENT is equipment used to provide mechanical cooling for a room or rooms in a building.

CRAWL SPACE is a space immediately under the first floor of a building adjacent to grade.

CRRC-1 is the Cool Roof Rating Council document entitled "Product Rating Program Manual."

CTI is the Cooling Technology Institute.

CTI ATC-105 is the Cooling Technology Institute document entitled "Acceptance Test Code for Water Cooling Towers," 2000. (CTI ATC-105-00)

CTI STD-201 is the Cooling Technology Institute document entitled "Standard for Certification of Water-Cooling Tower Thermal Performance," 2004. (CTI STD-201-04)

C-VALUE (also known as C-factor) is the time rate of heat flow through unit area of a body induced by a unit temperature difference between the body surfaces, in Btu ($hr \times ft^2 \times °F$). It is not the same as K-value or K-factor.

DAYLIGHT AREA is the floor area under skylights or next to windows. The daylight area includes primary sidelit daylight area, secondary sidelit daylight area and skylit daylight area.

DEADBAND is the temperature range within which the HVAC system is neither calling for heating or cooling.

DECORATIVE GAS APPLIANCE is a gas appliance that is designed or installed for visual effect only, cannot burn solid wood, and simulates a fire in a fireplace.

DEGREE DAY, HEATING, is a unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal annual heating load of a building. For any one day, when the mean temperature is less than 65°F, there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65°F. The number of degree days for specific geographical locations are those listed in the Reference Joint Appendix. For those localities not listed in the Reference Joint Appendix, the number of degree days is as determined by the applicable enforcing agency.

DEMAND RESPONSE is controlling electricity loads in buildings in response to an electronic signal sent by the local utility requesting their customers to reduce electricity consumption.

DEMAND RESPONSE PERIOD is a period of time during which the local utility is curtailing electricity loads by sending out a demand response signal.

DEMAND RESPONSE SIGNAL is an electronic signal sent out by the local utility indicating a request to their customers to curtail electricity consumption.

DEMAND RESPONSIVE LIGHTING CONTROL is a control that reduces lighting power consumption in response to a demand response signal.

DEMISING PARTITION is a wall, fenestration, floor or ceiling that separates conditioned space from enclosed unconditioned space.

DESIGN CONDITIONS are the parameters and conditions used to determine the performance requirements of space-conditioning systems. Design conditions for determining design heating and cooling loads are specified in Section 144(b) for nonresidential, high-rise residential, and hotel/motel buildings and in Section 150(h) for low-rise residential buildings.

DESIGN HEAT GAIN RATE is the total calculated heat gain through the building envelope under design conditions.

DESIGN HEAT LOSS RATE is the total calculated heat loss through the building envelope under design conditions.

DIMMING, CONTINUOUS is a lighting control method that is capable of varying the light output of lamps over a continuous range from full light output to minimum light output.

DIMMING, STEPPED is a lighting control method that varies the light output of lamps in one or more predetermined discrete steps between full light output and off.

DIRECT DIGITAL CONTROL (DDC) is a type of control where controlled and monitored analog or binary data, such as temperature and contact closures, are converted to digital format for manipulation and calculations by a digital computer or microprocessor, then converted back to analog or binary form to control mechanical devices.

DISPLAY LIGHTING is lighting confined to the area of a display that provides a higher level of illuminance than the level of surrounding ambient illuminance.

DISPLAY PERIMETER is the length of an exterior wall in a Group B; Group F, Division 1; or Group M Occupancy that immediately abuts a public sidewalk, measured at the sidewalk level for each story that abuts a public sidewalk.

DOOR is an operable opening in the building envelope that is not a fenestration product, including swinging and roll-up doors, fire doors and access hatches. Doors that are more than one-half glass in area are considered a fenestration product.

DUAL-GLAZED GREENHOUSE WINDOWS are a type of dual-glazed fenestration product which adds conditioned volume but not conditioned floor area to a building.

DUCT SEALING is a procedure for installing a space-conditioning distribution system that minimizes leakage of air from or to the distribution system. Minimum specifications for installation procedures, materials, diagnostic testing and field verification are contained in the Reference Residential Appendix RA3 and Reference Nonresidential Appendix NA1.

EAST-FACING (See "orientation.")

ECONOMIZER, AIR, is a ducting arrangement, including dampers, linkages and an automatic control system that allows a cooling supply fan system to supply outside air to reduce or eliminate the need for mechanical cooling.

ECONOMIZER, WATER, is a system by which the supply air of a cooling system is cooled directly or indirectly by evaporation of water, or other appropriate fluid, in order to reduce or eliminate the need for mechanical cooling.

EFFECTIVE APERTURE (EA) is a measure of the extent that vertical glazing or skylights are effective for providing daylighting.

EFFICACY, LAMP is the quotient of rated initial lamp lumens divided by the rated lamp power (watts), without including auxiliaries such as ballasts, transformers and power supplies.

ELECTRONICALLY-COMMUTATED MOTOR is a brushless DC motor with a permanent magnet rotor that is surrounded by stationary motor windings, and an electronic controller that varies rotor speed and direction by sequentially supplying DC current to the windings.

EMITTANCE, THERMAL is the ratio of the radiant heat flux emitted by a sample to that emitted by a blackbody radiator at the same temperature.

ENCLOSED SPACE is space that is substantially surrounded by solid surfaces, including walls, ceilings or roofs, doors, fenestration areas, and floors or ground.

ENERGY BUDGET is the maximum amount of Time Dependent Valuation (TDV) energy that a proposed building, or portion of a building, can be designed to consume, calculated with the approved procedures specified in Title 24, Part 6.

ENERGY EFFICIENCY RATIO (EER) is the ratio of net cooling capacity (in Btu/hr) to total rate of electrical energy input (in watts), of a cooling system under designated operating conditions, as determined using the applicable test method in the Appliance Efficiency Regulations or Section 112.

ENERGY FACTOR (EF) of a water heater is a measure of overall water heater efficiency as determined using the applicable test method in the Appliance Efficiency Regulations.

ENERGY MANAGEMENT CONTROL SYSTEM (EMCS) is often a computerized control system designed to regulate the energy consumption of a building by controlling the operation of energy consuming systems, such as the heating, ventilation and air conditioning (HVAC), lighting and water heating systems. The EMCS is also capable of monitoring environmental and system loads, and adjusting HVAC operations in order to optimize energy usage and respond to demand response signals.

ENERGY OBTAINED FROM DEPLETABLE SOURCES is electricity purchased from a public utility, or any energy obtained from coal, oil, natural gas or liquefied petroleum gases.

ENERGY OBTAINED FROM NONDEPLETABLE SOURCES is energy that is not energy obtained from depletable sources.

ENFORCEMENT AGENCY is the city, county or state agency responsible for issuing a building permit.

ENTIRE BUILDING is the ensemble of all enclosed space in a building, including the space for which a permit is sought, plus all existing conditioned and unconditioned space within the structure.

ENVELOPE (See "building envelope.")

EXFILTRATION is uncontrolled outward air leakage from inside a building, including leakage through cracks and interstices, around windows and doors, and through any other exterior partition or duct penetration.

EXTERIOR DOOR is a door through an exterior partition that is opaque or has a glazed area that is less than or equal to one half of the door area. Doors with a glazed area of more than one half of the door area are treated as a fenestration product.

EXTERIOR FLOOR/SOFFIT is a horizontal exterior partition, or a horizontal demising partition, under conditioned space. For low-rise residential occupancies, exterior floors also include those on grade.

EXTERIOR PARTITION is an opaque, translucent or transparent solid barrier that separates conditioned space from ambient air or space that is not enclosed. For low-rise residential occupancies, exterior partitions also include barriers that separate conditioned space from unconditioned space, or the ground.

EXTERIOR ROOF/CEILING is an exterior partition, or a demising partition, that has a slope less than 60 degrees from horizontal, that has conditioned space below, and that is not an exterior door or skylight.

EXTERIOR ROOF/CEILING AREA is the area of the exterior surface of exterior roof/ceilings.

EXTERIOR WALL is any wall or element of a wall, or any member or group of members, which defines the exterior boundaries or courts of a building and which has a slope of 60 degrees or greater with the horizontal plane. An exterior wall or partition is not an exterior floor/soffit, exterior door, exterior roof/ceiling, window, skylight or demising wall.

EXTERIOR WALL AREA is the area of the opaque exterior surface of exterior walls.

FACTORY ASSEMBLED COOLING TOWERS are cool ing towers constructed from factory-assembled modules either shipped to the site in one piece or put together in the field.

FENESTRATION, BAY WINDOW is a combination assembly which is composed of three or more individual windows either joined side by side or installed within opaque assemblies and which projects away from the wall on which it is installed.

Center windows, if used, are parallel to the wall on which the bay is installed. The two side windows are angled with respect to the center window(s). Common angles are 30° and 45°, although other angles are sometimes employed.

FENESTRATION, CURTAIN WALL is an external nonbearing wall intended to separate the exterior and interior environments, which may consist entirely (or principally) of a combination of framing materials, glass and glazing, opaque in-fill and other surfacing materials supported by or within a framework.

FENESTRATION, GARDEN WINDOW is a window unit that consists of a three-dimensional, five-sided structure, with or without an operating sash, also known as a greenhouse window.

FENESTRATION PRODUCT is any transparent or translucent material plus any sash, frame, mullions and dividers, in the envelope of a building, including, but not limited to, windows, sliding glass doors, French doors, skylights, curtain walls, garden windows and other doors with a glazed area of more than one half of the door area.

FENESTRATION PRODUCT, FIELD-FABRICATED is a fenestration product including a glazed exterior door whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product or exterior door. Field-fabricated does not include site-built fenestration with a label certificate or products required to have temporary or permanent labels.

FENESTRATION PRODUCT, MANUFACTURED is a fenestration product constructed of materials which are factory cut or otherwise factory formed with the specific intention of being used to fabricate a fenestration product. A manufactured fenestration product is typically factory-assembled before delivery to a job site. However a "knocked-down" or partially assembled product sold as a fenestration product is also a manufactured fenestration product when provided with temporary and permanent labels as described in Section 10-111; otherwise it is a site-built fenestration product when provided with temporary and permanent labels as described in Section 10-111.

FENESTRATION PRODUCT, SITE-BUILT is fenestration designed to be field-glazed or field assembled units using specific factory cut or otherwise factory formed framing and glazing units. Examples of site-built fenestration include storefront systems, curtain walls and atrium roof systems.

FENESTRATION SYSTEM is a collection of fenestration products included in the design of a building. (See "fenestration product.")

FIELD ERECTED COOLING TOWERS are cooling towers which are custom designed for a specific application and which cannot be delivered to a project site in the form of factory assembled modules due to their size, configuration or materials of construction.

FIREPLACE is a hearth and firechamber or similar prepared place in which a fire may be made and which is built in conjunction with a flue or chimney, including but not limited to factory-built fireplaces, masonry fireplaces and masonry heaters as further clarified in the CBC.

FLOOR/SOFFIT TYPE is a type of floor/soffit assembly having a specific heat capacity, framing type and U-factor.

FLUX is the rate of energy flow per unit area.

FOOD PREPARATION EQUIPMENT is cooking equipment intended for commercial use, including coffee machines, espresso coffee makers, conductive cookers, food warmers including heated food servers, fryers, griddles, nut warmers, ovens, popcorn makers, steam kettles, ranges and cooking appliances for use in commercial kitchens, restaurants or other business establishments where food is dispensed.

GAS COOLING EQUIPMENT is cooling equipment that produces chilled water or cold air using natural gas or liquefied petroleum gas as the primary energy source.

GAS HEATING SYSTEM is a natural gas or liquefied petroleum gas heating system.

GAS LOG is a self-contained, free-standing, open-flame, gas-burning appliance consisting of a metal frame or base supporting simulated logs, and designed for installation only in a vented fireplace.

GENERAL LIGHTING is lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect. When designed for lower-than-task illuminance used in conjunction with other specific task lighting systems, it is also called "ambient" lighting.

GLAZING (See "fenestration product.")

GOVERNMENTAL AGENCY is any public agency or subdivision thereof, including, but not limited to, any agency of the state, a county, a city, a district, an association of governments or a joint power agency.

GROSS EXTERIOR ROOF AREA is the sum of the skylight area and the exterior roof/ceiling area.

GROSS EXTERIOR WALL AREA is the sum of the window area, door area and exterior wall area.

GU-24 is the designation of a lamp holder and socket configuration, based on a coding system by the International Energy Consortium, where "G" indicates the broad type of two or more projecting contacts, such as pins or posts, "U" distinguishes between lamp and holder designs of similar type but that are not interchangeable due to electrical or mechanical requirements, and "24" indicates 24 millimeters center to center spacing of the electrical contact posts.

HABITABLE STORY is a story that contains space in which humans may work or live in reasonable comfort, and that has at least 50 percent of its volume above grade.

HEAT CAPACITY (HC) is the amount of heat necessary to raise the temperature of all the components of a unit area in an assembly by 1°F. It is calculated as the sum of the average thickness times the density times the specific heat for each component, and is expressed in Btu/ft^2 °F.

HEAT PUMP is a device that is capable of heating by refrigeration, and that may include a capability for cooling.

HEATED SLAB FLOOR is a concrete slab floor or a lightweight concrete topping slab laid over a raised floor, with embedded space heating by any means. The heating system

using the heated slab floor is sometimes referred to as radiant slab floors or radiant heating.

HEATING EQUIPMENT is equipment used to provide mechanical heating for a room or rooms in a building.

HEATING SEASONAL PERFORMANCE FACTOR (HSPF) is the total heating output of a central air-conditioning heat pump (in Btu) during its normal use period for heating divided by the total electrical energy input (in watt-hours) during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations.

HI is the Hydronics Institute of the Gas Appliance Manufacturers Association (GAMA).

HI HTG BOILER STANDARD is the Hydronics Institute document entitled "Testing and Rating Standard for Rating Boilers," 1989.

HIGH-RISE RESIDENTIAL BUILDING is a building, other than a hotel/motel, of occupancy Group R, Division 1 with four or more habitable stories.

HOTEL/MOTEL is a building or buildings incorporating six or more guest rooms or a lobby serving six or more guest rooms, where the guest rooms are intended or designed to be used, or which are used, rented or hired out to be occupied, or which are occupied for sleeping purposes by guests, and all conditioned spaces within the same building envelope. Hotel/motel also includes all conditioned spaces which are (1) on the same property as the hotel/motel, (2) served by the same central heating, ventilation and air-conditioning system as the hotel/motel, and (3) integrally related to the functioning of the hotel/motel as such, including, but not limited to, exhibition facilities, meeting and conference facilities, food service facilities, lobbies and laundries.

HVAC SYSTEM (See "space-conditioning system.")

IESNA HB (See "IESNA Lighting Handbook.")

IESNA LIGHTING HANDBOOK is the Illuminating Engineering Society National Association document entitled "The IESNA Lighting Handbook: Reference and Applications, Ninth Edition." (2000)

INFILTRATION is uncontrolled inward air leakage from outside a building or unconditioned space, including leakage through cracks and interstices, around windows and doors, and through any other exterior or demising partition or pipe or duct penetration.

INTEGRATED PART LOAD VALUE (IPLV) is a single-number figure of merit based on part load EER or COP expressing part load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment as determined using the applicable test method in the Appliance Efficiency Regulations or Section 112.

ISO 13256-1 is the International Organization for Standardization document entitled "Water-source heat pumps - Testing and rating for performance - Part 1: Water-to-air and brine-to-air heat pumps," 1998.

KITCHEN (See residential space type.)

LIGHT EMITTING DIODE (LED) is a *pn* junction semiconductor device that emits incoherent optical radiation when biased in the forward direction. The acronym "LED" typically refers to an LED Component, LED Device or LED Package.

Hybrid LED Luminaire is a complete lighting unit consisting of a light source and driver together with parts to distribute light, to position and protect the light source, and to connect the light source to a branch circuit. The light sources in the Hybrid LED Luminaire contain both LED Source Systems, or LED Lamps, as well as other types of light sources such as incandescent or fluorescent lamps. The Hybrid LED Luminaire is intended to be connected directly to a branch circuit.

LED Array is an assembly of LED Components, LED Devices or LED Packages on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical and electrical (LED Control Circuitry) interfaces that are connected to the load side of LED Driver (Power Source). LED Array does not contain an LED Driver (Power Source) and is not connected directly to the branch circuit.

LED Component (or LED Device, or LED Package) is a semiconductor die that contains wire bond connections, possibly with an optical element, or a thermal, mechanical, or electrical interface. LED Component, LED Device, or LED Package does not contain an LED Driver (Power Source) and is not connected directly to the branch circuit.

LED Control Circuitry is electronic components located between the Power Source (LED Driver) and the LED Component, or LED Device, or LED Package designed to limit voltage and current, to dim, to switch or otherwise control the electrical energy to the LED. The circuitry does not include a Power Source.

LED Driver is a power source with integral LED control circuitry designed to meet the specific requirements of an LED Lamp, an LED Array or an LED Module. Typically, an LED Driver (Power Source) contains the LED Control Circuitry.

LED Lamp is an LED Component, LED Device, or LED Package and other optical, thermal, mechanical and electrical (LED Control Circuitry) components with an integrated LED Driver (Power Source) and a standardized base that is designed to connect to the branch circuit via a standardized base, lamp-holder or socket.

In North America, "a standardized base" refers to an ANSI standard base. In the U.S., "branch circuit" is used to describe the "mains voltage" in IEC documents.

Note: Nonintegrated type of LED Lamp should not be defined; it is an LED Module.

LED Light Engine with Integral Heat Sink (or LED Light Source System) is a subsystem of an LED Luminaire that includes one or more LED Components, LED Devices or LED Packages, an LED Array, or LED Module; an LED Driver (Power Source); electrical and mechanical interfaces; and an integral heat sink to provide thermal dissipation. An LED Source System may be designed to accept additional components that provide aesthetic, optical and

environmental control (other than thermal dissipation). An LED Source System with standardized base is an LED Lamp.

LED Luminaire is a complete LED lighting unit consisting of a light source and driver together with parts to distribute light, to position and protect the light source, and to connect the light source to a branch circuit. The light source itself may be LED Components, LED Packages or LED Devices, LED Array, an LED Module, an LED Source System, or an LED Lamp. The LED Luminaire is intended to be connected directly to a branch circuit.

LED Module is a component part of an LED Source System that includes one or more LED Components, LED Devices or LED Packages, possibly with optical elements and additional thermal, mechanical and electrical (LED Control Circuitry) interfaces that are connected to the load side of LED Drive (Power Source). The LED Module does not contain a power source. An LED Array is equivalent to an LED Module.

LISTED is equipment, materials or services included in a list published by an organization that is recognized to have the authority to evaluate and test the equipment, material or services. The organization performs periodic inspection and evaluation to ensure that the listed equipments, material or services meet identified standards or has been tested and found suitable for a specified purpose. The recognized organizations include Underwriters Laboratories (UL) and other nationally recognized testing/rating laboratories.

LOW-RISE RESIDENTIAL BUILDING is a building, other than a hotel/motel that is of Occupancy Group R, Division 1, and is multifamily with three stories or less, or a single family residence of Occupancy R, Division 3 or an Occupancy Group U building located on a residential site.

LPG is liquefied petroleum gas.

LUMINAIRE is a complete lighting unit consisting of a lamp(s) and the parts designed to distribute the light, to position and protect the lamp(s), and to connect the lamp(s) to the power supply; commonly referred to as "lighting fixtures."

MANUAL is capable of being operated by personal intervention.

MANUFACTURED DEVICE is any heating, cooling, ventilation, lighting, water heating, refrigeration, cooking, plumbing fitting, insulation, door, fenestration product or any other appliance, device, equipment or system subject to Sections 110 through 119 of Title 24, Part 6.

MECHANICAL COOLING is lowering the temperature within a space using refrigerant compressors or absorbers, desiccant dehumidifiers or other systems that require energy from depletable sources to directly condition the space. In nonresidential, high-rise residential and hotel/motel buildings, cooling of a space by direct or indirect evaporation of water alone is not considered mechanical cooling.

MECHANICAL HEATING is raising the temperature within a space using electric resistance heaters, fossil fuel burners, heat pumps or other systems that require energy from depletable sources to directly condition the space.

METAL BUILDING is a complete integrated set of mutually dependent components and assemblies that form a building, which consists of a steel-framed superstructure and metal skin. This does not include structural glass or metal panels such as in a curtainwall system.

MODELING ASSUMPTIONS are the conditions (such as weather conditions, thermostat settings and schedules, internal gain schedules, etc.) that are used for calculating a building's annual energy consumption as specified in the Alternative Calculation Methods Manuals.

MOTION SENSOR, LIGHTING, is a device that automatically turns lights off soon after an area is vacated. The term motion sensor applies to a device that controls outdoor lighting systems. When the device is used to control indoor lighting systems, it is termed an occupant sensor. The device also may be called an occupancy sensor, occupant-sensing device or vacancy sensor.

MOVABLE SHADING DEVICE (See "operable shading device.")

MULTILEVEL LIGHTING CONTROL is a lighting control that reduces lighting power in multiple steps while maintaining a reasonably uniform level of illuminance throughout the area controlled.

MULTISCENE PROGRAMMABLE SYSTEM is a lighting control device that has the capability of setting light levels throughout a continuous range, and that has pre-established settings within the range.

NEWLY CONDITIONED SPACE is any space being converted from unconditioned to directly conditioned or indirectly conditioned space. Newly conditioned space must comply with the requirements for an addition. See Section 149 for nonresidential occupancies and Section 152 for residential occupancies.

NEWLY CONSTRUCTED BUILDING is a building that has never been used or occupied for any purpose.

NFRC 100 is the National Fenestration Rating Council document entitled "NFRC 100: Procedure for Determining Fenestration Product U-factors." (2007; NFRC 100 includes procedures for site fenestration formerly included in a separate document, NFRC 100-SB.)

NFRC 200 is the National Fenestration Rating Council document entitled "NFRC 200: Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence." (2007)

NFRC 400 is the National Fenestration Rating Council document entitled "NFRC 400: Procedure for Determining Fenestration Product Air Leakage." (2007)

NONRESIDENTIAL BUILDING is any building which is a Group A, B, E, F, H, M or S, and is a U Occupancy when the Group U Occupancy is on a nonresidential site.

Note: Requirements for high-rise residential buildings and hotels/ motels are included in the nonresidential sections of Title 24, Part 6.

NONRESIDENTIAL COMPLIANCE MANUAL is the manual developed by the Commission, under Section 25402.1

(e) of the Public Resources Code, to aid designers, builders and contractors in meeting the energy efficiency requirements for nonresidential, high-rise residential and hotel/motel buildings.

NONRESIDENTIAL FUNCTION AREA OR TYPE OF USE is one of the following:

Atrium is a large-volume space created by openings connecting two or more stories and is used for purposes other than an enclosed stairway, an elevator hoistway, an escalator opening or as a utility shaft for plumbing, electrical, air-conditioning or other equipment and is not a mall.

Auditorium is a public building where an audience sits in fixed seating, or a room, area or building with fixed seats used for public meetings or gatherings not specifically for the viewing of dramatic performances.

Auto repair is the portion of a building used to repair automotive equipment and/or vehicles, exchange parts, and may include work using an open flame or welding equipment.

Beauty salon is a room or area in which the primary activity is manicures, pedicures, facials, or the cutting or styling of hair. Also known as beauty shop or beauty parlor.

Civic meeting place is a city council or board of supervisors meeting chamber, courtroom or other official meeting space accessible to the public.

Classroom building is a building or group of buildings that is predominately classrooms used by an organization that provides instruction to students, which may include corridors and stairways, restrooms and small storage closets, faculty offices, and workshops and labs. A classroom building does not include buildings that are not predominantly classroom, including auditorium, gymnasium, kitchen, library, multipurpose, dining and cafeteria, student union, maintenance staff workroom or storage buildings.

Classroom, lecture, training, vocational room is a room or area where an audience or class receives instruction.

Commercial and industrial storage is a room, area or building used for storing items.

Convention, conference, multipurpose and meeting centers is an assembly room, area or building that is used for meetings, conventions and multiple purposes, including, but not limited to, dramatic performances, and that has neither fixed seating nor fixed staging.

Corridor is a passageway or route into which compartments or rooms open.

Dining is a room or rooms in a restaurant or hotel/motel (other than guest rooms) where meals that are served to the customers will be consumed.

Dormitory is a building consisting of multiple sleeping quarters and having interior common areas such as dining rooms, reading rooms, exercise rooms, toilet rooms, study rooms, hallways, lobbies, corridors and stairwells, other than high-rise residential, low-rise residential and hotel/motel occupancies.

Electrical/mechanical/telephone room is a room in which the building's electrical switchbox or control panels, telephone switchbox, and/or HVAC controls or equipment is located.

Exercise center/gymnasium is a room or building equipped for gymnastics, exercise equipment or indoor athletic activities.

Exhibit is a room or area that is used for exhibitions that has neither fixed seating nor fixed staging.

Financial institution is a public establishment used for conducting financial transactions including the custody, loan, exchange or issue of money, for the extension of credit, and for facilitating the transmission of funds.

Financial transactions is the teller, work station, and customers waiting areas to complete financial transactions. Financial transaction areas do not include private offices, hallways, restrooms or other support areas.

General commercial and industrial work is a room, area or building in which an art, craft, assembly or manufacturing operation is performed.

High bay: Luminaires 25 feet or more above the floor.

Low bay: Luminaires less than 25 feet above the floor.

Precision: Involving visual tasks of small size or fine detail such as electronic assembly, fine woodworking, metal lathe operation, fine hand painting and finishing, egg processing operations or tasks of similar visual difficulty.

Grocery sales is a room, area or building that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Grocery store is a building that has as its primary purpose the sale of foodstuffs requiring additional preparation prior to consumption.

Hotel function area is a hotel room or area such as a hotel ballroom, meeting room, exhibit hall or conference room, together with pre-function areas and other spaces ancillary to its function.

Housing, Public and Commons Areas is housing other than Occupancy Group I that are living quarters. Commons areas may include dining, reading, study, library or other community spaces and/or medical treatment or hospice facilities.

Multifamily: A multifamily building contains multiple dwelling units that share common walls and may also share common floors or ceilings (apartments).

Dormitory: A space in a building where group sleeping accommodations are provided in one room, or in a series of closely associated rooms, for persons not members of the same family group, under joint occupancy and single management, as in college dormitories or fraternity houses.

Senior housing: Is specifically for habitation by seniors, including but not limited to independent living quarters, and assisted living quarters.

Kitchen/food preparation is a room or area with cooking facilities and/or an area where food is prepared.

Laboratory, Scientific is a space or facility where research, experiments and measurement in medical and physical sciences are performed requiring examination of fine details. The space may include workbenches, countertops, scientific instruments and associated floor spaces. Scientific laboratory does not refer to film, computer and other laboratories where scientific experiments are not performed.

Laundry is a place where laundering activities occur.

Library is a repository for literary materials, such as books, periodicals, newspapers, pamphlets and prints, kept for reading or reference.

Reading areas: Is a library facility term describing areas within a prescribed building space containing tables, chairs or desks for library patrons to use for the purpose of reading books and other reference documents.Library reading areas include reading, circulation and checkout areas. Reading areas do not include private offices, meeting, photocopy or other rooms not used specifically for reading by library patrons.

Stacks: Is a library facility term describing a large grouping of shelving sections within a prescribed building space. Stack aisles include pedestrian paths located in stack areas. Book stack aisle lighting is typically a central aisle luminaire distributing light to stack faces on both sides of an aisle.

Lobby:

Hotel: Is the contiguous space in a hotel/motel between the main entrance and the front desk, including reception, waiting and seating areas.

Main entry: Is the contiguous space in buildings other than hotel/motel that is directly located by the main entrance of the building through which persons must pass, including reception, waiting and seating areas.

Locker/dressing room is a room or area for changing clothing, sometimes equipped with lockers.

Lounge/recreation is a room used for leisure activities which may be associated with a restaurant or bar.

Mall is a roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants.

Medical and clinical care is a non "I" occupancy room or area in a building that does not provide overnight patient care and that is used to provide physical and mental care through medical, dental or psychological examination and treatment, including, but not limited to, laboratories and treatment spaces.

Medical buildings and clinics is a building where medical and clinical care is provided.

Museum is a space in which the primary function is the care of exhibit of works of artistic, historical or scientific value. A museum does not include a gallery or other place where art is for sale. A museum does not include a lobby, conference room or other occupancies where the primary function is not the care or exhibit of works of artistic, historical or scientific value.

Office is a room, area or building of CBC Group B Occupancy other than restaurants.

Parking garage is a covered building or structure for the purpose of parking vehicles, which consists of at least a roof over the parking area, enclosed with walls on all sides. Parking garages may have fences, rails, partial walls or other barriers in place of one or more walls. The structure has an entrance(s) and exit(s), and includes areas for vehicle maneuvering to reach the parking spaces. If the roof of a parking structure is also used for parking, the section without an overhead roof is considered a parking lot instead of a parking garage.

Parking area is the area of a parking garage used for purpose of parking and maneuvering of vehicles on a single floor, and which is not the roof of a parking structure.

Ramps and entries are driveways for the purpose of moving vehicles between floors of a parking garage. Parking entries are driveways for the purpose of vehicles entering into a parking garage.

Religious facility is a building in which the primary function is for an assembly of people to worship. Religious facilities do not include classroom, housing or gymnasium buildings.

Religious worship is a room, area or building in which the primary function is for an assembly of people to worship. Religious worship does not include classrooms, offices or other areas in which the primary function is not for an assembly of people to worship.

Restaurant is a room, area or building that is a food establishment as defined in Section 27520 of the Health and Safety Code.

Restroom is a room or suite of rooms providing personal facilities such as toilets and washbasins.

Retail merchandise sales is a room, area or building in which the primary activity is the sale of merchandise.

School is a building or group of buildings that is used by an organization that provides instruction to students, which is predominately classroom buildings but may also include auditorium, gymnasium, kitchen, library, multipurpose rooms, dining and cafeteria, student union, maintenance staff workroom and small storage spaces.

Stairs is a series of steps providing passage from one level of a building to another, including escalators.

Support area is a room or area used as a passageway, utility room, storage space or other type of space associated with or secondary to the function of an occupancy that is listed in these regulations.

Tenant lease space is a portion of a building intended for lease for which a specific tenant is not identified at the time of permit application.

Theater:

Motion picture is an assembly room, a hall or a building with tiers of rising seats or steps for the showing of motion pictures.

Performance is an assembly room, a hall or a building with tiers of rising seats or steps for the viewing of dramatic performances, lectures, musical events and similar live performances.

Transportation function is the ticketing area, waiting area, baggage handling areas, concourse or other areas not covered by primary functions in Table 146-C in an airport terminal, bus or rail terminal or station, subway or transit station, or a marine terminal.

Videoconferencing studio is a room with permanently installed videoconferencing cameras, audio equipment and playback equipment for both audio-based and video-based two-way communication between local and remote sites.

Vocational room is a room used to provide training in a special skill to be pursued as a trade.

Waiting area is an area other than a hotel lobby or main entry lobby normally provided with seating and used for people waiting.

Wholesale showroom is a room where samples of merchandise are displayed.

NONSTANDARD PART LOAD VALUE (NPLV) is a single-number part-load efficiency figure of merit for chillers referenced to conditions other than IPLV conditions. (See "integrated part load value.")

NORTH-FACING (See "orientation.")

OCCUPANT SENSOR, LIGHTING is a device that automatically turns lights off soon after an area is vacated. The term occupant sensor applies to a device that controls indoor lighting systems. When the device is used to control outdoor lighting systems, it is termed a motion sensor. The device also may be called an occupancy sensor, occupant-sensing device or vacancy sensor.

OPEN COOLING TOWER is an open, or direct contact, cooling tower which exposes water directly to the cooling atmosphere, thereby transferring the source heat load from the water directly to the air by a combination of heat and mass transfer.

OPERABLE SHADING DEVICE is a device at the interior or exterior of a building or integral with a fenestration product, which is capable of being operated, either manually or automatically, to adjust the amount of solar radiation admitted to the interior of the building.

ORIENTATION, CARDINAL is one of the four principal directional indicators, north, east, south and west, which are marked on a compass. Also called cardinal directions.

ORIENTATION, EAST-FACING is oriented to within 45 degrees of true east, including 45°00'00" south of east (SE), but excluding 45°00'00" north of east (NE).

ORIENTATION, NORTH-FACING is oriented to within 45 degrees of true north, including 45°00'00" east of north (NE), but excluding 45°00'00"west of north (NW).

ORIENTATION, SOUTH-FACING is oriented to within 45 degrees of true south including 45°00'00" west of south (SW), but excluding 45°00'00" east of south (SE).

ORIENTATION, WEST-FACING is oriented to within 45 degrees of true west, including 45°00'00" north of due west (NW), but excluding 45°00'00" south of west (SW).

OUTDOOR AIR (Outside air) is air taken from outdoors and not previously circulated in the building.

OUTDOOR LIGHTING definitions include the following:

Building entrance is any operable doorway in or out of a building, including overhead doors.

Building facade is the exterior surfaces of a building, not including horizontal roofing, signs and surfaces not visible from any reasonable viewing location.

Canopy is a permanent structure, other than a parking garage as defined in Section 101, consisting of a roof and supporting building elements, with the area beneath at least partially open to the elements. A canopy may be freestanding or attached to surrounding structures. A canopy roof may serve as the floor of a structure above.

Carport is a covered, open-sided structure used solely for the purpose of parking vehicles, consisting of a roof over the parking area. Typically, carports are free-standing or projected from the side of the building and are only two or fewer car lengths deep.

Hardscape is an improvement to a site that is paved or has other structural features, including but not limited to, curbs, plazas, entries, parking lots, site roadways, driveways, walkways, sidewalks, bikeways, water features and pools, storage or service yards, loading docks, amphitheaters, outdoor sales lots, and private monuments and statuary.

Landscape lighting is lighting that is recessed into or mounted on the ground, paving or raised deck which is mounted less than 42″ above grade or mounted onto trees or trellises, and that is intended to be aimed only at landscape features.

Lantern is an ornamental outdoor luminaire that uses an electric lamp to replicate a pre-electric lantern, which used a flame to generate light.

Lighting zone is a geographic area designated by the California Energy Commission that determines requirements for outdoor lighting, including lighting power densities and specific control, equipment or performance requirements. Lighting zones are numbered LZ1, LZ2, LZ3 and LZ4.

Marquee lighting is a permanent lighting system consisting of one or more rows of many small lights, including light emitting diodes (LEDs), or fiber optic lighting, attached to a canopy.

Ornamental lighting is post-top luminaires, lanterns, pendant luminaires, chandeliers and marquee lighting.

Outdoor lighting is all electrical lighting for parking lots, signs, building entrances, outdoor sales areas, outdoor canopies, landscape lighting, lighting for building facades and hardscape lighting.

Outdoor sales frontage is the portion of the perimeter of an outdoor sales area immediately adjacent to a street, road or public sidewalk.

Outdoor sales lot is an uncovered paved area used exclusively for the display of vehicles, equipment or other merchandise for sale. All internal and adjacent access drives, walkway areas, employee and customer parking areas, vehicle service or storage areas are not outdoor sales lot areas, but are considered hardscape.

Parking lot is an uncovered area for the purpose of parking vehicles. Parking lot is a type of hardscape.

Paved area is an area that is paved with concrete, asphalt, stone, brick, gravel or other improved wearing surface, including the curb.

Pendant is a mounting method in which the luminaire is suspended from above.

Post-top luminaire is an ornamental outdoor luminaire that is mounted directly on top of a lamppost.

Principal viewing location is anywhere along the adjacent highway, street, road or sidewalk running parallel to an outdoor sales frontage.

Public monuments are statuary, buildings, structures and/or hardscape on public land.

Sales canopy is a canopy specifically to cover and protect an outdoor sales area.

Stairways and Ramps. Stairways are one or more flights of stairs with the necessary landings and platforms connecting them to form a continuous and uninterrupted passage from one level to another. An exterior stairway is open on at least one side, except for required structural columns, beams, handrails and guards. The adjoining open areas shall be either yards, courts or public ways. The other sides of the exterior stairway need not be open. Ramps are walking surfaces with a slope steeper than 5 percent.

Vehicle service station is a gasoline, natural gas, diesel or other fuel dispensing station.

PERMANENTLY INSTALLED LIGHTING includes all luminaires attached to the inside or outside of a building or site, including track and flexible lighting system lighting attached to walls, ceilings, columns, inside or outside of permanently installed cabinets, internally illuminated case work, mounted on poles, in trees, or in the ground; attached to ceiling fans and integral to exhaust fans that are other than exhaust hoods for cooking equipment. Permanently installed luminaires may have either plug-in or hardwired connections for electric power. Permanently installed lighting does not include portable lighting or lighting that is installed by the manufacturer in refrigerators, stoves, microwave ovens, exhaust hoods for cooking equipment, refrigerated cases, vending machines, food preparation equipment, and scientific and industrial equipment.

PHOTOCONTROL is an electric device that detects changes in illumination levels then controls lighting load at predetermined illumination levels.

POOLS, ANSI/NSPI-5 is the American National Standards Institute and National Spa and Pool Institute document entitled "American National Standard for Residential Inground Swimming Pools" 2003 (ANSI/NSPI-5 2003).

POOLS, AUXILIARY POOL LOADS are features or devices that circulate pool water in addition to that required for pool filtration, including, but not limited to, solar pool heating systems, filter backwashing, pool cleaners, waterfalls, fountains and spas.

POOLS, BACKWASH VALVE is a diverter valve designed to backwash filters located between the circulation pump and the filter, including, but not limited to, slide, push-pull, multiport and full-flow valves.

POOLS, MULTISPEED PUMP is a pump capable of operating at two (2) or more speeds and includes two-speed and variable-speed pumps.

POOLS, NSF/ANSI 50 is the NSF International (formerly National Sanitation Foundation) Standard and American National Standards Institute document entitled "Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs" 2005 (NSF/ANSI 50 – 2005).

POOLS, RESIDENTIAL are permanently installed residential in-ground swimming pools intended for use by a single-family home for noncommercial purposes and with dimensions as defined in ANSI/NSPI-5.

PORTABLE LIGHTING is lighting with plug-in connections for electric power that is table and freestanding floor lamps, attached to modular furniture, workstation task lights, lights attached to workstation panels, movable displays and other equipment that is not permanently installed lighting.

PRIMARY AIRFLOW is the airflow (cfm or L/s) supplied to the zone from the air-handling unit at which the outdoor air intake is located. It includes outdoor intake air and recirculated air from that air-handling unit but does not include air transferred or air recirculated to the zone by other means.

PROCESS is an activity or treatment that is not related to the space conditioning, lighting, service water heating or ventilating of a building as it relates to human occupancy.

PROCESS LOAD is a load resulting from a process.

PROCESS SPACE is a space that is thermostatically controlled to maintain a process environment temperature less than 55°F or to maintain a process environment temperature greater than 90°F for the whole space that the system serves, or that is a space with a space-conditioning system designed and controlled to be incapable of operating at temperatures above 55 °F or incapable of operating at temperatures below 90°F at design conditions.

PUBLIC AREAS are spaces generally open to the public at large, customers or congregation members, or similar spaces where occupants need to be prevented from controlling lights for safety, security or business reasons.

RADIANT BARRIER is a highly reflective, low emitting material installed at the underside surface of the roof deck and the inside surface of gable ends or other exterior vertical surfaces in attics to reduce solar heat gain into the attic.

RAISED FLOOR is a floor (partition) over a crawl space, or an unconditioned space, or ambient air.

READILY ACCESSIBLE is capable of being reached quickly for operation, repair or inspection, without requiring

climbing or removing obstacles, or resorting to access equipment.

RECOOL is the cooling of air that has been previously heated by space-conditioning equipment or systems serving the same building.

RECOVERED ENERGY is energy used in a building that (1) is recovered from space conditioning, service water heating, lighting, or process equipment after the energy has performed its original function; (2) provides space conditioning, service water heating, or lighting; and (3) would otherwise be wasted.

REFERENCE APPENDICES is the support document for the Building Energy Efficiency Standards and the ACM Approval Manuals. The document consists of three sections: the Reference Joint Appendices (JA), the Reference Residential Appendices (RA) and the Reference Nonresidential Appendices (NA).

REFLECTANCE, SOLAR is the ratio of the reflected solar flux to the incident solar flux.

REFRIGERATED CASE is a manufactured commercial refrigerator or freezer, including but not limited to display cases, reach-in cabinets, meat cases, and frozen food and soda fountain units.

REFRIGERATED SPACE is a building or a space that is a refrigerated warehouse, walk-in cooler or a freezer.

REFRIGERATED WAREHOUSE is a building or a space constructed for storage of products, where mechanical refrigeration is used to maintain the space temperature at 55°F or less.

REHEAT is the heating of air that has been previously cooled by cooling equipment or supplied by an economizer.

RELATIVE SOLAR HEAT GAIN is the ratio of solar heat gain through a fenestration product (corrected for external shading) to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

RELOCATABLE PUBLIC SCHOOL BUILDING is a relocatable building as defined by Title 24, Part 1, Section 4-314, which is subject to Title 24, Part 1, Chapter 4, Group 1.

REPAIR is the reconstruction or renewal for the purpose of maintenance of any component, system or equipment of an existing building. Replacement of any component, system or equipment for which there are requirements in the standards is considered an alteration and not a repair.

RESIDENTIAL BUILDING (See "high-rise residential building" and "low-rise residential building.")

RESIDENTIAL COMPLIANCE MANUAL is the manual developed by the Commission, under Section 25402.1 of the Public Resources Code, to aid designers, builders and contractors in meeting energy efficiency standards for low-rise residential buildings.

RESIDENTIAL SPACE TYPE is one of the following:

Bathroom is a room or area containing a sink used for personal hygiene, toilet, shower or a tub.

Closet is a nonhabitable room used for the storage of linens, household supplies, clothing, nonperishable food or similar uses, and which is not a hallway or passageway.

Garage is a nonhabitable building or portion of building, attached to or detached from a residential dwelling unit, in which motor vehicles are parked.

Kitchen is a room or area used for cooking, food storage and preparation and washing dishes, including associated counter tops and cabinets, refrigerator, stove, ovens and floor area.

Laundry is a nonhabitable room or space which contains plumbing and electrical connections for a washing machine or clothes dryer.

Storage building is a nonhabitable detached building used for the storage of tools, garden equipment or miscellaneous items.

Utility room is a nonhabitable room or building which contains only HVAC, plumbing, or electrical controls or equipment; and which is not a bathroom, closet, garage or laundry room.

ROOF is the outside cover of a building or structure including the structural supports, decking and top layer that is exposed to the outside with a slope less than 60 degrees from the horizontal.

ROOF, LOW-SLOPED is a roof that has a ratio of rise to run of 2:12 or less (9.5 degrees from the horizontal).

ROOF, STEEP-SLOPED is a roof that has a ratio of rise to run of greater than 2:12 (9.5 degrees from the horizontal).

ROOFING PRODUCT is the top layer(s) of the roof that is exposed to the outside, which has properties including but not limited to reflectance, emittance and mass.

RUNOUT is piping that is no more than 12 feet long and that connects to a fixture or an individual terminal unit.

SCIENTIFIC EQUIPMENT is measurement, testing or metering equipment used for scientific research or investigation, including but not limited to manufactured cabinets, carts and racks.

SCONCE is a wall-mounted ornamental luminaire.

SEASONAL ENERGY EFFICIENCY RATIO (SEER) is the total cooling output of an air conditioner in Btu during its normal usage period for cooling divided by the total electrical energy input in watt-hours during the same period, as determined using the applicable test method in the Appliance Efficiency Regulations.

SERIES FAN-POWERED TERMINAL UNIT is a terminal unit that combines a VAV damper in series with a downstream fan which runs at all times that the terminal unit is supplying air to the space.

SERVICE WATER HEATING is heating of water for sanitary purposes for human occupancy, other than for comfort heating.

SHADING is the protection from heat gains because of direct solar radiation by permanently attached exterior devices or

building elements, interior shading devices, glazing material or adherent materials.

SHADING COEFFICIENT(SC) is the ratio of the solar heat gain through a fenestration product to the solar heat gain through an unshaded $^1/_8$-inch-thick clear double strength glass under the same set of conditions. For nonresidential, high-rise residential and hotel/motel buildings, this shall exclude the effects of mullions, frames, sashes, and interior and exterior shading devices.

SIGN definitions include the following:

Electronic Message Center (EMC) is a pixilated image producing electronically controlled sign formed by any light source. Bare lamps used to create linear lighting animation sequences through the use of chaser circuits, also known as "chaser lights" are not considered an EMC.

Illuminated face is a side of a sign that has the message on it. For an exit sign it is the side that has the word "EXIT" on it.

Sign, cabinet is an internally illuminated sign consisting of frame and face(s), with a continuous translucent message panel, also referred to as a panel sign.

Sign, channel letter is an internally illuminated sign with multiple components, each built in the shape of an individual three-dimensional letter or symbol that are each independently illuminated, with a separate translucent panel over the light source for each element.

Sign, double-faced is a sign with two parallel opposing faces.

Sign, externally illuminated is any sign or a billboard that is lit by a light source that is external to the sign directed towards and shining on the face of the sign.

Sign, internally illuminated is a sign that is illuminated by a light source that is contained inside the sign where the message area is luminous, including cabinet signs and channel letter signs.

Sign, traffic is a sign for traffic direction, warning and roadway identification.

Sign, unfiltered is a sign where the viewer perceives the light source directly as the message, without any colored filter between the viewer and the light source, including neon, cold cathode and LED signs.

SINGLE PACKAGE VERTICAL AIR CONDITIONER (SPVAC) is a type of air-cooled small or large commercial package air-conditioning and heating equipment; factory assembled as a single package having its major components arranged vertically, which is an encased combination of cooling and optional heating components; is intended for exterior mounting on, adjacent interior to, or through an outside wall; and is powered by single or three-phase current. It may contain separate indoor grille(s), outdoor louvers, various ventilation options, indoor free air discharge, ductwork, wall plenum or sleeve. Heating components may include electrical resistance, steam, hot water, gas, or no heat but may not include reverse cycle refrigeration as a heating means.

SINGLE PACKAGE VERTICAL HEAT PUMP (SPVHP) is an SPVAC that utilizes reverse cycle refrigeration as its primary heat source, with secondary supplemental heating by means of electrical resistance, steam, hot water or gas.

SITE-BUILT FENESTRATION is fenestration designed to be field-glazed or field assembled units using specific factory cut or otherwise factory formed framing and glazing units that are manufactured with the intention of being assembled at the construction site and are provided with an NFRC label certificate for site-built fenestration. Examples of site-built fenestration include storefront systems, curtain walls and atrium roof systems.

SITE SOLAR ENERGY is thermal, chemical or electrical energy derived from direct conversion of incident solar radiation at the building site.

SKYLIGHT is fenestration installed on a roof less than 60 degrees from the horizontal.

SKYLIGHT AREA is the area of the rough opening for the skylight.

SKYLIGHT TYPE is one of the following three types of skylights: glass mounted on a curb, glass not mounted on a curb or plastic (assumed to be mounted on a curb).

SMACNA is the Sheet Metal and Air-conditioning Contractors National Association.

SMACNA RESIDENTIAL COMFORT SYSTEM INSTALLATION STANDARDS MANUAL is the Sheet Metal Contractors' National Association document entitled "Residential Comfort System Installation Standards Manual, Seventh Edition." (1998)

SOCIAL SERVICES BUILDING is a space where public assistance and social services are provided to individuals or families.

SOLAR HEAT GAIN COEFFICIENT (SHGC) is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

SOLAR HEAT GAIN COEFFICIENT, CENTER OF GLAZING (SHGCc) is the SHGC for the center of glazing area.

SOLAR HEAT GAIN COEFFICIENT, TOTAL FENESTRATION PRODUCT (SHGC or $SHGC_T$) is the SHGC for the total fenestration product.

SOLAR REFLECTANCE INDEX (SRI) is a measure of the roof's ability to reject solar heat which includes both reflectance and emittance.

SOUTH-FACING (See "orientation.")

SPA is a vessel that contains heated water in which humans can immerse themselves, is not a pool, and is not a bathtub.

SPACE-CONDITIONING SYSTEM is a system that may consist of but not limited to chiller/compressor, air handler unit, cooling and heating coils, air and water cooled condenser, economizers and the air distribution system, which provide

either collectively or individually heating, ventilating or cooling within or associated with conditioned spaces in a building.

STEPPED DIMMING (See "dimming, stepped.")

STEPPED SWITCHING is a lighting control method that varies the light output of a lighting system with the intent of maintaining approximately the relative uniformity of illumination by turning off alternate groups of lamps or luminaires.

STORAGE, COLD is a storage area within a refrigerated warehouse where space temperatures are maintained at or above 32°F.

STORAGE, FROZEN is a storage area within a refrigerated warehouse where the space temperatures are maintained below 32°F.

SYSTEM is a combination of equipment, controls, accessories, interconnecting means or terminal elements by which energy is transformed to perform a specific function, such as space conditioning, service waterheating or lighting.

TASK LIGHTING is lighting that is designed specifically to illuminate a task location, and that is generally confined to the task location.

TEMPORARY LIGHTING is a lighting installation with plug-in connections that does not persist beyond 60 consecutive days or more than 120 days per year.

TENANT SPACE is a portion of a building intended for occupancy by a single tenant.

THERMAL MASS is solid or liquid material used to store heat for later heating use or for reducing cooling requirements.

THERMAL RESISTANCE (R) is the resistance of a material or building component to the passage of heat in (hr × ft^2 × °F)/Btu.

THERMOSTATIC EXPANSION VALVE (TXV) is a refrigerant metering valve, installed in an air conditioner or heat pump, which controls the flow of liquid refrigerant entering the evaporator in response to the superheat of the gas leaving it.

THROW DISTANCE is the distance between the luminaire and the center of the plane lit by the luminaire on a display.

TIME DEPENDENT VALUATION (TDV) ENERGY is the time varying energy caused to be used by the building to provide space conditioning and water heating and for specified buildings lighting. TDV energy accounts for the energy used at the building site and consumed in producing and in delivering energy to a site, including, but not limited to, power generation, transmission and distribution losses.

U-FACTOR is the overall coefficient of thermal transmittance of a construction assembly, in Btu/(hr × ft^2 × °F), including air film resistance at both surfaces.

U-FACTOR, CENTER OF GLAZING (U-FACTOR$_c$) is the U-Factor for the center of glazing area.

U-FACTOR, TOTAL FENESTRATION PRODUCT (U-FACTOR or U-FACTOR$_t$) is the U-Factor for the total fenestration product.

UL® is the Underwriters Laboratories.

UL 181 is the Underwriters Laboratories document entitled "Standard for Factory-Made Air Ducts and Air Connectors," 1996.

UL 181A is the Underwriters Laboratories document entitled "Standard for Closure Systems for Use With Rigid Air Ducts and Air Connectors," 1994.

UL 181B is the Underwriters Laboratories document entitled "Standard for Closure Systems for Use With Flexible Air Ducts and Air Connectors," 1995.

UL 723 is the Underwriters Laboratories document entitled "Standard for Test for Surface Burning Characteristics of Building Materials," 1996.

UL 727 is the Underwriters Laboratories document entitled "Standard for Oil-Fired Central Furnaces," 1994.

UL 731 is the Underwriters Laboratories document entitled "Standard for Oil-Fired Unit Heaters," 1995.

UL 1574 is the Underwriters Laboratories document entitled "Track Lighting Systems," 2000.

UL 1598 is the Underwriters Laboratories document entitled "Standard for Luminaires," 2000.

UL 2108 is the Underwriters Laboratories document entitled "Low Voltage Lighting Systems," 2008.

UNCONDITIONED SPACE is enclosed space within a building that is not directly conditioned or indirectly conditioned.

UNIT INTERIOR MASS CAPACITY (UIMC) is the amount of effective heat capacity per unit of thermal mass, taking into account the type of mass material, thickness, specific heat, density and surface area.

VACANCY SENSOR, LIGHTING is an occupant sensor for which the lights must be manually turned on but the sensor automatically turns the lights off soon after an area is vacated. The device also may be called a manual-on occupant sensor.

VAPOR BARRIER is a material that has a permeance of one perm or less and that provides resistance to the transmission of water vapor.

VARIABLE AIR VOLUME (VAV) SYSTEM is a space-conditioning system that maintains comfort levels by varying the volume of supply air to the zones served.

VENDING MACHINE is a machine for vending and dispensing refrigerated or nonrefrigerated food and beverages or general merchandise.

VERTICAL GLAZING (See "window.")

VERY VALUABLE MERCHANDISE are rare or precious objects, including, but not limited to, jewelry, coins, small art objects, crystal, ceramics or silver, the selling of which involves customer inspection of very fine detail from outside of a locked case.

VISIBLE TRANSMITTANCE (VT) is the ratio (expressed as a decimal) of visible light that is transmitted through a glazing material to the light that strikes the material as calculated in NFRC 200.

VISIBLE TRANSMITTANCE, CENTER OF GLAZING (VTc) is the VT for the center of glazing area.

VISIBLE TRANSMITTANCE, TOTAL FENESTRATION PRODUCT (VT or VTt) is the VT for the total fenestration product.

WALL TYPE is a type of wall assembly having a specific heat capacity, framing type and U-factor.

WEST-FACING (See "orientation.")

WINDOW is fenestration that is not a skylight.

WINDOW AREA is the area of the surface of a window, plus the area of the frame, sash and mullions.

WINDOW TYPE is a window assembly having a specific solar heat gain coefficient, relative solar heat gain and U-factor.

WINDOW WALL RATIO is the ratio of the window area to the gross exterior wall area.

WOOD HEATER is an enclosed wood-burning appliance used for space heating and/or domestic water heating.

WOOD STOVE (See "wood heater.")

ZONE, CRITICAL is a zone serving a process where reset of the zone temperature setpoint during a demand shed event might disrupt the process, including but not limited to data centers, telecom and private branch exchange (PBX) rooms, and laboratories.

ZONE, NONCRITICAL is a zone that is not a critical zone.

ZONE, SPACE-CONDITIONING, is a space or group of spaces within a building with sufficiently similar comfort conditioning requirements so that comfort conditions, as specified in Section 144(b)3 or 150(h), as applicable, can be maintained throughout the zone by a single controlling device.

SECTION 102
CALCULATION OF TIME DEPENDENT VALUATION (TDV) ENERGY

Time Dependent Valuation (TDV) energy shall be used to compare proposed designs to their energy budget when using the performance compliance approach. TDV energy is calculated by multiplying the site energy use (electricity kWh, natural gas therms, or fuel oil or LPG gallons) for each energy type times the applicable TDV multiplier. TDV multipliers vary for each hour of the year and by energy type (electricity, natural gas or propane), by climate zone and by building type (low-rise residential or nonresidential, high-rise residential or hotel/motel). TDV multipliers are summarized in Reference Joint Appendix 3. TDV multipliers for propane shall be used for all energy obtained from depletable sources other than electricity and natural gas.

SECTION 103- Reserved.

SECTION 104- Reserved.

SECTION 105- Reserved.

SECTION 106- Reserved.

SECTION 107- Reserved.

SECTION 108- Reserved.

SECTION 109- Reserved.

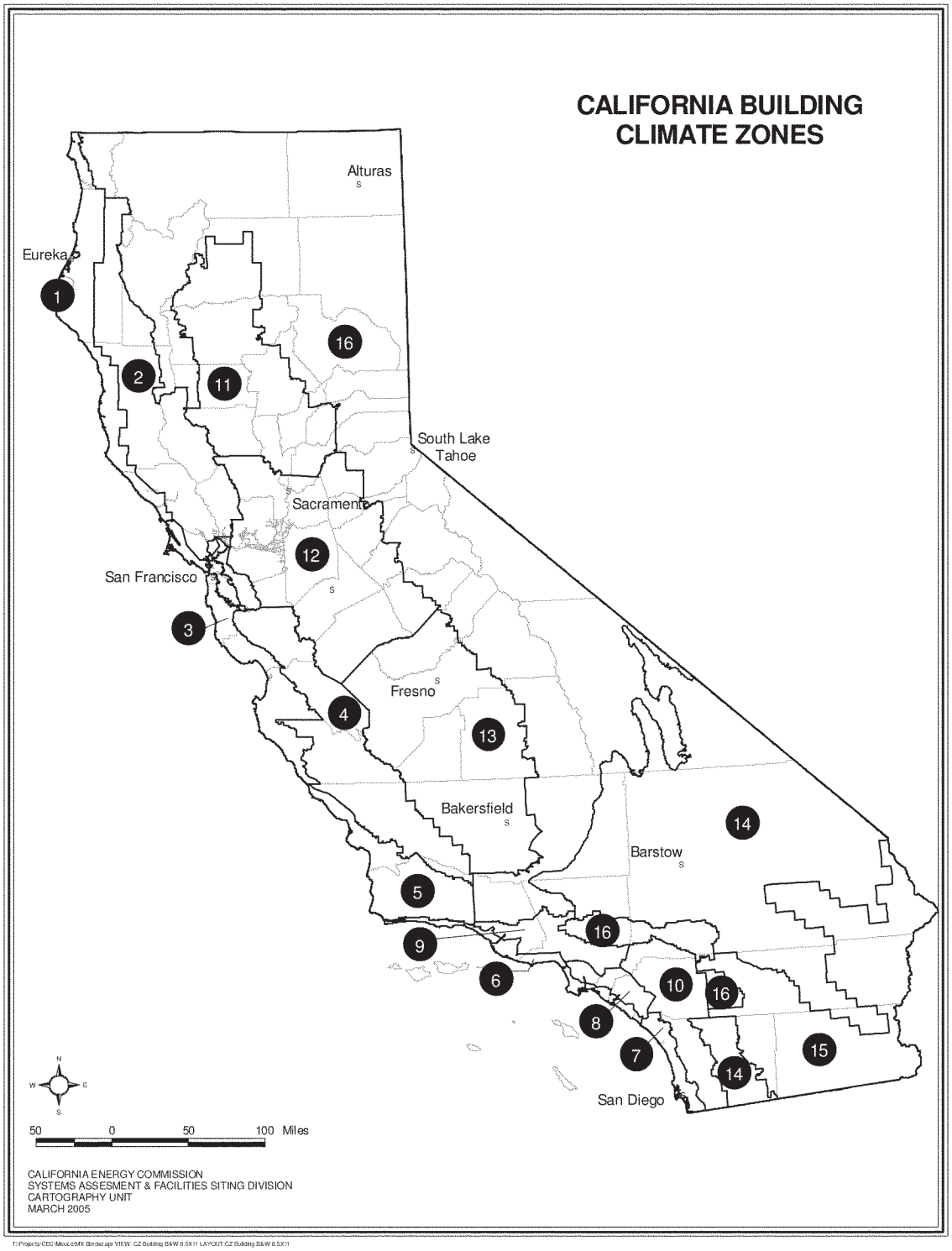

FIGURE 101-A—CALIFORNIA CLIMATE ZONES

Climate Zones for Residential and Nonresidential Occupancies

FIGURE 101-A CALIFORNIA CLIMATE ZONES

SUBCHAPTER 2

ALL OCCUPANCIES—MANDATORY REQUIREMENTS FOR THE MANUFACTURE, CONSTRUCTION AND INSTALLATION OF SYSTEMS, EQUIPMENT AND BUILDING COMPONENTS

SECTION 110
SYSTEMS AND EQUIPMENT—GENERAL

Sections 111 through 119 establish requirements for manufacturing, construction and installation of certain systems, equipment and building components that are installed in buildings regulated by Title 24, Part 6. Systems, equipment and building components listed below may be installed only if:

(a) The manufacturer has certified that the system, equipment or building component complies with the applicable manufacturing provisions of Sections 111 through 119; and

(b) The system, equipment or building component complies with the applicable installation provisions of Sections 111 through 119.

No system, equipment or building component covered by the provisions of Sections 111 through 119 that is not certified or that fails to comply with the applicable installation requirements may be installed in a building regulated by Title 24, Part 6.

The systems, equipment and building components covered are:

Appliances regulated by the Appliance Efficiency Regulations (Section 111).

Other space-conditioning equipment (Section 112).

Other service water-heating systems and equipment (Section 113).

Pool and spa systems and equipment (Section 114).
Gas appliances (Section 115).
Doors, windows and fenestration products (Section 116).
Joints and other openings (Section 117).
Insulation and roofing products (Section 118).
Lighting control devices, ballasts and luminaires (Section 119).

SECTION 111
MANDATORY REQUIREMENTS FOR APPLIANCES REGULATED BY THE APPLIANCE EFFICIENCY REGULATIONS

Any appliance for which there is a California standard established in the Appliance Efficiency Regulations may be installed only if the manufacturer has certified to the Commission, as specified in those regulations, that the appliance complies with the applicable standard for that appliance. For certified appliances, go to www.energy.ca.gov/appliances/database.

SECTION 112
MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

Certification by manufacturers. Any space-conditioning equipment listed in this section may be installed only if the manufacturer has certified that the equipment complies with all the applicable requirements of this section.

(a) **Efficiency.** Equipment shall meet the applicable requirements in Tables 112-A through 112-M, subject to the following:

1. If more than one standard is listed for any equipment in Tables 112-A through 112-M, the equipment shall meet all the applicable standards that are listed; and
2. If more than one test method is listed in Tables 112-A through 112-M, the equipment shall comply with the applicable standard when tested with each test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

   Exception to Section 112(a): Water-cooled centrifugal water-chilling packages that are not designed for operation at ARI Standard 550 test conditions of 44°F leaving chilled water temperature and 85°F entering condenser water temperature shall have a minimum full load COP rating as shown in Tables 112-H, 112-1, and 112-J and a minimum NPLV rating as shown in Tables 112-K, 112-L and 112-M. The table values are only applicable over the following full load design ranges:

Leaving Chiller Water Temperature	40 to 48°F
Entering Condenser Water Temperature	75 to 85°F
Condensing Water Temperature Rise	5 to 15°F

(b) **Controls for heat pumps with supplementary electric resistance heaters.** Heat pumps with supplementary electric resistance heaters shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.

Exception to Section 112(b): The controls may allow supplementary heater operation during:

A. Defrost; and

B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

(c) Thermostats. All unitary heating and/or cooling systems including heat pumps that are not controlled by a central energy management control system (EMCS) shall have a setback thermostat.

1. **Setback Capabilities.** All thermostats shall have a clock mechanism that allows the building occupant to program the temperature set points for at least four periods within 24 hours. Thermostats for heat pumps shall meet the requirements of Section 112(b).

Exception to Section 112(c): Gravity gas wall heaters, gravity floor heaters, gravity room heaters, noncentral electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps need not comply with this requirement. Additionally, room air-conditioner heat pumps need not comply with Section 112(b). Under performance method of compliance, the resulting increase in energy use due to elimination of the setback thermostat shall be factored into the compliance analysis in accordance with a method prescribed by the Executive Director.

(d) **Gas-fired and oil-fired furnace standby loss controls.** Gas-fired and oil-fired forced-air furnaces with input ratings ≥ 225,000 Btu/hr shall also have an intermittent ignition or interrupted device (IID), and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for furnaces where combustion air is drawn from the conditioned space. All furnaces with input ratings ≥ 225,000 Btu/hr, including electric furnaces, that are not located within the conditioned space shall have jacket losses not exceeding 0.75 percent of the input rating.

TABLE 112-A
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	EFFICIENCY[1]		TEST PROCEDURE
		Before 1/1/2010	After 1/1/2010	
Air conditioners, air cooled	≥ 65,000 Btu/hr and < 135,000 Btu/hr	10.3 EER[2]	11.2 EER[2]	ARI 340/360
	≥ 135,000 Btu/hr and < 240,000 Btu/hr	9.7 EER[2]	11.0 EER[2]	ARI 340/360
	≥ 240,000 Btu/hr and < 760,000 Btu/hr	9.5 EER[2] and 9.7 IPLV[2]	10.0 EER[2] and 9.7 IPLV[2]	
	≥ 760,000 Btu/hr	9.2 EER[2] and 9.4 IPLV[2]	9.7 EER[2] and 9.4IPLV[2]	
Air conditioners, water and evaporatively cooled				ARI 210/240
	> 240,000 Btu/hr	11.0 EER[2] and 10.3 IPLV[2]		ARI 340/360
Condensing units, air cooled	≥ 135,000 Btu/hr	10.1 EER and 11.2 IPLV		ARI 365
Condensing units, water or evaporatively cooled	≥ 135,000 Btu/hr	13.1 EER and 13.1 IPLV		

[1]IPLVs are applicable only to equipment with capacity modulation.

[2]Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

TABLE 112-B
UNITARY AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY[1]		TEST PROCEDURE
			Before 1/1/2010	After 1/1/2010	
Air cooled (cooling mode)	≥ 65,000 Btu/hr and < 135,000 Btu/hr	Split system and single package	10.1 EER[2]	11.0	ARI 340/360
	≥ 135,000 Btu/hr and < 240,000 Btu/hr	Split system and single package	9.3 EER[2]	10.6	ARI 340/360
	≥ 240,000 Btu/hr	Split system and single package	9.0 EER[2] 9.2 IPLV[2]	9.5EER[2] and 9.2 IPLV[2]	
Air cooled (heating mode)	≥ 65,000 Btu/hr and < 135,000 Btu/hr (cooling capacity)	47°Fdb/43°Fwb outdoor air	3.2 COP	3.3 COP	ARI 210/240
	≥ 135,000 Btu/hr (cooling capacity)	47°Fdb/43°Fwb outdoor air	3.1 COP	3.2 COP	ARI 340/360

[1]IPLVs and Part load rating conditions are applicable only to equipment with capacity modulation.
[2]Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

TABLE 112-C
AIR-COOLED GAS-ENGINE HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	EFFICIENCY	TEST PROCEDURE
Air-cooled gas-engine heat pump (cooling mode)	All capacities	95°F db outdoor air	0.6 COP	ANSI Z21.40.4
Air-cooled gas-engine heat pump (heating mode)	All capacities	47°F db/43°F wb outdoor air	0.72 COP	ANSI Z21.40.4

TABLE 112-D
WATER CHILLING PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	EFFICIENCY	TEST PROCEDURE
Air cooled, with condenser, electrically operated	<150 tons	2.80 COP 3.05 IPLV	ARI 550/590
	≥ 150 tons		
Air cooled, without condenser, electrically operated	All capacities	3.10 COP 3.45 IPLV	
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	4.20 COP 5.05 IPLV	ARI 550/590
Water cooled, electrically operated, positive displacement (rotary screw and scroll)	< 150 tons	4.45 COP 5.20 IPLV	ARI 550/590
	≥150 tons and < 300 tons	4.90 COP 5.60 IPLV	
	≥ 300 tons	5.50 COP 6.15 IPLV	
Water cooled, electrically operated, centrifugal	<150 tons	5.00 COP 5.25 IPLV	ARI 550/590
	≥ 150 tons and < 300 tons	5.55 COP 5.90 IPLV	
	≥ 300 tons	6.10 COP 6.40 IPLV	
Air cooled absorption single effect	All capacities	0.60 COP	ARI 560
Water cooled absorption single effect	All capacities	0.70 COP	
Absorption double effect, indirect-fired	All capacities	1.00 COP 1.05 IPLV	
Absorption double effect, direct-fired	All capacities	1.00 COP 1.00 IPLV	
Water cooled gas engine driven chiller	All capacities	1.2 COP 2.0 IPLV	ANSI Z21.40.4

TABLE 112-E
PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY (Input)	SUBCATEGORY OR RATING CONDITION	EFFICIENCY[1]	TEST PROCEDURE
PTAC (cooling mode) new construction	All capacities	95°F db outdoor air	12.5-(0.213 × Cap/1000)[1] EER	ARI 310/380
PTAC (cooling mode) replacements[2]	All capacities	95°F db outdoor air	10.9-(0.213 × Cap/1000)[1] EER	
PTHP (cooling mode) new construction	All capacities	95 °F db outdoor air	12.3- (0.213 × Cap/1000)[1] EER	
PTHP (cooling mode) replacements[2]	All capacities	95°F db outdoor air	10.8-(0.213 × Cap/1000)[1] EER	
PTHP (heating mode) new construction	All capacities		3.2-(0.026 × Cap/1000)[1] COP	
PTHP (heating mode) replacements[2]	All capacities		2.9-(0.026 × Cap/1000)[1] COP	
SPVAC (cooling mode)	<65,000 Btu/h	95°F db/75°F wb outdoor air	9.0 EER	ARI 390
	≥65,000 Btu/h and <135,000 Btu/h		8.9 EER	
	≥135,000 Btu/h and <240,000 Btu/h		8.6 EER	
SPVHP (cooling mode)	<65,000 Btu/h		9.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h		8.9 EER	
	≥135,000 Btu/h and <240,000 Btu/h		8.6 EER	
SPVHP (heating mode)	<65,000 Btu/H and	47°F db/43°F wb outdoor air	3.0 COP	
	≥65,000 Btu/h and <135,000 Btu/h		3.0 COP	
	≥135,000 Btu/h and <240,000 Btu/h		2.9 COP	

[1]Cap means the rated cooling capacity of the product in Btu/hr. If the unit's capacity is less than 7000 Btu/hr, use 7000 Btu/hr in the calculation. If the unit's capacity is greater than 15,000 Btu/hr, use 15,000 Btu/hr in the calculation.

[2]Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches high and less than 42 inches wide.

TABLE 112-G
PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

EQUIPMENT TYPE	TOTAL SYSTEM HEAT REJECTION CAPACITY AT RATED CONDITIONS	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[1,2]	TEST PROCEDURE[3]
Propeller or axial fan open cooling towers	All	95°F entering water 85°F leaving water 75°F wb outdoor air	> 38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan open cooling towers	All	95°F entering water 85°F leaving water 75°F wb outdoor air	> 20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Air-cooled condensers	All	125°F condensing temperature R22 test fluid 190°F entering gas temperature 15°F subcooling 95°F entering drybulb	> 176,000 Btu/hr hp	ARI 460

[1]For purposes of this table, open cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power.

[2]For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.

[3]Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90% of the CTI certified performance of the associated base model or at the manufacturer's stated performance, whichever is less. Base models of open factory assembled cooling towers are open cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field erected cooling towers.

[4]The efficiencies for open cooling towers listed in Table 112-G are not appicable for closed-circuit towers.

TABLE 112-H
COPS FOR NONSTANDARD CENTRIFUGAL CHILLERS < 150 TONS

CENTRIFUGAL CHILLERS < 150 Tons COP_{std} = 5.0								
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT[1] (°F)	Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
			Required COP					
46	75	29	5.58	5.83	6.03	6.32	6.54	6.70
45	75	30	5.50	5.74	5.92	6.19	6.38	6.53
44	75	31	5.42	5.65	5.82	6.07	6.24	6.37
43	75	32	5.35	5.57	5.72	5.95	6.11	6.23
42	75	33	5.27	5.49	5.64	5.85	6.00	6.11
41	75	34	5.19	5.41	5.56	5.75	5.89	5.99
46	80	34	5.19	5.41	5.56	5.75	5.89	5.99
40	75	35	5.11	5.33	5.48	5.67	5.79	5.88
45	80	35	5.11	5.33	5.48	5.67	5.79	5.88
44	80	36	5.03	5.26	5.40	5.58	5.70	5.79
43	80	37	4.94	5.18	5.32	5.50	5.62	5.70
42	80	38	4.84	5.10	5.25	5.43	5.53	5.61
41	80	39	4.73	5.01	5.17	5.35	5.46	5.53
46	85	39	4.73	5.01	5.17	5.35	5.46	5.53
40	80	40	4.62	4.92	5.09	5.27	5.38	5.45
45	85	40	4.62	4.92	5.09	5.27	5.38	5.45
44	85	41	4.49	4.82	5.00	5.20	5.30	5.38
43	85	42	4.35	4.71	4.91	5.12	5.23	5.30
42	85	43	4.19	4.59	4.81	5.03	5.15	5.22
41	85	44	4.02	4.46	4.70	4.94	5.06	5.14
40	85	45	3.84	4.32	4.58	4.84	4.98	5.06
Condenser DT[2]			14.04	11.23	9.36	7.02	5.62	4.68

[1]LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)
[2]Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)
$K_{adj} = 6.1507 – 0.30244(X) + 0.0062692(X)^2 – 0.000045595(X)^3$
where X = Condenser DT + LIFT
$COP_{adj} = K_{adj} * COP_{std}$

TABLE 112-I
COPS FOR NONSTANDARD CENTRIFUGAL CHILLERS > 150 TONS, ≤ 300 TONS

CENTRIFUGAL CHILLERS > 150 Tons, ≤ 300 Tons COP_{std} = 5.55								
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT[1] (°F)	Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
			Required COP					
46	75	29	6.17	6.44	6.66	6.99	7.23	7.40
45	75	30	6.08	6.34	6.54	6.84	7.06	7.22
44	75	31	6.00	6.24	6.43	6.71	6.9	7.05
43	75	32	5.91	6.15	6.33	6.58	6.76	6.89
42	75	33	5.83	6.07	6.23	6.47	6.63	6.75
41	75	34	5.74	5.98	6.14	6.36	6.51	6.62
46	80	34	5.74	5.98	6.14	6.36	6.51	6.62
40	75	35	5.65	5.90	6.05	6.26	6.40	6.51
45	80	35	5.65	5.90	6.05	6.26	6.40	6.51
44	80	36	5.56	5.81	5.97	6.17	6.30	6.40
43	80	37	5.46	5.73	5.89	6.08	6.21	6.30
42	80	38	5.35	5.64	5.80	6.00	6.12	6.20
41	80	39	5.23	5.54	5.71	5.91	6.03	6.11
46	85	39	5.23	5.54	5.71	5.91	6.03	6.11
40	80	40	5.10	5.44	5.62	5.83	5.95	6.03
45	85	40	5.10	5.44	5.62	5.83	5.95	6.03
44	85	41	4.96	5.33	5.55	5.74	5.86	5.94
43	85	42	4.81	5.21	5.42	5.66	5.78	5.86
42	85	43	4.63	5.08	5.31	5.56	5.69	5.77
41	85	44	4.45	4.93	5.19	5.46	5.60	5.69
40	85	45	4.24	4.77	5.06	5.35	5.50	5.59
Condenser DT[2]			14.04	11.23	9.36	7.02	5.62	4.68

[1]LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)
[2]Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)
$K_{adj} = 6.1507 – 0.30244(X) + 0.0062692(X)^2 – 0.000045595(X)^3$
where X = Condenser DT + LIFT
$COP_{adj} = K_{adj} * COP_{std}$

TABLE 112-J
COPS FOR NONSTANDARD CENTRIFUGAL CHILLERS > 300 TONS

CENTRIFUGAL CHILLERS > 300 Tons COP_{std} = 6.1								
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT[1] (°F)	Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
			Required COP					
46	75	29	6.80	7.11	7.35	7.71	7.97	8.16
45	75	30	6.71	6.99	7.21	7.55	7.78	7.96
44	75	31	6.61	6.89	7.09	7.40	7.61	7.77
43	75	32	6.52	6.79	6.98	7.26	7.45	7.60
42	75	33	6.43	6.69	6.87	7.13	7.31	7.44
41	75	34	6.33	6.60	6.77	7.02	7.18	7.30
46	80	34	6.33	6.60	6.77	7.02	7.18	7.30
40	75	35	6.23	6.50	6.68	6.91	7.06	7.17
45	80	35	6.23	6.50	6.68	6.91	7.06	7.17
44	80	36	6.13	6.41	6.58	6.81	6.95	7.05
43	80	37	6.02	6.31	6.49	6.71	6.85	6.94
42	80	38	5.90	6.21	6.40	6.61	6.75	6.84
41	80	39	5.77	6.11	6.30	6.52	6.65	6.74
46	85	39	5.77	6.11	6.30	6.52	6.65	6.74
40	80	40	5.63	6.00	6.20	6.43	6.56	6.65
45	85	40	5.63	6.00	6.20	6.43	6.56	6.65
44	85	41	5.47	5.87	6.10	6.33	6.47	6.55
43	85	42	5.30	5.74	5.98	6.24	6.37	6.46
42	85	43	5.11	5.60	5.86	6.13	6.28	6.37
41	85	44	4.90	5.44	5.72	6.02	6.17	6.27
40	85	45	4.68	5.26	5.58	5.90	6.07	6.17
Condenser DT[2]			14.04	11.23	9.36	7.02	5.62	4.68

[1]LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)
[2]Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)
$K_{adj} = 6.1507 – 0.30244(X) + 0.0062692(X)^2 – 0.000045595(X)^3$
where X = Condenser DT + LIFT
$COP_{adj} = K_{adj} * COP_{std}$

TABLE 112-K
IPLV/NPLV FOR NONSTANDARD CENTRIFUGAL CHILLERS < 150 TONS

CENTRIFUGAL CHILLERS < 150 Tons $IPIV_{std}$ = 5.25								
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT[1] (°F)	Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
			Required IPLV/NPLV					
46	75	29	5.84	6.10	6.30	6.61	6.84	7.00
45	75	30	5.75	6.00	6.19	6.47	6.68	6.83
44	75	31	5.67	5.91	6.08	6.34	6.53	6.67
43	75	32	5.59	5.82	5.99	6.23	6.39	6.52
42	75	33	5.51	5.74	5.90	6.12	6.27	6.39
41	75	34	5.43	5.66	5.81	6.02	6.16	6.26
46	80	34	5.43	5.66	5.81	6.02	6.16	6.26
40	75	35	5.35	5.58	5.73	5.93	6.06	6.15
45	80	35	5.35	5.58	5.73	5.93	6.06	6.15
44	80	36	5.26	5.50	5.65	5.84	5.96	6.05
43	80	37	5.16	5.42	5.57	5.76	5.87	5.96
42	80	38	5.06	5.33	5.49	5.67	5.79	5.87
41	80	39	4.95	5.24	5.41	5.60	5.71	5.78
46	85	39	4.95	5.24	5.41	5.60	5.71	5.78
40	80	40	4.83	5.14	5.32	5.52	5.63	5.70
45	85	40	4.83	5.14	5.32	5.52	5.63	5.70
44	85	41	4.69	5.04	5.25[3]	5.43	5.55	5.62
43	85	42	4.55	4.93	5.13	5.35	5.47	5.54
42	85	43	4.38	4.80	5.03	5.26	5.38	5.46
41	85	44	4.21	4.67	4.91	5.17	5.30	5.38
40	85	45	4.01	4.52	4.79	5.06	5.20	5.29
Condenser DT[2]			14.04	11.23	9.36	7.02	5.62	4.68

[1]LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)
[2]Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)
[3]AU values shown are NPLV except at conditions of 3 gpn/ton and 41 °F LIFT which is IPLV.
$K_{adj} = 6.1507 – 0.30244(X) + 0.0062692(X)^2 – 0.000045595(X)^3$
where X = Condenser DT + LIFT
$COP_{adj} = K_{adj} * COP_{std}$

TABLE 112-L
IPLV/NPLV FOR NONSTANDARD CENTRIFUGAL CHILLERS > 150 TONS < 300 TONS

CENTRIFUGAL CHILLERS > 300 Tons $IPLV_{std}$ = 6.4								
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT[1] (°F)	Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
			Required IPLV/NPLV					
46	75	29	7.15	7.47	7.72	8.10	8.37	8.58
45	75	30	7.05	7.35	7.58	7.93	8.18	8.36
44	75	31	6.95	7.23	7.45	7.77	8.00	8.16
43	75	32	6.85	7.13	7.33	7.63	7.83	7.98
42	75	33	6.75	7.03	7.22	7.49	7.68	7.82
41	75	34	6.65	6.93	7.12	7.37	7.55	7.67
46	80	34	6.65	6.93	7.12	7.37	7.55	7.67
40	75	35	6.55	6.83	7.01	7.26	7.42	7.54
45	80	35	6.55	6.83	7.01	7.26	7.42	7.54
44	80	36	6.44	6.73	6.92	7.15	7.30	7.41
43	80	37	6.32	6.63	6.82	7.05	7.19	7.30
42	80	38	6.20	6.53	6.72	6.95	7.09	7.19
41	80	39	6.06	6.42	6.62	6.85	6.99	7.08
46	85	39	6.06	6.42	6.62	6.85	6.99	7.08
40	80	40	5.91	6.30	6.52	6.76	6.89	6.98
45	85	40	5.91	6.30	6.52	6.76	6.89	6.98
44	85	41	5.75	6.17	6.40[3]	6.66	6.79	6.89
43	85	42	5.57	6.03	6.28	6.55	6.70	6.79
42	85	43	5.37	5.88	6.16	6.44	6.59	6.69
41	85	44	5.15	5.71	6.01	6.33	6.49	6.59
40	85	45	4.91	5.53	5.86	6.20	6.37	6.48
Condenser DT[2]			14.04	11.23	9.36	7.02	5.62	4.68

[1]LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)
[2]Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)
[3]A11 values shown are NPLV except at conditions of 3 gpn/ton and 41 °F LIFT which is IPLV.
$K_{adj} = 6.1507 – 0.30244(X) + 0.0062692(X)^2 – 0.000045595(X)^3$
where X = Condenser DT + LIFT
$COP_{adj} = K_{adj} * COP_{std}$

TABLE 112-M
IPLV/NPLV FOR NONSTANDARD CENTRIFUGAL CHILLERS > 300 TONS

CENTRIFUGAL CHILLERS > 300 Tons $IPLV_{std}$ = 6.4								
Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT[1] (°F)	Condenser Flow Rate					
			2 gpm/ton	2.5 gpm/ton	3 gpm/ton	4 gpm/ton	5 gpm/ton	6 gpm/ton
			Required IPLV/NPLV					
46	75	29	7.15	7.47	7.72	8.10	8.37	8.58
45	75	30	7.05	7.35	7.58	7.93	8.18	8.36
44	75	31	6.95	7.23	7.45	7.77	8.00	8.16
43	75	32	6.85	7.13	7.33	7.63	7.83	7.98
42	75	33	6.75	7.03	7.22	7.49	7.68	7.82
41	75	34	6.65	6.93	7.12	7.37	7.55	7.67
46	80	34	6.65	6.93	7.12	7.37	7.55	7.67
40	75	35	6.55	6.83	7.01	7.26	7.42	7.54
45	80	35	6.55	6.83	7.01	7.26	7.42	7.54
44	80	36	6.44	6.73	6.92	7.15	7.30	7.41
43	80	37	6.32	6.63	6.82	7.05	7.19	7.30
42	80	38	6.20	6.53	6.72	6.95	7.09	7.19
41	80	39	6.06	6.42	6.62	6.85	6.99	7.08
46	85	39	6.06	6.42	6.62	6.85	6.99	7.08
40	80	40	5.91	6.30	6.52	6.76	6.89	6.98
45	85	40	5.91	6.30	6.52	6.76	6.89	6.98
44	85	41	5.75	6.17	6.40[3]	6.66	6.79	6.89
43	85	42	5.57	6.03	6.28	6.55	6.70	6.79
42	85	43	5.37	5.88	6.16	6.44	6.59	6.69
41	85	44	5.15	5.71	6.01	6.33	6.49	6.59
40	85	45	4.91	5.53	5.86	6.20	6.37	6.48
Condenser DT[2]			14.04	11.23	9.36	7.02	5.62	4.68

[1]LIFT = Entering Condenser Water Temperature (°F) – Leaving Chilled Water Temperature (°F)
[2]Condenser DT = Leaving Condenser Water Temperature (°F) – Entering Condenser Water Temperature (°F)
[3]A11 values shown are NPLV except at conditions of 3 gpn/ton and 41 °F LIFT which is IPLV.
$K_{adj} = 6.1507 – 0.30244(X) + 0.0062692(X)^2 – 0.000045595(X)^3$
where X = Condenser DT + LIFT
$COP_{adj} = K_{adj} * COP_{std}$

SECTION 113
MANDATORY REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

(a) **Certification by manufacturers.** Any service water-heating system or equipment may be installed only if the manufacturer has certified that the system or equipment complies with all of the requirements of this subsection for that system or equipment.

1. **Temperature controls for service water-heating systems.** Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use as listed in Table 2, Chapter 49 of the ASHRAE Handbook, HVAC Applications Volume.

   Exception to Section 113(a)1: Residential occupancies.

(b) **Efficiency.** Equipment shall meet the applicable requirements of the Appliance Efficiency Regulations as required by Section 111, subject to the following:

1. If more than one standard is listed in the Appliance Efficiency Regulations, the equipment shall meet all the standards listed; and
2. If more than one test method is listed in the Appliance Efficiency Regulations, the equipment shall comply with the applicable standard when tested with each test method; and

3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

(c) **Installation.** Any service water-heating system or equipment may be installed only if the system or equipment complies with all of the applicable requirements of this subsection for the system or equipment.

1. **Outlet temperature controls.** On systems that have a total capacity greater than 167,000 Btu/hr, outlets that require higher than service water temperatures as listed in the ASHRAE Handbook, Applications Volume, shall have separate remote heaters, heat exchangers or boosters to supply the outlet with the higher temperature.
2. **Controls for hot water distribution systems.** Service hot water systems with circulating pumps or with electrical heat trace systems shall be capable of automatically turning off the system.

   Exception to Section 113(c)**2:** Water heating systems serving a single dwelling unit.

3. **Temperature controls for public lavatories.** The controls shall limit the outlet temperature to 110°F.
4. **Insulation.** Unfired service water heater storage tanks and backup tanks for solar water-heating systems shall have:

   A. External insulation with an installed *R*-value of at least R-12; or

   B. Internal and external insulation with a combined *R*-value of at least R-16; or

   C. The heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.

5. **Water heating recirculation loops serving multiple dwelling units, high-rise residential, hotel/motel and nonresidential occupancies.** A water heating recirculation loop is a type of hot water distribution system that reduces the time needed to deliver hot water to fixtures that are distant from the water heater, boiler or other water heating equipment. The recirculation loop is comprised of a supply portion, connected to branches that serve multiple dwelling units, guest rooms, or fixtures and a return portion that completes the loop back to the water heating equipment. A water heating recirculation loop shall meet the following requirements:

   A. **Air release valve or vertical pump installation.** An automatic air release valve shall be installed on the recirculation loop piping on the inlet side of the recirculation pump and no more than 4 feet from the pump. This valve shall be mounted on top of a vertical riser at least 12" in length and shall be accessible for replacement and repair. Alternatively, the pump shall be installed on a vertical section of the return line.

   B. **Recirculation loop backflow prevention.** A check valve or similar device shall be located between the recirculation pump and the water heating equipment to prevent water from flowing backwards though the recirculation loop.

   C. **Equipment for pump priming.** A hose bibb shall be installed between the pump and the water heating equipment. An isolation valve shall be installed between the hose bibb and the water heating equipment. This hose bibb is used for bleeding air out of the pump after pump replacement.

   D. **Pump isolation valves.** Isolation valves shall be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as in item C.

   E. **Cold water supply and recirculation loop connection to hot water storage tank.** Storage water heaters and boilers shall be plumbed in accordance with the boiler manufacturer's specifications The cold water piping and the recirculation loop piping shall not be connected to the hot water storage tank drain port.

   F. **Cold water supply backflow prevention.** A check valve shall be installed on the cold water supply line between the hot water system and the next closest tee on the cold water supply line. The system shall comply with the expansion tank requirements as described in the *California Plumbing Code* Section 608.3.

6. **Service water heaters in state buildings.** Any newly constructed building constructed by the State shall derive its service water heating from a system that provides at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy.

   Exception to Section 113(c)**6:** Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

SECTION 114
MANDATORY REQUIREMENTS FOR POOL AND SPA SYSTEMS AND EQUIPMENT

(a) **Certification by manufacturers.** Any pool or spa heating system or equipment may be installed only if the manufacturer has certified that the system or equipment has all of the following:

1. **Efficiency.** A thermal efficiency that complies with the Appliance Efficiency Regulations; and
2. **On-off switch.** A readily accessible on-off switch, mounted on the outside of the heater that allows shutting off the heater without adjusting the thermostat setting; and

3. **Instructions.** A permanent, easily readable and weatherproof plate or card that gives instruction for the energy efficient operation of the pool or spa heater and for the proper care of pool or spa water when a cover is used; and

4. **Electric resistance heating.** No electric resistance heating; and

Exception 1 to Section 114(a)4: Listed package units with fully insulated enclosures, and with tight-fitting covers that are insulated to at least R-6.

Exception 2 to Section 114(a)4: Pools or spas deriving at least 60 percent of the annual heating energy from site solar energy or recovered energy.

(b) **Installation.** Any pool or spa system or equipment shall be installed with all of the following:

1. **Piping.** At least 36 inches of pipe shall be installed between the filter and the heater or dedicated suction and return lines, or built-in or built-up connections shall be installed to allow for the future addition of solar heating equipment; and

2. **Covers.** A cover for outdoor pools or outdoor spas that have a heat pump or gas heater.

3. **Directional inlets and time switches for pools.** If the system or equipment is for a pool:

i. The pool shall have directional inlets that adequately mix the pool water; and

ii. A time switch or similar control mechanism shall be installed as part of a pool water circulation control system that will allow all pumps to be set or programmed to run only during off-peak electric demand period, and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

SECTION 115
NATURAL GAS CENTRAL FURNACES, COOKING EQUIPMENT, AND POOL AND SPA HEATERS: PILOT LIGHTS PROHIBITED

Any natural gas system or equipment listed below may be installed only if it does not have a continuously burning pilot light:

(a) Fan-type central furnaces.

(b) Household cooking appliances.

Exception to Section 115(b): Household cooking appliances without an electrical supply voltage connection and in which each pilot consumes less than 150 Btu/hr.

(c) Pool heaters.

(d) Spa heaters.

SECTION 116
MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

(a) **Certification of fenestration products and exterior doors other than field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the Commission, or if an independent certifying organization approved by the Commission has certified, that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft^{2}of window area, 0.3 cfm/ft^2 of door area for residential doors, 0.3 cfm/ft^2 of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft^2 for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E 283 at a pressure differential of 75 pascals (or 1.57 pounds/ft^2), incorporated herein by reference.

2. **U-factor.** A fenestration product's U-factor shall be rated in accordance with NFRC 100, or the applicable default U-factor set forth in Table 116-A.

Exception to Section 116(a)2: If the fenestration product is a skylight or is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration, the default U-factor may be calculated as set forth in Reference Nonresidential Appendix NA6.

3. **SHGC.** A fenestration product's SHGC shall be rated in accordance with NFRC 200 for site-built fenestration, or use the applicable default SHGC set forth in Table 116-B.

Exception to Section 116(a)3: If the fenestration product is a skylight or is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration, the default SHGC may be calculated as set forth in Reference Nonresidential Appendix NA6.

4. **Labeling.** Fenestration products shall:

A. Have a temporary label (or label certificate for site-built fenestration) meeting the requirements of Section 10-111(a)1, not to be removed before inspection by the enforcement agency, listing the certified U-factor and SHGC, and certifying that the air leakage requirements of Section 116(a)1 are met for each product line; and

B. Have a permanent label (or label certificate for site-built fenestration) meeting the requirements of Section 10-111(a)2 if the product is rated using NFRC procedures.

5. **Fenestration acceptance requirements.** Before an occupancy permit is granted, site-built fenestration products in other than low-rise residential buildings shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Refer-

ence Nonresidential Appendix NA7 to ensure that site-built fenestration meets Standards requirements, including a matching label certificate for each product installed and be readily accessible at the project location. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the fenestration product meets the acceptance requirements.

Exception to Section 116(a): Fenestration products removed and reinstalled as part of a building alteration or addition.

(b) **Installation of field-fabricated fenestration and exterior doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using U-factors from Table 116-A and SHGC values from Table 116-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped.

Exception to Section 116(b): Unframed glass doors and fire doors need not be weatherstripped or caulked.

TABLE 116-A
DEFAULT FENESTRATION PRODUCT U-FACTORS

FRAME[1,2]	PRODUCT TYPE	SINGLE PANE U-FACTOR	DOUBLE PANE U-FACTOR	GLASS BLOCK[1] U-FACTOR
Metal	Operable	1.28	0.79	0.87
	Fixed	1.19	0.71	0.72
	Greenhouse/garden window	2.26	1.40	NA
	Doors	1.25	0.77	NA
	Skylight	1.98	1.3	NA
Metal, Thermal Break	Operable	NA	0.66	NA
	Fixed	NA	0.55	NA
	Greenhouse/garden window	NA	1.12	NA
	Doors	NA	0.59	NA
	Skylight	NA	1.11	NA
Nonmetal	Operable	0.99	0.58	0.60
	Fixed	1.04	0.55	0.57
	Doors	0.99	0.53	NA
	Greenhouse/garden window	1.94	1.06	NA
	Skylight	1.47	0.84	NA

[1]For all dual-glazed fenestration products, adjust the listed U-factors as follows:
a. Add 0.05 for products with dividers between panes if spacer is less than $^{7}/_{16}$ inch wide.
b. Add 0.05 to any product with true divided lite (dividers through the panes).
[2]Translucent or transparent panels shall use glass block values.

TABLE 116-B
DEFAULT SOLAR HEAT GAIN COEFFICIENT

FRAME TYPE	PRODUCT	GLAZING	TOTAL WINDOW SHGC[1]		
			Single Pane	Double Pane	Glass Block[1]
Metal	Operable	Clear	0.80	0.70	0.70
	Fixed	Clear	0.83	0.73	0.73
	Operable	Tinted	0.67	0.59	NA
	Fixed	Tinted	0.68	0.60	NA
Metal, Thermal Break	Operable	Clear	NA	0.63	NA
	Fixed	Clear	NA	0.69	NA
	Operable	Tinted	NA	0.53	NA
	Fixed	Tinted	NA	0.57	NA
Nonmetal	Operable	Clear	0.74	0.65	0.70
	Fixed	Clear	0.76	0.67	0.67
	Operable	Tinted	0.60	0.53	NA
	Fixed	Tinted	0.63	0.55	NA

[1]Translucent or transparent panels shall use glass block values.

SECTION 117
MANDATORY REQUIREMENTS FOR JOINTS AND OTHER OPENINGS

Joints and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather-stripped or otherwise sealed to limit infiltration and exfiltration.

SECTION 118
MANDATORY REQUIREMENTS FOR INSULATION AND ROOFING PRODUCTS

(a) **Certification by manufacturers.** Any insulation shall be certified by Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12 – 13, Article 3 "Standards for Insulating Material."

(b) **Installation of urea formaldehyde foam insulation.** Urea formaldehyde foam insulation may be applied or installed only if:

1. It is installed in exterior side walls; and
2. A 4-mil-thick plastic polyethylene vapor barrier or equivalent plastic sheathing vapor barrier is installed between the urea formaldehyde foam insulation and the interior space in all applications.

(c) **Flamespread rating.** All insulating material shall be installed in compliance with the flamespread rating and smoke density requirements of the CBC.

(d) **Installation of insulation in existing buildings.** Insulation installed in an existing attic, or on an existing duct or water heater, shall comply with the applicable requirements of subsections 1, 2 and 3 below. If a contractor installs the insulation, the contractor shall certify to the customer, in writing, that the insulation meets the applicable requirements of subsections 1, 2 and 3 below.

1. **Attics.** If insulation is installed in the existing attic of a low-rise residential building, the *R*-value of the total amount of insulation (after addition of insulation to the amount, if any, already in the attic) shall be at least R-38 in climate zones 1 and 16; and R-30 in all other climate zones.

   Exception to Section 118(d)1: Where the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space shall be filled with insulation, provided such installation does not violate Section 1203.2 of Title 24, Part 2.

2. **Water heaters.** If external insulation is installed on an existing unfired water storage tank or on an existing back-up tank for a solar water-heating system, it shall have an R-value of at least R-12, or the heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
3. **Ducts.** If insulation is installed on an existing space-conditioning duct, it shall comply with Section 605 of the CMC.

(e) **Placement of roof/ceiling insulation.** Insulation installed to limit heat loss and gain through the top of conditioned spaces shall comply with the following:

1. Insulation shall be installed in direct contact with a continuous roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 117, including but not limited to, placing insulation either above or below the roof deck or on top of a drywall ceiling; and
2. When insulation is installed at the roof in nonresidential buildings, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed, and the space between the ceiling and the roof is either directly or indirectly conditioned space and shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements; and
3. Insulation placed on top of a suspended ceiling with removable ceiling panels shall be deemed to have no affect on envelope heat loss; and

   Exception to Section 118(e)3: When there are conditioned spaces with a combined floor area no greater than 2,000 square feet in an otherwise unconditioned building, and when the average height of the space between the ceiling and the roof over these spaces is greater than 12 feet, insulation placed in direct contact with a suspended ceiling with removable ceiling panels shall be an acceptable method of reducing heat loss from a conditioned space and shall be accounted for in heat loss calculations.

4. Insulation shall be installed below the roofing membrane or layer used to seal the roof from water penetration unless the insulation has a maximum water absorption of 0.3 percent by volume when tested according to ASTM Standard C 272.

   Note: Vents that do not penetrate the roof deck, that are designed for wind resistance for roof membranes, are not within the scope of Section 118(e)2.

(f) **Demising walls in nonresidential buildings.** The opaque portions of framed demising walls in nonresidential buildings shall be insulated with an installed *R*-value of no less than R-13 between framing members.

(g) **Insulation requirements for heated slab floors.** Heated slab-on-grade floors shall be insulated according to the requirements in Table 118-A.

1. Insulation materials in ground contact must:
   A. Comply with the certification requirements of Section 118(a); and
   B. Have a water absorption rate for the insulation material alone without facings that is no greater than 0.3 percent when tested in accordance with Test Method A - 24 Hour-Immersion of ASTM C 272.
2. Insulation installation must:
   A. Cover the insulation with a solid guard that protects against damage from ultraviolet radiation, moisture, landscaping operation, equipment maintenance and wind; and

B. Include a rigid plate, which penetrates the slab and blocks the insulation from acting as a conduit for insects from the ground to the structure above the foundation.

(h) **Wet insulation systems.** When insulation is installed on roofs above the roofing membrane or layer used to seal the roof from water penetration, the effective *R*-value of the insulation shall be as specified in Reference Joint Appendix JA4.

(i) **Roofing products solar reflectance and thermal emittance.**

1. In order to meet the requirements of Sections 141, 142, 143(a)1, 149(b)1B, 151(f)12, 152(b)1H or 152(b)2, a roofing product's thermal emittance and 3-year aged solar reflectance shall be certified and labeled according to the requirements of Section 10-113.

   Exception to Section 118(i)1: Roofing products that are not certified according to Section 10-113 shall assume the following default aged reflectance/emittance values:

   A. For asphalt shingles, 0.08/0.75

   B. For all other roofing products, 0.10/0.75

2. If CRRC testing for 3-year aged reflectance is not available for any roofing products, the 3-year aged value shall be derived from the CRRC initial value using the equation $R_{aged} = [0.2+0.7[\rho_{initial}-0.2]$, where $\rho_{initial}$ = the initial solar reflectance.

3. Solar Reflectance Index (SRI), calculated as specified by ASTM E 1980-01, may be used as an alternative to thermal emittance and 3-year aged solar reflectance when complying with the requirements of Sections 141, 142, 143(a)1, 149(b)1B, 151(f)12, 152(b)H or 152(b)2. SRI calculations shall be based on moderate wind velocity of 2 – 6 meters per second. The SRI shall be calculated based on the 3-year aged reflectance value of the roofing products.

4. Liquid applied roof coatings applied to low-sloped roofs in the field as the top surface of a roof covering shall:

   A. Be applied across the entire roof surface to meet the dry mil thickness or coverage recommended by the coating manufacturer, taking into consideration the substrate on which the coating is applied, and

   B. Meet the minimum performance requirements listed in Table 118-B or the minimum performance requirements of ASTM C 836, D 3468, D 6083 or D 6694, whichever are appropriate to the coating material.

   Exception 1 to Section 118(i)4B: Aluminum-pigmented asphalt roof coatings shall meet the requirements of ASTM D 2824 or ASTM D 6848 and be installed as specified by ASTM D 3805.

   Exception 2 to Section 118(i)4B: Cement-based roof coatings shall contain a minimum of 20 percent cement and shall meet the requirements of ASTM C 1583, ASTM D 822 and ASTM D 5870.

SECTION 119
MANDATORY REQUIREMENTS FOR LIGHTING CONTROL DEVICES, BALLASTS AND LUMINAIRES

Any lighting control device, ballast or luminaire subject to the requirements of Section 119 shall be installed only if the manufacturer has certified to the Commission that the device complies with all of the applicable requirements of Section 119.

Lighting control devices may be individual devices or systems consisting of two or more components. For control systems consisting of two or more components, such as an Energy Management Control System (EMCS), the manufacturer of the control system shall certify each of the components required for the system to comply with Section 119.

TABLE 118-A
SLAB INSULATION REQUIREMENTS FOR HEATED SLAB-ON-GRADE

INSULATION LOCATION	INSULATION ORIENTATION	INSTALLATION REQUIREMENTS	CLIMATE ZONE	INSULATION R-FACTOR
Outside edge of heated slab, either inside or outside the foundation wall	Vertical	From the level of the top of the slab, down 16 inches or to the frost line, whichever is greater. Insulation may stop at the top of the footing where this is less than the required depth. For below grade slabs, vertical insulation shall be extended from the top of the foundation wall to the bottom of the foundation (or the top of the footing) or to the frost line, whichever is greater.	1 - 15	5
			16	10
Between heated slab and outside foundation wall	Vertical and Horizontal	Vertical insulation from top of slab at inside edge of outside wall down to the top of the horizontal insulation. Horizontal insulation from the outside edge of the vertical insulation extending 4 feet toward the center of the slab in a direction normal to the outside of the building in plan view.	1 - 15	5
			16	10 vertical and 7 horizontal

TABLE 118-B
MINIMUM PERFORMANCE REQUIREMENTS FOR LIQUID APPLIED ROOF COATINGS

PHYSICAL PROPERTY	ASTM TEST PROCEDURE	REQUIREMENT
Initial percent elongation (break)	D 2370	Minimum 200% 73°F (23°C)
Initial percent elongation (break) or Initial flexibility	D 2370 D 522, Test B	Minimum 60% 0°F (–18°C) Minimum pass 1″ mandrel 0°F (–18°C)
Initial tensile strength (maximum stress)	D 2370	Minimum 100 psi (1.38 Mpa) 73°F (23°C)
Initial tensile strength (maximum stress) or Initial flexibility	D 2370 D 522, Test B	Minimum 200 psi (2.76 Mpa) 0°F (–18°C) Minimum pass 1″ mandrel 0°F (–18°C)
Final percent elongation (break) after accelerated weathering 1000 h	D 2370	Minimum 100% 73°F (23°C)
Final percent elongation (break) after accelerated weathering 100 h or Flexibility after accelerated weathering 100 h	D 2370 D 522, Test B	Minimum 40% 0°F (–18°C) Minimum pass 1″ mandrel 0°F (–18°C)
Permeance	D 1653	Maximum 50 perms
Accelerated weathering 1000 h	D 4798	No cracking or checking[1]

[1]Any cracking or checking visible to the eye fails the test procedure.

(a) **All devices: instructions for installation and calibration.** The manufacturer shall provide step-by-step instructions for installation and start-up calibration of the device.

(b) **Indicator lights.** Indicator lights integral to lighting control devices shall consume no more than one watt of power per indicator light.

(c) **Automatic time switch control devices.** Automatic time switch control devices shall:

1. Be capable of programming different schedules for weekdays and weekends; and
2. Have program backup capabilities that prevent the loss of the device's schedules for at least 7 days, and the device's time and date setting for at least 72 hours, if power is interrupted.

(d) **Occupant sensors, motion sensors and vacancy sensors.** Occupant sensors, motion sensors and vacancy sensors shall be capable of automatically turning off all the lights in an area no more than 30 minutes after the area has been vacated, and shall have a visible status signal that indicates that the device is operating properly or that is has failed or malfunctioned. The visible status signal may have an override switch that turns the signal off. In addition, ultrasonic and microwave devices shall have a built-in mechanism that allows calibration of the sensitivity of the device to room movement in order to reduce the false sensing of occupants, and shall comply with either Item 1 or 2 below, as applicable:

1. If the device emits ultrasonic radiation as a signal for sensing occupants within an area, the device shall:
   A. Have had a Radiation Safety Abbreviated Report submitted to the Center for Devices and Radiological Health, Federal Food and Drug Administration, under 21 Code of Federal Regulations, Section 1002.12 (1996), and a copy of the report shall have been submitted to the California Energy Commission; and
   B. Emit no audible sound; and
   C. Not emit ultrasound in excess of the decibel (dB) values shown in Table 119-A, measured no more than 5 feet from the source, on axis.

TABLE 119-A
ULTRASOUND MAXIMUM DECIBEL VALUES

MIDFREQUENCY OF SOUND PRESSURE THIRD-OCTAVE BAND (in kHz)	MAXIMUM dB LEVEL WITHIN THIRD-OCTAVE BAND (in dB reference 20 micropascals)
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

2. If the device emits microwave radiation as a signal for sensing occupants within the area, the device shall:
   A. Comply with all applicable provisions in 47 Code of Federal Regulations, Parts 2 and 15 (1996), and have an approved Federal Communications Commission Identifier that appears on all units of the device and that has been submitted to the California Energy Commission; and
   B. Not emit radiation in excess of 1 milliwatt per square centimeter measured at no more than 5 centimeters from the emission surface of the device; and
   C. Have permanently affixed to it installation instructions recommending that it be installed at least 12 inches from any area normally used by room occupants.

(e) Multilevel Occupant Sensor. Multilevel occupant sensors shall have an automatic OFF function that turns off all the lights, and either an automatic or a manually controlled ON function capable of meeting all the multilevel and uniformity requirements of Section 131(b) for the controlled lighting. The first stage shall be capable of activating between 30 – 70 percent of the lighting power in a room either through an automatic or manual action, and may be a switching or dimming

system. After that event occurs the device shall be capable of all of the following actions when manually called to do so by the occupant:

1. Activating the alternate set of lights.
2. Activating 100 percent of the lighting power.
3. Deactivating all lights.

(f) **Automatic daylighting control devices.** Automatic day-lighting control devices used to control lights in daylit zones shall:

1. Be capable of reducing the power consumption of the general lighting in the controlled area by at least two thirds in response to the availability of daylight; and
2. If the device is a dimmer, controlling incandescent or fluorescent lamps, provide electrical outputs to lamps for reduced flicker operation through the dimming range, so that the light output has an amplitude modulation of less than 30 percent for frequencies less than 200 Hz, and without causing premature lamp failure; and
3. If the devices reduce lighting in control steps, incorporate time-delay circuits to prevent cycling of light level changes of less than three minutes and have (a manual or automatic means of adjusting the deadband to provide separation) of on and off points for each control step; and
4. If the device is placed in calibration mode, automatically restore its time delay settings to normal operation programmed time delays after no more than 60 minutes; and
5. Have a setpoint control that easily distinguishes settings to within 10 percent of full scale adjustment; and
6. Have a light sensor that has a linear response with 5 percent accuracy over the range of illuminances measured by the light sensor; and
7. Have a light sensor that is physically separated from where calibration adjustments are made, or is capable of being calibrated in a manner that the person initiating calibration is remote from the sensor during calibration to avoid influencing calibration accuracy.

(g) **Interior photosensors.** Interior photosensors shall not have a mechanical slide cover or other device that permits easy unauthorized disabling of the control, and shall not be incorporated into wall-mounted occupant-sensors.

(h) **Multilevel astronomical time-switch controls.** Multilevel astronomical time-switch controls used to control lighting in daylit zones shall:

1. Contain at least two separately programmable steps per zone that reduce illuminance in a relatively uniform manner as specified in Section 131(b); and
2. Have a separate offset control for each step of 1 to 240 minutes; and
3. Have sunrise and sunset prediction accuracy within +/– 15 minutes and timekeeping accuracy within 5 minutes per year; and
4. Store astronomical time parameters (used to develop longitude, latitude, time zone) for at least 7 days if power is interrupted; and
5. Display date/time, sunrise and sunset, and switching times for each step; and
6. Have an automatic daylight savings time adjustment; and
7. Have automatic time switch capabilities specified in Section 119(c).

(i) **Outdoor astronomical time-switch controls.** Outdoor astronomical time-switch controls used to control outdoor lighting as specified in Section 132(c) shall:

1. Contain at least two separately programmable steps per function area; and
2. Have the ability to independently offset the on and off times for each channel by 0 to 99 minutes before or after sunrise or sunset; and
3. Have sunrise and sunset prediction accuracy within +/– 15 minutes and timekeeping accuracy within 5 minutes per year; and
4. Store astronomical time parameters (used to develop longitude, latitude, time zone) for at least 7 days if power is interrupted; and
5. Display date/time, sunrise and sunset; and
6. Have an automatic daylight savings time adjustment; and
7. Have automatic time switch capabilities specified in Section 119(c).

(j) **Manual-on occupant sensor (residential vacancy sensor).** A residential manual-on occupant sensor (also known as a vacancy sensor) used to comply with Section150(k) shall be a device or system which meets all of the following requirements:

1. Turns off the lighting automatically within 30 minutes or less after the room has been vacated in response to the absence of occupants in the room; and
2. Has a visible status signal in accordance with Section 119(d); and
3. Shall not turn on the lighting automatically, except the sensor shall have a grace period of 15 seconds to 30 seconds to turn on the lighting automatically after the sensor has timed out; and
4. Shall not have an override switch that disables the occupant sensor; and
5. Shall not have an override switch that converts the sensor from a manual-on to an automatic-on system.

(k) **Dimmers.** Dimmers used to control lighting shall:

1. Be capable of reducing power consumption by a minimum of 65 percent when the dimmer is at its lowest light level; and
2. If the device is a dimmer controlling incandescent or fluorescent lamps, provide electrical outputs to lamps for reduced flicker operation through the dimming range, so that the light output has an amplitude modulation of less than 30 percent for frequencies less than 200 Hz, and without causing premature lamp failure; and
3. Be listed by a rating lab recognized by the International Code Council (ICC) as being in compliance with Underwriters Laboratories Standards; and

4. If the device is a wall box dimmer designed to be used in a three or more-way circuit with nondimmable switches, the level set by the dimmer shall not be overridden by any of the switches in the circuit. The dimmer and all of the switches in the circuit shall have the capability of turning lighting OFF if it is ON, and turning lighting ON to the level set by the dimmer if the lighting is OFF. Any wall box dimmer that is connected to a system with an emergency override function shall be controlled by the emergency override.
5. If the device is a stepped dimmer, it shall include an off position to turn lights completely off.

(l) **Track lighting integral current limiter.** Integral current limiters shall meet the following requirements or a method approved by the Executive Director:

1. Be designed so that the integral current limiter housing is permanently attached to the track so that the track will be irreparably damaged if the integral current limiter housing were to be removed after installation into the track; and
2. Have the volt-ampere (VA) rating of the current limiter clearly marked on the circuit breaker visible for the building officials' field inspection without opening coverplates, fixtures or panels, and also on a permanent factory-installed label inside the wiring compartment; and
3. Employ tamper resistant fasteners for the cover to the wiring compartment; and
4. Have a conspicuous permanent factory installed label affixed to the inside of the wiring compartment warning against removing, tampering with, rewiring or bypassing the device.

(m) **High efficacy LED lighting systems.** To qualify as high efficacy for compliance with Section 150(k), a high efficacy LED luminaire, or LED light engine with integral heat sink shall meet the minimum efficacy requirements in Table 150-C, and luminaire power shall be determined as specified by Section 130(d)5.

(n) **Ballasts for residential recessed luminaires.** To qualify as high efficacy for compliance with Section 150(k), any ballast in a residential recessed luminaire shall meet all of the following conditions:

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

(o) **Dimmable fluorescent ballasts for power adjustment factor.** To qualify for the Power Adjustment Factor in Section 146(a)2 and Table 146-C, ballasts for T5 and T8 linear fluorescent lamps shall be electronic, dimmable, and shall meet the minimum Relative System Efficiency (RSE) in Table 146-D.

SUBCHAPTER 3

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING AND SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

SECTION 120
SPACE-CONDITIONING AND SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT—GENERAL

Sections 121 through 129 establish requirements for the design and installation of space-conditioning and service water-heating systems and equipment in nonresidential, high-rise residential and hotel/motel buildings subject to Title 24, Part 6. All such buildings shall comply with the applicable provisions of Sections 121 through 129.

SECTION 121
REQUIREMENTS FOR VENTILATION

All nonresidential, high-rise residential and hotel/motel occupancies shall comply with the requirements of Sections 121(a) through 121(e).

(a) **General requirements.**

1. All enclosed spaces in a building that are normally used by humans shall be ventilated in accordance with the requirements of this section and the CBC.
2. The outdoor air-ventilation rate and air-distribution assumptions made in the design of the ventilating system shall be clearly identified on the plans required by Section 10-103 of Title 24, Part 1.

(b) **Design requirements for minimum quantities of outdoor air.** Every space in a building shall be designed to have outdoor air ventilation according to Item 1 or 2 below:

1. **Natural ventilation.**
   A. Naturally ventilated spaces shall be permanently open to and within 20 feet of operable wall or roof openings to the outdoors, the openable area of which is not less than 5 percent of the conditioned floor area of the naturally ventilated space. Where openings are covered with louvers or otherwise obstructed, openable area shall be based on the free unobstructed area through the opening.

      Exception to Section 121(b)1A: Naturally ventilated spaces in high-rise residential dwelling units and hotel/motel guest rooms shall be open to and within 25 feet of operable wall or roof openings to the outdoors.

   B. The means to open required operable openings shall be readily accessible to building occupants whenever the space is occupied.
2. **Mechanical ventilation.** Each space that is not naturally ventilated under Item 1 above shall be ventilated with a mechanical system capable of providing an outdoor air rate no less than the larger of:
   A. The conditioned floor area of the space times the applicable ventilation rate from Table 121-A; or
   B. 15 cfm per person times the expected number of occupants. For meeting the requirement in Section 121(b)2B for spaces without fixed seating, the expected number of occupants shall be either the expected number specified by the building designer or one half of the maximum occupant load assumed for egress purposes in the CBC, whichever is greater. For spaces with fixed seating, the expected number of occupants shall be determined in accordance with the CBC.

      Exception to Section 121(b)2: Transfer air. The rate of outdoor air required by Section 121(b)2 may be provided with air transferred from other ventilated spaces if:

      A. None of the spaces from which air is transferred have any unusual sources of indoor air contaminants; and

      B. The outdoor air that is supplied to all spaces combined is sufficient to meet the requirements of Section 121(b)2 for each space individually.

(c) **Operation and control requirements for minimum quantities of outdoor air.**

1. **Times of occupancy.** The minimum rate of outdoor air required by Section 121(b)2 shall be supplied to each space at all times when the space is usually occupied.

   Exception 1 to Section 121(c)1: Demand control ventilation. In intermittently occupied spaces that do not have processes or operations that generate dusts, fumes, mists, vapors or gasses and are not provided with local exhaust ventilation (such as indoor operation of internal combustion engines or areas designated for unvented food service preparation), the rate of outdoor air may be reduced if the ventilation system serving the space is controlled by a demand control ventilation device complying with Section 121(c)4.

   Exception 2 to Section 121(c)1: Temporary reduction. The rate of outdoor air provided to a space may be reduced below the level required by Section 121(b)2 for up to 5 minutes each hour if the average rate for each hour is equal to or greater than the required ventilation rate.

Note: VAV must comply with Section 121(c)1 at minimum supply airflow.

2. **Pre-occupancy.** The lesser of the minimum rate of outdoor air required by Section 121(b)2 or three complete air changes shall be supplied to the entire building during the one-hour period immediately before the building is normally occupied.

3. **Required demand control ventilation.** HVAC systems with the following characteristics shall have demand ventilation controls complying with Section 121(c)4:

   A. They have an air economizer; and

   B. They serve a space with a design occupant density, or a maximum occupant load factor for egress purposes in the CBC, greater than or equal to 25 people per 1000 ft^2 (40 square feet per person); and

   C. They are either:

      i. Single zone systems with any controls; or

      ii. Multiple zone systems with Direct Digital Controls (DDC) to the zone level.

      Exception 1 to Section 121(c)3: Classrooms, call centers, office spaces served by multiple zone systems that are continuously occupied during normal business hours with occupant density greater than 25 people per 1000 ft^2 per Section 121(b)2B, healthcare facilities and medical buildings, and public areas of social services buildings are not required to have demand control ventilation.

      Exception 2 to Section 121(c)3: Where space exhaust is greater than the design ventilation rate specified in Section 121(b)2B minus 0.2 cfm per ft^2 of conditioned area.

      Exception 3 to Section 121(c)3: Spaces that have processes or operations that generate dusts, fumes, mists, vapors or gases and are not provided with local exhaust ventilation, such as indoor operation of internal combustion engines or areas designated for unvented food service preparation, or beauty salons shall not install demand control ventilation.

      Exception 4 to Section 121(c)3: Spaces with an area of less than 150 square feet, or a design occupancy of less than 10 people per Section 121(b)2B.

4. **Demand control ventilation devices.**

   A. For each system with demand control ventilation, CO_2 sensors shall be installed in each room that meets the criteria of Section 121(c)3B with no less than one sensor per 10,000 ft^2 of floor space. When a zone or a space is served by more than one sensor, a signal from any sensor indicating that CO_2 is near or at the setpoint within a space shall trigger an increase in ventilation to the space;

   B. CO_2 sensors shall be located in the room between 3 ft and 6 ft above the floor or at the anticipated height of the occupants heads;

   C. Demand ventilation controls shall maintain CO_2 concentrations less than or equal to 600 ppm plus the outdoor air CO_2 concentration in all rooms with CO_2 sensors;

      Exception to Section 121(c)4C: The outdoor air ventilation rate is not required to be larger than the design outdoor air ventilation rate required by Section 121(b)2 regardless of CO_2 concentration.

   D. Outdoor air CO_2 concentration shall be determined by one of the following:

      i. CO_2 concentration shall be assumed to be 400 ppm without any direct measurement; or

      ii. CO_2 concentration shall be dynamically measured using a CO_2 sensor located within 4 ft of the outdoor air intake.

   E. When the system is operating during hours of expected occupancy, the controls shall maintain system outdoor air ventilation rates no less than the rate listed in Table 121-A times the conditioned floor area for spaces with CO_2 sensors, plus the rate required by Section 121(b)2 for other spaces served by the system, or the exhaust air rate, whichever is greater.

   F. CO_2 sensors shall be certified by the manufacturer to be accurate within plus or minus 75 ppm at a 600 and 1000 ppm concentration when measured at sea level and 25°C, factory calibrated or calibrated at start-up, and certified by the manufacturer to require calibration no more frequently than once every 5 years. Upon detection of sensor failure, the system shall provide a signal which resets to supply the minimum quantity of outside air to levels required by Section 121(b)(2) to the zone serviced by the sensor at all times that the zone is occupied.

   G. The CO_2 sensor(s) reading for each zone shall be displayed continuously, and shall be recorded on systems with DDC to the zone level.

(d) **Ducting for zonal heating and cooling units.** Where a return plenum is used to distribute outdoor air to a zonal heating or cooling unit, which then supplies the air to a space in order to meet the requirements of Section 121(b)2, the outdoor air shall be ducted to discharge either:

1. Within 5 feet of the unit; or
2. Within 15 feet of the unit, substantially toward the unit, and at a velocity not less than 500 feet per minute.

(e) **Design and control requirements for quantities of outdoor air.** All mechanical ventilation and space-conditioning systems shall be designed with and have installed ductwork, dampers and controls to allow outside air rates to be operated at the larger of (1) the minimum levels specified in Section 121(b)1; or (2) the rate required for make-up of exhaust systems that are required for a process, for control of odors, or for the removal of contaminants within the space.

TABLE 121-A
MINIMUM VENTILATION RATES

TYPE OF USE	CFM PER SQUARE FOOT OF CONDITIONED FLOOR AREA
Auto repair workshops	1.50
Barber shops	0.40
Bars, cocktail lounges and casinos	0.2
Beauty shops	0.40
Coin-operated dry cleaning	0.30
Commercial dry cleaning	0.45
High-rise residential	Ventilation rates specified by the CBC
Hotel guest rooms (less than 500 ft^2)	30 cfm/guest room
Hotel guest rooms (500 ft^2 or greater)	0.15
Retail stores	0.20
All others	0.15

SECTION 122
REQUIRED CONTROLS FOR SPACE-CONDITIONING SYSTEMS

Space-conditioning systems shall be installed with controls that comply with the applicable requirements of Subsections (a) through (h).

(a) **Thermostatic controls for each zone.** The supply of heating and cooling energy to each space-conditioning zone or dwelling unit shall be controlled by an individual thermostatic control that responds to temperature within the zone and that meets the applicable requirements of Section 122(b).

Exception to Section 122(a): An independent perimeter heating or cooling system may serve more than one zone without individual thermostatic controls if:

A. All zones are also served by an interior cooling system;

B. The perimeter system is designed solely to offset envelope heat losses or gains;

C. The perimeter system has at least one thermostatic control for each building orientation of 50 feet or more; and

D. The perimeter system is controlled by at least one thermostat located in one of the zones served by the system.

(b) **Criteria for zonal thermostatic controls.** The individual thermostatic controls required by Section 122(a) shall meet the following requirements as applicable:

1. Where used to control comfort heating, the thermostatic controls shall be capable of being set, locally or remotely, down to 55°F or lower.
2. Where used to control comfort cooling, the thermostatic controls shall be capable of being set, locally or remotely, up to 85°F or higher.
3. Where used to control both comfort heating and comfort cooling, the thermostatic controls shall meet Items 1 and 2 and shall be capable of providing a temperature range or dead band of at least 5°F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

   Exception to Section 122(b)3: Systems with thermostats that require manual changeover between heating and cooling modes.

4. Thermostatic controls for all unitary single zone, air conditioners, heat pumps and furnaces, shall comply with the setback thermostat requirements of Section 112(c) or, if equipped with DDC to the Zone level, with the Automatic Demand Shed Controls of Section 122(h).

   Exception to Section 122(b): Systems serving zones that must have constant temperatures to prevent degradation of materials, a process, plants or animals.

(c) **Hotel/motel guest room and high-rise residential dwelling unit thermostats.** Hotel/motel guest room thermostats shall have:

1. Numeric temperature setpoints in °F; and
2. Setpoint stops accessible only to authorized personnel, to restrict overheating and overcooling.

High-rise residential dwelling unit thermostats shall meet the control requirements of Section 150(i).

(d) **Heat pump controls.** All heat pumps with supplementary electric resistance heaters shall be installed with controls that comply with Section 112(b).

(e) **Shut-off and reset controls for space-conditioning systems.** Each space-conditioning system shall be installed with controls that comply with Items 1 and 2 below:

1. The control shall be capable of automatically shutting off the system during periods of nonuse and shall have:

   A. An automatic time switch control device complying with Section 119(c), with an accessible manual override that allows operation of the system for up to 4 hours; or

   B. An occupancy sensor; or

   C. A 4-hour timer that can be manually operated.

   Exception to Section 122(e)1: Mechanical systems serving retail stores and associated malls, restaurants, grocery stores, churches and theaters equipped with 7-day programmable timers.

2. The control shall automatically restart and temporarily operate the system as required to maintain:

   A. A setback heating thermostat setpoint if the system provides mechanical heating; and

   Exception to Section 122(e)2A: Thermostat setback controls are not required in nonresidential buildings in areas where the Winter Median of Extremes outdoor air temperature determined in accordance with Section 144(b)4 is greater than 32°F.

   B. A setup cooling thermostat setpoint if the system provides mechanical cooling.

Exception to Section 122(e)2B: Thermostat setup controls are not required in nonresidential buildings in areas where the Summer Design Dry Bulb 0.5 percent temperature determined in accordance with Section 144(b)4 is less than 100°F.

Exception 1 to Section 122(e): Where it can be demonstrated to the satisfaction of the enforcing agency that the system serves an area that must operate continuously.

Exception 2 to Section 122(e): Where it can be demonstrated to the satisfaction of the enforcing agency that shutdown, setback and setup will not result in a decrease in overall building source energy use.

Exception 3 to Section 122(e): Systems with full load demands of 2 kW or less, if they have a readily accessible manual shut-off switch.

Exception 4 to Section 122(e): Systems serving hotel/motel guest rooms, if they have a readily accessible manual shut-off switch.

(f) **Dampers for air supply and exhaust equipment.** Outdoor air supply and exhaust equipment shall be installed with dampers that automatically close upon fan shutdown.

Exception 1 to Section 122(f): Where it can be demonstrated to the satisfaction of the enforcing agency that the equipment serves an area that must operate continuously.

Exception 2 to Section 122(f): Gravity and other non-electrical equipment that has readily accessible manual damper controls.

Exception 3 to Section 122(f): At combustion air intakes and shaft vents.

Exception 4 to Section 122(f): Where prohibited by other provisions of law.

(g) **Isolation area devices.** Each space-conditioning system serving multiple zones with a combined conditioned floor area of more than 25,000 square feet shall be designed, installed and controlled to serve isolation areas.

1. Each zone, or any combination of zones not exceeding 25,000 square feet, shall be a separate isolation area.
2. Each isolation area shall be provided with isolation devices, such as valves or dampers, that allow the supply of heating or cooling to be reduced or shut off independently of other isolation areas.
3. Each isolation area shall be controlled by a device meeting the requirements of Section 122(e)1.

Exception to Section 122(g): A zone need not be isolated if it can be demonstrated to the satisfaction of the enforcement agency that the zone must be heated or cooled continuously.

(h) **Automatic demand shed controls.** HVAC systems with DDC to the Zone level shall be programmed to allow centralized demand shed for noncritical zones as follows:

1. The controls shall have a capability to remotely set up the operating cooling temperature set points by four degrees or more in all non-critical zones on signal from a centralized contact or software point within an Energy Management Control System (EMCS).
2. The controls shall remotely set down the operating heating temperature set points by four degrees or more in all non-critical zones on signal from a centralized contact or software point within an EMCS.
3. The controls shall have capabilities to remotely reset the temperatures in all non-critical zones to original operating levels on signal from a centralized contact or software point within an EMCS.
4. The controls shall be programmed to provide an adjustable rate of change for the temperature setup and reset.

SECTION 123
REQUIREMENTS FOR PIPE INSULATION

The piping for all space-conditioning and service water-heating systems with fluid temperatures listed in Table 123-A shall have the amount of insulation specified in Subsection (a) or (b). Insulation conductivity shall be determined in accordance with ASTM C 335 at the mean temperature listed in Table 123-A, and shall be rounded to the nearest $^{1}/_{100}$ Btu-inch per hour per square foot per °F.

Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, including but not limited to, the following:

Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

Insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

Exception 1 to Section 123: Factory-installed piping within space-conditioning equipment certified under Section 111 or 112.

Exception 2 to Section 123: Piping that conveys fluids with a design operating temperature range between 60°F and 105°F.

Exception 3 to Section 123: Piping that serves process loads, gas piping, cold domestic water piping, condensate drains, roof drains, vents or waste piping.

Exception 4 to Section 123: Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use.

Exception 5 to Section 123: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing.

(a) For insulation with a conductivity in the range shown in Table 123-A for the applicable fluid temperature range, the insulation shall have the applicable thickness shown in Table 123-A.

(b) For insulation with a conductivity outside the range shown in Table 123-A for the applicable fluid temperature range, the insulation shall have a minimum thickness as calculated with Equation 123-A:

EQUATION 123-A INSULATION THICKNESS EQUATION

$$T = PR\left[\left(1 + \frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$

where:

T = minimum insulation thickness for material with conductivity K, inches.

PR = pipe actual outside radius, inches.

t = insulation thickness from Table 123-A, inches.

K = conductivity of alternate material at the mean rating temperature indicated in Table 123-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in Table 123-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

SECTION 124
REQUIREMENTS FOR AIR DISTRIBUTION SYSTEM DUCTS AND PLENUMS

(a) **CMC compliance.** All air distribution system ducts and plenums, including but not limited to building cavities, mechanical closets, air-handler boxes and support platforms used as ducts or plenums, shall be installed, sealed and insulated to meet the requirements of the 2007 CMC Sections 601, 602, 603, 604, 605 and Standard 6-5, incorporated herein by reference. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape, aerosol sealant or other duct-closure system that meets the applicable requirements of UL 181, UL 181A, or UL 181B. If mastic or tape is used to seal openings greater than $^1/_4$ inch, the combination of mastic and either mesh or tape shall be used.

Portions of supply-air and return-air ducts conveying heated or cooled air located in one or more of the following spaces shall be insulated to a minimum installed level of R-8:

1. Outdoors, or
2. In a space between the roof and an insulated ceiling, or
3. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or
4. In an unconditioned crawlspace, or
5. In other unconditioned spaces.

Portions of supply-air ducts that are not in one of these spaces, including ducts buried in concrete slab, shall be insulated to a minimum installed level of R-4.2 (or any higher level required by CMC Section 605) or be enclosed in directly conditioned space.

TABLE 123-A
PIPE INSULATION THICKNESS

FLUID TEMPERATURE RANGE, (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot per °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)					
			Runouts up to 2	1 and less	1.25-2	2.50-4	5-6	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)					
Space heating systems (steam, steam condensate and hot water)								
Above 350	0.32-0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251-350	0.29-0.31	200	1.5	2.0	2.5	2.5	3.5	3.5
201-250	0.27-0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141-200	0.25-0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105-140	0.24-0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Service water-heating systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)								
Above 105	0.24-0.28	100	0.5	1.0	1.0	1.5	1.5	1.5
Space cooling systems (chilled water, refrigerant and brine)								
40-60	0.23-0.27	75	0.5	0.5	0.5	1.0	1.0	1.0
Below 40	0.23-0.27	75	1.0	1.0	1.5	1.5	1.5	1.5

(b) **Duct and plenum materials.**

1. **Factory-fabricated duct systems.**

A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be labeled as complying with UL 181. UL 181 testing may be performed by UL laboratories or a laboratory approved by the Executive Director.

B. All pressure-sensitive tapes, heat-activated tapes, and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

2. **Field-fabricated duct systems.**

A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A and UL 181B.

B. **Mastic sealants and mesh.**

i. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 181B, and be nontoxic and water resistant.

ii. Sealants for interior applications shall pass ASTM tests C 731 (extrudability after aging) and D 2202 (slump test on vertical surfaces), incorporated herein by reference.

iii. Sealants for exterior applications shall pass ASTM tests C 731, C 732 (artificial weathering test), and D 2202, incorporated herein by reference.

iv. Sealants and meshes shall be rated for exterior use.

C. **Pressure-sensitive tape.** Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

E. **Drawbands used with flexible duct.**

i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.

iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

F. **Aerosol-sealant closures.**

i. Aerosol sealants shall meet the requirements of UL 723 and be applied according to manufacturer specifications.

ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

(c) All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor barriers or other duct components) and tested *C*-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C 518 or ASTM C 177, incorporated herein by reference, and certified pursuant to Section 118.

(d) The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

(e) Insulated flexible duct products installed to meet this requirement must include labels, in maximum intervals of 3 feet, showing the thermal performance *R*-value for the duct insulation itself (excluding air films, vapor barriers or other duct components), based on the tests in Section 124(c) and the installed thickness determined by Section 124(d)3.

(f) **Protection of insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, but not limited to the following:

Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

SECTION 125
REQUIRED NONRESIDENTIAL MECHANICAL SYSTEM ACCEPTANCE

(a) Before an occupancy permit is granted, the following equipment and systems shall be certified as meeting the Acceptance Requirements for Code Compliance, as specified by the Reference Nonresidential Appendix NA7. A Certificate of Acceptance shall be submitted to the enforcement agency that certifies that the equipment and systems meet the acceptance requirements:

1. Outdoor air ventilation systems shall be tested in accordance with NA7.5.1
2. Constant volume, single zone unitary air conditioning and heat pump unit controls shall be tested in accordance with NA7.5.2.
3. Duct systems shall be tested in accordance with NA7.5.3 where either:
   A. They are new duct systems that meet the criteria of Sections 144(k)1, 144(k)2 and 144(k)3, or
   B. They are part of a system that meets the criteria of Section 149(b)1D.
4. Air economizers shall be tested in accordance with NA7.5.4.

   Exception to Section 125(a)4: Air economizers installed by the HVAC system manufacturer and certified to the Commission as being factory calibrated and tested are not required to be field tested per NA7.5.4.2.
5. Demand control ventilation systems required by Section 121(c)3 shall be tested in accordance with NA7.5.5.
6. Supply fan variable flow controls shall be tested in accordance with NA7.5.6.
7. Hydronic system variable flow controls shall be tested in accordance with NA7.5.7 and NA7.5.9.
8. Boiler or chillers that require isolation controls per Section 144(j)2 or 144(j)3 shall be tested in accordance with NA7.5.7.
9. Hydronic systems with supply water temperature reset controls shall be tested in accordance with NA7.5.8.
10. Automatic demand shed controls shall be tested in accordance with NA7.5.10.
11. Fault Detection and Diagnostics (FDD) for Packaged Direct-Expansion Units shall be tested in accordance with NA7.5.11.
12. Automatic fault detection and diagnostics (FDD) for air handling units and zone terminal units shall be tested in accordance with NA7.5.12.
13. Distributed Energy Storage DX AC Systems shall be tested in accordance with NA7.5.13.
14. Thermal Energy Storage (TES) Systems shall be tested in accordance with NA7.5.14.

SECTION 126
MANDATORY REQUIREMENTS FOR REFRIGERATED WAREHOUSES

A refrigerated warehouse with total cold storage and frozen storage area of 3,000 ft^2 or larger shall meet the requirements of this section.

Exception 1 to Section 126: A refrigerated space less than 3,000 ft^2 shall meet the Appliance Efficiency Regulations for walk-in refrigerators or freezers.

Exception 2 to Section 126: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling or freezing of products with design cooling capacities of greater than 240 Btu/hr-ft^2 (2 tons per 100 ft^2).

(a) **Insulation requirements.** Exterior surfaces of refrigerated warehouses shall be insulated at least to the R-values in Table 126-A.

TABLE 126-A REFRIGERATED WAREHOUSE INSULATION

SPACE	SURFACE	MNIMUM R-VALUE (°F·hr·sf/Btu)
Frozen storage	Roof/Ceiling	R-36
	Wall	R-36
	Floor	R-36
Cold storage	Roof/Ceiling	R-28
	Wall	R-28

(b) **Underslab heating.** Electric resistance heat shall not be used for the purposes of underslab heating.

Exception to Section 126(b): Underslab heating systems controlled such that the electric resistance heat is thermostatically controlled and disabled during the summer on-peak period defined by the local electric utility.

(c) **Evaporators.** Fan-powered evaporators used in coolers and freezers shall conform to the following:

1. Single phase fan motors less than 1 hp and less than 460 volts shall be electronically commutated motors.
2. Evaporator fans shall be variable speed, and the speed shall be controlled in response to space conditions.

   Exception to Section 126(c)2: Evaporators served by a single compressor without unloading capability.

(d) **Condensers.** Fan-powered condensers shall conform to the following:

1. Condensers for systems utilizing ammonia shall be evaporatively cooled.
2. Condensing temperatures for evaporative condensers under design conditions, including but not limited to condensers served by cooling towers, shall be less than or equal to:
   A. The design wetbulb temperature plus 20°F in locations where the design wetbulb temperature is less than or equal to 76°F,
   B. The design wetbulb temperature plus 19°F in locations where the design wetbulb temperature is between 76°F and 78°F, or
   C. The design wetbulb temperature plus 18°F in locations were the design wetbulb temperature is greater than or equal to 78°F.
3. Condensing temperatures for air-cooled condensers under design conditions shall be less than or equal to the design drybulb temperature plus 10°F for systems serving frozen storage and shall be less than or equal to the design drybulb temperature plus 15°F for systems serving cold storage.

Exception to Section 126(d)3. Unitary condensing units.

4. All condenser fans for evaporative condensers shall be continuously variable speed, and the condensing temperature control system shall control the speed of all condenser fans serving a common condenser loop in unison. The minimum condensing temperature setpoint shall be less than or equal to 70°F.
5. All condenser fans for air-cooled condensers shall be continuously variable speed, and the condensing temperature or pressure control system shall control the speed of all condenser fans serving a common condenser loop in unison. The minimum condensing temperature setpoint shall be less than or equal to 70°F, or reset in response to ambient drybulb temperature or refrigeration system load.
6. All single phase condenser fan motors less than 1 hp and less than 460 volts shall be either permanent split capacitor or electronically commutated motors.

(e) **Compressors.** Compressor systems utilized in refrigerated warehouses shall conform to the following:

1. Compressors shall be designed to operate at a minimum condensing temperature of 70°F or less.
2. The compressor speed of a screw compressor greater than 50 hp shall be controllable in response to the refrigeration load, or the input power to the compressor shall be controlled to be less than or equal to 60 percent of full load input power when operated at 50 percent of full refrigeration capacity.

   Exception to Section 126(e)2: Refrigeration plants with more than one dedicated compressor per suction group.

SECTION 127 — Reserved.

SECTION 128 — Reserved.

SECTION 129 — Reserved.

SUBCHAPTER 4

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—MANDATORY REQUIREMENTS FOR LIGHTING SYSTEMS AND EQUIPMENT

SECTION 130 LIGHTING CONTROLS AND EQUIPMENT—GENERAL

(a) Except as provided in Subsection (b) and (c), the design and installation of all lighting systems and equipment in nonresidential, high-rise residential, hotel/motel buildings and outdoor lighting subject to Title 24, Part 6, shall comply with the applicable provisions of Sections 131 through 139. All lighting controls and equipment shall be installed in accordance with the manufacturer's instructions.

(b) **Indoor lighting in high-rise residential dwelling units and hotel/motel guest rooms.** The design and installation of all lighting systems, lighting controls and equipment in high-rise residential dwelling units and in hotel/motel guest rooms shall comply with the applicable provisions of Section 150(k).

(c) **Outdoor lighting for high-rise residential dwelling units and hotel/motel guest rooms.** Outdoor lighting that is permanently attached to the building, and is separately controlled from the inside of a high-rise residential dwelling unit or guest room, shall comply with Section 150(k)13.

(d) **Luminaire power.** Luminaire wattage shall be determined as follows, or by a method approved by the Executive Director:

1. The wattage of luminaires with line voltage lamp holders, other than GU-24 as determined according to Section 130(e), and not containing permanently installed ballasts or transformers, shall be determined as follows:
   - A. For other than recessed luminaries, the maximum relamping rated wattage of the luminaire, as listed on a permanent, preprinted, factory-installed label, as specified by UL 1598.
   - B. For recessed luminaires, the larger of the maximum relamping rated wattage of the luminaire, as listed on a permanent, preprinted, factory-installed label, as specified by UL 1598, or the following:
     - i. 50 watts per socket for luminaires with housings or trims with an aperture diameter less than 5 inches regardless of mounting height; or
     - ii. 50 watts per socket for luminaires with housings or trims with an aperture diameter of greater than or equal to 5 inches and a mounting height of 11 feet or less, or
     - iii. 60 watts per socket for luminaires with housings or trims with an aperture diameter of greater than or equal to 5 inches and a mounting height of greater than 11 feet but less than 15 feet; or
     - iv. 75 watts per socket for luminaires with housings or trims with an aperture diameter of greater than or equal to 5 inches and a mounting height of 15 feet or more.
   - C. For luminaires designed to accommodate a variety of trims or modular components that allow the conversion between screw-based and pin-based sockets without changing the luminaire housing or wiring, the highest wattage designated by the correlated marking on a permanent, preprinted, factory-installed label on the luminaire housing shall be used.
   - D. For luminaires with line voltage lamp holders, the factory-installed wattage label shall not consist of peel-off or peel-down layers or other methods which allow the rated wattage to be changed after the luminaire has been shipped from the manufacturer.
2. The wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the rated lamp/ballast combination published in manufacturer's catalogs based on independent testing lab reports as specified by UL 1598. The wattage of a compact fluorescent or high intensity discharge luminaire that can accommodate a range of wattages without changing the luminaire housing, ballast or wiring shall be the larger of the installed wattage, or the average wattage of the lamp/ballast combinations for which the luminaire is rated.
3. The wattage of line-voltage lighting track and plug-in busway which allow the addition or relocation of luminaires without altering the wiring of the system shall be determined by one of the following methods:
   - A. The wattage of line voltage busway and track rated for more than 20 amperes shall be the total volt-ampere rating of the branch circuit feeding the busway and track.
   - B. The wattage of line voltage busway and track rated for 20 amperes or less shall be determined by one of the following methods:
     - i. The volt-ampere rating of the branch circuit feeding the track or busway; or
     - ii. The higher of the rated wattage of all of the luminaires included in the system, where wattage is determined according to Section 130(d)(1, 2, 4, 5 or 6) as applicable, or 45 watts per linear foot; or
     - iii. When using an integral current limiter, the higher of the volt-ampere rating of an integral current limiter controlling the track or busway,

or 12.5 watts per linear foot of track or busway, provided that the integral current limiter complies with Section 119(l); or

iv. When using a dedicated track lighting supplementary overcurrent protection panel, the sum of the ampere (A) rating of all of the overcurrent protection devices times the branch circuit voltages. The panel shall meet all of the following requirements:

a. Be listed as defined in Section 101; and

b. Be used only with line voltage track lighting; and

c. Be permanently installed in an electrical equipment room, or permanently installed adjacent to the lighting panel board providing supplementary overcurrent protection for the track lighting circuits served by the supplementary over current protection panel; and

d. Be prominently labeled "NOTICE: This Panel for Track Lighting Energy Code Compliance Only. The overcurrent protection devices in this panel shall only be replaced with the same or lower amperage. No other overcurrent protective device shall be added to this panel. Adding to, or replacement of, existing overcurrent protective device(s) with higher continuous ampere rating will void the panel listing and require resubmittal and recertification of California Title 24, Part 6 compliance documentation."

4. The wattage of luminaires or lighting systems with permanently installed or remotely installed transformers, shall be determined as follows:

A. The rated wattage of the lamp/transformer combination, listed on a permanent, preprinted, factory-installed label as specified by UL 2108, and

B. For luminaires or lighting systems with transformers rated greater than 53 watts, the factory-installed wattage label shall not consist of peel-off or peel-down layers or other methods which allow the rated wattage to be changed after the luminaire or lighting system has been shipped from the manufacturer.

5. The wattage of light emitting diode (LED) Luminaires, or LED Light Engine with Integral Heat Sink shall be the maximum rated input wattage of the system when tested in accordance with Reference Joint Appendix JA8. The maximum rated input wattage shall be listed on a permanent, preprinted, factory-installed label.

6. The wattage of all other miscellaneous lighting equipment shall be the maximum rated wattage of the lighting equipment or operating input wattage of the system, listed on a permanent, preprinted, factory-installed label or published in manufacturers' catalogs, based on independent testing lab reports as specified by UL 1574 or UL 1598.

(e) **GU-24 Lamps, luminaires and adaptors.** GU-24 lamps, luminaires, and adaptors installed in California shall meet the following requirements:

1. Lamps with GU-24 bases shall have a minimum efficacy no lower than specified in Table 150-C.
2. The wattage of luminaires with GU-24 lamp holders shall be the operating input wattage as listed on a permanent, preprinted, factory-installed label on the luminaire housing, as specified by UL. Luminaires with GU-24 lampholders shall not be rated for any lamp or lighting system that has an efficacy lower than specified in Table 150-C.
3. Luminaires with GU-24 lampholders shall not have modular components allowing conversion to any lamp or lighting system that has an efficacy lower than specified in Table 150-C.
4. There shall be no adaptors that convert a GU-24 socket or GU-24 lamp holder to any other line voltage socket or lamp holder, or to any lighting system that has an efficacy lower than specified in Table 150-C.

SECTION 131
INDOOR LIGHTING CONTROLS THAT SHALL BE INSTALLED

(a) **Area controls.**

1. Each area enclosed by ceiling-height partitions shall have an independent switching or control device. This switching or control device shall be:

A. Readily accessible; and

B. Located so that a person using the device can see the lights or area controlled by that switch, or so that the area being lit is annunciated; and

C. Manually operated, or automatically controlled by an occupant sensor that meets the applicable requirements of Section 119.

2. Other devices may be installed in conjunction with the switching or control device, provided that they:

A. Permit the switching or control device to manually turn the lights off in each area enclosed by ceiling height partitions; and

B. Reset the mode of any automatic system to normal operation without further action.

Exception 1 to Section 131(a): 1. Up to 3 watts per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress, if:

A. The area is designated a security or emergency egress area on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Title 24, Part 1; and

B. The security or egress lighting is controlled by switches accessible only to authorized personnel.

Exception 2 to Section 131(a): Public areas with switches that are accessible only to authorized personnel.

(b) **Multilevel lighting controls.** The general lighting of any enclosed space 100 square feet or larger, and has a connected lighting load that exceeds 0.8 watts per square foot, shall have multilevel lighting controls. Multilevel controls shall have at least one control step that is between 30 percent and 70 percent of design lighting power and allow the power of all lights to be manually turned off. A reasonably uniform level of illuminance shall be achieved by any of the following:

1. Continuous or stepped dimming of all lamps or luminaires; or
2. Switching alternate lamps in luminaires, alternate luminaires and alternate rows of luminaires.

Exceptions to Section 131(b):

1. Lights in corridors.
2. A space that has only one luminaire with no more than two lamps.

(c) **Daylight areas.**

1. Daylight areas shall be defined as follows:

A. **DAYLIGHT AREA** is the total daylight area shall not double count overlapping areas with any primary sidelit daylight area, secondary sidelit daylight area or skylit daylight area.

B. **DAYLIGHT AREA, PRIMARY SIDELIT** is the combined primary sidelit area without double counting overlapping areas. The floor area for each primary sidelit area is directly adjacent to vertical glazing below the ceiling with an area equal to the product of the sidelit width and the primary sidelit depth.

The primary sidelit width is the width of the window plus, on each side, the smallest of:

i. 2 feet; or

ii. The distance to any 5 feet or higher permanent vertical obstruction.

The primary sidelit depth is the horizontal distance perpendicular to the glazing, which is the smaller of:

i. One window head height; or

ii. The distance to any 5 feet or higher permanent vertical obstruction.

C. **DAYLIGHT AREA. SECONDARY SIDELIT** is the combined secondary sidelit area without double counting overlapping areas. The floor area for each secondary sidelit area is directly adjacent to primary sidelit area with an area equal to the product of the sidelit width and the secondary sidelit depth.

The secondary sidelit width is the width of the window plus, on each side, the smallest of:

I. 2 feet; or

ii. The distance to any 5 feet or higher permanent vertical obstruction; or

iii. The distance to any skylit daylight area.

The secondary sidelit depth is the horizontal distance perpendicular to the glazing which begins from one window head height, and ends at the smaller of:

i. Two window head heights;

ii. The distance to any 5 feet or higher permanent vertical obstruction; or

iii. The distance to any skylit daylight area.

D. **DAYLIGHT AREA, SKYLIT** is the combined daylight area under each skylight without double counting overlapping areas. The daylight area under each skylight is bounded by the rough opening of the skylight, plus horizontally in each direction the smallest of:

i. 70 percent of the floor-to-ceiling height; or

ii. The distance to any primary sidelit area, or the daylight area under rooftop monitors; or

iii. The distance to any permanent partition or permanent rack which is farther away than 70 percent of the distance between the top of the permanent partition or permanent rack and the ceiling.

2. Luminaires providing general lighting that are in or are partially in the skylit daylight area and/or the primary sidelit daylight area shall be controlled as follows:

A. Primary sidelit and skylit daylight areas shall have at least one lighting control that:

i. Controls at least 50 percent of the general lighting power in the primary sidelit and skylit daylight areas separately from other lighting in the enclosed space.

ii. Controls luminaires in primary sidelit areas separately from skylit areas.

Exception to Section 131(c)2A: Primary sidelit and skylit daylight areas that have a combined area totaling less than or equal to 250 square feet within any enclosed space.

B. For all skylit daylight areas:

i. The skylit daylight area shall be shown on the plans.

ii. All of the general lighting in the skylit area shall be controlled independently by an automatic daylighting control device that meets the applicable requirements of Section 119.

iii. The automatic daylighting control shall be installed in accordance with Section 131(c)4.

Exception 1 to Section 131(c)2B: Where the total skylit daylight area in any enclosed space is less than or equal to 2,500 square feet.

Exception 2 to Section 131(c)2B: Skylit daylight areas where existing adjacent structures obstruct direct beam sunlight for at least 6 hours per day during the equinox as calculated using computer or graphical methods.

Exception 3 to Section 131(c)2B: When the skylight effective aperture is greater than 4.0 percent, and all general lighting in the skylit area is controlled by a multilevel astronomical time switch that meets the requirements of Section 119(h) and that has an override switch that meets the requirements of Section 131(d)2.

Exception 4 to Section 131(c)2B: Skylit daylight areas where the effective aperture is less than 0.006. The effective aperture for skylit daylight areas is specified in Section 146(a)2E.

C. The primary sidelit area(s) shall be shown on the plans, and the general lighting in the primary sidelit areas shall be controlled independently by an automatic daylighting control device that meets the applicable requirements of Section 119 and is installed in accordance with Section 131(c)2D.

Exception 1 to Section 131(c)2C: Where the total primary sidelit daylight area in any enclosed space has an area less than or equal to 2,500 square feet.

Exception 2 to Section 131(c)2C: Primary sidelit daylight areas where the effective aperture is less than 0.1. The effective aperture for primary sidelit daylight areas is specified in Section 146(a)2E.

Exception 3 to Section 131(c)2C: Primary sidelit daylight areas where existing adjacent structures are twice as tall as their distance away from the windows.

Exception 4 to Section 131(c)2C: Parking garages.

D. **Automatic daylighting control device installation and operation.** Automatic daylighting control devices shall be installed and configured to operate according to all of the following requirements:

i. Automatic daylighting control devices shall have photosensors that are located so that they are not readily accessible in accordance with the designer's or manufacturer's instructions.

ii. The location where calibration adjustments are made to the automatic daylighting control device shall be readily accessible to authorized personnel, or located within 2 feet of a ceiling access panel that is no higher than 11 feet above floor level.

iii. Automatic daylighting controls shall be multilevel, including continuous dimming, and have at least one control step that is between 50 percent to 70 percent of rated power of the controlled lighting.

Exception 1 to Section 131(c)2D(iii): Controlled lighting having a lighting power density less than 0.3 W/ft^2.

Exception 2 to Section 131(c)2D(iii): When skylights are replaced or added to on an existing building with an existing general lighting system.

iv. Under all daylight conditions in all areas served by the controlled lighting, the combined illuminance from the controlled lighting and daylight is not less than the illuminance from controlled lighting when no daylight is available.

v. When all areas served by the controlled lighting are receiving daylight illuminance levels greater than 150 percent of the illuminance from controlled lighting when no daylight is available, the controlled lighting power consumption shall be no greater than 35 percent of the rated power of the controlled lighting.

(d) **Shut-off controls.**

1. In addition to the manual controls installed to comply with Section 131(A) and (b), for every floor, all indoor lighting systems shall be equipped with separate automatic controls to shut off the lighting. These automatic controls shall meet the requirements of Section 119 and may be an occupant sensor, automatic time switch or other device capable of automatically shutting off the lighting.

   Exception 1 to Section 131(d)1: Where the lighting system is serving an area that must be continuously lit, 24 hours per day/365 days per year.

   Exception 2 to Section 131(d)1: Lighting in corridors, guest rooms and dwelling units of high-rise residential buildings and hotel/motels, and parking garages.

   Exception 3 to Section 131(d)1: Up to 0.3 watts per square foot of lighting in any area within a building that must be continuously illuminated for reasons of building security or emergency egress, provided that the area is designated a security or emergency egress area on the plans and specifications submitted to the enforcement agency under Section 10-103(a)2 of Title 24, Part 1.

2. If an automatic control device is installed to comply with Section 131(d)1, it shall incorporate an override switching device that:

   A. Is readily accessible; and

   B. Is located so that a person using the device can see the lights or the area controlled by that switch, or so that the area being lit is annunciated; and

   C. Is manually operated; and

   D. Allows the lighting to remain on for no more than two hours when an override is initiated; and

Exception to Section 131(d)2D: In malls, auditoriums, single tenant retail spaces, industrial facilities and arenas where captive-key override is utilized, override time may exceed 2 hours.

E. Controls an area enclosed by ceiling height partitions not exceeding 5,000 square feet.

Exception to Section 131(d)2E: In malls, auditoriums, single tenant retail spaces, industrial facilities, convention centers and arenas, the area controlled may not exceed 20,000 square feet.

3. If an automatic time switch control device is installed to comply with Section 131(d)1, it shall incorporate an automatic holiday "shut-off" feature that turns off all loads for at least 24 hours, and then resumes the normally scheduled operation.

Exception to Section 131(d)3: Retail stores and associated malls, restaurants, grocery stores, churches and theaters.

4. Offices 250 square feet or smaller; multipurpose rooms of less than 1,000 square feet, and classrooms and conference rooms of any size, shall be equipped with occupant sensor(s) to shut off the lighting. In addition, controls shall be provided that allow the lights to be manually shut off in accordance with Section 131(a) regardless of the sensor status.

(e) **Display lighting.** Floor and wall display, window display and case display lighting shall each be separately switched on circuits that are 20 amps or less.

(f) **Automatic controls required for tailored method.** When the tailored method in Section 146 is used for calculating allowed indoor lighting power density, the general lighting shall be controlled separately from the display, ornamental and display case lighting.

(g) **Demand responsive lighting controls.** Demand responsive automatic lighting controls that uniformly reduce lighting power consumption by a minimum of 15 percent shall be installed in retail buildings with sales floor areas greater than 50,000 square feet.

Exception to Section 131(g): Buildings where more than 50 percent of the lighting power is controlled by daylighting controls.

SECTION 132
OUTDOOR LIGHTING CONTROLS AND EQUIPMENT

(a) **Outdoor lighting.** All permanently installed outdoor luminaires employing lamps rated over 100 watts shall either: have a lamp efficacy of at least 60 lumens per watt; or be controlled by a motion sensor.

Exception 1 to Section 132(a): Lighting required by a health or life safety statute, ordinance or regulation, including but not limited to, emergency lighting.

Exception 2 to Section 132(a): Lighting used in or around swimming pools, water features or other locations subject to Article 680 of the *California Electrical Code*.

Exception 3 to Section 132(a): Searchlights.

Exception 4 to Section 132(a): Theme lighting for use in theme parks.

Exception 5 to Section 132(a): Lighting for film or live performances.

Exception 6 to Section 132(a): Temporary outdoor lighting.

Exception 7 to Section 132(a): Light emitting diode, light emitting capacitors, neon and cold cathode lighting.

Exception 8 to Section 132(a): Sign lighting.

(b) **Luminaire cutoff requirements.** All outdoor luminaires that use lamps rated greater than 175 watts in hardscape areas including parking lots, building entrances, sales and nonsales canopies, and all outdoor sales areas shall be designated Cutoff for light distribution. To comply with this requirement the luminaire shall be rated Cutoff in a photometric test report that includes any tilt or other nonlevel mounting condition of the installed luminaire. Cutoff is a luminaire light distribution classification where the candela per 1000 lamp lumens does not numerically exceed 25 at or above a vertical angle of 90 degrees above nadir, and 100 at or above a vertical angle of 80 degrees above nadir. Nadir is in the direction of straight down, as would be indicated by a plumb line. Ninety degrees above nadir is horizontal. Eighty degrees above nadir is 10 degrees below horizontal.

Exception 1 to Section 132(b): Signs.

Exception 2 to Section 132(b): Lighting for building facades, public monuments, statues and vertical surfaces of bridges.

Exception 3 to Section 132(b): Lighting required by a health or life safety statute, ordinance or regulation, including but not limited to, emergency lighting.

Exception 4 to Section 132(b): Temporary outdoor lighting.

Exception 5 to Section 132(b): Lighting used in or around swimming pools, water features or other locations subject to Article 680 of the *California Electrical Code*.

Exception 6 to Section 132(b): Replacement of existing pole mounted luminaires in hardscape areas meeting all of the following conditions:

A. Where the existing luminaire does not meet the luminaire cutoff requirements in Section 132(b); and
B. Spacing between existing poles is greater than six times the mounting height of the existing luminaires; and
C. Where no additional poles are being added to the site; and
D. Where new wiring to the luminaires is not being installed; and
E. Provided that the connected lighting power wattage is not increased.

(c) **Controls for outdoor lighting**

1. All permanently installed outdoor lighting shall be controlled by a photocontrol or astronomical time switch

that automatically turns off the outdoor lighting when daylight is available.

Exception to Section 132(c)1: Lighting in tunnels and large covered areas that require illumination during daylight hours.

2. For lighting of building facades, parking lots, sales and nonsales canopies, all outdoor sales areas, and student pick-up/drop-off zones where two or more luminaires are used, an automatic time switch shall be installed that is capable of (1) turning off the lighting when not needed and (2) reducing the lighting power (in watts) by at least 50 percent but not exceeding 80 percent or providing continuous dimming through a range that includes 50 percent through 80 percent reduction. This control shall meet the requirements of Section 119 (c).

   Exception 1 to Section 132(c)2: Lighting required by a health or life-safety statute, ordinance or regulation, including but not limited to, emergency lighting.

   Exception 2 to Section 132(c)2: Lighting for steps or stairs that require illumination during daylight hours.

   Exception 3 to Section 132(c)2: Lighting that is controlled by a motion sensor and photocontrol.

   Exception 4 to Section 132(c)2: Lighting for facilities that have equal lighting requirements at all hours and are designed to operate continuously.

   Exception 5 to Section 132(c)2: Temporary outdoor lighting.

   Exception 6 to Section 132(c)2: Signs.

SECTION 133
SIGN LIGHTING CONTROLS

(a) **Controls for all signs.** All signs with permanently connected lighting shall meet the requirements of Section 133 below:

1. **Automatic time switch control.** All signs with permanently connected lighting shall be controlled with an automatic time switch control that complies with the applicable requirements of Section 119.
2. **Photocontrol or outdoor astronomical time switch control.** All outdoor signs shall be controlled with a photocontrol or outdoor astronomical time switch control.

   Exception to Section 133(a)2: Outdoor signs in tunnels and large covered areas that require illumination during daylight hours.

3. **Dimming.** All outdoor signs shall be controlled with a dimmer that provides the ability to automatically reduce sign power by a minimum of 65 percent during night time hours.

   Exception 1 to Section 133(a)3: Signs that are illuminated for less than one hour per day during daylight hours.

   Exception 2 to Section 133(a)3: Outdoor signs in tunnels and large covered areas that require illumination during daylight hours.

   Exception 3 to Section 133(a)3: Metal halide, high pressure sodium, cold cathode and neon lamps used to illuminated signs or parts of signs.

4. **Demand Responsive Electronic Message Center Control.** An Electronic Message Center (EMC) having a new connected lighting power load greater than 15 kW shall have a control installed that is capable of reducing the lighting power by a minimum of 30 percent when receiving a demand response signal that is sent out by the local utility.

   Exception to Section 133(a)4: EMCs required by a health or life safety statue, ordinance or regulation, including but not limited to exit signs and traffic signs.

SECTION 134
REQUIRED NONRESIDENTIAL LIGHTING CONTROL ACCEPTANCE

(a) **Lighting control acceptance.** Before an occupancy permit is granted for a new building or space, or a new lighting system serving a building, space or site is operated for normal use, all indoor and outdoor lighting controls serving the building, space or site shall be certified as meeting the Acceptance Requirements for Code Compliance. A Certificate of Acceptance shall be submitted to the enforcement agency under Section 10-103(a) of Title 24, Part 1, that:

1. Certifies plans, specifications, installation certificates, and operating and maintenance information meet the requirements of Part 6.
2. Certifies that automatic daylighting controls meet the applicable requirements of Sections 119 and 131(c)2D.
3. Certifies that when a multilevel astronomical time switch is used to meet the Exception 3 to Section 131(c)2B all general lighting in the skylit area is controlled by a multilevel astronomical time switch that meets the applicable requirements of Section 119 and that has an override switch that meets the requirements of Section 131(d)2.
4. Certifies that lighting controls meet the requirements of Section 131(a) through Section 131(c), Sections 131(e) and (f), and Section 146(a)2 as applicable.
5. Certifies that automatic lighting controls meet the applicable requirements of Sections 119 and 131(d).
6. Certifies that occupants-sensors meet the applicable requirements of Sections 119 and 131(d).
7. Certifies that outdoor lighting controls meet the applicable requirements of Sections 119 and 132.

SECTION 135 — Reserved.

SECTION 136 — Reserved.

SECTION 137 — Reserved.

SECTION 138 — Reserved.

SECTION 139 — Reserved.

SUBCHAPTER 5

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR ACHIEVING ENERGY EFFICIENCY

SECTION 140
CHOICE OF PERFORMANCE AND PRESCRIPTIVE APPROACHES

The envelope and the space-conditioning, lighting and service water-heating systems of all nonresidential, high-rise residential and hotel/motel buildings subject to Title 24, Part 6, shall be designed, constructed and installed in accordance with either:

(a) **Performance approach**—to use no more TDV energy from depletable sources than the energy budget, calculated according to Section 141; or

(b) **Prescriptive approach**—in accordance with all the applicable requirements of Sections 142 through 148.

SECTION 141
PERFORMANCE APPROACH: ENERGY BUDGETS

In order to meet the energy budget, a proposed building's use of TDV energy calculated under Subsection (b) must be no greater than the TDV energy budget calculated under Subsection (a).

(a) **Energy budget.** The energy budget for a proposed building is the sum of the space-conditioning, lighting and service water-heating budgets in Subdivisions 1, 2 and 3 of this subsection, expressed in Btu per square foot of conditioned floor area per year.

1. **Space-conditioning budget.** The space-conditioning budget is the TDV energy used for space conditioning in a standard building in the climate zone in which the proposed building is located, calculated with a method approved by the Commission (expressed in TDV energy per square foot of conditioned floor area per year), and assuming that:
   A. The standard building has space heating, space cooling and ventilation systems that meet, but do not exceed, the minimum efficiency requirements of Sections 111 and 112, and the requirements of Section 144; and
   B. The performance of the roof/ceiling, walls, floors and soffits, windows, and skylights is equal to an applicable value using the same assembly type from Table 143-A, 143-B or 143-C, and for nonresidential buildings with low-sloped roofs, the roof aged solar reflectance and thermal emittance is equal to the values specified in Section 118(i)1; and
   C. The zoning, the orientation of each building feature, and the gross envelope areas of the standard building are the same as in the proposed building; and
   D. The window area of the west-facing wall is the greater of: (1) the window area of the proposed building excluding the window area in demising walls, or 40 percent of the gross exterior west-facing wall area of the standard building, whichever is less; or (2) 6 feet times the west-facing display perimeter; and the window area of the standard building is the greater of (1) or (2): (1) the window area of the proposed building, excluding the window area in demising walls, or 40 percent of the gross exterior wall area of the standard building, whichever is less; or (2) 6 feet times the display perimeter; and
   E. For buildings subject to Section 143(c), the skylight area of the standard building shall be the minimum area required by Section 143(c). For all other buildings, the skylight area of the standard building is the same as in the proposed building, or is 5 percent of the gross exterior roof/ceiling area of the standard building, whichever is less.
2. **Lighting budget.** The lighting budget is the TDV energy used for lighting in a standard building calculated with a method approved by the Commission (expressed in Btu per square foot of conditioned floor area per year), and assuming that:
   A. The lighting power density of the standard building, for areas where no lighting plans or specifications are submitted for permit and the occupancy of the building is known, is the maximum allowed lighting power density calculated according to Section 146(c)1; and
   B. The lighting power density of the standard building, for areas where no lighting plans or specifications are submitted for permit, and the occupancy of the building is not known, is 1.2 watts per square foot; and
   C. The lighting power density of the standard building, for areas where lighting plans and specifications are being submitted for permit, is the maximum allowed lighting power density calculated according to Section 146(c)1, 2 or 3; and
   D. The lighting power density of the standard building is adjusted as described in the Nonresidential ACM Manual for an astronomical timeclock when required by Section 131(c)2.
3. **Service water-heating budget.** The service water-heating budget is the TDV energy used for service water heating in a standard building in the climate zone in which the proposed building is located, calculated

with a method approved by the Commission (expressed in Btu per square foot of conditioned floor area per year), and assuming that the standard building has a service water-heating system that meets, but does not exceed, the applicable requirements of Sections 111, 113, 123 and 145.

(b) **TDV energy use of proposed building.** The TDV energy use of a proposed building is the sum of the space-conditioning, lighting and service water-heating TDV energy use calculated in Subdivisions 1, 2 and 3 of this subsection, using the same compliance software used to calculate the budget under Subsection (a), and expressed in Btu per square foot of conditioned floor area per year. If any feature of the proposed building, including, but not limited to, the envelope or the space-conditioning, lighting or service water-heating system, is not included in the building permit application, the energy performance of the feature shall be assumed to be that of the corresponding feature calculated in Subsection (a).

1. **Space-conditioning TDV energy use.** The space-conditioning TDV energy use shall be calculated by:
   A. Using a method approved by the Commission; and
   B. Using the proposed building's space heating, space cooling, lighting and ventilation systems, roof and ceiling, walls, floors and soffits, opaque envelope areas, windows, skylights, zoning and orientation, as shown on the plans and specifications submitted in the building permit application under Section 10-103 of Title 24, Part 1.
2. **Lighting TDV energy use.** The lighting TDV energy use shall be calculated using a method approved by the Commission, and using the actual lighting power density calculated under Section 146(c), including reduction of wattage by the applicable lighting power adjustment factors specified in Section 146(a)2. The lighting power density shall also be adjusted as described in the Nonresidential ACM Manual for an astronomical timeclock when required by Section 131(c)2.
3. **Service water-heating TDV energy use.** The service water-heating TDV energy use shall be calculated using a method approved by the Commission, and using the proposed building's actual service water-heating system.

(c) **Calculation of budget and energy use.** When calculating the energy budget under Subsection (a) and the TDV energy use under Subsection (b), all of the following rules shall apply:

1. **Methodology.** The methodology, computer programs, inputs and assumptions approved by the Commission shall be used.
2. **Energy included.** All energy from depletable sources, recovered from space conditioning equipment, and used for space conditioning, lighting and service water heating shall be included.
3. **Energy excluded.** The following energy shall be excluded:
   A. Process loads; and
   B. Loads of redundant or backup equipment, if the plans submitted under Section 10-103 of Title 24, Part 1, show controls that will allow the redundant or backup equipment to operate only when the primary equipment is not operating, and if such controls are installed; and
   C. Recovered energy other than from space conditioning equipment; and
   D. Additional energy use caused solely by outside air filtration and treatment for the reduction and treatment of unusual outdoor contaminants with final pressure drops more than 245 pascals or 1-inch water column. Only the energy accounted for by the amount of the pressure drop that is over 1 inch may be excluded.
4. **U-factors.** U-factors shall be calculated as follows:
   A. **All building components.** The U-factor of all building components shall be calculated to three decimal places; the calculations shall assume still inside air and a 15 miles per hour outside air velocity, or other assumptions approved by the Commission.
   B. **Wood-framed assemblies.** U-factors for wood-framed assemblies shall be calculated using the parallel path method listed in ASHRAE Handbook, Fundamentals Volume, Chapter 23, with framing factors approved by the Commission.
   C. **Metal-framed assemblies.** U-factors for metal-framed assemblies shall be calculated using the zone method listed in ASHRAE Handbook, Fundamentals Volume, Chapter 23, or a method approved by the Commission.
   D. **Fenestration.** U-factors for fenestration shall be determined using NFRC 100 as specified in Section 116.
   E. **Masonry assemblies.** U-factors for masonry assemblies shall be calculated using the transverse isothermal planes method listed in ASHRAE Handbook, Fundamentals Volume, Chapter 23, or a method approved by the Commission.
   F. **Other.** U-factors for components not listed in this subsection shall be calculated using a method approved by the Commission.
5. **Solar heat gain coefficients.** Solar heat gain coefficients shall be determined using NFRC 200 as specified in Section 116, and shall not be adjusted for the effects of interior of exterior shading devices.
6. **Visible light transmittance.** Visible light transmittance shall be determined using the values listed in ASHRAE Handbook, Fundamentals Volume, Chapter 30, or manufacturers' literature, and shall be adjusted for the effects of framing and interior or exterior shading devices.

(d) **Relocatable public school buildings.** When the manufacturer/builder certifies the relocatable public school building for use in any climate zone, the energy budget shall be met in

the most severe climate zones as specified in the Nonresidential ACM Manual, assuming the prescriptive envelope criteria in Table 143-C. When the manufacturer/builder certifies that the relocatable building is manufactured for use in specific climate zones and that the relocatable building cannot be lawfully used in other climate zones, the energy budget shall be met in each climate zone that the manufacturer/building certifies, assuming the prescriptive envelope criteria in Table 143-A, including the non-north window RSHG and skylight SHGC requirements for each climate zone. The energy budget and the energy use of the proposed building shall be determined using the multiple orientation approach specified in the Nonresidential ACM Manual. The manufacturer/builder shall meet the requirements for identification labels specified in Section 143(a)8.

SECTION 142
PRESCRIPTIVE APPROACH

In order to comply with the prescriptive approach under this section, a building shall be designed with and shall have constructed and installed:

(a) A building envelope that complies with Section 143(a) or (b) and for applicable buildings Section 143(c);

(b) A space-conditioning system that complies with Section 144;

(c) A service water-heating system that complies with Section 145;

(d) A lighting system that complies with Section 146;

(e) An outdoor lighting system that complies with Section 147; and

(f) Interior and exterior signs that comply with Section 148.

SECTION 143
PRESCRIPTIVE REQUIREMENTS FOR BUILDING ENVELOPES

A building complies with this section by being designed with and having constructed and installed either (1) envelope components that comply with each of the requirements in Subsection (a) for each individual component, and the requirements of Subsection (c) where they apply, or (2) an envelope that complies with the overall requirements in Subsection (b) and the requirements of Subsection (c) where they apply. When making calculations under Subsection (a) or (b), all of the rules listed in Section 141(c)1, 4 and 5 shall apply.

(a) **Envelope component approach.**

1. **Exterior roofs and ceilings.** Exterior roofs and ceilings shall:

   A. **Roofs.** All roofing products shall meet the requirements of Section 118 and the applicable requirements of Subsections i through iii:

      i. Nonresidential buildings with low-sloped roofs in climate zones 2 – 15 shall have a minimum 3-year aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum aged SRI of 64.

         Exception 1 to Section 143(a)1Ai: Wood-framed roofs in climate zones 3 and 5 are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI if the roof assembly has a U-factor of 0.039 or lower.

         Exception 2 to Section 143(a)1Ai: Metal building roofs in climate zones 3 and 5 are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI if the roof assembly has a U-factor of 0.048 or lower.

         Exception 3 to Section 143(a)1Ai: Roof area covered by building integrated photovoltaic panels and building integrated solar thermal panels are not required to meet the minimum requirements for solar reflectance and thermal emittance or SRI.

         Exception 4 to Section 143(a)1Ai: Roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft^2.

      ii. Nonresidential steep-sloped roofs with roofing products that have a roof weight of less than 5 pounds per square foot in climate zones 2 – 16 shall have a minimum 3-year aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16. Steep-sloped roofing products that have a roof weight of 5 pounds per square foot or more in climate zones 1 through 16 shall have a minimum 3-year aged reflectance of 0.15 and a minimum emittance of 0.75, or a minimum SRI of 10.

      iii. High-rise residential buildings and hotels and motels with low-sloped roofs in climate zones 10, 11, 13, 14 and 15 shall have a minimum 3-year aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

   B. Have insulation placed in direct contact with a continuous roof or drywall ceiling where required by Section 118(e); and

   C. Have an overall assembly *U*-factor no greater than the applicable value in Table 143-A, 143-B or 143-C.

2. **Exterior walls.** Exterior walls shall have an overall assembly *U*-factor no greater than the applicable value in Table 143-A, 143-B or 143-C.

3. **Demising walls.** Demising walls shall meet the requirements of Section 118(f).

4. **External floors and soffits.** External floors and soffits shall have an overall assembly *U*-factor no greater than the applicable value in Table 143-A, 143-B or 143-C.

5. **Windows.** Windows shall:

   A. Have (1) a west-facing area no greater than 40 percent of the gross west-facing exterior wall area, or 6 feet times the west-facing display perimeter, whichever is greater; and (2) a total area no greater than 40 percent of the gross exterior wall area, or 6 feet times the display perimeter, whichever is greater; and

   Exception to Section 143(a)5A: Window area in demising walls is not counted as part of the window area for this requirement. Demising wall area is not counted as part of the gross exterior wall area or display perimeter.

   B. Have a U-factor no greater than the applicable value in Table 143-A, 143-B or 143-C; and

   C. Have a relative solar heat gain, excluding the effects of interior shading, no greater than the applicable value in Table 143-A, 143-B or 143-C. The relative solar heat gain of windows is:

      i. The solar heat gain coefficient of the windows; or

TABLE 143-A
PRESCRIPTIVE ENVELOPE CRITERIA FOR NONRESIDENTIAL BUILDINGS(INCLUDING RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE ONLY IN SPECIFIC CLIMATE ZONE; NOT INCLUDING HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS)

			CLIMATE ZONES															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Roofs/ ceilings	Metal building Wood framed and other		0.065 0.049	0.065 0.039	0.065 0.039	0.065 0.039	0.065 0.049	0.065 0.075	0.065 0.067	0.065 0.067	0.065 0.039	0.065 0.039	0.065 0.039	0.065 0.039	0.065 0.039	0.065 0.039	0.065 0.039	0.065 0.039
Roofing products	Low-sloped	Aged reflectance emittance	NR NR	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	0.55 0.75	NR NR
	Steep sloped (less than 5 lb/ft^2)		NR NR	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75	0.20 0.75
	Steep sloped (5 lb/ft^2 or more)		0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75	0.15 0.75
Walls[1]	Metal building Metal-framed Mass light Mass heavy Wood-framed and other		0.113 0.098 0.196 0.253 0.102	0.061 0.062 0.170 0.650 0.059	0.113 0.082 0.268 0.650 0.110	0.061 0.062 0.227 0.650 0.059	0.061 0.062 0.44 0.650 0.102	0.113 0.098 0.44 0.690 0.110	0.113 0.098 0.44 0.690 0.110	0.061 0.062 0.44 0.690 0.102	0.061 0.062 0.44 0.690 0.059	0.061 0.062 0.170 0.650 0.059	0.061 0.062 0.170 0.184 0.059	0.061 0.062 0.170 0.253 0.059	0.061 0.062 0.170 0.211 0.059	0.061 0.062 0.170 0.184 0.059	0.057 0.062 0.170 0.184 0.042	0.061 0.062 0.170 0.160 0.059
Floors/ soffits	Mass Other		0.092 0.048	0.092 0.039	0.269 0.071	0.269 0.071	0.269 0.071	0.269 0.071	0.269 0.071	0.269 0.071	0.269 0.071	0.269 0.071	0.092 0.039	0.092 0.071	0.092 0.071	0.092 0.039	0.092 0.039	0.058 0.039
Windows	U-factor		0.47	0.47	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.47	0.47	0.47	0.47	0.47	0.47	0.47
	RSHG North	0-10% WWR 10-20% WWR 20-30% WWR 30-40% WWR	0.72 0.49 0.47 0.47	0.61 0.51 0.47 0.47	0.61 0.61 0.61 0.61	0.61 0.61 0.61 0.61	0.61 0.61 0.61 0.61	0.61 0.61 0.61 0.61	0.61 0.61 0.61 0.61	0.61 0.61 0.61 0.61	0.61 0.61 0.61 0.61	0.61 0.51 0.47 0.47	0.61 0.51 0.47 0.47	0.61 0.51 0.47 0.47	0.61 0.51 0.47 0.47	0.61 0.51 0.47 0.40	0.61 0.51 0.47 0.40	0.72 0.49 0.47 0.47
	RSHG Non-north	0-10% WWR 10-20% WWR 20-30% WWR 30-40% WWR	0.49 0.43 0.43 0.43	0.47 0.36 0.36 0.31	0.61 0.55 0.41 0.41	0.61 0.55 0.41 0.41	0.61 0.55 0.41 0.41	0.61 0.61 0.39 0.34	0.61 0.61 0.39 0.34	0.61 0.61 0.39 0.34	0.61 0.61 0.39 0.34	0.47 0.36 0.36 0.31	0.47 0.36 0.36 0.31	0.47 0.36 0.36 0.31	0.47 0.36 0.36 0.31	0.46 0.36 0.36 0.31	0.46 0.36 0.36 0.31	0.49 0.43 0.43 0.43
Doors, U-factor	Nonswinging Swinging		0.50 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.45 0.70	1.50 0.70
Skylight[2]	U-factor	Glass, curb Glass, no curb Plastic	1.11 0.68 1.04	1.11 0.68 1.11	1.11 0.82 1.11	1.11 0.82 1.11	1.11 0.82 1.11	1.11 0.82 1.11	1.11 0.82 1.11	1.11 0.82 1.11	1.11 0.82 1.11	1.11 0.68 1.11	1.11 0.68 1.11	1.11 0.68 1.11	1.11 0.68 1.11	1.11 0.68 1.11	1.11 0.68 1.11	1.11 0.68 1.04
	SHGC	Glass, 0-2% Glass, 2.1-5% Plastic, 0-2% Plastic, 2.1-5%	NR NR 0.69 0.57	0.46 0.36 0.69 0.57	0.57 0.40 0.69 0.57	0.57 0.40 0.69 0.57	0.57 0.40 0.69 0.57	0.57 0.40 0.69 0.57	0.57 0.40 0.69 0.57	0.57 0.40 0.69 0.57	0.57 0.40 0.69 0.57	0.46 0.36 0.69 0.57	0.46 0.36 0.69 0.57	0.46 0.36 0.69 0.57	0.46 0.36 0.69 0.57	0.46 0.36 0.69 0.57	0.46 0.36 0.69 0.57	NR NR 0.69 0.57

Notes:
[1]Mass, light walls are defined as having a heat capacity greater than or equal to 7.0 Btu/h-ft^2 and less than 15.0 Btu/h-ft^2. Heavy mass walls are defined as having a heat capacity greater than or equal to 15.0 Btu/h-ft^2.
[2]No skylight SHGC requirements are defined for climate zones 1 and 16. A climate zone without a requirement is designated as "NR".

ii. Relative solar heat gain as calculated by Equation 143-A, if an overhang extends beyond both sides of the window jamb a distance equal to the overhang projection.

Exception to Section 143(a)5C: The applicable "north" value for relative solar heat gain in Table 143-A, 143-B or 143-C or 0.56, whichever is greater, shall be used for windows:

a. That are in the first story of exterior walls that form a display perimeter; and

b. For which codes restrict the use of overhangs to shade the windows.

EQUATION 143-A RELATIVE SOLAR HEAT GAIN

$$RSHG = SHGC_{win} \times \left[1 + \frac{aH}{V} + b \left(\frac{H}{V} \right)^2 \right]$$

where:

$RSHG$ = relative solar heat gain.

$SHGC_{win}$ = solar heat gain coefficient of the window.

H = horizontal projection of the overhang from the surface of the window in feet, but no greater than V.

V = vertical distance from the window sill to the bottom of the overhang, in feet.

a = -0.41 for north-facing windows, -1.22 for south-facing windows and -0.92 for east- and west-facing windows.

b = 0.20 for north-facing windows, 0.66 for south-facing windows and 0.35 for east- and west-facing windows.

6. **Skylights.** Skylights shall:

A. Have an area no greater than 5 percent of the gross exterior roof area; and

TABLE 143-B
PRESCRIPTIVE ENVELOPE CRITERIA FOR HIGH-RISE RESIDENTIAL BUILDINGS AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS

			CLIMATE ZONES															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Roofs/ ceilings	Metal building		0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065
	Wood framed and other		0.034	0.028	0.039	0.028	0.039	0.039	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
Roofing products	Low-sloped	Aged reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.55	0.55	NR	0.55	0.55	0.55	NR
		emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	NR	0.75	0.75	0.75	NR
Walls[1]	Metal building		0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
	Metal-framed		0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105
	Mass light		0.170	0.170	0.170	0.170	0.170	0.227	0.227	0.227	0.196	0.170	0.170	0.170	0.170	0.170	0.170	0.170
	Mass heavy		0.160	0.160	0.160	0.184	0.211	0.690	0.690	0.690	0.690	0.690	0.184	0.253	0.211	0.184	0.184	0.160
	Wood-framed and other		0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.042	0.059	0.059	0.042	0.042	0.042
Floors/ soffits	Mass		0.045	0.045	0.058	0.058	0.058	0.069	0.092	0.092	0.092	0.069	0.058	0.058	0.058	0.045	0.058	0.037
	Other		0.034	0.034	0.039	0.039	0.039	0.039	0.071	0.039	0.039	0.039	0.039	0.039	0.039	0.034	0.039	0.034
Windows	U-factor		0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
	RSHG North	0-10% WWR	0.68	0.49	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.49	0.49	0.49	0.49	0.47	0.47	0.68
		10-20% WWR	0.68	0.49	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.49	0.49	0.49	0.49	0.43	0.43	0.68
		20-30% WWR	0.47	0.40	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.40	0.40	0.40	0.40	0.43	0.43	0.47
		30-40% WWR	0.47	0.40	0.55	0.55	0.55	0.61	0.61	0.61	0.61	0.40	0.40	0.40	0.40	0.41	0.41	0.47
	RSHG Non-north	0-10% WWR	0.46	0.36	0.41	0.41	0.41	0.47	0.47	0.47	0.47	0.36	0.36	0.36	0.36	0.36	0.36	0.46
		10-20% WWR	0.46	0.36	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.36	0.36	0.36	0.36	0.31	0.31	0.46
		20-30% WWR	0.36	0.31	0.31	0.31	0.31	0.36	0.36	0.36	0.36	0.31	0.31	0.31	0.31	0.26	0.26	0.36
		30-40% WWR	0.30	0.26	0.26	0.26	0.26	0.31	0.31	0.31	0.31	0.26	0.26	0.26	0.26	0.26	0.26	0.30
Doors, U-factor	Nonswinging		0.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.50
	Swinging		0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Skylight[2]	U-factor	Glass, curb	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
		Glass, no curb	0.68	0.68	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.68	0.68	0.68	0.68	0.68	0.68	0.68
		Plastic	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11
	SHGC	Glass, 0-2%	0.46	0.46	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.46	0.46	0.46	0.46	0.46	0.46	0.46
		Glass, 2.1-5%	0.36	0.32	0.32	0.32	0.32	0.40	0.40	0.40	0.40	0.32	0.32	0.32	0.32	0.31	0.31	0.36
		Plastic, 0-2%	0.69	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
		Plastic, 2.5-5%	0.55	0.34	0.39	0.39	0.39	0.57	0.57	0.57	0.57	0.34	0.34	0.34	0.34	0.27	0.27	0.55

Notes:

[1]Mass, light walls are defined as having a heat capacity greater than or equal to 7.0 Btu/h-ft^2 and less than 15.0 Btu/h-ft^2. Heavy mass walls are defined as having a heat capacity greater than or equal to 15.0 Btu/h-ft^2.

[2]No skylight SHGC requirements are defined for climate zones 1 and 16. A climate zone without a requirement is designated as "NR".

Exception to Section 143(a)6A: Atria over 55 feet high shall have a skylight area no greater than 10 percent of the gross exterior roof area.

B. Have a *U*-factor no greater than the applicable value in Table 143-A, 143-B or 143-C; and

C. Have a solar heat gain coefficient no greater than the applicable value in Table 143-A, 143-B or 143-C.

7. **Exterior doors.** All exterior doors for conditioned spaces shall have a U-factor not greater than the applicable value in Table 143-A, 143-B or 143-C.
8. **Relocatable public school buildings.** In complying with Sections 143(a)1 to 7, relocatable public school buildings shall comply either with Table 143-A, including the non-north window RSHG and skylight SHGC requirements, when the manufacturer/builder certifies that the relocatable building is manufactured only for use in a specific climate zone(s) and that the relocatable building cannot be lawfully used in other climate zones or with Table 143-C when the manufacturer/builder certifies that the relocatable building is manufactured for use in any climate zone. When the relocatable building complies with Table 143-C for use in more than one climate zone, the relocatable building shall meet the most stringent requirements for each building component in all of the climate zones for which the relocatable building is certified.

The manufacturer/builder shall place two metal identification labels on each relocatable building module, one mechanically fastened and visible from the exterior and the other mechanically fastened to the interior frame above the ceiling, at the end of the module. In addition to information required by the Division of the State Architect (DSA), the labels shall state either "Complies with Title 24, Part 6 for all Climate Zones" or "Complies with Title 24, Part 6 for Climate Zones" and then list all of the climate zones for which the manufacturer has manufactured the relocatable building to

TABLE 143-C
PRESCRIPTIVE ENVELOPE CRITERIA FOR RELOCATABLE PUBLIC SCHOOL BUILDINGS WHERE MANUFACTURER CERTIFIES USE IN ALL CLIMATE ZONES

		ALL CLIMATE ZONES
Roof/Ceiling U-factor		
Metal building		0.048
Wood-framed and other		0.039
Roofing products — aged reflectance/emittance		
Low-sloped		0.55/0.75
Steep-sloped — Less than 5 lb/ft^2		0.20/0.75
5 lb/ft^2 or more		0.15/0.75
Wall U-factor		
Wood frame		0.059
Metal frame		0.062
Metal building		0.057
Mass/7.0 ≤ HC		0.170
Other		0.059
Floor/Soffit U-factor		
Wood-framed and other		0.048
Windows		
U-factor		0.47
Relative solar heat gain		
0 – 10% WWR		0.36
11 – 20% WWR		0.31
21 – 30% WWR		0.26
31 – 40% WWR		0.26
Skylights		
Doors, *U*-factor	Nonswinging	0.50
	Swinging	0.70
U-factor	Glass w/curb	0.99
	Glass wo/curb	0.57
	Plastic w/curb	0.87
SHGC Glass	0 – 2%	0.46
	2.1 – 5%	0.36
SHGC Plastic	0 – 2%	0.69
	2.1 – 5%	0.57

Note: Construction assembly *U*-factors shall be calculated in accordance with Reference Joint Appendix JA4.

comply. The location of the identification labels shall be shown on the building plans.

(b) **Overall envelope TDV energy approach.** The total TDV energy of the overall envelope of the proposed building, TDV_{prop}, shall be no greater than the total TDV energy of the overall envelope of a standard building, TDV_{std}, as calculated in Reference Nonresidential Appendix NA5 "Envelope Trade-off Procedure." In making the calculations, it shall be assumed that the orientation and area of each envelope component of the standard building are the same as in the proposed building. If the proposed building has Window-Wall-Ratio greater than 40 percent or Skylight-Roof-Ratio greater than 5 percent, the area of walls and windows or roofs and skylights will be adjusted accordingly in the standard building to cap the WWR at 40 percent and SRR at 5 percent.

(c) Minimum skylight area for large enclosed spaces in buildings with three or fewer stories. In climate zones 2 through 15, low-rise conditioned or unconditioned enclosed spaces that are greater than 8,000 ft^2 directly under a roof with ceiling heights greater than 15 feet shall meet Section 143(c)1 – 4 below.

1. **Daylit area.** At least one half of the floor area shall be in the skylit daylight area, the primary sidelit daylight area or a combination of the skylit and primary sidelit daylight areas. The skylit and primary sidelit daylight areas shall be shown on the building plans. Skylit and primary sidelit daylight areas are defined in Section 131(c).
2. **Minimum skylight area or effective aperture.** Areas that are skylit shall have a minimum skylight area to skylit area ratio of at least 3.3 percent or minimum skylight effective aperture of at least 1.1 percent. Skylight effective aperture shall be determined as specified in Equation 146-C. If primary sidelit area is used to comply with Section 143(c)1, the primary sidelit daylight areas shall have an effective aperture greater than 10 percent. The effective aperture for primary sidelit daylight areas is specified in Section 146(a)2E.
3. **Skylight characteristics.** Skylights shall:
   A. Have a glazing material or diffuser that has a measured haze value greater than 90 percent, tested according to ASTM D 1003 (notwithstanding its scope) or other test method approved by the Commission; and
   B. If the space is conditioned, meet the requirements in Section 143(a)6 or 143(b).
4. **Controls.** Electric lighting in the daylit area shall be controlled as described in Section 131(c)2.

   Exception 1 to Section 143(c): Auditoriums, churches, movie theaters, museums and refrigerated warehouses.

   Exception 2 to Section 143(c): In buildings with unfinished interiors, future enclosed spaces where it is planned to have less than or equal to 8,000 square feet of floor area, or ceiling heights less than or equal to 15 feet, based on proposed future interior wall and ceiling locations as delineated in the plans. This exception shall not apply to these future enclosed spaces when interior walls and ceilings are installed for the first time, the enclosed space floor area is greater than 8,000 square feet, and the ceiling height is greater than 15 feet (see Section 149(b)1M). This exception shall not be used for S-1 or S-2 (storage), or for F-1 or F-2 (factory) occupancies.

   Exception 3 to Section 143(c): Enclosed spaces having a designed general lighting system with a lighting power density less than 0.5 watts per square foot.

SECTION 144
PRESCRIPTIVE REQUIREMENTS FOR SPACE-CONDITIONING SYSTEMS

A building complies with this section by being designed with and having constructed and installed a space-conditioning system that meets the requirements of Subsections (a) through (k).

(a) **Sizing and equipment selection.** Mechanical heating and mechanical cooling equipment shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building, as calculated according to Subsection (b).

Exception 1 to Section 144(a): Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building TDV energy use.

Exception 2 to Section 144(a): Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating.

Exception 3 to Section 144(a): Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load.

(b) **Calculations.** In making equipment sizing calculations under Subsection (a), all of the following rules shall apply:

1. **Methodology.** The methodologies, computer programs, inputs and assumptions approved by the Commission shall be used.
2. **Heating and cooling loads.** Heating and cooling system design loads shall be determined in accordance with the procedures described in the ASHRAE Handbook, Fundamentals Volume or as specified in a method approved by the Commission.
3. **Indoor design conditions.** Indoor design temperature and humidity conditions for general comfort applications shall be determined in accordance with ASHRAE Standard 55 or the ASHRAE Handbook, Fundamentals Volume, Chapter 8 except that winter humidification and summer dehumidification shall not be required.
4. **Outdoor design conditions.** Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X. Heating design temperatures shall be no lower than the Heating Winter Median of Extremes values. Cooling design temperatures shall be

no greater than the 0.5 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

Exception to Section 144(b)4: Cooling design temperatures for cooling towers shall be no greater than the 0.5 percent Cooling Design Wet bulb values.

5. **Ventilation.** Outdoor air ventilation loads shall be calculated using the ventilation rates required in Section 121.
6. **Envelope.** Envelope heating and cooling loads shall be calculated using envelope characteristics, including square footage, thermal conductance, solar heat gain coefficient or shading coefficient, and air leakage, consistent with the proposed design.
7. **Lighting.** Lighting loads shall be based on actual design lighting levels or power densities as specified in Section 146.
8. **People.** Occupant density shall be based on the expected occupancy of the building and shall be the same as determined under Section 121(b)2B, if used. Sensible and latent heat gains shall be as listed in the 2001 ASHRAE Handbook—Fundamentals, Chapter 30, Table 1.
9. **Process loads.** Loads caused by a process shall be based upon actual information on the intended use of the building.
10. **Miscellaneous equipment.** Equipment loads shall be calculated using design data compiled from one or more of the following sources:
    A. Actual information based on the intended use of the building; or
    B. Published data from manufacturer's technical publications and from technical societies, such as the ASHRAE Handbook, Applications Volume; or
    C. Other data based on the designer's experience of expected loads and occupancy patterns.
11. **Internal heat gains.** Internal heat gains may be ignored for heating load calculations.
12. **Safety factor.** Design loads may be increased by up to 10 percent to account for unexpected loads or changes in space usage.
13. **Other loads.** Loads such as warm-up or cool-down shall be calculated from principles based on the heat capacity of the building and its contents, the degree of setback, and desired recovery time; or may be assumed to be no more than 30 percent for heating and 10 percent for cooling of the steady-state design loads. The steady-state load may include a safety factor in accordance with Section 144(b)12.

(c) **Power consumption of fans.** Each fan system used for comfort space conditioning shall meet the requirements of Item 1 or 2 below, as applicable. Total fan system power demand equals the sum of the power demand of all fans in the system that are required to operate at design conditions in order to supply air from the heating or cooling source to the conditioned space, and to return it back to the source or to exhaust it to the outdoors; however, total fan system power demand need not include the additional power demand caused solely by air treatment or filtering systems with final pressure drops more than 245 pascals or 1-inch water column (only the energy accounted for by the amount of pressure drop that is over 1 inch may be excluded) or fan system power caused solely by process loads.

1. **Constant volume fan systems.** The total fan power index at design conditions of each fan system with total horsepower over 25 hp shall not exceed 0.8 watts per cubic feet per minute of supply air.
2. **Variable air volume (VAV) systems.**
    A. The total fan power index at design conditions of each fan system with total horsepower over 25 hp shall not exceed 1.25 watts per cubic feet per minute of supply air; and
    B. Individual VAV fans with motors 10 hp or larger shall meet one of the following:
        i. The fan motor shall be driven by a mechanical or electrical variable speed drive.
        ii. The fan shall be a vane-axial fan with variable pitch blades.
        iii. For prescriptive compliance, the fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume when static pressure set point equals $^1/_3$ of the total design static pressure, based on certified manufacturer's test data.
    C. Static Pressure Sensor Location. Static pressure sensors used to control variable air volume fans shall be placed in a position such that the controller set point is no greater than one-third the total design fan static pressure, except for systems with zone reset control complying with Section 144(c)2D. If this results in the sensor being located downstream of major duct splits, multiple sensors shall be installed in each major branch with fan capacity controlled to satisfy the sensor furthest below its setpoint.
    D. Setpoint Reset. For systems with direct digital control of individual zone boxes reporting to the central control panel, static pressure setpoint shall be reset based on the zone requiring the most pressure; i.e., the setpoint is reset lower until one zone damper is nearly wide open.
3. **Air-treatment or filtering systems.** For systems with air-treatment or filtering systems, calculate the adjusted fan power index using Equation 144-A:

EQUATION 144-A ADJUSTED FAN POWER INDEX

Adjusted fan power index = Fan power index × Fan adjustment

$$\text{Fan adjustment} = 1 - \left(\frac{SP_a - 1}{SP_f} \right)$$

where:

SP_a = Air pressure drop across the air-treatment or filtering system.

SP_f = Total pressure drop across the fan.

4. **Fan motors of series fan-powered terminal units.** Fan motors of series fan-powered terminal units 1 hp or less shall be electronically-commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with NEMA Standard MG 1 2006 at full load rating conditions.

(d) **Space-conditioning zone controls.** Each space-conditioning zone shall have controls that prevent:

1. Reheating; and
2. Recooling; and
3. Simultaneous provisions of heating and cooling to the same zone, such as mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by cooling equipment or by economizer systems.

Exception 1 to Section 144(d): Zones served by variable air-volume systems that are designed and controlled to reduce, to a minimum, the volume of reheated, recooled or mixed air supply are allowed only if the controls meet the following requirements:

A. For each zone with direct digital controls (DDC):

1. The volume of primary air that is reheated, recooled, or mixed air supply shall not exceed the larger of:
   a. 50 percent of the peak primary airflow; or
   b. The design zone outdoor airflow rate per Section 121.
2. The primary airflow in the deadband shall not exceed the larger of:
   a. 20 percent of the peak primary airflow; or
   b. The design zone outdoor airflow rate per Section 121.
3. Airflow between deadband and full heating or full cooling must be modulated.

B. For each zone without DDC, the volume of primary airflow that is reheated, recooled, or mixed air supply shall not exceed the larger of the following:

1. 30 percent of the peak primary airflow; or
2. The design zone outdoor airflow rate per Section 121.

Exception 2 to Section 144(d): Zones with special pressurization relationships or cross-contamination control needs.

Exception 3 to Section 144(d): Zones served by space-conditioning systems in which at least 75 percent of the energy for reheating, or providing warm air in mixing systems, is provided from a site-recovered or site-solar energy source.

Exception 4 to Section 144(d): Zones in which specific humidity levels are required to satisfy process needs.

Exception 5 to Section 144(d): Zones with a peak supply-air quantity of 300 cfm or less.

(e) **Economizers.**

1. Each individual cooling fan system that has a design supply capacity over 2,500 cfm and a total mechanical cooling capacity over 75,000 Btu/hr shall include either:

A. An air economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside air; or

B. A water economizer capable of providing 100 percent of the expected system cooling load as calculated in accordance with a method approved by the Commission, at outside air temperatures of 50°F dry-bulb/45°F wet-bulb and below.

Exception 1 to Section 144(e)1: Where it can be shown to the satisfaction of the enforcing agency that special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes compliance infeasible.

Exception 2 to Section 144(e)1: Where the use of outdoor air for cooling will affect other systems, such as humidification, dehumidification or supermarket refrigeration systems, so as to increase overall building TDV energy use.

Exception 3 to Section 144(e)1: Systems serving high-rise residential living quarters and hotel/motel guest rooms.

Exception 4 to Section 144(e)1: Where it can be shown to the satisfaction of the enforcing agency that the use of outdoor air is detrimental to equipment or materials in a space or room served by a dedicated space-conditioning system, such as a computer room or telecommunications equipment room.

Exception 5 to Section 144(e)1: Where electrically operated unitary air conditioners and heat pumps have cooling efficiencies that meet or exceed the efficiency requirements of Tables 144-A and 144-B.

2. If an economizer is required by subparagraph 1, it shall be:

A. Designed and equipped with controls so that economizer operation does not increase the building heating energy use during normal operation; and

Exception to Section 144(e)2A: Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source.

B. Capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

3. Air economizers shall have high limit shutoff controls complying with Table 144-C.

(f) **Supply air temperature reset controls.** Mechanical space-conditioning systems supplying heated or cooled air to

multiple zones shall include controls that automatically reset supply air temperatures:

1. In response to representative building loads or to outdoor air temperature; and
2. By at least 25 percent of the difference between the design supply-air temperature and the design room air temperature.

Air distribution systems serving zones that are likely to have constant loads, such as interior zones, shall be designed for the air flows resulting from the fully reset supply air temperature.

Exception 1 to Section 144(f): Systems that meet the requirements of Section 144(d), without using Exception 1 or 2 to that section.

Exception 2 to Section 144(f): Where supply-air temperature reset would increase overall building energy use.

Exception 3 to Section 144(f): Zones in which specific humidity levels are required to satisfy process needs.

(g) **Electric resistance heating.** Electric resistance heating systems shall not be used for space heating.

Exception 1 to Section 144(g): Where an electric resistance heating system supplements a heating system in which at least 60 percent of the annual energy requirement is supplied by site-solar or recovered energy.

Exception 2 to Section 144(g): Where an electric resistance heating system supplements a heat pump heating system, and the heating capacity of the heat pump is more than 75 percent of the design heating load calculated in accordance with Section 144(a) at the design outdoor temperature specified in Section 144(b)4.

Exception 3 to Section 144(g): Where the total capacity of all electric resistance heating systems serving the entire building is less than 10 percent of the total design output capacity of all heating equipment serving the entire building.

Exception 4 to Section 144(g): Where the total capacity of all electric resistance heating systems serving the building, excluding those allowed under Exception 2, is no more than 3 kW.

Exception 5 to Section 144(g): Where an electric resistance heating system serves an entire building that is not a high-rise residential or hotel/motel building; and has a conditioned floor area no greater than 5,000 square feet; and has no mechanical cooling; and is in an area where natural gas is not currently available and an extension of a natural gas system is impractical, as determined by the natural gas utility.

(h) **Heat rejection systems.**

1. **General.** Section 144(h) applies to heat rejection equipment used in comfort cooling systems, such as

TABLE 144-A
ECONOMIZER TRADE-OFF TABLE FOR ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS

CLIMATE ZONE	SIZE CATEGORY			
	> = 760,000	> = 240,000 and < 760,000	> = 135,000 and < 240,000	> = 65,000 and < 135,000
1	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A
4	11.9 (before 1/1/2010) 12.5 (as of 1/1/2010)	12.2 (before 1/1/2010) 12.9 (as of 1/1/2010)	12.4 (before 1/1/2010) 14.1 (as of 1/1/2010)	N/A
5	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A
8	11.9 (before 1/1/2010) 12.5 (as of 1/1/2010)	12.2 (before 1/1/2010) 12.9 (as of 1/1/2010)	12.4 (before 1/1/2010) 14.1 (as of 1/1/2010)	N/A
9	11.6 (before 1/1/2010) 12.2 (as of 1/1/2010)	11.9 (before 1/1/2010) 12.5 (as of 1/1/2010)	12.1 (before 1/1/2010) 13.7 (as of 1/1/2010)	N/A
10	11.4 (before 1/1/2010) 12.0 (as of 1/1/2010)	11.7 (before 1/1/2010) 12.3 (as of 1/1/2010)	11.9 (before 1/1/2010) 13.5 (as of 1/1/2010)	12.4 (before 1/1/2010) 13.5 (as of 1/1/2010)
11	11.5 (before 1/1/2010) 12.1 (as of 1/1/2010)	11.8 (before 1/1/2010) 12.4 (as of 1/1/2010)	12.0 (before 1/1/2010) 13.6 (as of 1/1/2010)	N/A
12	11.7 (before 1/1/2010) 12.3 (as of 1/1/2010)	12.0 (before 1/1/2010) 12.6 (as of 1/1/2010)	12.2 (before 1/1/2010) 13.8 (as of 1/1/2010)	N/A
13	11.2 (before 1/1/2010) 11.8 (as of 1/1/2010)	11.5 (before 1/1/2010) 12.1 (as of 1/1/2010)	11.7 (before 1/1/2010) 13.3 (as of 1/1/2010)	12.3 (before 1/1/2010) 13.4 (as of 1/1/2010)
14	11.7 (before 1/1/2010) 12.3 (as of 1/1/2010)	12.0 (before 1/1/2010) 12.6 (as of 1/1/2010)	12.2 (before 1/1/2010) 13.8 (as of 1/1/2010)	NA
15	10.0 (before 1/1/2010) 10.6 (as of 1/1/2010)	10.4 (before 1/1/2010) 11.0 (as of 1/1/2010)	10.6 (before 1/1/2010) 12.0 (as of 1/1/2010)	11.3 (before 1/1/2010) 12.3 (as of 1/1/2010)
16	N/A	N/A	N/A	N/A

air-cooled condensers, open cooling towers, closed-circuit cooling towers and evaporative condensers.

2. **Fan speed control.** Each fan powered by a motor of 7.5 hp (5.6 kW) or larger shall have the capability to operate that fan at two thirds of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

   Exception 1 to Section 144(h)2: Heat rejection devices included as an integral part of the equipment listed in Tables 112-A through 112-E.

   Exception 2 to Section 144(h)2: Condenser fans serving multiple refrigerant circuits.

   Exception 3 to Section 144(h)2: Condenser fans serving flooded condensers.

   Exception 4 to Section 144(h)2: Up to one third of the fans on a condenser or tower with multiple fans where the lead fans comply with the speed control requirement.

3. **Tower flow turndown.** Open cooling towers configured with multiple condenser water pumps shall be designed so that all cells can be run in parallel with the larger of:

   A. The flow that is produced by the smallest pump, or

   B. 33 percent of the design flow for the cell.

4. **Limitation on centrifugal fan cooling towers.** Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall use propeller fans and shall not use centrifugal fans.

   Exception 1 to Section 144(h)4: Cooling towers that are ducted (inlet or discharge) or have an external sound trap that requires external static pressure capability.

   Exception 2 to Section 144(h)4: Cooling towers that meet the energy efficiency requirement for propeller fan towers in Section 112, Table 112-G.

(i) **Limitation of air-cooled chillers.**

1. Chilled water plants with more than 300 tons total capacity shall not have more than 100 tons provided by air-cooled chillers.

   Exception 1 to Section 144(i): Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.

TABLE 144-B
ECONOMIZER TRADE-OFF TABLE FOR ELECTRICALLY OPERATED UNITARY HEAT PUMPS

CLIMATE ZONE	SIZE CATEGORY		
	> = 240,000	> = 135,000 and < 240,000	> = 65,000 and < 135,000
1	N/A	N/A	N/A
2	N/A	N/A	N/A
3	N/A	N/A	N/A
4	11.7 (before 1/1/2010) 13.8 (as of 1/1/2010)	12.1 (before 1/1/2010) 13.8 (as of 1/1/2010)	N/A
5	N/A	N/A	N/A
6	N/A	N/A	N/A
7	12.3 (before 1/1/2010) 14.5 (as of 1/1/2010)	N/A	N/A
8	11.7 (before 1/1/2010) 13.8 (as of 1/1/2010)	12.0 (before 1/1/2010) 13.7 (as of 1/1/2010)	N/A
9	11.3 (before 1/1/2010) 13.3 (as of 1/1/2010)	11.7 (before 1/1/2010) 13.3 (as of 1/1/2010)	12.5 (before 1/1/2010) 13.6 (as of 1/1/2010)
10	11.1 (before 1/1/2010) 13.1 (as of 1/1/2010)	11.5 (before 1/1/2010) 13.1 (as of 1/1/2010)	12.3 (before 1/1/2010) 13.4 (as of 1/1/2010)
11	11.3 (before 1/1/2010) 13.3 (as of 1/1/2010)	11.6 (before 1/1/2010) 13.2 (as of 1/1/2010)	12.4 (before 1/1/2010) 13.5 (as of 1/1/2010)
12	11.5 (before 1/1/2010) 13.5 (as of 1/1/2010)	11.8 (before 1/1/2010) 13.4 (as of 1/1/2010)	N/A
13	10.9 (before 1/1/2010) 12.8 (as of 1/1/2010)	11.3 (before 1/1/2010) 12.9 (as of 1/1/2010)	12.1 (before 1/1/2010) 13.2 (as of 1/1/2010)
14	11.5 (before 1/1/2010) 13.5 (as of 1/1/2010)	11.8 (before 1/1/2010) 13.4 (as of 1/1/2010)	N/A
15	9.8 (before 1/1/2010) 11.5 (as of 1/1/2010)	10.1 (before 1/1/2010) 11.5 (as of 1/1/2010)	11.1 (before 1/1/2010) 12.1 (as of 1/1/2010)
16	N/A	N/A	N/A

Exception 2 to Section 144(i): Plants that employ a cooling thermal energy storage system.

Exception 3 to Section 144(i): Air cooled chillers with minimum efficiencies approved by the Commission pursuant to Section 10-109(d).

(j) **Hydronic system measures.**

1. **Hydronic variable flow systems.** HVAC chilled and hot water pumping shall be designed for variable fluid flow and shall be capable of reducing pump flow rates to no more than the larger of: a) 50 percent or less of the design flow rate; or b) the minimum flow required by the equipment manufacturer for the proper operation of equipment served by the system.

   Exception 1 to Section 144(j)1: Systems that include no more than three control valves.

   Exception 2 to Section 144(j)1: Systems having a total pump system power less than or equal to $1^1/_2$ hp.

2. **Chiller isolation.** When a chilled water plant includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller.
3. **Boiler isolation.** When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s).
4. **Chilled and hot water temperature reset controls.** Chilled and hot water systems with a design capacity exceeding 500,000 Btu/hr supplying chilled or heated water (or both) shall include controls that automatically reset supply water temperatures as a function of representative building loads or outside air temperature.

   Exception to Section 144(j)4: Hydronic systems that use variable flow to reduce pumping energy in accordance with 144(j)1.

5. **Water-cooled air conditioner and hydronic heat pump systems.** Water circulation systems serving water-cooled air conditioners, hydronic heat pumps, or both that have total pump system power exceeding 5 hp shall have flow controls that meet the requirements of Section 144(j)6. Each air conditioner or heat pump shall have a two-position automatic valve interlocked to shut off water flow when the compressor is off.
6. **Variable flow controls.**

   A. Variable speed drives. Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp shall have controls and/or devices (such as variable speed control) that will result in pump motor demand of no more than 30 percent of design wattage at 50 percent of design water flow. The pumps shall be controlled as a function of required differential pressure. Differential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

   B. Pressure sensor location and setpoint.

      i. For systems without direct digital control of individual coils reporting to the central control panel, differential pressure shall be measured at or near the most remote heat exchanger or the heat exchanger requiring the greatest differential pressure.

      ii. For systems with direct digital control of individual coils with central control panel, the static pressure setpoint shall be reset based on the valve requiring the most pressure, and the setpoint shall be no less than 80 percent open. The pressure sensor(s) may be mounted anywhere.

   Exception 1 to Section 144(j)6: Heating hot water systems.

   Exception 2 to Section 144(j)6: Condenser water systems serving only water-cooled chillers.

TABLE 144-C
AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS

DEVICE TYPE	CLIMATE ZONES	REQUIRED HIGH LIMIT (ECONOMIZER OFF WHEN):	
		Equation	Description
Fixed dry bulb	1, 2, 3, 5, 11, 13, 14, 15 and 16	$T_{OA} > 75°F$	Outdoor air temperature exceeds 75°F
	4, 6, 7, 8, 9, 10 and 12	$T_{OA} > 70°F$	Outdoor air temperature exceeds 70°F
Differential dry bulb	All	$T_{OA} > T_{RA}$	Outdoor air temperature exceeds return air temperature
Fixed enthalpy[1]	4, 6, 7, 8, 9, 10 and 12	$H_{OA} > 28$ Btu/lb[2]	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[2]
Electronic enthalpy	All	$(T_{OA}, RH_{OA}) > A$	Outdoor air temperature/RH exceeds the "A" setpoint curve[3]
Differential enthalpy	All	$h_{OA} > h_{RA}$	Outdoor air enthalpy exceeds return air enthalpy

[1]Fixed enthalpy controls are prohibited in climate zones 1, 2, 3, 5, 11, 13, 14, 15 and 16.

[2]At altitudes substantially different than sea level, the fixed enthalpy limit value shall be set to the enthalpy value at 75°F and 50 percent relative humidity. As an example, at approximately 6000-foot elevation, the fixed enthalpy limit is approximately 30.7 Btu/lb.

[3]Setpoint "A" corresponds to a curve on the psychometric chart that goes through a point at approximately 75°F and 40 percent relative humidity and is nearly parallel to dry bulb lines at low humidity levels and nearly parallel to enthalpy lines at high humidity levels.

7. **Hydronic heat pump (WLHP) controls.** Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection and heat addition shall have controls that are capable of providing a heat pump water supply temperature dead band of at least 20°F between initiation of heat rejection and heat addition by the central devices.

   Exception to Section 144(j)7: Where a system loop temperature optimization controller is used to determine the most efficient operating temperature based on real-time conditions of demand and capacity, dead bands of less than 20°F shall be allowed.

(k) **Air distribution system duct leakage sealing.** All duct systems shall be sealed to a leakage rate not to exceed 6 percent of the fan flow if the duct system:

1. Is connected to a constant volume, single zone, air conditioners, heat pumps or furnaces, and
2. Serving less than 5,000 square feet of floor area; and
3. Having more than 25 percent duct surface area located in one or more of the following spaces:
   A. Outdoors, or
   B. In a space directly under a roof where the U-factor of the roof is greater than the U-factor of the ceiling, or

      Exception to Section 144(k)3B: Where the roof meets the requirements of Section 143(a)1C.

   C. In a space directly under a roof with fixed vents or openings to the outside or unconditioned spaces, or
   D. In an unconditioned crawlspace, or
   E. In other unconditioned spaces.

The leakage rate shall be confirmed through field verification and diagnostic testing, in accordance with procedures set forth in the Reference Nonresidential Appendix NA1.

(l) **Variable air volume control for single zone systems.** Effective January 1, 2012 all unitary air conditioning equipment and air-handling units with mechanical cooling capacity at ARI conditions greater than or equal to 110,000 Btu/hr that serve single zones shall be designed for variable supply air volume with their supply fans controlled by two-speed motors, variable speed drives or equipment that has been demonstrated to the Executive Director to use no more energy. The supply fan controls shall modulate down to a minimum of two-thirds of the full fan speed or lower at low cooling demand.

SECTION 145
PRESCRIPTIVE REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS

(a) **Nonresidential occupancies.** A service water-heating system installed in a nonresidential building complies with this section if it complies with the applicable requirements of Sections 111, 113 and 123.

(b) **High-rise residential and hotel/motel occupancies.** A service water-heating system installed in high-rise residential and hotel/motel buildings complies with this section if it meets the requirements of Section 151(f)8.

SECTION 146
PRESCRIPTIVE REQUIREMENTS FOR INDOOR LIGHTING

A building complies with this section if the actual lighting power density calculated under Subsection (a) is no greater than the allowed indoor lighting power density calculated under Subsection (c).

(a) **Calculation of actual indoor lighting power density.** The actual indoor lighting power of the proposed building area is the total watts of all planned permanent and portable lighting systems subject to the following specific requirements and adjustments under Subsections 1 through 4.

Exception to Section 146(a). Up to 0.2 watts per square foot of portable lighting for office areas shall not be required to be included in the calculation of actual indoor lighting power density.

1. **Multiple interlocked lighting systems serving a space.** When multiple interlocked lighting systems serve an auditorium, convention center, conference room, multipurpose room or theater, the watts of all systems except the system with the highest wattage may be excluded if the lighting systems are interlocked with a nonprogrammable double throw switch to prevent simultaneous operation.
2. **Reduction of wattage through controls.** The controlled watts of any luminaire may be reduced by the number of controlled watts times the applicable Power Adjustment Factor (PAF) from Table 146-C if:
   A. The control complies with the applicable requirements of Section 119; and
   B. At least 50 percent of the light output of the luminaire is within the applicable space listed in Table 146-C; and
   C. Except as noted in Table 146-C, only one PAF is used for the luminaire; and
   D. Multilevel occupant sensors used to qualify for the PAF in any space less than or equal to 250 square feet enclosed by floor-to-ceiling partitions, or any size classroom, corridor, conference or waiting room, shall meet the applicable requirements of Section 119. The multilevel occupancy sensor shall be installed to meet all the multilevel and uniformity requirements of Section 131(b) for the controlled lighting. The first stage shall activate between 30 – 70 percent of the lighting power in a room either through an automatic or manual action, and may be a switching or dimming system. After that event occurs any of the following actions shall be assigned to occur when manually called to do so by the occupant.
      i. Activating the alternate set of lights.
      ii. Activating 100 percent of the lighting power.
      iii. Deactivating all lights.
   E. For automatic daylighting control PAFs, the luminaire(s) shall be controlled by the automatic daylighting control(s) complying with applicable

requirements of Section 119 and installed according to Section 131(c)2D. The PAFs are calculated based on PAFs described below in Section 146(a)2E(i through iii), and at least 50 percent of the controlled luminaires shall be located within the daylit area. Daylight controls shall not control lamps that are outside of the daylight area (skylit, primary sidelit, and/or secondary sidelit daylight areas). The daylight area associated with the daylighting control receiving the PAF shall be shown on the building plans. PAFs shall not be available for automatic daylighting controls required by Section 131(c)2B and C.

i. **Power adjustment factor for controlling primary sidelit daylight areas:**
The PAF for the primary sidelit daylight area shall be used only if the daylighting control is separately controlling lighting within the primary sidelit daylight area. If lighting in the primary sidelit area is controlled together with lighting in the secondary sidelit area, the PAF for the secondary sidelit area in accordance with Section 146(a)2Eii shall be used. The PAF is a function of the effective aperture of the primary sidelit daylight area in accordance with Equation 146-A.

EQUATION 146-A EFFECTIVE APERTURE OF THE PRIMARY SIDELIT AREA

$$\text{Primary Sidelit Effective Aperture} = \frac{\Sigma\ \text{Window Area} \times \text{VT}}{\text{Primary Sidelit Daylight Area}}$$

where,

Window area = rough opening of windows adjacent to the sidelit area, ft^2

Window VT = visible light transmittance of window, no units

Primary sidelit daylight area = see Section 131(c)1 daylight area, primary sidelit

ii. **Power adjustment factor for controlling secondary sidelit areas:**
To qualify for the secondary sidelit daylight area PAF, the lighting in the secondary sidelit daylight area, or the lighting in the combined primary and secondary sidelit areas shall be controlled separately from lighting outside of these sidelit areas. The PAF is a function of the effective aperture of the secondary sidelit area in accordance with Equation 146-B.

EQUATION 146-B EFFECTIVE APERTURE OF THE SECONDARY SIDELIT AREA

$$\text{Secondary Sidelit Effective Aperture} = \frac{\Sigma\ \text{Window Area} \times \text{VT}}{\text{Secondary Sidelit Daylight Area} + \text{Primary Sidelit Daylight Area}}$$

where,

Window area = rough opening of windows adjacent to the sidelit area, ft^2

Window VT = visible light transmittance of window, no units

Primary sidelit daylight area = see Section 131(c)1B daylight area, primary sidelit

Secondary sidelit daylight area = see Section 131(c)1C daylight area, secondary sidelit.

iii. **Power adjustment factor for controlling skylit areas:**
The PAF is a function of the lighting power density of the general lighting in the space, and the effective aperture of the skylights shall be determined in accordance with Equation 146-C.

EQUATION 146-C EFFECTIVE APERTURE OF SKYLIGHTS

$$\text{Skylit Effective Aperture} = \frac{0.85 \times \Sigma\ \text{Skylight Area} \times \text{VT} \times \text{Well Efficiency}}{\text{Skylit Daylight Area}}$$

where,

Skylight area = the area of each individual skylight

Skylit daylight area = see Section 131(c)1D Daylight area, Skylit

VT = visible light transmittance

The VT shall include all skylighting system accessories including diffusers, louvers and other attachments that impact the diffusion of skylight into the space. The visible light transmittance of movable accessories shall be rated in the full open position. When the visible light transmittance of glazing and accessories are rated separately, the overall glazing transmittance is the product of the visible light transmittances of the glazings and accessories.

Well efficiency equals the ratio of the amount of visible light leaving a skylight well to the amount of visible light entering the skylight well. Well efficiency shall be determined from Equation 146-F or Table 146-B for specular and tubular light wells and from Table 146-A for all other light wells, based on the weighted average reflectance of the walls of the well and the geometry of the light well, or other test method approved by the Commission.

The well efficiency for nonspecular or nontubular light wells is based on the average weighted reflectance of the walls of the light well and the well cavity ratio. The well cavity ratio (WCR) is determined by the geometry of the skylight well and shall be determined using either Equation 146-D or Equation 146-E.

EQUATION 146-D WELL CAVITY RATIO FOR RECTANGULAR WELLS

$$WCR = \left(\frac{5 \times \text{well height} \left(\text{well length} + \text{well width} \right)}{\text{well length} \times \text{well width}} \right); \text{or}$$

EQUATION 146-E WELL CAVITY RATIO FOR NONRECTANGULAR-SHAPED WELLS

$$WCR = \left(\frac{2.5 \times \text{well height} \times \text{well perimeter}}{\text{well area}} \right)$$

Where the well perimeter and well area are measured at the bottom of the well.

EQUATION 146-F WELL EFFICIENCY FOR SPECULAR TUBULAR LIGHT WELLS

$$WE_{Tube} = \rho\left(2.2 * \frac{L}{D}\right)$$

where,

ρ = specular reflectance of interior light well wall
L/D = ratio of light well length to light well interior diameter

F. PAFs shall not be available for demand responsive lighting controls required by Section 131(g).

3. **Lighting wattage excluded.** The watts of the following lighting applications may be excluded from Section 146(c):

A. In theme parks: lighting for themes and special effects;

B. Studio lighting for film or photography, provided that these lighting systems are separately switched from a general lighting system;

C. Lighting for dance floors, lighting for theatrical and other live performances, and theatrical lighting used for religious worship, provided that these lighting systems are additions to a general lighting system and are separately controlled by a multiscene or the-

TABLE 146-A
WELL EFFICIENCY FOR NON-SPECULAR OR NON-TUBULAR LIGHT WELLS

	LIGHT WELL WALL REFLECTANCE					
WCR	ρ = 99%	ρ = 90%	ρ = 80%	ρ = 70%	ρ = 60%	ρ = 40%
0	1.00	1.00	1.00	1.00	1.00	1.00
1	1.00	0.98	0.96	0.94	0.92	0.89
2	0.99	0.95	0.91	0.88	0.84	0.78
4	0.99	0.90	0.82	0.76	0.70	0.61
6	0.98	0.85	0.74	0.65	0.58	0.48
8	0.97	0.79	0.66	0.56	0.49	0.38
10	0.96	0.74	0.59	0.49	0.41	0.31
12	0.95	0.70	0.53	0.43	0.35	0.26
14	0.95	0.66	0.48	0.38	0.31	0.22
16	0.94	0.62	0.44	0.34	0.27	0.18
18	0.93	0.59	0.41	0.31	0.24	0.16
20	0.92	0.56	0.38	0.28	0.21	0.14

TABLE 146-B
WELL EFFICIENCY FOR SPECULAR TUBULAR LIGHT WELLS

	Light Well Reflectance (ñ)						
L/D	ρ = 99%	ρ = 97%	ρ = 95%	ρ = 92%	ρ = 90%	ρ = 85%	ρ = 80%
0.5	0.99	0.97	0.95	0.91	0.89	0.84	0.78
1.0	0.98	0.94	0.89	0.83	0.79	0.70	0.61
1.5	0.97	0.90	0.84	0.76	0.71	0.58	0.48
2.0	0.96	0.87	0.80	0.69	0.63	0.49	0.37
2.5	0.95	0.85	0.75	0.63	0.56	0.41	0.29
3.0	0.94	0.82	0.71	0.58	0.50	0.34	0.23
3.5	0.93	0.79	0.67	0.53	0.44	0.29	0.18
4.0	0.92	0.76	0.64	0.48	0.39	0.24	0.14
4.5	0.91	0.74	0.60	0.44	0.35	0.20	0.11
5.0	0.90	0.71	0.57	0.40	0.31	0.17	0.09
5.5	0.88	0.68	0.52	0.35	0.26	0.13	0.06
6.0	0.87	0.65	0.48	0.30	0.22	0.10	0.04

atrical cross-fade control station accessible only to authorized operators;

D. In civic facilities, transportation facilities, convention centers and hotel function areas: lighting for temporary exhibits, if the lighting is in addition to a general lighting system, and is separately controlled from a panel accessible only to authorized operators;

E. Lighting installed by the manufacturer in refrigerated cases, walk-in freezers, vending machines, food preparation equipment, and scientific and industrial equipment;

F. In medical and clinical buildings, examination and surgical lights, low ambient night lights and lighting integral to medical equipment, provided that these lighting systems are additions to and separately switched from a general lighting system;

G. Lighting for plant growth or maintenance if it is controlled by a multilevel astronomical time-switch control that complies with the applicable provisions of Section 119;

H. Lighting equipment that is for sale;

I. Lighting demonstration equipment in lighting education facilities;

J. Lighting that is required for exit signs subject to the CBC. Exit signs shall meet the requirements of the Appliance Efficiency Regulations;

K. Exitway or egress illumination that is normally off and that is subject to the CBC;

L. In hotel/motel buildings, lighting in guest rooms (lighting in hotel/motel guestrooms shall comply with Section 130(b);

M. In high-rise residential buildings, lighting in dwelling units (lighting in high-rise residential dwelling units shall comply with Section 130(b);

N. Temporary lighting systems;

O. Lighting in occupancy group U buildings less than 1000 square feet;

P. Lighting in unconditioned agricultural buildings less than 2500 square feet;

Q. Lighting systems in qualified historic buildings, as defined in the *California Historical Building Code* (Title 24, Part 8), are exempt from the lighting power allowances, if they consist solely of historic lighting components or replicas of historic lighting components. If lighting systems in qualified 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 shall comply with the lighting power allowances;

R. Lighting in parking garages for seven or less vehicles shall comply with the applicable provisions of Section 150(k);

S. Lighting for signs (signs shall comply with Section 148);

T. Lighting in a videoconferencing studio: Up to 2.5 watts per square foot of lighting in a videoconferencing studio, provided the videoconferencing lighting is in addition to and separately switched from a general lighting system, all of the lighting is controlled by a multiscene programmable control system and the video conferencing studio has permanently installed videoconferencing cameras, audio equipment and playback equipment;

U. Lighting for automatic teller machines that are located inside parking garages.

4. **Luminaire power.** Luminaire power shall be determined in accordance with Section 130(d) and (e) or by a method approved by the Commission.

(b) **Indoor lighting power trade-offs.** Indoor lighting power trade-offs shall be determined as follows:

1. Allowed lighting power determined according to the Complete Building Method may be traded only within a single building. Allowed lighting power shall not be traded between two or more buildings using the Complete Building Method, provided that conditioned and unconditioned spaces shall be separate allotments, which shall be met separately without trade-offs between the separate allotments.
2. Allowed lighting power determined according to the Area Category Method may be traded between the primary function areas using the Area Category Method. provided that conditioned and unconditioned spaces shall be separate allotments, which shall be met separately without trade-offs between the separate allotments.

   Exception to Section 146(b)2: Additional lighting power allowed according to Table 146-F footnotes shall not be traded.

3. Allowed lighting power for wall display, floor display and ornamental/special effects lighting determined according to the Tailored Method shall be separate allotments without trade-offs between the separate allotments. Allowed lighting power for general illumination determined according to the Tailored Method may be traded only within the primary function areas using the Tailored Method.
4. Allowed lighting power shall not be traded between the Complete Building Method, Area Category Method or Tailored Method.

   Exception to Section 146(b)4: Allowed lighting power may be traded from primary function areas using the Area Category Method to primary function areas using the Tailored Method.

5. Trading of lighting power allowances between indoor and outdoor areas shall not be permitted.

(c) **Calculation of allowed indoor lighting power density.** The allowed indoor lighting power density for each building type of use, or each primary function area shall be calculated

using one and only one of the methods in Subsection 1, 2 or 3, as applicable.

1. **Complete Building Method.** The Complete Building Method shall be used only on projects involving entire buildings with one type of use occupancy, mixed occupancy buildings where one type of use occupancy makes up 90 percent of the entire building, or a tenant space where one type of use makes up 90 percent of the space. This approach shall only be used when the applicant is applying for a lighting permit and submits plans and specifications for the entire building or the entire tenant space. Under this approach, the allowed lighting power density is the lighting power density value in Table 146-E times the floor area of the entire building.

TABLE 146-C
LIGHTING POWER ADJUSTMENT FACTORS

TYPE OF CONTROL		TYPE OF SPACE				FACTOR
Multilevel occupant sensor (see Note 2) combined with multilevel circuitry and switching in accordance with Section 146(a)2.D		Any space ≤ 250 square feet enclosed by floor-to-ceiling partitions; any size classroom, corridor, conference or waiting room.				0.20
Multilevel occupant sensor (see Note 2) that reduces lighting power at least 50% when no persons are present. May be a switching or dimming (see Note 3) system.		Hallways of hotels/motels, multifamily, dormitory and senior housing				0.25
		Commercial and industrial storage stack areas (max. 2 aisles per sensor)				0.15
		Library stacks (maximum 2 aisles per sensor)				0.15
Dimming system	Manual	Hotels/motels, restaurants, auditoriums, theaters				0.10
	Multiscene programmable	Hotels/motels, restaurants, auditoriums, theaters				0.20
Demand responsive lighting control that reduces lighting power consumption in response to a demand response signal. (See Note 1)		All building types				0.05
Manual dimming of dimmable electronic ballasts. (see Note 3)		All building types				0.10
Demand responsive lighting control that reduces lighting power consumption in response to a demand response signal when used in combination with manual dimming of dimmable electronic ballasts (see Notes 1 and 3).		All building types				0.15
Combined controls	Multilevel occupant sensor (see Note 2) combined with multilevel circuitry and switching in accordance with Section 146(a)2.D combined with automatic multilevel daylighting controls	Any space ≤ 250 square feet within a daylit area and enclosed by floor-to-ceiling partitions, any size classroom, corridor, conference or waiting room. The PAF may be added to the daylighting control credit.				0.10
	Manual dimming of dimmable electronic ballasts (see Note 3) when used in combination with a multilevel occupant sensor (see Note 2) combined with multilevel circuitry and switching in accordance with Section 146(a)2.D.	Any space ≤ 250 square feet enclosed by floor-to-ceiling partitions; any size classroom, corridor, conference or waiting room.				0.25
Automatic multilevel daylighting controls (See Note 1)	Total primary sidelit daylight areas less than 2,500 ft^2 in an enclosed space and all secondary sidelit areas. (see Note 4)	Effective Aperture				
		General lighting power density (W/ft^2)	> 10% and ≤ 20%	> 20% and ≤ 35%	> 35% and ≤ 65%	> 65%
		All	0.12	0.20	0.25	0.30
	Total skylit daylight areas in an enclosed space less than 2,500 square feet, and where glazing material or diffuser has ASTM D1003 haze measurement greater than 90%.	Effective Aperture				
		General lighting power density (W/ft^2)	0.6% ≤ EA < 1%	1% ≤ EA < 1.4%	1.4% ≤ EA < 1.8%	1.8% ≤ EA
		LPD < 0.7	0.24	0.30	0.32	0.34
		0.7 ≤ LPD < 1.0	0.18	0.26	0.30	0.32
		1.0 ≤ LPD < 1.4	0.12	0.22	0.26	0.28
		1.4 ≤ LPD	0.08	0.20	0.24	0.28

[1]PAFs shall not be available for lighting controls required by Title 24, Part 6.

[2]To qualify for the PAF the multilevel occupant sensor shall comply with the applicable requirements of Section 119.

[3]To qualify for the PAF all dimming ballasts for T5 and T8 linear fluorescent lamps shall be electronic and shall be certified to the Commission with a minimum RSE in accordance with Table 146-D.

[4]If the primary sidelit daylight area and the secondary sidelit daylight area are controlled together, the PAF is determined based on the secondary sidelit effective aperture for both the primary sidelit daylight area and the secondary sidelit daylight area.

Retail and wholesale stores, hotel/motel and high-rise residential buildings shall not use this method.

Exception to Section 146(c)1: When using the Complete Building Method, if a parking garage and another type of use are part of a single building, the parking garage portion of the building and the remaining portion of the building shall each separately use the Complete Building Method type of use categories from Table 146-E.

2. **Area category method.** Under the Area Category Method, the total allowed lighting power for the building is the sum of all allowed lighting powers for all areas in the building. For purposes of the Area Category Method, an "area" shall be defined as all contiguous spaces which accommodate or are associated with a single one of the primary functions listed in Table 146-F. Where areas are bounded or separated by interior partitions, the floor space occupied by those interior partitions shall be included in any area. If at the time of permitting a tenant is not identified for a multitenant space, the tenant leased space allowance from Table 146-F shall be used. When the Area Category Method is used to calculate the allowed total lighting power for an entire building, main entry lobbies, corridors,

TABLE 146-D
RELATIVE SYSTEM EFFICIENCY (RSE) FOR DIMMABLE ELECTRONIC BALLASTS USED TO QUALIFY FOR POWER ADJUSTMENT FACTOR
RSE is required only for dimmable electronic ballasts for T5 and T8 fluorescent lighting systems used to qualify for a PAF according to Note 2 for Table 146-C.

	REQUIRED RELATIVE SYSTEM EFFICIENCY (RSE)			CORRESPONDING BALLAST EFFICACY FACTOR (BEF)[1]			
Lamp category	1 or 2 lamps			1 × 28W lamps	2 × 28W lamps	1 × 54W HO lamps	2 × 54W HO lamps
T5	0.85			3.03	1.51	1.57	0.78
	REQUIRED RELATIVE SYSTEM EFFICIENCY (RSE)			CORRESPONDING BALLAST EFFICACY FACTOR (BEF)[1]			
Lamp category	1 lamp	2 or 3 lamps	4 lamps	1 × 32W lamps	2 × 32W lamps	3 × 32W lamps	4 × 32W lamps
T8	0.86	0.90	0.98	2.69	1.40	0.93	0.76

[1]To calculate corresponding BEFs for lamp wattages and number of lamps not shown, use the following formula:

$$BEF = \left(\frac{RSE \times 100}{\#\,\text{lamps} \times \text{lamp watts}} \right)$$

$$RSE = \left(\frac{\text{Ballast Factor}}{\text{Ballast Input Power} \,/\, \text{Total Rated Lamp Power}} \right)$$

NOTE: Total Rated Lamp Power = number of Lamps per Ballast × Rated Lamp Power.

TABLE 146-E
COMPLETE BUILDING METHOD-LIGHTING POWER DENSITY VALUES (Watts/ft^2)

TYPE OF USE	ALLOWED LIGHTING POWER
Auditoriums	1.5
Classroom building	1.1
Commercial and industrial storage buildings	0.6
Convention Centers	1.2
Financial Institutions	1.1
General commercial and industrial work buildings High bay Low bay	1.0
Grocery stores	1.5
Library	1.3
Medical buildings and clinics	1.1
Office buildings	0.85
Parking Garages	0.3
Religious facilities	1.6
Restaurants	1.2
Schools	1.0
Theaters	1.3
All others	0.6

restrooms and support functions shall be treated as separate areas.

3. **Tailored Method.** The tailored method shall be used only on projects with primary function areas that do not use the Area Category Method.

   Under the Tailored Method, the allowed indoor lighting power shall be calculated according to primary function type as permitted in column 1 of Table 146-G.

   A. For all spaces, determine the general lighting allowance according to Section 146(c)3A.

      i. If a specific IESNA Illuminance Category is listed in Column 2 of Table 146-G, then such illuminance category shall be used. Otherwise, determine the illuminance category for each lighting primary function type according to categories specified in the IESNA Lighting Handbook (IESNA HB), using the "Design Guide" for illuminance. Tasks that are performed less than two hours a day, or poor quality tasks that can be improved shall not be employed to justify use of Illuminance Categories E, F or G.

      ii. Determine the area of each primary function.

      iii. Determine the room cavity ratio (RCR) for each primary function area. The RCR shall be calculated using either Equation 146-G or Equation 146-H.

TABLE 146-F
AREA CATEGORY METHOD-LIGHTING POWER DENSITY VALUES (watts/ft^2)

PRIMARY FUNCTION		ALLOWED LIGHTING POWER (W/ft^2)	PRIMARY FUNCTION		ALLOWED LIGHTING POWER (W/ft^2)
Auditorium		1.5[1]	Laboratory, scientific		1.4[4]
Auto repair		0.9[2]	Laundry		0.9
Beauty salon		1.7	Library	Reading areas	1.2
Civic meeting place		1.3[1]		Stacks	1.5
Classrooms, lecture, training, vocational room		1.2	Lobbies	Hotel lobby	1.1[1]
Commercial and industrial storage (conditioned & unconditioned)		0.6		Main entry lobby	1.5[1]
Commercial and industrial storage (refrigerated)		0.7	Locker/dressing room		0.8
Convention, conference, multipurpose and meeting centers		1.4[1]	Lounge/recreation		1.1
Corridors, restrooms, stairs and support areas		0.6	Malls and atria		1.2[1]
Dining		1.1[1]	Medical and clinical care		1.2
Electrical, mechanical, telephone rooms		0.7[2]	Offices	> 250 square feet	0.9
Exercise center, gymnasium		1.0		≤ 250 square feet	1.1
Exhibit, museum		2.0	Parking garage	Parking area	0.2
Financial transactions		1.2[1]		Ramps and entries	0.6
General commercial and industrial work	Low bay	0.9[2]	Religious worship		1.5[1]
	High bay	1.0[2]	Retail merchandise sales, wholesale showrooms		1.6
	Precision	1.2[3]	Tenant lease space		1.0
Grocery sales		1.6	Theaters	Motion picture	0.9[1]
Hotel function area		1.5[1]		Performance	1.4[1]
Housing, Public and Commons Areas	Multifamily, dormitory	1.0	Transportation function		1.2
	Senior Housing	1.5	Waiting area		1.1[1]
Kitchen, food preparation		1.6	All other		0.6

[1]The smallest of the following values may be added to the allowed lighting power for ornamental chandeliers and sconces that are in addition to and switched or dimmed on circuits different from the circuits for general lighting:
a. One watt per square foot times the area of the task space that the chandelier or sconce is in; or
b. The actual design wattage of the chandelier or sconce.

[2]The smallest of the following values may be added to the allowed lighting power for specialized task work:
a. 0.5 watt per square foot times the area of the task space required for an art, craft assembly or manufacturing operation; or
b. The actual design wattage of the luminaire(s) providing illuminance to the specialized task area. For spaces employing this allowance, the plans shall clearly identify all task spaces using these tasks and the lighting equipment designed to illuminate these tasks. Tasks that are performed less than two hours per day or poor quality tasks that can be improved are not eligible for this specialized task work allowance.

[3]The smallest of the following values may be added to the allowed power for precision commercial and industrial work:
a. One watt per square foot times the area of the task space required for the precision work; or
b. The actual design wattage of the luminaire(s) providing the illuminance to the precision task area. For spaces employing this allowance, the plans shall clearly identify all task spaces using these tasks and the lighting equipment designed to illuminate these tasks. Tasks that are performed less than two hours per day or poor quality tasks that can be improved are not eligible for this precision task work allowance.

[4]The smallest of the following values may be added to the allowed lighting power for specialized task work:
a. 0.2 watt per square foot times the area of the task space required for a lab in a school; or
b. The actual design wattage of the luminaire(s) providing illuminance to the specialized task area

TABLE 146-G
TAILORED METHOD SPECIAL LIGHTING POWER ALLOWANCES

PRIMARY FUNCTION	ILLUMINATION CATEGORY	WALL DISPLAY POWER (W/ft)	ALLOWED FLOOR DISPLAY POWER (W/ft^2)	ALLOWED ORNAMENTAL/SPECIAL EFFECT LIGHTING
Auditorium	D	2.25	0.3	0.5
Civic meeting place	D	3.15	0.2	0.5
Commercial and industrial storage:				
Inactive	B			
Active: bulky items; large labels	C			
Active: small items; small labels	D			
Convention, conference, multipurpose and meeting centers	D	2.5	0.4	0.5
Correction facility cells and day rooms	D	0	0	0
Dining	B	1.5	0.6	0.6
Dressing room	D	0	0	0
Education facilities				
Classrooms, lecture, training, vocational room	D	5.5	0	0
Science labs	E	5.5	0	0
Exercise center, gymnasium	IESNA HB	0	0	0
Exhibit, museum	C	20.0	1.4	0.7
Financial transactions	D	3.15	0.2	0.6
Food Service Facilities				
Butcher shop, food display, galley, kitchen, scullery	E	0	0	0
All other	C	0	0	0
Grocery store	D	9.9	1.1	0
Housing, public and commons areas:				
Multifamily	D	0	0	0.9
Dormitory, senior housing	D	0	0	0.9
Hotel function area	D	2.25	0.2	0.5
Laundry	D	0	0	0
Library (Reading areas, stacks)[1]	D	0	0	0.6
Lobbies:				
Hotel lobby	C	3.15	0.2	0.6
Main entry lobby	C	3.15	0.2	0
Locker[1]	C	0	0	0
Lounge/recreation	C	7	0	0.7
Malls and atria	D	3.5	0.5	0.6
Medical and clinical care	IESNA HB	0	0	0
Office:				
Open office; Intensive VDT use	D	0	0	0
Open office; Intermittant VDT use	E			
Private office	E			
Police or fire stations	IESNA HB	0	0	0
Public rest areas along state and federal roadways	IESNA HB	0	0	0
Religious worship	D	1.5	0.5	0.5
Retail merchandise sales, wholesale showrooms	D	17.0	1.2	0.7
Stairways and corridors; toilets and washrooms	B	0	0	0
Tenant lease space	C	0	0	0
Theaters:				
Motion picture	C	3	0	0.6
Performance	D	6	0	0.6
Transportation function	D	3.15	0.3	0.6
Waiting area	C	3.15	0.2	0.6
All other not included above	IESNA HB	0	0	0

[1]Library stacks and locker rooms may use a room cavity ratio (RCR) of > 7 in Table 146-I.

EQUATION 146-G ROOM CAVITY RATIO FOR RECTANGULAR ROOMS

$$RCR = \frac{5H(L+W)}{LW}$$

EQUATION 146-H ROOM CAVITY RATIO FOR IRREGULAR-SHAPED ROOMS

$$RCR = \frac{2.5H \times P}{A}$$

where:

L = Length of room.
W = Width of room.
H = Vertical distance from the work plane to the centerline of the lighting fixture.
P = Perimeter of room.
A = Area of room.

iv. Multiply the area of each primary function by the allowed lighting power density for the illuminance category and RCR for each primary function area according to Table 146-I. The product, or the actual installed lighting power for the primary function, whichever is less, is the Allowable General Lighting Power for the space.

B. Determine additional allowed power for display and decorative lighting according to Section 146(c)3B. Displays that are installed against a wall shall not qualify for the floor display lighting power allowances. Floor displays shall not qualify for the wall display allowances.

i. Separate wall display lighting power is permitted if allowed by column 3 of Table 146-G. The allowed wall display lighting power is the smaller of:

a. The product of the room wall lengths and the listed allowed power density watts per linear foot (W/ft) in column 3 of Table 146-G, if applicable, or

b. The actual power of wall lighting systems.

The length of display walls shall include the length of the perimeter walls, including closable openings and permanent full-height interior partitions. Permanent full-height partitions are those which extend from the floor to within 2 feet of the ceiling or are taller than 10 feet, and are permanently anchored to the floor. Commercial and industrial storage stacks are not permanent full-height partitions. For lighting mounting height of 11 feet-6 inches above the finished floor or higher, this amount may be increased by multiplying the product by the appropriate factor from Table 146-H. Qualifying wall lighting systems shall be mounted within 10 feet of the wall and shall be of a lighting system type appropriate for wall lighting including a lighting track, wallwasher, valance, cove or accent light including adjustable or fixed luminaires with PAR, R, MR, AR or other projector lamp types.

ii. Separate floor display lighting power is allowed if allowed by column 4 of Table 146-G. The allowed floor display lighting power is the smaller of:

a. The product of the area of the primary function and the allowed floor display lighting power density listed in column 4 of Table 146-G, if applicable, or

b. The actual power of floor display lighting systems.

For display lighting mounting of 11 feet-6 inches above finished floor or higher, this amount may be increased by multiplying the product by the appropriate factor from Table 146-H. Qualifying floor display lighting systems shall be mounted no closer than 2 feet to a wall and shall be a lighting system type such as track lighting, adjustable or fixed luminaires with PAR, R, MR, AR or other projector lamp types or employing optics providing directional display light from nondirectional lamps. Except for lighting that is external to display cases as defined below, lighting mounted inside of display cases shall also be considered floor display lighting.

iii. Separate ornamental/special effects lighting power is permitted if allowed by column 5 of Table 146-G. If so, the allowed ornamental/special effects lighting power is the smaller of:

a. The product of the area of the primary function and the allowed ornamental/special effects lighting power density specified in column 5 of Table 146-G, if applicable, or

b. The actual power of allowed ornamental/special effects lighting luminaires.

Qualifying ornamental luminaires include chandeliers, sconces, lanterns, neon and cold cathode, light emitting diodes, theatrical projectors, moving lights and light color panels when used in a decorative manner that does not serve as display lighting. Ornamental/special effects lighting shall not be the only light source in the space.

iv. In retail merchandise sales, museum and religious worship, the smallest of the following separate lighting power for display cases presenting very valuable display items is permitted:

a. The product of the area of the primary function and 1.0 watt per square foot; or

b. The product of the area of the display case and 16 watts per square foot, or

c. The actual power of lighting for very valuable displays.

Qualifying lighting includes internal display case lighting or external lighting employing highly directional luminaires specifically designed to illuminate the case or inspection area without spill light. To qualify for this allowance, cases shall contain jewelry, coins, fine china or crystal, precious stones, silver, small art objects and artifacts, and/or valuable collections the display of which involves customer inspection of very fine detail from outside of a locked case.

v. Only the general portion of the lighting power determined in Section 146(c)3A above shall be used for trade-offs among the various occupancy or task types of the permitted space. The allowed wall display lighting power, the allowed floor display lighting power, the allowed ornamental/special effect lighting power, and the allowed lighting power for very valuable displays are "use it or lose it" power allowances that shall not be traded off.

SECTION 147
REQUIREMENTS FOR OUTDOOR LIGHTING

This section applies to all outdoor lighting, whether attached to buildings, poles, structures or self-supporting, including but not limited to, hardscape areas including parking lots, lighting for building entrances, sales and nonsales canopies; lighting for all outdoor sales areas; and lighting for building facades.

Exceptions to Section 147: When more than 50 percent of the light from a luminaire falls on one or more of the following applications, the lighting power for that luminaire shall be exempt from Section 147(b):

1. Temporary outdoor lighting.
2. Lighting required and regulated by the Federal Aviation Administration, and the Coast Guard.
3. Lighting for public streets, roadways, highways and traffic signage lighting, including lighting for driveway entrances occurring in the public right-of-way.
4. Lighting for sports and athletic fields, and children's playgrounds.
5. Lighting for industrial sites, including but not limited to, rail yards, maritime shipyards and docks, piers and marinas, chemical and petroleum processing plants, and aviation facilities.
6. Lighting specifically for Automated teller machine as required by *California Financial Code* Section 13040, or required by law through a local ordinance.
7. Lighting of public monuments.
8. Signs shall meet the requirements of Section 148.
9. Lighting used in or around swimming pools, water features or other locations subject to Article 680 of the *California Electrical Code*.
10. Lighting of tunnels, bridges, stairs, wheelchair elevator lifts for American with Disabilities Act (ADA) compliance, and ramps that are other than parking garage ramps.
11. Landscape lighting.
12. In theme parks: outdoor lighting for themes and special effects.
13. Lighting for outdoor theatrical and other outdoor live performances, provided that these lighting systems are additions to area lighting systems and are controlled by a multiscene or theatrical cross-fade control station accessible only to authorized operators.
14. Outdoor lighting systems for qualified historic buildings, as defined in the *California Historic Building Code* (Title 24, Part 8), if they consist solely of historic

TABLE 146-H
ADJUSTMENTS FOR MOUNTING HEIGHT ABOVE FLOOR

HEIGHT IN FEET ABOVE FINISHED FLOOR AND BOTTOM OF LUMINAIRE(S)	FLOOR DISPLAY—MULTIPLY BY	WALL DISPLAY—MULTIPLY BY
11′ 6″ or less	1.0	1.0
> 11′ 6″	1.2	1.15
> 16′	1.4	1.35
> 20′	2.0	1.75

TABLE 146-I
ILLUMINANCE CATEGORIES A THROUGH G—LIGHTING POWER DENSITY VALUES (Watts/ft^2)

IESNA ILLUMINANCE CATEGORY	RCR < 3.5	3.5 < RCR < 7.0	RCR > 7.0
A	0.2	0.3	0.4
B	0.4	0.5	0.7
C	0.6	0.8	1.1
D	0.9	1.2	1.4
E	1.3	1.8	2.5
F	2.7	3.5	4.7
G	8.1	10.5	13.7

lighting components or replicas of historic lighting components. If lighting systems for 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 outdoor lighting systems for qualified historic buildings shall comply with Section 147.

(a) **Outdoor lighting power trade-offs.** Outdoor lighting power trade-offs shall be determined as follows:

1. Allowed lighting power determined according to Section 147(d)1 for general hardscape lighting allowance may be traded to specific applications in Section 147(d)2, provided the hardscape area from which the lighting power is traded continues to be illuminated in accordance with Section 147(d)1A.
2. Allowed lighting power determined according to Section 147(d)2 for additional lighting power allowances for specific applications shall not be traded between specific applications, or to hardscape lighting in Section 147(d)1.
3. Allowed lighting power determined according to Section 147(d)3 for additional lighting power allowances for local ordinance shall not be traded to specific applications in Section 147(d)2 or to hardscape areas not covered by the local ordinance.
4. Trading of lighting power allowances between outdoor and indoor areas shall not be permitted.

(b) **Outdoor lighting power.** An outdoor lighting installation complies with this section if the actual outdoor lighting power installed is no greater than the allowed outdoor lighting power calculated under Subsection (d). The allowed outdoor lighting shall be calculated by Lighting Zone as defined in Section 10-114. Local governments may amend lighting zones in compliance with Section 10-114.

(c) **Calculation of actual lighting power.** The wattage of outdoor luminaires shall be determined in accordance with Section 130(d).

(d) **Calculation of allowed lighting power.** The allowed lighting power shall be the combined total of the sum of the general hardscape lighting allowance determined in accordance with Section 147(d)1, the sum of the additional lighting power allowance for specific applications determined in accordance with Section 147(d)2, and the sum of the additional lighting power allowances for local ordinance determined in accordance with Section 147(d)3.

1. **General hardscape lighting allowance.** Determine the general hardscape lighting power allowances as follows:

   A. The general hardscape area of a site shall include parking lot(s), roadway(s), driveway(s), sidewalk(s), walkway(s), bikeway(s), plaza(s) and other improved area(s) that are illuminated. In plan view of the site, determine the illuminated hardscape area, which is defined as any hardscape area that is within a square pattern around each luminaire or pole that is ten times the luminaire mounting height with the luminaire in the middle of the pattern, less any areas that are within a building, beyond the hardscape area, beyond property lines or obstructed by a structure. The illuminated hardscape area shall include portions of planters and landscaped areas that are within the lighting application and are less than or equal to 10 feet wide in the short dimensions and are enclosed by hardscape or other improvement on at least three sides. Multiply the illuminated hardscape area by the Area Wattage Allowance (AWA) from Table 147-A for the appropriate Lighting Zone.

   B. Determine the perimeter length of the general hardscape area. The total perimeter shall not include portions of hardscape that are not illuminated according to Section 147(d)1A. Multiply the hardscape perimeter by the Linear Wattage Allowance (LWA) for hardscape from Table 147-A for the appropriate lighting zone. The perimeter length for hardscape around landscaped areas and permanent planters shall be determined as follows:

      i. Landscaped areas completely enclosed within the hardscape area, and which have width or length less than 10 feet wide, shall not be added to the hardscape perimeter length.

      ii. Landscaped areas completely enclosed within the hardscape area, and which width or length are a minimum of 10 feet wide, the perimeter of the landscaped areas or permanent planter shall be added to the hardscape perimeter length.

      iii. Landscaped edges that are not abutting the hardscape shall not be added to the hardscape perimeter length.

   C. Determine the Initial Wattage Allowance (IWA) for general hardscape lighting from Table 147-A for the appropriate lighting zone. The hardscape area shall be permitted one IWA per site.

   D. The general hardscape lighting allowance shall be the sum of the allowed watts determined from (A), (B) and (C) above.

2. **Additional lighting power allowance for specific applications.** Additional lighting power for specific applications shall be the smaller of the additional lighting allowances for specific applications determined in accordance with Table 147-B for the appropriate lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

3. **Additional lighting power allowance for local ordinance requirements.** For hardscape areas, including parking lots, site roadways, driveways, sidewalks, walkways or bikeways, when specific light levels are required by law through a local ordinance, and provided the local ordinance meets Section 10-114, additional lighting power for those hardscape areas covered by the local ordinance requirement shall be the smaller of the additional lighting allowances for local ordinance determined from Table 147-C for the appropriate

lighting zone, or the actual installed lighting power meeting the requirements for the allowance.

SECTION 148
REQUIREMENTS FOR SIGNS

This section applies to all internally illuminated and externally illuminated signs, unfiltered light emitting diodes (LEDs) and unfiltered neon, both indoor and outdoor. Each sign shall comply with either subsection (a) or (b), as applicable.

(a) **Maximum allowed lighting power.**

1. For internally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 12 watts per square foot. For double-faced signs, only the area of a single face shall be used to determine the allowed lighting power.
2. For externally illuminated signs, the maximum allowed lighting power shall not exceed the product of the illuminated sign area and 2.3 watts per square foot. Only areas of an externally lighted sign that are illuminated without obstruction or interference, by one or more luminaires, shall be used.

(b) **Alternate lighting sources.** The sign shall comply if it is equipped only with one or more of the following light sources:

1. High pressure sodium lamps; or
2. Metal halide lamps that are:
   A. Pulse start or ceramic served by a ballast that has a minimum efficiency of 88 percent or greater, or
   B. Pulse start that are 320 watts or smaller, are not 250 watt or 175 watt lamps, and are served by a ballast that has a minimum efficiency of 80 percent.

   Where ballast efficiency is the measured output wattage to the lamp divided by the measured operating input wattage when tested according to ANSI C82.6-2005; or
3. Neon or cold cathode lamps with transformer or power supply efficiency greater than or equal to the following:
   A. A minimum efficiency of 75 percent when the transformer or power supply rated output current is less than 50 mA; or
   B. A minimum efficiency of 68 percent when the transformer or power supply rated output current is 50 mA or greater.

   Where the ratio of the output wattage to the input wattage is at 100 percent tubing load; or
4. Fluorescent lamps with a minimum color rendering index (CRI) of 80; or
5. Light emitting diodes (LEDs) with a power supply having an efficiency of 80 percent or greater; or

   Exception to Section 148(b)5. Single voltage external power supplies that are designed to convert 120 volt AC input into lower voltage DC or AC output, and have a nameplate output power less than or equal to 250 watts, shall comply with the applicable requirements of the Appliance Efficiency Regulations (Title 20).
6. Compact fluorescent lamps that do not contain a medium screw base sockets (E24/E26); or
7. Electronic ballasts with a fundamental output frequency not less than 20 kHz.

Exception 1 to Section 148: Unfiltered incandescent lamps that are not part of an electronic message center (EMC), an internally illuminated sign or an externally illuminated sign.

Exception 2 to Section 148: Exit signs. Exit signs shall meet the requirements of the Appliance Efficiency Regulations.

Exception 3 to Section 148: Traffic Signs. Traffic signs shall meet the requirements of the Appliance Efficiency Regulations.

TABLE 147-A
GENERAL HARDSCAPE LIGHTING POWER ALLOWANCE

TYPE OF POWER ALLOWANCE	LIGHTING ZONE 1	LIGHTING ZONE 2	LIGHTING ZONE 3	LIGHTING ZONE 4
Area Wattage Allowance (AWA)	0.036 W/ft^2	0.045 W/ft^2	0.092 W/ft^2	0.115 W/ft^2
Linear Wattage Allowance (LWA)	0.36 W/lf	0.45 W/lf	0.92 W/lf	1.15 W/lf
Initial Wattage Allowance (IWA)	340 W	510 W	770 W	1030 W

TABLE 147-B
ADDITIONAL LIGHTING POWER ALLOWANCE FOR SPECIFIC APPLICATIONS
All area and distance measurements in plan view unless otherwise noted.

LIGHTING APPLICATION	LIGHTING ZONE 1	LIGHTING ZONE 2	LIGHTING ZONE 3	LIGHTING ZONE 4
WATTAGE ALLOWANCE PER APPLICATION. Use all that apply as appropriate.				
Building entrances or exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 feet of the door.	30 watts	75 watts	100 watts	120 watts
Primary entrances to senior care facilities, police stations, hospitals, fire stations and emergency vehicle facilities. Allowance per primary entrance(s) only. Primary entrances shall provide access for the general public and shall not be used exclusively for staff or service personnel. This allowance shall be in addition to the building entrance or exit allowance above. Luminaires qualifying for this allowance shall be within 100 feet of the primary entrance.	45 watts	80 watts	120 watts	130 watts
Drive up windows. Allowance per customer service location. Luminaires qualifying for this allowance shall be within two mounting heights of the sill of the window.	40 watts	75 watts	125 watts	200 watts
Vehicle service station uncovered fuel dispenser. Allowance per fueling dispenser. Luminaires qualifying for this allowance shall be within two mounting heights of the dispenser.	120 watts	175 watts	185 watts	330 watts
WATTAGE ALLOWANCE PER UNIT LENGTH (W/linear ft). May be used for one or two frontage side(s) per site.				
Outdoor sales frontage. Allowance for frontage immediately adjacent to the principal viewing location(s) and unobstructed for its viewing length. A corner sales lot may include two adjacent sides, provided that a different principal viewing location exists for each side. Luminaires qualifying for this allowance shall be located between the principal viewing location and the frontage outdoor sales area.	No Allowance	22.5 W/linear ft	36 W/linear ft	45 W/linear ft
WATTAGE ALLOWANCE PER HARDSCAPE AREA (W/ft^2). May be used for any illuminated hardscape area on the site.				
Hardscape ornamental lighting. Allowance for the total site illuminated hardscape area. Luminaires qualifying for this allowance shall be rated for 100 watts or less as determined in accordance with Section 130(d), and shall be post-top luminaires, lanterns, pendant luminaires or chandeliers.	No Allowance	0.02 W/ft^2	0.04 W/ft^2	0.06 W/ft^2
WATTAGE ALLOWANCE PER SPECIFIC AREA (W/ft^2). Use as appropriate, provided that none of the following specific applications shall be used for the same area.				
Building facades. Only areas of building facade that are illuminated shall qualify for this allowance. Luminaires qualifying for this allowance shall be aimed at the facade and shall be capable of illuminating it without obstruction or interference by permanent building features or other objects.	No Allowance	0.18 W/ft^2	0.35 W/ft^2	0.50 W/ft^2
Outdoor sales lots. Allowance for uncovered sales lots used exclusively for the display of vehicles or other merchandise for sale. Driveways, parking lots or other nonsales areas shall be considered hardscape areas even if these areas are completely surrounded by sales lot on all sides. Luminaires qualifying for this allowance shall be within five mounting heights of the sales lot area.	0.164 W/ft^2	0.555 W/ft^2	0.758 W/ft^2	1.285 W/ft^2
Vehicle service station hardscape. Allowance for the total illuminated hardscape area less area of buildings, under canopies, off property, or obstructed by signs or structures. Luminaires qualifying for this allowance shall be illuminating the hardscape area and shall not be within a building, below a canopy, beyond property lines or obstructed by a sign or other structure.	0.014 W/ft^2	0.155 W/ft^2	0.308 W/ft^2	0.485 W/ft^2
Vehicle service station canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	0.514 W/ft^2	1.005 W/ft^2	1.358 W/ft^2	2.285 W/ft^2
Sales canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	No Allowance	0.655 W/ft^2	0.908 W/ft^2	1.135 W/ft^2
Nonsales canopies. Allowance for the total area within the drip line of the canopy. Luminaires qualifying for this allowance shall be located under the canopy.	0.084 W/ft^2	0.205 W/ft^2	0.408 W/ft^2	0.585 W/ft^2
Guard Stations. Allowance up to 1,000 square feet per vehicle lane. Guard stations provide access to secure areas controlled by security personnel who stop and may inspect vehicles and vehicle occupants, including identification, documentation, vehicle license plates and vehicle contents. Qualifying luminaires shall be within two mounting heights of a vehicle lane or the guardhouse.	0.154 W/ft^2	0.355 W/ft^2	0.708 W/ft^2	0.985 W/ft^2
Student Pick-up/Drop-off zone. Allowance for the area of the student pick-up/drop-off zone, with or without canopy, for preschool through 12th grade school campuses. A student pick-up/drop off zone is a curbside, controlled traffic area on a school campus where students are picked-up and dropped off from vehicles. The allowed area shall be the smaller of the actual width or 25 feet, times the smaller of the actual length or 250 feet. Qualifying luminaires shall be within two mounting heights of the student pick-up/drop-off zone.	No Allowance	0.12 W/ft^2	0.45 W/ft^2	No Allowance
Outdoor dining. Allowance for the total illuminated hardscape of outdoor dining. Outdoor dining areas are hardscape areas used to serve and consume food and beverages. Qualifying luminaires shall be within two mounting heights of the hardscape area of outdoor dining.	0.014 W/ft^2	0.135 W/ft^2	0.258 W/ft^2	0.435 W/ft^2
Special security lighting for retail parking and pedestrian hardscape. This additional allowance is for illuminated retail parking and pedestrian hardscape identified as having special security needs. This allowance shall be in addition to the building entrance or exit allowance.	0.007 W/ft^2	0.009 W/ft^2	0.019 W/ft^2	No Allowance

TABLE 147-C
ADDITIONAL LIGHTING POWER ALLOWANCE FOR ORDINANCE REQUIREMENTS

ADDITIONAL LIGHTING POWER ALLOWANCE (W/ft^2) WHEN AVERAGE LIGHT LEVELS ARE REQUIRED BY LOCAL ORDINANCE				
Required (horizontal foot-candles, AVERAGE)	Lighting zone 1	Lighting zone 2	Lighting zone 3	Lighting zone 4
0.5	0	0	0	0
1.0	0.004	0	0	0
1.5	0.024	0.015	0	0
2.0	0.044	0.035	0	0
3.0	0.084	0.075	0.028	0.005
4.0 or greater	0.124	0.115	0.068	0.045
ADDITIONAL LIGHTING POWER ALLOWANCE (W/ft^2) WHEN MINIMUM LIGHT LEVELS ARE REQUIRED BY LOCAL ORDINANCE				
Required (horizontal foot-candles, MINIMUM)	Lighting zone 1	Lighting zone 2	Lighting zone 3	Lighting zone 4
0.5	0.004	0	0	0
1.0	0.044	0.035	0	0
1.5	0.124	0.115	0.068	0.045
2.0	0.164	0.155	0.108	0.085
3.0	0.164	0.155	0.108	0.085
4.0 or greater	0.164	0.155	0.108	0.085

SUBCHAPTER 6

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES—ADDITIONS, ALTERATIONS AND REPAIRS

SECTION 149
ADDITIONS, ALTERATIONS AND REPAIRS TO EXISTING BUILDINGS THAT WILL BE NONRESIDENTIAL, HIGH-RISE RESIDENTIAL AND HOTEL/MOTEL OCCUPANCIES AND TO EXISTING OUTDOOR LIGHTING FOR THESE OCCUPANCIES AND TO INTERNALLY AND EXTERNALLY ILLUMINATED SIGNS

(a) **Additions.** Additions shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The envelope and lighting of the addition, any newly installed space-conditioning or water-heating system serving the addition, any addition to an outdoor lighting system and any new sign installed in conjunction with an indoor or outdoor addition shall meet the applicable requirements of Sections 110 through 139 and Sections 142 through 148.
2. **Performance approach.**

   A. The envelope and indoor lighting in the conditioned space of the addition, and any newly installed space conditioning or water heating system serving the addition, shall meet the applicable requirements of Sections 110 through 139; and

   B. Either:

      i. The addition alone shall comply with Section 141; or

      ii. The energy use of the combination of the altered existing building plus the proposed addition shall be equal to or less than the energy use of the existing building with all alterations meeting the requirements of Section 149(b)2 plus the standard energy budget of an addition that complies with Section 141.

      Exception 1 to Section 149(a): When heating, cooling or service water heating to an addition are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110 through 129 or Sections 144 through 145.

      Exception 2 to Section 149(a): Where an existing system with electric reheat is expanded by adding variable air volume (VAV) boxes to serve an addition, total electric reheat capacity may be expanded so that the total capacity does not exceed 150 percent of the existing installed electric heating capacity in any one permit, and the system need not comply with Section 144(g). Additional electric reheat capacity in excess of 150 percent of the existing installed electric heating capacity may be added subject to the requirements of the Section 144(g).

      Exception 3 to Section 149(a): When ducts will be extended from an existing duct system to serve the addition, the ducts shall meet the requirements of Section 149(b)1D.

(b) **Alterations.** Alterations to existing nonresidential, high-rise residential or hotel/motel buildings or alterations in conjunction with a change in building occupancy to a nonresidential, high-rise residential or hotel/motel occupancy not subject to Subsection (a) shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The altered envelope, space conditioning, lighting and water heating components, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110 through 139; and

   Note: Replacement of parts of an existing luminaire, including installing a new ballast or new lamps, without replacing the entire luminaire is not an alteration subject to the requirements of Section 149(b)l.

   A. Alterations to the building envelope other than those subject to Section 149(b)1B shall comply with the applicable Subsections i through iii below:

      i. For all nonresidential, high-rise residential, and hotel/motel occupancies, when fenestration is not altered or where there are no alterations that increase the fenestration area, all altered components shall meet the requirements of Section 143(a) for the altered component.

      Exception to Section 149(b)1Ai: When either (1) less than 150 square feet of an entire building's fenestration is replaced, or (2) 50 square feet or less of fenestration area is added, compliance may be shown with Section 149(b)Ai except that the RSGC requirement of Section 143(a)5 or the solar heat gain coefficient of Section 143(a)6 is not required.

      ii. Nonresidential buildings shall not increase the Overall TDV Energy of the building envelope.

      iii. For high-rise residential and hotel/motel buildings, alterations shall meet the requirements of Sections 143(a)1 through 143(a)7.

      Exception to Section 149(b)1Aiii: Up to 150 square feet of added window area may be excepted from the requirements of Section 143(a)5, and up to 50 square feet of added skylight area may be excepted from the requirements of Section 143(a)6A. The added windows shall meet the RSHG requirements

for the 30 – 40 percent of WWR of Table 143-B, and added skylights shall meet the SHGC for the 2.1 – 5 percent area of Table 143-B.

B. Replacements, recovering or recoating of the exterior surface of existing nonresidential roofs shall meet the requirements of Section 118(i). For nonresidential buildings, high-rise residential buildings, and hotels/motels, where more than 50 percent of the roof or more than 2,000 square feet of roof, whichever is less, is being replaced, recovered or recoated, this altered roof area shall meet the applicable requirements of Subsections i through iv below.

i. Nonresidential buildings with low-sloped roofs in climate zones 2 – 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

ii. Nonresidential buildings with steep-sloped roofs in climate zones 2 – 16 with roofing product density less than 5 pounds per square foot shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16. Buildings with steep-sloped roofs in climate zones 1 – 16 with roofing product density of 5 pounds per square foot or more shall have a minimum aged solar reflectance of 0.15 and a minimum thermal emittance of 0.75, or a minimum SRI of 10.

iii. High-rise residential buildings and hotels/motels with low-sloped roofs in climate zones 10, 11, 13, 14 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 64.

iv. For nonresidential buildings,high-rise residential buildings and hotels/motels, when low-sloped roofs are exposed to the roof deck or to the recover boards, the exposed area shall be insulated to the levels specified in Table 149-A.

Exception 1 to Section 149(b)1Biv: The existing roof is insulated with at least R-7 insulation, or it has a U-factor lower than 0.089.

Exception 2 to Section 149(b)1Biv: If mechanical equipment is located on the roof, and it will not be disconnected and lifted as part of the roof replacement, insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing.

Exception 3 to Section 149(b)1Biv: If adding the required insulation will reduce the base flashing height to less than 8 inches (203 mm) at penthouse or parapet walls, the insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing, provided that the conditions in Subsections i through iv apply:

I. The penthouse or parapet walls are finished with an exterior cladding material other than the roofing covering membrane material; and

ii. The penthouse or parapet walls have exterior cladding material that must be removed to install the new roof covering membrane to maintain a base flashing height of 8 inches (203 mm); and

iii. For nonresidential buildings, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for climate zones 2 and 10 through 16, and less than 100 square feet per linear foot for climate zones 1 and 3 though 9; and

iv. For high-rise residential buildings, hotels or motels, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for all climate zones.

Exception 4 to Section 149(b)1Biv: Tapered insulation may be used which has a thermal resistance less than that prescribed in Table 149-A at the drains and other low points, provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value that is specified in Table 149-A.

Exception 1 to Section 149(b)1B: Roof recoverings allowed by the CBC are not required to meet Section 149(b)1B when all of the following occur:

1. The existing roof has a rock or gravel surface; and
2. The new roof has a rock or gravel surface; and
3. There is no removal of existing layers of roof coverings of more than 50 percent of the roof or more than 2,000 square feet of roof, whichever is less; and
4. There is no recoating with a liquid applied coating; and
5. There is no installation of a recover board, rigid insulation or other rigid, smooth substrate to separate and protect the new roof recovering from the existing roof.

Exception 2 to Section 149(b)1B: If the roofing product does not meet the requirements of Section 149(b)1B, then the Overall Envelope TDV Energy Approach of Section 143(b) may

be used, and the standard building shall be based on the higher roof/ceiling insulation value of the following;

i. For low-sloped roofs, the insulation values specified in Table 149-A

ii. For steep-sloped roofs, the insulation values specified in Section 143(a); or

iii. The existing installed insulation.

C. New space-conditioning systems or components other than new or replacement space conditioning ducts shall meet the requirements of Section 144 applicable to the systems or components being altered; and

Exception 1 to Section 149(b)1C: For expansions of existing chilled water plants. Section 144(i) applies only to expansions of more than 300 tons.

Exception 2 to Section 149(b)1C: For replacements of equivalent or lower capacity electric resistance space heaters for high rise residential apartment units.

Exception 3 to Section 149(b)1C: For replacement of electric reheat of equivalent or lower capacity electric resistance space heaters, when natural gas is not available.

D. When new or replacement space-conditioning ducts are installed to serve an existing building, the new ducts shall meet the requirements of Section 124, and if they meet the criteria of Section 144(k)1, 2 and 3, the duct system shall be sealed and labeled as confirmed through field verification and diagnostic testing in accordance with procedures for duct sealing of existing duct systems as specified in the Reference Nonresidential Appendix NA2, to meet one of the following requirements:

i. If the new ducts form an entirely new duct system directly connected to the air handler, the measured duct leakage shall be no more than 6 percent of fan flow; or

ii. If the new ducts are an extension of an existing duct system, the combined new and existing duct system shall meet one of the following requirements:

a. The measured duct leakage shall be less than 15 percent of fan flow; or

b. The duct leakage shall be reduced by more than 60 percent relative to the leakage prior to the equipment having been replaced and a visual inspection shall demonstrate that all accessible leaks have been sealed; or

c. If it is not possible to meet the duct sealing requirements of Subsection a or b, all accessible leaks shall be sealed and verified through a visual inspection by a certified HERS rater.

Exception to Section 149(b)1Dii: Existing duct systems that are extended, which are constructed insulated or sealed with asbestos.

E. When a space conditioning system is altered by the installation or replacement of space conditioning

TABLE 149-A
INSULATION REQUIREMENTS FOR ROOF ALTERATIONS

	NONRESIDENTIAL		HIGH-RISE RESIDENTIAL AND GUEST ROOMS OF HOTEL/MOTEL BUILDINGS	
CLIMATE ZONE	Continuous Insulation R-value	U-factor	Continuous Insulation R-value	U-factor
1	R-8	0.081	R-14	0.055
2	R-14	0.055	R-14	0.055
3	R-8	0.081	R-14	0.055
4	R-8	0.081	R-14	0.055
5	R-8	0.081	R-14	0.055
6	R-8	0.081	R-14	0.055
7	R-8	0.081	R-14	0.055
8	R-8	0.081	R-14	0.055
9	R-8	0.081	R-14	0.055
10	R-14	0.055	R-14	0.055
11	R-14	0.055	R-14	0.055
12	R-14	0.055	R-14	0.055
13	R-14	0.055	R-14	0.055
14	R-14	0.055	R-14	0.055
15	R-14	0.055	R-14	0.055
16	R-14	0.055	R-14	0.055

equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger).

1. Existing non-setback thermostats shall be replaced with setback thermostats for all altered units. All newly installed space conditioning systems requiring a thermostat shall be equipped with a setback thermostat. All setback thermostats shall meet the requirements of Section 112(c); and

2. The duct system that is connected to the new or replaced space conditioning equipment, if the duct system meets the criteria of Section 144(k)1, 2 and 3, shall be sealed, as confirmed through field verification and diagnostic testing in accordance with procedures for duct sealing of existing duct systems as specified in the Reference Nonresidential Appendix NA2, to one of the requirements of Section 149(b)1D.

Exception 1 to Section 149(b)1E: Buildings altered so that the duct system no longer meets the criteria of Section 144(k)1, 2 and 3.

Exception 2 to Section 149(b)1E: Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Nonresidential Appendix NA2.

Exception 3 to Section 149(b)1E: Existing duct systems constructed, insulated or sealed with asbestos.

F. Spaces with lighting systems installed for the first time shall meet the requirements of Sections 119, 130, 131, 132, 134, 143(c), 146 and 147; and

G. When the requirements of Section 131(c)2B are triggered by the addition of skylights to an existing building and the lighting system is not recircuited, the daylighting control need not meet the multilevel requirements in Section 131(c)2Diii.

H. New internally and externally illuminated signs shall meet the requirements of Sections 119, 133 and 148.

I. Alterations to existing indoor lighting systems shall meet the following requirements:

1. Alterations that increase the connected lighting load, replace, or remove and reinstall a total of 50 percent or more of the luminaires in an enclosed space shall meet the requirements of Sections 130 and 146; and

2. The following wiring alterations shall meet the requirements of Sections 119, 131 and 134:

i. Where new or moved wiring is being installed to serve added or moved luminaires; or

ii. Where conductor wiring from the panel or from a light switch to the luminaires is being replaced, or

iii. Where a lighting panel is installed or relocated.

3. For an alteration where an existing enclosed space is subdivided into two or more spaces, the new enclosed spaces shall meet the requirements of Section 131(a) and (d); and

4. Alterations that have less than 0.5 watts per square foot and increase the existing lighting power density to 0.5 watts per square foot or greater shall meet the requirements of Sections 119, 130, 131, 134, 143(c) and 146.

J. Alterations to existing outdoor lighting systems that for any lighting application increase the connected lighting load or replace more than 50 percent of the luminaires shall meet the requirements of Section 147; and

K. Alterations to existing internally and externally illuminated signs that increase the connected lighting load, replace and rewire more than 50 percent of the ballasts, or relocate the sign to a different location on the same site or on a different site shall meet the requirements of Section 148; and

Note: Replacement of parts of an existing sign, including replacing lamps, the sign face or ballasts, that do not require rewiring or that are done at a time other than when the sign is relocated, is not an alteration subject to the requirements of Section 149(b)1K.

L. New service water-heating systems shall meet the requirements of Section 145.

M. A building shell for which interior walls or ceilings are installed for the first time shall meet the requirements of Section 143(c).

2. **Performance approach.**

A. The altered envelope, space conditioning, lighting and water heating components, and any newly installed equipment serving the alteration, shall meet the applicable requirements of Sections 110 through 139; and

B. When the altered components do not meet the requirements specified in the sections that are stated in Subsections i through viii, the standard energy budget (energy budget) shall be based on the requirements stated in those sections as follows:

i. Roof/Ceiling insulation. The energy budget shall be based on the requirements of Tables 143-A, 143-B and 143-C.

ii. Roofing products. The energy budget shall be based on the requirements of Section 149(b)1B.

iii. Wall insulation. The energy budget shall be based on the requirements of Tables 143-A, 143-B and 143-C.

iv. Floor/Soffit Insulation. The energy budget shall be based on the requirements of Tables 143-A, 143-B and 143-C.

v. Fenestration. The energy budget shall be based on the U-factor and SHGC value requirements of Tables 143-A, 143-B and 143-C. The allowed glass area shall be the smaller of the Subsections a and b below:

a. The proposed glass area

b. The larger of:

1. The existing glass area; or

2. The area allowed in Section 143(a)5A.

vi. Space-Conditioning equipment and ducts. The energy budget shall be based on the requirements of Sections 149(b)1C, 149(b)1Di or Section 149(b)1Dii , and Section 149(b)1E.

vii. Service water heating systems. The energy budget shall be based on requirements of Section 145.

viii. Lighting. The energy budget shall be based on the requirements of Sections 149(b)1F and 149(b)1I.

C. When the altered components meet the requirements specified in the sections that are stated in Section 149(b)2B, Subsections i through viii, the standard energy budget shall be based on existing conditions.

NOTES TO SECTION 149(b)2:

A. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the energy budget and must meet the requirements of Section 149(b)2.

B. The proposed design shall be based on the actual values of the altered components.

C. The standard design shall assume the same geometry and orientation as the proposed design.

D. The performance approach of Section 149(b)2 may not be used when Exceptions 1 or 2 to Section 149(b)1Biv are used.

Exception 1 to Section 149(b): When heating, cooling or service water heating for an alteration are provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110 through 129 and Section 144 or 145.

Exception 2 to Section 149(b): When existing heating, cooling or service water heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110 through 129 and Section 144 or 145.

Exception 3 to Section 149(b): Where an existing system with electric reheat is expanded when adding variable air volume (VAV) boxes to serve an alteration, total electric reheat capacity may be expanded not to exceed 20 percent of the existing installed electric capacity in any one permit and the system need not comply with Section 144(g). Additional electric reheat capacity in excess of 20 percent may be added subject to the requirements of Section 144(g).

Note: Relocation or moving of a relocatable public school building is not considered an alteration for the purposes of complying with Title 24, Part 6. If an alteration is made to envelope, space conditioning, lighting or water heating components of a relocatable public school building, the alteration is subject to Section 149(b). <

(c) **Repairs.** Repairs shall not increase the preexisting energy consumption of the repaired component, system or equipment.

(d) **Alternate method of compliance.** Any addition, alteration or repair may comply with the requirements of Title 24, Part 6 by meeting the applicable requirements for the entire building.

SUBCHAPTER 7

LOW-RISE RESIDENTIAL BUILDINGS—MANDATORY FEATURES AND DEVICES

SECTION 150
MANDATORY FEATURES AND DEVICES

Any new construction in a low-rise residential building shall meet the requirements of this section.

(a) **Ceiling insulation.** The opaque portions of ceilings separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 or 2 below:

1. Ceilings shall be insulated between wood-framing members with insulation resulting in an installed thermal resistance of R-19 or greater for the insulation alone.

   Alternative to Section 150(a)1: Insulation which is not penetrated by framing members may meet an *R*-value equivalent to installing R-19 insulation between wood-framing members and accounting for the thermal effects of framing members.

2. The weighted average *U*-factor of ceilings shall not exceed the *U*-factor that would result from installing R-19 insulation between wood-framing members in the entire ceiling and accounting for the effects of framing members.

(b) **Loose-fill insulation.** When loose-fill insulation is installed, the minimum installed weight per square foot shall conform with the insulation manufacturer's installed design weight per square foot at the manufacturer's labeled *R*-value.

(c) **Wall insulation.** The opaque portions of frame walls separating conditioned spaces from unconditioned spaces or ambient air shall meet the requirements of either Item 1 or 2 below:

1. Wood-framed walls shall be insulated between framing members with insulation having an installed thermal resistance of R-13 or greater. Framed foundation walls of heated basements or heated crawl spaces shall be insulated above the adjacent outside ground line with insulation having an installed thermal resistance of at least R-13.

   Alternative to Section 150(c)1: Insulation which is not penetrated by framing members may meet an *R*-value equivalent to installing R-13 insulation between wood-framing members and accounting for the thermal effects of framing members.

2. The weighted average *U*-factor of walls shall not exceed the *U*-factor that would result from installing R-13 insulation between wood-framing members and accounting for the effects of framing members.
3. Bay window roofs and floors shall be insulated to meet the wall insulation requirements of Package D.

(d) **Raised-floor insulation.** Raised floors separating conditioned space from unconditioned space shall meet the requirements of either Item 1 or 2 below:

1. Floors shall be insulated between wood-framing members with insulation having an installed thermal resistance of R-13 or greater.
2. The weighted average *U*-factor of floor assemblies shall not exceed the *U*-factor that would result from installing R-13 insulation between wood-framing members and accounting for the effects of framing members.

   Alternative to Section 150(d)1 and 2: Raised floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in Tables 151-B, 151-C and 151-D, a vapor barrier is placed over the entire floor of the crawl space, and vents are fitted with automatically operated louvers that are temperature actuated.

(e) **Installation of fireplaces, decorative gas appliances and gas logs.**

1. If a masonry or factory-built fireplace is installed, it shall have the following:

   A. Closable metal or glass doors covering the entire opening of the firebox;

   B. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable and tight-fitting damper or combustion-air control device; and

      Exception to Section 150(e)1B: An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.

   C. A flue damper with a readily accessible control.

      Exception to Section 150(e)1C: When a gas log, log lighter or decorative gas appliance is installed in a fireplace, the flue damper shall be blocked open if required by the CMC or the manufacturer's installation instructions.

2. Continuous burning pilot lights and the use of indoor air for cooling a firebox jacket, when that indoor air is vented to the outside of the building, are prohibited.

(f) **Air retarding wrap.** If an air retarding wrap is installed to meet the compliance credit under performance approach, it shall be tested and labeled by the manufacturer to comply with ASTM E1677-95, Standard Specification for an Air Retarder (AR) Material or system for Low-Rise Framed Building Walls, and have a minimum perm rating of 10. The air-retarding wrap

shall be installed per the manufacturer's specifications that shall be provided to comply with ASTM E1677-95 (2000).

(g) **Vapor barriers.** In Climate Zones 14 and 16 shown in Figure 101-A, a vapor barrier shall be installed on the conditioned space side of all insulation in all exterior walls, unvented attics and unvented crawl spaces to protect insulation from condensation.

If a building has a control ventilation crawl space, a vapor barrier shall be placed over the earth floor of the crawl space to reduce moisture entry and protect insulation from condensation, as specified in the alternative to Section 150(d).

(h) **Space-conditioning equipment.**

1. **Building cooling and heating loads.** Building heating and cooling loads shall be determined using a method based on any one of the following:

   A. The ASHRAE Handbook, Equipment Volume, Applications Volume and Fundamentals Volume, or

   B. The SMACNA Residential Comfort System Installation Standards Manual, or

   C. The ACCA Manual J.

The cooling and heating loads are two of the criteria that shall be used for equipment sizing and selection.

Note: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC. The furnace output capacity and other specifications are published in the Commission's directory of certified equipment or other directories approved by the Commission.

2. **Design conditions.** For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 70°F for heating and 75°F for cooling. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X. The outdoor design temperatures for heating shall be no lower than the Heating Winter Median of Extremes values. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

(i) **Thermostats.** Heating systems shall be equipped with thermostats that meet the setback thermostat requirements of Section 112(c).

(j) **Water system pipe and tank insulation and cooling systems line insulation.**

1. **Storage tank insulation.**

   A. Storage gas water heaters with an energy factor equal to or less than the federal minimum standards shall be externally wrapped with insulation having an installed thermal resistance of R-12 or greater.

   B. Unfired hot water tanks, such as storage tanks and backup storage tanks for solar water-heating systems, shall be externally wrapped with insulation having an installed thermal resistance of R-12 or greater or have internal insulation of at least R-16 and a label on the exterior of the tank showing the insulation *R*-value.

2. **Water piping and cooling system line insulation thickness and conductivity.** Piping, whether buried or unburied, for recirculating sections of domestic hot water systems; piping from the heating source to the storage tank for an indirect-fired domestic water-heating system; the first 5 feet of hot and cold water pipes from the storage tank for nonrecirculating systems; and cooling system lines shall be thermally insulated as specified in Subsection A or B. Piping for steam and hydronic heating systems or hot water systems with pressure above 15 psig shall meet the requirements in Table 123-A.

   A. For insulation with conductivity in the range shown in Table 150-A for the applicable fluid temperature range, the insulation shall have the applicable thickness shown in Table 150-B.

   B. For insulating with an alternate material with conductivity outside the range shown in Table 150-A for the applicable fluid temperature range, the insulation shall have a minimum thickness as calculated by Equation 150-A.

EQUATION 150-A INSULATION THICKNESS

$$T = PR\left[\left(1+\frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$

TABLE 150-A
PIPE INSULATION CONDUCTIVITY RANGE

FLUID TEMPERATURE RANGE (°F)	INSULATION MEAN RATING TEMPERATURE (°F)	CONDUCTIVITY RANGE (Btu-inch per hour per square foot per °F)[1]
201 – 250	150	0.27 – 0.30
105 – 201	100	0.24 – 0.28
below 105	75	0.23 – 0.27

[1]Insulation conductivity shall be determined in accordance with ASTM C 335 at the mean temperature listed in Table 150-A and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F.

where:

T = Minimum insulation thickness for alternate material with conductivity K, inches.

PR = Pipe actual outside radius, inches.

t = Insulation thickness for the applicable system from Table 150-B, inches.

K = Conductivity of alternate material at the mean rating temperature indicated in Table 150-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in Table 150-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

Exception 1 to Section 150(j)2: Factory-installed piping within space-conditioning equipment certified under Section 111 or 112.

Exception 2 to Section 150(j)2: Piping that serves process loads, gas piping, cold domestic water piping, condensate drains, roof drains, vents or waste piping.

Exception 3 to Section 150(j)2: Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to assure that no contact is made with the metal framing. Insulation shall butt securely against all framing members.

Exception 4 to Section 150(j)2: Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with the Insulation Installation Quality compliance option as specified by the Residential ACM Manual.

Exception 5 to Section 150(j)2: Piping installed in attics with a minimum of 4 inches of attic insulation on top of the piping shall not be required to have pipe insulation.

Note: Where the Executive Director approves a water heater calculation method for a particular water heating recirculation system, piping insulation requirements are those specified in the approved calculation method.

3. **Insulation protection.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, including but not limited to, the following:

   A. Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

   B. Insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation (unless the insulation is inherently vapor retardant), all penetrations and joints of which shall be sealed.

4. Solar water-heating systems and/or collectors shall be certified by the Solar Rating and Certification Corporation.

(k) **Residential lighting.**

1. **High efficacy luminaires.** A high efficacy luminaire or LED Light Engine with Integral Heat Sink has an efficacy that is no lower than the efficacies contained in Table 150-C and is not a low efficacy luminaire as specified by Section 150(k)2.

   Exception 1 to Section 150(k)1: To qualify as high efficacy, a luminaire rated only for use with a high intensity discharge reflector lamp shall have a minimum lamp efficacy within 2 lumens per watt of the minimum lamp efficacies in Table 150-C.

   Exception 2 to Section 150(k)1: When a high efficacy LED Light Engine with Integral Heat Sink is combined with a low efficacy lighting system in a Hybrid LED Luminaire as defined in Section 101, the high efficacy and low efficacy lighting systems shall separately comply with the applicable provisions of Section 150(k).

TABLE 150-B
PIPE INSULATION MINIMUM THICKNESS REQUIREMENTS

SYSTEM	PIPE DIAMETER	
	Less than or equal to 2 inches	Greater than 2 inches
	INSULATION THICKNESS REQUIRED (in inches)	
Domestic hot water (above 105°F)	1.0	1.5
Hydronic heating supply lines (above 200°F to 250°F)[1]	1.0	2.0
Hydronic heating supply lines (105°F to 200°F)	1.0	1.5
Cooling systems refrigerant suction, chilled water and brine lines	0.75	1.0

[1]Steam hydronic heating systems or hot water systems with pressure above 15 psi shall meet the requirements of Table 123-A.

2. **Low efficacy luminaires. A** low efficacy luminaire is any luminaire that does not qualify as high efficacy as specified by Section 150(k)1, or any of the following regardless of the efficacy:

   A. Contains a medium screw base socket (E24/E26) or other line-voltage socket or a line-voltage lamp holder; or

      Exception 1 to Section 150(k)2A: High intensity discharge (HID) luminaires containing factory installed ballasts and HID rated medium screw base sockets shall be considered high efficacy luminaires, provided they meet the efficacies contained in Table 150-C.

   Exception 2 to Section 150(k)2A: A luminaire with a factory installed GU-24 lamp holder may be classified as high efficacy, provided that it meets all of the following requirements:

      i. Is not a recessed downlight that is rated to be used with compact fluorescent lamps; and

      ii. Does not contain any other type of line-voltage socket or lamp holder; and

      iii. The manufacturer does not make available adaptors or modular components for the luminaire which convert the GU-24 lamp holder to any other type of socket or lamp holder; and

      iv. Is rated, as specified by UL 1598, for use only with high efficacy lamps or high efficacy LED Light Engine with Integral Heat Sink meeting the requirements contained in Table 150-C, as listed on a permanent, preprinted, factory-installed label on the luminaire housing.

   B. Low-voltage incandescent lighting; or

   C. Track lighting or other lighting systems which allow the addition or relocation of luminaires without altering the wiring of the system; or

   D. Lighting systems which have modular components that allow conversion between screw-based and pin-based sockets without changing the luminaire's housing or wiring; or

   E. Electrical boxes finished with a blank cover or where no electrical equipment has been installed, and where the electrical box can be used for a luminaire or a surface mounted ceiling fan.

3. **Luminaire wattage.** The wattage of permanently installed luminaires shall be determined as specified by Section 130(d). In residential kitchens the wattage of electrical boxes finished with a blank cover or where no electrical equipment has been installed, and where the electrical box can be used for a luminaire or a surface mounted ceiling fan, shall be calculated as 180 watts of low efficacy lighting per electrical box.
4. **Electronic ballasts.** Ballasts for fluorescent lamps rated 13 watts or greater shall be electronic and shall have an output frequency no less than 20 kHz.
5. **Night lights.** Permanently installed night lights and night lights integral to a permanently installed luminaire or exhaust fan shall meet one of the following conditions:

   A. Shall contain only high efficacy lamps meeting the minimum efficacies contained in Table 150-C and shall not contain a line-voltage socket or line-voltage lamp holder; or

   B. Shall be rated to consume no more than five watts of power as determined by Section 130(d), and shall not contain a medium screw-base socket.

      Note: Indicator lights that are integral to lighting controls shall comply with Section 119(b).

TABLE 150-C
HIGH EFFICIENCY LUMINAIRE REQUIREMENTS

LAMP POWER RATING FOR NON-LED LIGHTING (see Note 1), OR SYSTEM POWER RATING FOR LED LIGHTING (see Notes 2, 3 and 4)	MINIMUM LAMP EFFICACY FOR NON-LED LIGHTING, OR MINIMUM SYSTEM EFFICACY FOR LED LIGHTING
5 watts or less	30 lumens per watt
over 5 watts to 15 watts	40 lumens per watt
over 15 watts to 40 watts	50 lumens per watt
over 40 watts	60 lumens per watt

[1]Determine minimum lamp efficacy category for lighting systems which are not LED using the initial rated lumens divided by the rated watts of the lamp (not including the ballast).

[2]To qualify as high efficacy, an LED luminaire shall meet the minimum system efficacy requirements in Table 150-C when determined according to Reference Joint Appendix JA8, and be certified to comply with Section 119(m), and input power shall be determined according to Section 130(d)5.

[3]For a Hybrid LED Luminaire to qualify as a high efficacy luminaire, all lighting systems in the luminaire shall qualify as high efficacy according to Section 150(k)1, and the LED Light Engine with Integral Heat Sink shall comply with Note 4, below.

[4]To qualify as high efficacy, an LED Light Engine with Integral Heat Sink shall meet the minimum system efficacy requirements in Table 150-C when determined according to Reference Joint Appendix JA8, shall be certified to comply with Section 119(m), and input power shall be determined according to Section 130(d)5.

6. **Lighting integral to exhaust fans.** Lighting integral to exhaust fans, in rooms other than kitchens, shall meet the applicable requirements of Section 150(k).
7. **Switching devices and controls.**
   A. All permanently installed high efficacy luminaires shall be switched separately from low efficacy luminaires.
   B. All exhaust fans shall be switched separately from lighting system(s).

      Exception to Section 150(k)7B: An exhaust fan with an integral lighting system where the lighting system can be manually turned on and off while allowing the fan to continue to operate for an extended period of time.

   C. All permanently installed luminaires shall be switched with readily accessible controls that permit the luminaires to be manually switched on and off.
   D. All lighting controls and equipment shall be installed in accordance with the manufacturer's instructions.
   E. A lighting circuit controlled by more than one switch where a dimmer or manual-on occupant sensor has been installed to comply with Section 150(k) shall meet the following conditions:
      i. No controls shall bypass the dimmer or manual-on occupant sensor function.
      ii. The dimmer or manual-on occupant sensor shall comply with the applicable requirements of Section 119.
   F. Manual-on occupant sensors, motion sensors and dimmers installed to comply with Section 150(k) shall comply with the applicable requirements of Section 119.
8. **Lighting in kitchens.** A minimum of 50 percent of the total rated wattage of permanently installed lighting in kitchens shall be high efficacy.

   Exception to Section 150(k)8: Up to 50 watts for dwelling units less than or equal to 2,500 ft^2 or 100 watts for dwelling units larger than 2,500 ft^2 may be exempt from the 50 percent high efficacy requirement when the following conditions are met:

   A. All low efficacy luminaires in the kitchen are controlled by a manual-on occupant sensor, dimmer, energy management control system (EMCS), or a multiscene programmable control system; and
   B. All permanently installed luminaires in garages, laundry rooms, closets greater than 70 square feet, and utility rooms are high efficacy and are controlled by a manual-on occupant sensor.

      Note: For the purpose of this requirement, kitchen lighting includes all permanently installed lighting in the kitchen except for lighting that is internal to cabinets for the purpose of illuminating only the inside of the cabinets. Lighting in areas adjacent to the kitchen, including but not limited to dining and nook areas, are considered kitchen lighting if they are not separately switched from kitchen lighting.

9. **Lighting internal to cabinets.** Permanently installed lighting that is internal to cabinets shall use no more than 20 watts of power per linear foot of illuminated cabinet.
10. **Lighting in bathrooms, garages, laundry rooms, closets and utility rooms.** Permanently installed luminaires in bathrooms, attached and detached garages, laundry rooms, closets and utility rooms shall be high efficacy luminaires.

    Exception 1 to Section 150(k)10: Permanently installed low efficacy luminaires shall be allowed provided that they are controlled by a manual-on occupant sensor certified to comply with the applicable requirements of Section 119.

    Exception 2 to Section 150(k)10: Permanently installed low efficacy luminaires in closets less than 70 square feet are not required to be controlled by a manual-on occupant sensor.

11. **Lighting other than in kitchens, bathrooms, garages, laundry rooms, closets and utility rooms.** Permanently installed luminaires located in rooms or areas other than in kitchens, bathrooms, garages, laundry rooms, closets and utility rooms shall be high efficacy luminaires.

    Exception 1 to Section 150(k)11: Permanently installed low efficacy luminaires shall be allowed, provided they are controlled by either a dimmer switch that complies with the applicable requirements of Section 119, or by a manual-on occupant sensor that complies with the applicable requirements of Section 119.

    Exception 2 to Section 150(k)11: Lighting in detached storage buildings less than 1,000 square feet located on a residential site is not required to comply with Section 150(k)11.

12. **Recessed luminaires in insulated ceilings.** Luminaires recessed into insulated ceilings shall meet all of the following conditions:
    A. Be listed, as defined in Section 101, for zero clearance insulation contact (IC) by Underwriters Laboratories or other nationally recognized testing/rating laboratories; and
    B. Have a label that certifies that the luminaire is airtight with air leakage less than 2.0 CFM at 75 pascals when tested in accordance with ASTM E283; and

       Exception to Section 150(k)12B: An exhaust fan housing shall not be required to be certified airtight.

    C. Be sealed with a gasket or caulk between the luminaire housing and ceiling, and shall have all air leak paths between conditioned and unconditioned spaces sealed with a gasket or caulk; and

Note: An exhaust fan shall be sealed with a gasket or caulk between the exhaust fan housing and ceiling.

D. For recessed luminaires with ballasts to qualify as high efficacy for compliance with Section 150(k), the ballasts shall be certified to the Commission to comply with Section 119(n); and

E. Allow ballast maintenance and replacement to be readily accessible to building occupants from below the ceiling without requiring the cutting of holes in the ceiling.

13. **Outdoor lighting.** Luminaires providing outdoor lighting, including outdoor lighting for private patios on low-rise residential buildings with four or more dwelling units, entrances, balconies and porches, and which are permanently mounted to a residential building or to other buildings on the same lot shall be high efficacy luminaires.

Exception 1 to Section 150(k)13: Permanently installed outdoor low efficacy luminaires shall be allowed, provided that they are controlled by a manual on/off switch, a motion sensor not having an override or bypass switch that disables the motion sensor, and one of the following methods:

A. Photocontrol not having an override or bypass switch that disables the photocontrol; or

B. Astronomical time clock not having an override or bypass switch that disables the astronomical time clock; or

C. Energy management control system (EMCS) not having an override or bypass switch that allows the luminaire to be always on.

Exception 2 to Section 150(k)13: Outdoor luminaires used to comply with Exception 1 to Section 150(k)13 may be controlled by a temporary override switch which bypasses the motion sensing function, provided that the motion sensor is automatically reactivated within 6 hours.

Exception 3 to Section 150(k)13: Permanently installed luminaires in or around swimming pools, water features or other locations subject to Article 680 of the *California Electrical Code* need not be high efficacy luminaires.

14. Internally illuminated address signs. Internally illuminated address signs shall:

A. Comply with Section 148; or

B. Not contain a screw-base socket, and consume no more than 5 watts of power as determined according to Section 130(d).

15. **Parking lots and garages.** Lighting for parking lots and carports with a total of eight or more vehicles per site shall comply with the applicable requirements in Sections 130, 132, 134 and 147. Lighting for parking garages for eight or more vehicles shall comply with the applicable requirements in Sections 130, 131, 134 and 146.

16. **Common areas of low-rise residential buildings.** Permanently installed lighting in the enclosed, nondwelling spaces of low-rise residential buildings with four or more dwelling units shall be high efficacy luminaires.

Exception to Section 150(k)16: Permanently installed low efficacy luminaires shall be allowed, provided that they are controlled by an occupant sensor(s) certified to comply with the applicable requirements of Section 119.

(l) **Slab edge insulation.** Material used for slab edge insulation shall meet the following minimum specifications:

1. Water absorption rate for the insulation material alone without facings no greater than 0.3 percent when tested in accordance with Test Method A—24-Hour-Immersion of ASTM C 272.
2. Water vapor permeance no greater than 2.0 perm/inch when tested in accordance with ASTM E 96.
3. Concrete slab perimeter insulation shall be protected from physical damage and ultraviolet light deterioration.

(m) **Air-distribution system ducts, plenums and fans.**

1. **CMC compliance.** All air-distribution system ducts and plenums, including but not limited to, mechanical closets and air-handler boxes, shall be installed, sealed and insulated to meet the requirements of the CMC Sections 601, 602, 603, 604, 605 and Standard 6-5, incorporated herein by reference. Portions of supply-air and return-air ducts and plenums shall either be insulated to a minimum installed level of R-4.2 (or any higher level required by CMC Section 605) or be enclosed entirely in conditioned space. Connections of metal ducts and the inner core of flexible ducts shall be mechanically fastened. Openings shall be sealed with mastic, tape or other duct-closure system that meets the applicable requirements of UL 181, UL181A or UL 181B or aerosol sealant that meets the requirements of UL 723. If mastic or tape is used to seal openings greater than $^1/_4$ inch, the combination of mastic and either mesh or tape shall be used.

Building cavities, support platforms for air handlers and plenums defined or constructed with materials other than sealed sheet metal, duct board or flexible duct shall not be used for conveying conditioned air. Building cavities and support platforms may contain ducts. Ducts installed in cavities and support platforms shall not be compressed to cause reductions in the cross-sectional area of the ducts.

Exception to Section 150(m)1: The requirements do not apply to ducts and fans integral to a wood heater or fireplace.

2. **Factory-fabricated duct systems.**

A. All factory-fabricated duct systems shall comply with UL 181 for ducts and closure systems, including collars, connections and splices, and be labeled as complying with UL 181. UL 181 testing may be

performed by UL laboratories or a laboratory approved by the Executive Director.

B. All pressure-sensitive tapes, heat-activated tapes and mastics used in the manufacture of rigid fiberglass ducts shall comply with UL 181 and UL 181A.

C. All pressure-sensitive tapes and mastics used with flexible ducts shall comply with UL 181 and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

3. **Field-fabricated duct systems.**

A. Factory-made rigid fiberglass and flexible ducts for field-fabricated duct systems shall comply with UL 181. All pressure-sensitive tapes, mastics, aerosol sealants or other closure systems used for installing field-fabricated duct systems shall meet the applicable requirements of UL 181, UL 181A and UL 181B.

B. **Mastic sealants and mesh.**

i. Sealants shall comply with the applicable requirements of UL 181, UL 181A and UL 18IB, and be nontoxic and water resistant.

ii. Sealants for interior applications shall be tested in accordance with ASTM C 731 and D 2202 incorporated herein by reference.

iii. Sealants for exterior applications shall be tested in accordance with ASTM C 731, C 732 and D 2202, incorporated herein by reference.

iv. Sealants and meshes shall be rated for exterior use.

C. **Pressure-sensitive tape.** Pressure-sensitive tapes shall comply with the applicable requirements of UL 181, UL 181A and UL 181B.

D. Joints and seams of duct systems and their components shall not be sealed with cloth-back rubber adhesive duct tapes unless such tape is used in combination with mastic and drawbands.

E. **Drawbands used with flexible duct.**

i. Drawbands shall be either stainless-steel worm-drive hose clamps or UV-resistant nylon duct ties.

ii. Drawbands shall have a minimum tensile strength rating of 150 pounds.

iii. Drawbands shall be tightened as recommended by the manufacturer with an adjustable tensioning tool.

F. **Aerosol-sealant closures.**

i. Aerosol sealants shall meet the requirements of UL 723, and be applied according to manufacturer specifications.

ii. Tapes or mastics used in combination with aerosol sealing shall meet the requirements of this section.

4. All duct insulation product *R*-values shall be based on insulation only (excluding air films, vapor barriers or other duct components) and tested C-values at 75°F mean temperature at the installed thickness, in accordance with ASTM C 518 or ASTM C 177, incorporated herein by reference, and certified pursuant to Section 118.

5. The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

A. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

B. For duct wrap, installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.

C. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

6. Insulated flexible duct products installed to meet this requirement shall include labels, in maximum intervals of 3 feet, showing the thermal performance *R*-value for the duct insulation itself (excluding air films, vapor barriers or other duct components), based on the tests in Section 150(m)4 and the installed thickness determined by Section 150(m)5C.

7. All fan systems, regardless of volumetric capacity, that exhaust air from the building to the outside shall be provided with backdraft or automatic dampers to prevent air leakage.

8. All gravity ventilating systems that serve conditioned space shall be provided with either automatic or readily accessible, manually operated dampers in all openings to the outside except combustion inlet and outlet air openings and elevator shaft vents.

9. **Protection of insulation.** Insulation shall be protected from damage, including that due to sunlight, moisture, equipment maintenance and wind, but not limited to the following: Insulation exposed to weather shall be suitable for outdoor service, e.g., protected by aluminum, sheet metal, painted canvas or plastic cover. Cellular foam insulation shall be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation that can cause degradation of the material.

10. **Porous inner core flex duct.** Flexible ducts having porous inner cores shall not be used.

(n) **Water heating recirculation loops serving multiple dwelling units.** Water heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 113(c)5.

(o) **Ventilation for indoor air quality.** All dwelling units shall meet the requirements of ANSI/ASHRAE Standard 62.2. Ventilation and Acceptable Indoor Air Quality in Low-Rise

Residential Buildings. Window operation is not a permissible method of providing the Whole Building Ventilation required in Section 4 of that standard.

(p) **Pool systems and equipment installation.** Any residential pool system or equipment installed shall comply with the applicable requirements of Section 114, as well as the requirements listed in this section.

1. **Pump sizing and flow rate.**
   A. All pumps and pump motors installed shall be listed in the Commission's directory of certified equipment and shall comply with the Appliance Efficiency Regulations.
   B. All pump flow rates shall be calculated using the following system equation:

   $H = C \times F^2$

   where:

   H is the total system head in feet of water.

   F is the flow rate in gallons per minute (gpm).

   C is a coefficient based on the volume of the pool:

   0.0167 for pools less than or equal to 17,000 gallons.

   0.0082 for pools greater than 17,000 gallons.

   and;

   C. Filtration pumps shall be sized, or if programmable shall be programmed, so that the filtration flow rate is not greater than the rate needed to turn over the pool water volume in 6 hours or 36 gpm, whichever is greater; and
   D. Pump motors used for filtration with a capacity of 1 hp or more shall be multispeed; and
   E. Each auxiliary pool load shall be served by either separate pumps, or the system shall be served by a multispeed pump; and

      Exception to Section 150(p)1E: Pumps if less than 1 hp may be single speed.

   F. Multispeed pumps shall have controls which default to the filtration flow rate when no auxiliary pool loads are operating; and
   G. For multispeed pumps, the controls shall default to the filtration flow rate setting within 24 hours and shall have an override capability for servicing.
2. System piping.
   A. A length of straight pipe that is greater than or equal to at least 4 pipe diameters shall be installed before the pump; and
   B. Pool piping shall be sized so that the velocity of the water at maximum flow for auxiliary pool loads does not exceed 8 feet per second in the return line and 6 feet per second in the suction line; and
   C. All elbows shall be sweep elbows or elbow-type that have a pressure drop of less than the pressure drop of straight pipe with a length of 30 pipe diameters.
3. **Filters.** Filters shall be at least the size specified in NSF/ANSI 50 for public pool intended applications.
4. **Valves.** Minimum diameter of backwash valves shall be 2 inches or the diameter of the return pipe, whichever is greater.

SUBCHAPTER 8

LOW-RISE RESIDENTIAL BUILDINGS—PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

SECTION 151
PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

(a) **Basic requirements.** New low-rise residential buildings shall meet all of the following:

1. The requirements of Sections 111 through 119 applicable to new residential buildings.
2. The requirements of Section 150 (mandatory features).
3. Either the performance standards (energy budgets) or the prescriptive standards (alternative component packages) set forth in this section for the climate zone in which the building will be located. Climate zones are shown in Figure 101-A.

   Alternative to Section 151(a)3: If a single contiguous subdivision or tract falls in more than one climate zone, all buildings in the subdivision or tract may be designed to meet the performance or prescriptive standards for the climate zone that contains 50 percent or more of the dwelling units.

   Note: The Commission periodically updates, publishes and makes available to interested persons and local building departments precise descriptions of the metes and bounds for climate zone boundaries depicted in Figure 101-A and a list of the communities in each zone.

4. For other provisions applicable to new low-rise residential buildings, refer to Section 100.

(b) **Performance standards.** A building complies with the performance standard if the combined depletable TDV energy use for water heating Section 151(b)1 and space conditioning Section 151(b)2 is less than or equal to the combined maximum allowable TDV energy use for both water heating and space conditioning, even if the building fails to meet either the water heating or space conditioning budget alone.

1. **Water-heating budgets.** The water heating budgets for each climate zone shall be the calculated consumption of energy from depletable sources required for water heating in buildings in which the requirements of Section 151(a) and of Section 151(f)8A for systems serving individual dwelling units or of Section 151(f)8C for systems serving multiple dwelling units are met. To determine the water heating budget, use an approved calculation method.
2. **Space-conditioning budgets.** The space-conditioning budgets for each climate zone shall be the calculated consumption of energy from depletable sources required for space conditioning in buildings in which the basic requirements of Section 151(a) and the measures in Section 151(f) applicable to Alternative Component Package D are installed. To determine the space-conditioning budget, use an approved calculation method.
3. **Multiple heating systems.** If a space or a zone is served by more than one heating system, compliance shall be demonstrated with the most TDV energy consuming system serving the space or the zone. For spaces or zones that are served by electric resistance heat in addition to other heating systems, the electric resistance heat shall be deemed to be the most TDV energy consuming system.

   Exception to Section 151(b)3: A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed 2 kilowatts or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.

(c) **Compliance demonstration requirements for performance standards.** The application for a building permit shall include documentation which demonstrates, using an approved calculation method, that the newly constructed building has been designed so that its TDV energy use from depletable energy sources does not exceed the combined water-heating and space-conditioning energy budgets for the appropriate climate zone.

1. To demonstrate compliance, the applicant's documentation shall:

   A. Determine the combined energy budget for the proposed building by adding the following:

      i. The annual water-heating budget (TDV kBtu/yr-ft^2) as determined pursuant to Section 151(b)1 and

      ii. The annual space-conditioning budget (TDV kBtu/ yr-ft^2) as determined pursuant to Section 151(b)2.

   B. Calculate the TDV energy consumption total of the proposed building, using the proposed building's actual glazing area, orientation and distribution, and its actual energy conservation and other features, including the actual water-heating, space-conditioning equipment and duct conditions and locations.

      Include in the calculation the energy required for building cooling even if the building plans do not indicate that air conditioning will be installed.

2. The proposed building design complies if the energy consumption calculated pursuant to Section 151(c)1B is equal to or less than the combined energy budget established in Section 151(c)1A.

   Multiple orientation alternative to Section 151(c): A permit applicant may demonstrate compliance with the energy budget requirements of Section 151(a) and

(b) for any orientation of the same building model if the documentation demonstrates that the building model with its proposed designs and features would comply in each of the four cardinal orientations.

(d) **Compliance methods for performance standards.** Compliance with the energy budget requirements of Section 151(b) must be demonstrated by using the compliance version of the Commission's Public Domain Computer Program or any alternative calculation method approved by the Commission for use in complying with Section 151(a), (b), (c) and (e).

(e) **Required calculation assumptions.** The Commission shall publish the assumptions and calculation methods it used to develop the standards for low-rise residential buildings, including those specified in Section 151. In determining the water-heating and space-conditioning budgets and calculating the energy use of the proposed building design, the applicant shall use only these assumptions and calculation methods or alternative assumptions and methods approved by the Commission.

1. Such assumptions shall include, but not be limited to, the following:
   A. The operating conditions regarding indoor temperature; occupancy loads and schedules; equipment loads and operation schedules, including lighting, HVAC and miscellaneous electrical; and outdoor weather conditions.
   B. The physical characteristics of building pressurization, interior heat transfer, film coefficients, solar heat gain coefficient and operation of installed shading devices, ground temperatures and the method of determining slab heat loss.
   C. The applicable modeling procedures for the assumptions, design conditions and physical characteristics described in Section 151(e)1.
   D. Water heating use schedules, cold water inlet temperatures and average outdoor temperatures for calculating water heating loads and losses.

      Exception to Section 151(e)1: The Commission may approve alternative schedules, assumptions and performance modeling procedures that may be used in lieu of those described in Section 151(e)1, provided such alternatives do not alter the efficiency level required by these standards.
2. The total calculated annual energy consumption shall include all energy used for comfort heating, comfort cooling, ventilation for the health and comfort of occupants, and service water heating.
3. Heat tranfers within the same building to adjacent spaces that are not covered by the permit and that are independently provided with space conditioning may be considered to be zero. Heat transfers to spaces not yet provided with space conditioning may be modeled as separate unconditioned zones, or as outdoor conditions.
4. The total calculated annual energy consumption need not include energy from any nondepletable sources, regardless of the purpose of the energy consumed.
5. Solar heat gain coefficients for interior shading devices used with fenestration products shall be 0.68 for vertical fenestration products and 1.0 for nonvertical fenestration products. No other solar heat gain coefficients shall be used for interior shading. The calculations for vertical fenestration products include the effects of draperies and insect screens without installation being verified at the time of final inspection.

(f) **Prescriptive standards/component packages.** Buildings that comply with the prescriptive standards shall be designed, constructed and equipped to meet all of the requirements of one of the packages of components shown in Table 151-B, 151-C or Table 151-D for the appropriate climate zone shown in Figure 101-A. In Tables 151-B, 151-C and 151-D, a NA (not allowed) means that feature is not allowed in a particular climate zone and a NR (no requirement) means that there is no prescriptive requirement for that feature in a particular climate zone. Installed components shall meet the following requirements:

1. **Insulation.**
   A. Ceiling, wall, slab floor perimeter and raised-floor insulation which have an *R*-value equal to or higher than that shown in Table 151-B, 151-C or 151-D shall be installed. The minimum opaque ceiling, wall (including heated basements and crawl spaces) and raised-floor *R*-values shown are for insulation installed between wood-framing members.

      Alternative to Section 151(f)1A: The insulation requirements of Table 151-B, 151-C or 151-D may also be met by ceiling, wall or floor assemblies that meet equivalent minimum *R*-values that consider the effects of all elements of the assembly, using a calculation method approved by the Executive Director.

      Exception to Section 151(f)1A: Raised-floor insulation may be omitted if the foundation walls are insulated to meet the wall insulation minimums shown in Table 151-B, 151-C or 151-D, a vapor barrier is placed over the entire floor of the crawl space and the vents are fitted with automatically operated louvers.
   B. The minimum depth of concrete-slab floor perimeter insulation shall be 16 inches or the depth of the footing of the building, whichever is less.

      Exception to Section 151(f)1B: Perimeter insulation is not required along the slab edge between conditioned space and the concrete slab of an attached unconditioned enclosed space, covered porches or covered patios.
2. **Radiant barrier.** A radiant barrier required in Table 151-B, 151-C or 151-D shall have an emittance of 0.05 or less, tested in accordance with ASTM C 1371 or ASTM E 408, shall be certified to the Department of Consumer Affairs as required by Title 24, Part 12, Chapter 12-13, Standards for Insulating Material, and shall meet the installation criteria specified in the Reference Residential Appendix RA4.

3. **Fenestration.**

   A. Installed fenestration products shall have an area weighted average *U*-factor equal to or lower than those shown in Table 151-B, 151-C or 151-D. The *U*-factor of installed fenestration products shall be determined in accordance with Section 116.

      Exception to Section 151(f)3A: For each building, up to 3 square feet of the glazing installed indoors and up to 2 square foot of tubular skylights with dual-pane diffusers.

   B. Total fenestration area shall not exceed the percentage of conditioned floor area specified in Table 151-B, 151-C or 151-D.

   C. For Package D, the west-facing fenestration area shall not exceed the percentage of conditioned floor area specified in Table 151-B, 151-C or 151-D. West-facing fenestration area includes skylights tilted to the west or tilted in any direction when the pitch is less than 1:12.

4. **Shading.** Where Table 151-B, 151-C or 151-D requires a solar heat gain coefficient (SHGC), the requirements shall be met by either:

   A. Installing fenestration products, except for skylights, that have an area weighted average SHGC equal to or lower than those shown in Table 151-B, 151-C or 151-D. Skylights shall have an SHGC equal to or lower than those shown in Table 151-B, 151-C or 151-D. The solar heat gain coefficient of installed fenestration products shall be determined in accordance with Section 116; or

   B. An exterior operable louver or other exterior shading device that meets the required solar heat gain coefficient; or

   C. A combination of exterior shading device and fenestration product to achieve the same performance as achieved in Item A.

   D. For south-facing glazing by optimal overhangs installed so that the south-facing glazing is fully shaded at solar noon on August 21 and substantially exposed to direct sunlight at solar noon on December 21.

      Except where the CBC requires emergency egress, exterior shading devices must be permanently attached to the outside of the structure with fasteners that require additional tools to remove (as opposed to clips, hooks, latches, snaps or ties).

5. **Thermal mass.** Thermal mass required for Package C in Table 151-B shall meet or exceed the minimum interior mass capacity specified in Table 151-A.

   The mass requirements in Table 151-A may be met by calculating the combined interior mass capacity of the mass materials using Equation 151-A.

EQUATION 151-A CALCULATION OF INTERIOR MASS CAPACITY

$$IMC = [(A_1 \times UIMC_1) + (A_2 \times UIMC_2) + \ldots + (A_n \times UIMC_n)]$$

where:

A_n = area of mass material, *n*.

$UIMC_n$ = unit interior mass capacity of mass material, *n*.

Note: The Commission's Residential Compliance Manual lists the unit interior mass capacity (UIMC) of various mass materials.

6. **Heating system type.** Heating system types shall be installed as required in Table 151-B, 151-C or 151-D. A gas-heating system is a natural or liquefied petroleum gas-heating system.

7. **Space heating and space cooling.** All space heating and space cooling equipment shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110 through 112 and meet the requirements of Subsections A and B:

   A. When refrigerant charge measurement or charge indicator display is shown as required by Table 151-B, 151-C or 151-D, ducted split system central air conditioners and ducted split system heat pumps shall:

      i. Have temperature measurement access holes (TMAH), saturation temperature measurement sensors (STMS), and proper refrigerant charge confirmed through field verification and diagnostic testing in accordance with procedures set forth in the Reference Residential Appendix RA3.2; or

      ii. Be equipped with a charge indicator display (CID) clearly visible to the occupant. The display shall demand attention when the air conditioner fails to meet the requirements contained in Reference Joint Appendix JA6.2. The display shall be constantly visible and within one foot of the thermostat. The Systems equipped with a CID shall meet the requirements of Residential Field Verification and Diagnostic Test Procedures of Reference Residential Appendix RA3.4 and the specifications of Reference Joint Appendix JA6.

   B. When airflow and fan watt draw is shown as required by Table 151-B, 151-C or 151-D, ducted split system central air conditioners and ducted split system heat pumps shall:

      i. Central forced air system fans shall simultaneously demonstrate, in every zonal control mode, an airflow greater than 350 CFM/ton of nominal cooling capacity and a fan watt draw less than 0.58 W/CFM as specified in Reference Residential Appendix RA3; and

      ii. Have a hole for the placement of a static pressure probe (HSPP) or a permanently installed static pressure probe (PSPP) in the supply plenum downstream of the air conditioning evaporator coil. The size, location and labeling shall meet the requirements specified in Reference Residential Appendix RA3.3.

TABLE 151-A
INTERIOR MASS CAPACITY REQUIREMENTS FOR PACKAGE C

FLOOR TYPE	MINIMUM INTERIOR MASS CAPACITY
slab floor	2.36 × ground floor area (ft^2)
raised floor	0.18 × ground floor area (ft^2)

8. **Domestic water-heating systems.** Water heating systems shall meet the requirements of either A, B or C and meet the requirements of D and E or shall meet the requirements of Section 151(b)1.
   A. For systems serving individual dwelling units, a single gas or propane storage type water heater with an input of 75,000 Btu per hour or less and no recirculation pumps, and that meets the tank insulation requirements of Section 150(j) and the requirements of Sections 111 and 113 shall be installed.
   B. For systems serving individual dwelling units, a single gas or propane instantaneous water heater with an input of 75,000 Btu per hour or less and no recirculation pumps or storage tank, and that meets the requirements of Sections 111 and 113 shall be installed.
   C. For systems serving multiple dwelling units, a central water heating system that has gas or propane water heaters, boilers or other water heating equipment that meet the minimum efficiency requirements of Sections 111 and 113 and a water heating recirculation loop that meets the requirements of Section 113(c)2 and Section 113(c)5 shall be installed.
   D. All hot water pipes from the heating source to the kitchen fixtures shall be thermally insulated as specified by Section 150(j)2.
   E. All buried hot water piping shall be insulated to meet the requirements of Section 150(j)2 and be installed in a waterproof and noncrushable casing or sleeve that allows for installation, removal and replacement of the enclosed water piping. The internal cross-section or diameter of the casing or sleeve shall be large enough to allow for insulation of the hot water piping.
9. **Thermostats.** Heating systems shall be equipped with thermostats that meet the setback thermostat requirements of Section 112(c). The Exception 1 to Section 112(c) shall not apply to any heating system installed in conjunction with Tables 151-B, 151-C or 151-D.
10. **Space-conditioning ducts.** All ducts shall either be in conditioned space or be insulated to a minimum installed level as specified by Table 151-B, 151-C or 151-D and meet the minimum mandatory requirements of Section 150(m).

When duct sealing is shown as required by Table 151-B, 151-C or 151-D, duct systems shall be sealed, as confirmed through field verification and diagnostic testing, in accordance with procedures specified in the Reference Residential Appendix RA3.

Note: Requirements for duct sealing and duct insulation in Tables 151-B, 151-C and 151-D do not apply to buildings with space conditioning systems that have no ducts.

11. **Central fan integrated ventilation systems.** Central forced air system fans used in central fan integrated ventilation systems shall demonstrate, in Air Distribution Mode, a watt draw less than 0.58 W/CFM.
12. **Roofing Products.** All roofing products shall meet the requirements of Section 118 and the applicable requirements of Subsection A or B:
   A. In low-rise residential buildings with steep-sloped roofs:
      i. For roofing products with a density of less than five pounds per square foot, in climate zones 10 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.
      ii. For roofing products with a density of 5 pounds per square foot or more, in climate zones 1 through 16 shall have a minimum aged solar reflectance of 0.15 and a minimum thermal emittance of 0.75, or a minimum SRI of 10.
   B. Low-rise residential buildings with low-sloped roofs, in climate zones 13 and 15 shall have a minimum aged solar reflectance of 0.55 and a minimum thermal emittance of 0.75, or a minimum SRI of 0.64.

      Exception 1 to Section 151(f)12: Building integrated photovoltaic panels and building integrated solar thermal panels are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

      Exception 2 to Section 151(f)12: Roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft^2 are exempt from the minimum requirements for solar reflectance and thermal emittance or SRI.

TABLE 151-B
COMPONENT PACKAGE C

CLIMATE ZONE	1, 16	3	4	5	6	7	8, 9	10	2, 11-13	14	15
BUILDING ENVELOPE Insulation minimums[1]											
Ceiling	R49	R38	R38	R38	R38	R38	R38	R49	R49	R49	R49
Wood-frame walls	R29	R25	R25	R25	R21	R21	R21	R25	R29	R29	R29
"Heavy mass" walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
"Light mass" walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Below-grade walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slab floor perimeter	R7	R7	R7	R7	R7	R7	R7	R7	R7	R7	R7
Raised floors	R30	R30	R30	R30	R21	R21	R21	R30	R30	R30	R21
Concrete raised floors	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radiant Barrier	NR	NR	REQ	NR	NR	NR	REQ	REQ	REQ	REQ	REQ
Roofing Products	See TABLE 151-C, COMPONENT PACKAGE D										
FENESTRATION											
Maximum *U*-factor[2]	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Maximum Solar Heat Gain Coefficient (SHGC)[3]	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Maximum total area	14%	14%	14%	16%	14%	14%	14%	16%	16%	14%	16%
Maximum west facing area	NR	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%
THERMAL MASS[4]	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
SPACE-HEATING[5]											
Electric-resistant allowed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
If gas, AFUE =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
If heat pump, HSPF[6] =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
SPACE-COOLING											
SEER =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
If split system	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ
Refrigerant charge measurement or charge indicator display											
Central Forced Air Handler	See TABLE 151-C, COMPONENT PACKAGE D										
DUCTS											
Duct sealing	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Duct insulation	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
WATER-HEATING	System shall meet Section 151(f)8 or Section 151(f)b1[7]										

FOOTNOTES TO TABLES 151-B AND 151-C APPEAR ON PAGE 102.

TABLE 151-C
COMPONENT PACKAGE D

			CLIMATE ZONES															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Insulation minimums[1]	Ceilings		R38	R30	R30	R30	R30	R30	R30	R30	R30	R30	R38	R38	R38	R38	R38	R38
	Walls	Wood-frame walls	R21	R13	R13	R13	R13	R13	R13	R13	R13	R13	R19	R19	R19	R21	R21	R21
		Heavy mass walls	(R4.76)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R4.76)	(R4.76)	(R4.76)	(R4.76)	(R4.76)	(R4.76)
		Light mass walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Below-grade walls	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R13
	Floors	Slab floor perim.	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R7
		Raised floors	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19
		Concrete raised floors	R8	R8	R0	R0	R0	R0	R0	R0	R0	R0	R8	R4	R8	R8	R4	R8
Radiant barrier			NR	REQ	NR	REQ	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Roofing products	Low-sloped	Aged solar reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.55	NR	0.55	NR
		Thermal emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
	Steep sloped (less than 5 lb/ft^2)	Aged solar reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
		Thermal emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
	Steep sloped (5 lb/ft^2 or more)	Aged solar reflectance	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Thermal emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Fenestration	Maximum U-factor[2]		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
	Maximum Solar Heat Gain Coefficient (SHGC)[3]		NR	0.40	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.35	NR
	Maximum total area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Maximum west facing area		NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR
Thermal mass[4]			NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Space-heating[5,10]	Electric-resistant allowed		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	If gas, AFUE =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	If heat pump, HSPF[6] =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
Space-cooling	SEER =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	If split system, refrigerant charge measurement or charge indicator display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Central forced air handlers	Cooling airflow and watt draw		NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	NR
	Central fan integrated ventilation system watt drive		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Ducts	Duct sealing		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Duct insulation		R-6	R-6	R-6	R-6	R-6	R-4.2	R-4.2	R-4.2	R-6	R-6	R-6	R-6	R-6	R-8	R-8	R-8
Water-heating			System shall meet Section 151(f)8 or Section 151(b)1															

TABLE 151-D
COMPONENT PACKAGE E

			CLIMATE ZONES															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Insulation minimums[1]	Ceilings		R38	R30	R38	R30	R38	R38	R30	R30	R30	R30	R38	R38	R38	R38	R38	R49
	Walls	Wood-Frame walls	R21	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R21	R21	R21
		Heavy mass walls	(R4.76)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R2.44)	(R4.76)	(R4.76)	(R4.76)	(R4.76)	(R4.76)	(R4.76)
		Light mass walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Below-grade walls	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R13
	Floors	Slab floor perim.	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R7
		Raised floors	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19
		Concrete raised floors	R8	R8	R0	R0	R0	R0	R0	R0	R0	R0	R8	R4	R8	R8	R4	R8
Radiant barrier			NR	REQ	NR	REQ	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Roofing products	Low-sloped	Aged solar reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.55	NR	0.55	NR
		Thermal emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR
	Steep sloped (less than 5 lb/ft^2)	Aged solar reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
		Thermal emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
	Steep sloped (5 lb/ft2 or more)	Aged solar reflectance	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Thermal emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Fenestration	Maximum U-factor[2]		0.50[8]	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.45[9]
	Maximum Solar Heat Gain Coefficient (SHGC)[3]		NR	0.40	0.40	0.25	0.40	0.40	0.25	0.40	0.40	0.40	0.25	0.25	0.30	0.25	0.25	NR
	Maximum total area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Maximum West facing area		NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR
Thermal mass[4]			NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Space-heating[5,10]	Electric-resistant allowed		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	If gas, AFUE =		MIN[8]	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN[9]
	If heat pump, HSPF[6] =		MIN[8]	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN[9]
Space-cooling	SEER =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
	If split system, Refrigerant charge measurement or charge indicator display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
Central forced air handlers	Cooling airflow and watt draw		NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	NR
	Central fan integrated ventilation system watt drive		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Ducts	Duct sealing		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Duct insulation		R-8	R-6	R-8	R-6	R-6	R-4.2	R-4.2	R-4.2	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8
Water-heating			System shall meet Section 151(f)8 or Section 151(b)1															

FOOTNOTE REQUIREMENTS TO TABLES 151-B, 151-C AND TABLE 151-D

[1]The *R*-values shown for ceiling, wood frame wall and raised floor are for wood-frame construction with insulation installed between the framing members. For alternative construction assemblies, see Section 151(f)1A.

The heavy mass wall *R*-value in parentheses is the minimum *R*-value for the entire wall assembly if the wall weight exceeds 40 pounds per square foot. The light mass wall *R*-value in brackets is the minimum *R*-value for the entire assembly if the heat capacity of the wall meets or exceeds the result of multiplying the bracketed minimum *R*-value by 0.65. Any insulation installed on heavy or light-mass walls must be integral with, or installed on the outside of, the exterior mass. The inside surface of the thermal mass, including plaster or gypsum board in direct contact with the masonry wall, shall be exposed to the room air. The exterior wall used to meet the *R*-value in parentheses cannot also be used to meet the thermal mass requirement.

[2]The installed fenestration products shall meet the requirements of Section 151(f)3.

[3]The installed fenestration products shall meet the requirements of Section 151(f)4.

[4]If the package requires thermal mass, the thermal mass shall meet the requirements of Section 151(f)5.

[5]Thermostats shall be installed in conjunction with all space-heating systems in accordance with Section 151(f)9.

[6]HSPF means "heating seasonal performance factor."

[7]Electric-resistance water heating may be installed as the main water heating source in Package C only if the water heater is located within the building envelope and a minimum of 25 percent of the energy for water heating is provided by a passive or active solar system.

[8]As an alternative under Package E in climate zone 1, glazing with a maximum 0.57 U-factor and a 92% AFUE furnace or an 8.4 HSPF heat pump may be substituted for the Package E glazing U-factor requirement. All other requirements of Package E must be met.

[9]As an alternative under Package E in climate zone 16, glazing with a maximum 0.57 U-factor and a 90% AFUE furnace or an 8.4 HSPF heat pump may be substituted for the Package E glazing U-factor requirement. All other requirements of Package E must be met.

[10]A supplemental heating unit may be installed in a space served directly or indirectly by a primary heating system, provided that the unit thermal capacity does not exceed two kilowatts or 7,000 Btu/hr and is controlled by a time-limiting device not exceeding 30 minutes.

SUBCHAPTER 9

LOW-RISE RESIDENTIAL BUILDINGS—ADDITIONS AND ALTERATIONS IN EXISTING LOW-RISE RESIDENTIAL BUILDINGS

SECTION 152
ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS IN EXISTING BUILDINGS THAT WILL BE LOW-RISE RESIDENTIAL OCCUPANCIES

(a) **Additions.** Additions to existing residential buildings shall meet the requirements of Sections 111 through 118, Section 119, and Section 150, and either Section 152(a)1 or 2.

1. **Prescriptive approach.** Additions to existing buildings shall meet the following additional requirements:

   A. Fenestration in additions up to 100 square feet shall not have more than 50 square feet of fenestration area, and shall meet the *U*-factor and Solar Heat Gain Coefficient requirements of Package D [Sections 151(f)3A, 151(f)4 and Table 151-C]; or

   B. Additions up to 1,000 square feet shall meet all the requirements of Package D [Section 151(f) and Table 151-C], except that the addition's total glazing area limit is the maximum allowed in Package D plus the glazing area that was removed as a result of the construction of the addition, and the wall insulation value need not exceed R-13.

      Exception to Section 152(a)1B: In climate zones 2, 4, 7 – 15 the total allowed west-facing glazing area shall be 5 percent of the conditioned floor area of the addition plus the amount of west-facing glazing removed from the existing building as a result of the construction of the addition.

   C. Additions of more than 1,000 square feet shall meet the prescriptive requirements of Section 151(f).

2. **Performance approach.** Performance calculations shall meet the requirements of Section 151(a) through (e), pursuant to either Item A or B, below.

   A. For additions alone, the addition complies if the addition alone meets the combined water-heating and space-conditioning energy budgets as specified in Section 151(b).

   B. For existing plus addition plus alteration compliance. The energy use of the combination of the altered existing building plus the proposed addition shall be equal to or less than the energy use of the existing building with all alterations meeting the requirements of Section 152(b)2, plus the standard energy budget of an addition that complies with Sections 151(a) through (e). When determining the standard design, the fenestration area shall be the smaller of the sum of the installed fenestration area up to 20 percent of the conditioned floor area of the addition plus glass removed from the existing building as a result of the construction of the addition or the proposed glass area in the addition.

Exception 1 to Section152(a): Existing structures with R-11 framed walls showing compliance with Section 152(a)2 (Performance Approach) are exempt from Section 150(c).

Exception 2 to Section 152(a): If the addition will increase the total number of water heaters in the building, one of the following types of water heaters may be installed to comply with Section 152(a)1 or Section 152(a)2A:

1. A gas storage nonrecirculating water-heating system that does not exceed 50 gallons capacity; or
2. If no natural gas is connected to the building, an electric storage water heater that does not exceed 50 gallons capacity, has an energy factor not less than 0.90; or
3. A water-heater system determined by the Executive Director to use no more energy than the one specified in Item 1 above; or if no natural gas is connected to the building, a water-heating system determined by the executive director to use no more energy than the one specified in Item 2 above.

For prescriptive compliance with Section 152(a)1, the water-heating systems requirement in Section 151(f)8 shall not apply. For performance compliance for the addition alone, only the space-conditioning budgets of Section 151(b)2 shall be used; the water-heating budgets of Section 151(b)1 shall not apply.

The performance approach for the existing building and the addition in Section 152(a)2B may be used to show compliance, regardless of the type of water heater installed.

Exception 3 to Section 152(a): When heating and/or cooling will be extended to an addition from the existing system(s), the existing heating and cooling equipment need not comply with Title 24, Part 6. The heating system capacity must be adequate to meet the minimum requirements of CBC Section 1204.1.

Exception 4 to Section 152(a): When ducts will be extended from an existing duct system to serve the addition, the ducts shall meet the requirements of Section 152(b)1D.

Exception 5 to Section 152(a): Additions 1,000 square feet or less are exempt from the require-

ments of Section 150(o). For additions larger than 1,000 ft^2, application of Section 150(o) shall be based on the conditioned floor area of the entire dwelling unit, not just the addition.

(b) **Alterations.** Alterations to existing residential buildings or alterations in conjunction with a change in building occupancy to a low-rise residential occupancy shall meet either Item 1 or 2 below.

1. **Prescriptive approach.** The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of Sections 110 through 118, Section 119 and Section 150(a) through (p); and

   A. Alterations that add fenestration area shall meet the *U*-factor requirements of Package D [Section 151(f)3 A and Table 151-C], the total fenestration area requirements of Package D [Section 151(f)3B and C and Table 151-C], and the Solar Heat Gain coefficient requirements of Package D [Section 151(f)4 and Table 151-C].

      Exception to Section 152(b)1A: Alterations that add fenestration area of up to 50 square feet shall not be required to meet the total fenestration area and west-facing fenestration area requirements of Section 151(f)3B and C. The existing west-facing fenestration area shall not be increased by more than 50 square feet.

   B. Replacement fenestration, where existing glazing is replaced with a new manufactured fenestration product in the same orientation and tilt, shall meet the *U*-factor and Solar Heat Gain Coefficient requirements of Package D [Sections 151(f)3A and 151(f)4 and Table 151-C].

      Note: Glass replaced in an existing sash and frame, or replacement of a single sash in a multisash fenestration product is considered a repair.

   C. New or replacement space-conditioning systems shall:

      i. Meet the requirements of Sections 150(h), 150(i), 150(j)2, 151(f)6, 151(f)7, 151(f)9 and 151(f)11; and

      ii. Be limited to natural gas, liquefied petroleum gas or the existing fuel type unless it can be demonstrated that the TDV energy use of the new system is more efficient than the existing system.

   D. When more than 40 feet of new or replacement space-conditioning ducts are installed in unconditioned space, the new ducts shall meet the requirements of Section 150(m) and the duct insulation requirements of Package D, Section 151(f)10. If ducts are installed in climate zones 2, 9, 10, 11, 12, 13, 14, 15 or 16, the duct system shall be sealed as confirmed through field verification and diagnostic testing in accordance with procedures for duct sealing of existing duct systems as specified in the Reference Residential Appendix RA3, to meet one of the following requirements:

      i. If the new ducts form an entirely new duct system directly connected to the air handler, the measured duct leakage shall be less than 6 percent of fan flow and meet the airflow requirements of Reference Residential Appendix RA3; or

      ii. If the new ducts are an extension of an existing duct system, the combined new and existing duct system shall meet one of the following requirements:

         a. The measured duct leakage shall be less than 15 percent of system fan flow; or

         b. The measured duct leakage to outside shall be less than 10 percent of system fan flow; or

         c. The duct leakage shall be reduced by more than 60 percent relative to the leakage prior to the installation of the new ducts, and a visual inspection including a smoke test shall demonstrate that all accessible leaks have been sealed; or

         d. If it is not possible to meet the duct sealing requirements of Subsection a, b or c, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS rater.

         Exception to Section 152(b)1Dii: Existing duct systems that are extended, which are constructed, insulated or sealed with asbestos.

   E. In climate zones 2, 9, 10, 11, 12, 13, 14, 15 and 16, when a space-conditioning system is altered by the installation or replacement of space-conditioning equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger), the duct system that is connected to the new or replacement space-conditioning equipment shall be sealed, as confirmed through field verification and diagnostic testing in accordance with procedures for duct sealing of existing duct systems as specified in the Reference Residential Appendix RA3, to one of the following requirements:

      i. The measured duct leakage shall be less than 15 percent of system fan flow; or

      ii. The measured duct leakage to outside shall be less than 10 percent of system fan flow; or

      iii. The measured duct leakage shall be reduced by more than 60 percent relative to the measured leakage prior to the installation or replacement of the space conditioning equipment and a visual inspection including a smoke test shall demonstrate that all accessible leaks have been sealed; or

iv. If it is not possible to meet the duct requirements of i, ii or iii, all accessible leaks shall be sealed and verified through a visual inspection and a smoke test by a certified HERS rater.

Exception 1 to Section 152(b)1E: Duct systems that are documented to have been previously sealed as confirmed through field verification and diagnostic testing in accordance with procedures in the Reference Residential Appendix RA3.

Exception 2 to Section 152(b)1E: Duct systems with less than 40 linear feet in unconditioned spaces.

Exception 3 to Section 152(b)1E: Existing duct systems constructed, insulated or sealed with asbestos.

F. When a space-conditioning system is altered by the installation or replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, cooling or heating coil, or the furnace heat exchanger, the following requirements shall be met:

i. Non-setback thermostats shall be replaced with setback thermostats meeting the requirements of Section 112(c); and

ii. Meet the refrigerant charge and airflow requirements of Reference Residential Appendix RA3.

Exception to Section 152(b)1Fii: Heating only systems need not comply with this requirement.

G. New service water-heating systems or components shall:

i. Meet the requirements of Section 150(j); and

ii. Be limited to natural gas, liquefied petroleum gas or the existing fuel type unless it can be demonstrated that the TDV energy use of the new system is more efficient than the existing system.

H. Replacements of the exterior surface of existing roofs shall meet the requirements of Section 118 and the applicable requirements of Subsections i through iii where more than 50 percent of the roof or more than 1,000 square feet of roof, whichever is less, is being replaced:

i. For steep-sloped roofs, roofing products with a density of less than 5 pounds per square foot in climate zones 10 through 15 shall have a minimum aged solar reflectance of 0.20 and a minimum thermal emittance of 0.75, or a minimum SRI of 16.

ii. For steep-sloped roofs, roofing products with a density of 5 pounds per square foot or more in climate zones 1 through 16 shall have a minimum aged solar reflectance of 0.15 and a minimum thermal emittance of 0.75, or a minimum SRI of 10.

Alternative to Section 152(b)1Hi and ii: The following shall be considered equivalent to Subsections i and ii:

a. Insulation with a thermal resistance of at least 0.85 hr•ft^2•°F/Btu or at least a $^3/_4$ inch airspace is added to the roof deck over an attic; or

b. Existing ducts in the attic are insulated and sealed according to Section 151(f)10; or

c. In climate zones 10, 12 and 13, with 1 ft^2 of free ventilation area of attic ventilation for every 150 ft^2 of attic floor area, and where at least 30 percent of the free ventilation area is within 2 feet vertical distance of the roof ridge; or

d. Buildings with at least R-30 ceiling insulation; or

e. Buildings with a radiant barrier in the attic meeting the requirements of Section 151(f)2; or

f. Buildings that have no ducts in the attic; or

g. In climate zones 10, 11, 13 and 14, R-3 or greater roof deck insulation above vented attic.

iii. Low-sloped roofs in climate zones 13 and 15 shall have a 3-year aged solar reflectance equal or greater than 0.55 and a thermal emittance equal or greater than 0.75, or a minimum SRI of 64.

Exception to Section 152(b)1Hiii: Buildings with no ducts in the attic.

2. **Performance approach.**

A. The altered components shall meet the applicable requirements of Sections 110 through 118, Section 119 and Section 150(a) through (p); and

B. When the altered components do not meet the requirements specified in the sections that are stated in subsections i through viii, the standard energy budget (energy budget) shall be based on the requirements stated in those sections as follows:

i. Ceiling Insulation. The energy budget shall be based on the requirements of Section 118(d).

ii. Wall insulation. The energy budget shall be based on the requirements of Section 150(c).

iii. Raised-floor Insulation. The energy budget shall be based on the requirements of Section 150(d).

iv. Fenestration. The energy budget shall be based on the U-factor and SHGC value requirements of Table 151-C. The allowed glass area shall be the glass area of the existing building.

v. Space-heating and space-cooling equipment. The energy budget shall be based on the requirements of Table 151-C.

vi. Ducts. The energy budget shall be based on the requirements of Section 152(b)1D.

vii. Water heating systems. The energy budget shall be based on requirements of Section 151(b)1.

viii. Roofing products. The energy budget shall be based on Section 152(b)1H.

C. When the altered components meet the requirements specified in Section 152(b)2B, subsections i through viii, the standard energy budget shall be based on existing conditions.

Notes to Section 152(b)2:

A. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the energy budget and must meet the requirements of Section 152(b)2B.

B. The proposed design shall be based on the actual values of the altered components.

C. The standard design shall assume the same geometry and orientation as the proposed design.

Exception to Section 152(b)1A: Any dual-glazed greenhouse window installed as part of an alteration complies with the *U*-factor requirements in Section 151(f)3.

(c) Any addition or alteration may comply with the requirements of Title 24, Part 6 by meeting the requirements for the entire building.

2001 CALIFORNIA MECHANICAL CODE
PART 4, TITLE 24, CALIFORNIA CODE OF REGULATIONS

CHAPTER 6
DUCT SYSTEMS

TABLE P4-A
ADOPTION TABLE

CODE SECTION	CEC
Entire 2001 CMC as noted in this table[1]	
601	X
602	X
604	X
605	X
Standard 6-5	X

[1]Adopted by reference for occupancies A, B, E, F, H, M, R and S; see Section 118(d), 124 and 150(m).

APPENDIX 1-A

STANDARDS AND DOCUMENTS REFERENCED IN THE ENERGY EFFICIENCY REGULATIONS

AIR-CONDITIONING AND REFRIGERATION INSTITUTE

ARI 210/240-2003 Unitary Air Conditioning and Air-Source Heat Pump Equipment (2003)

ARI 310/380-93 Packaged Terminal Air-Conditioners and Heat Pumps (1993)

ARI 320-98 Water-Source Heat Pumps

ARI 325-98 Ground Water-Source Heat Pumps (1998)

ARI 340/360-2000 Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment (2000)

ARI 365-2002 Commercial and Industrial Unitary Air-Conditioning Condensing Units (2002)

ARI 460-2000 Remote Mechanical-Draft Air-Cooled Refrigerant Condensers (2000)

ARI 550/590-98 Standard for Water-Chilling Packages Using the Vapor Compression Cycle (1998)

ARI 560-2000 Absorption Water Chilling and Water Heating Packages (2000)

Available from: Air-Conditioning and Refrigeration Institute
4301 North Fairfax Drive, Suite 425
Arlington, Virginia 22203
(703) 524-8800

AIR CONDITIONING CONTRACTORS OF AMERICA

Manual J—Residential Load Calculation, Eighth Edition (2003)

Available from: Air Conditioning Contractors of America, Inc.
2800 Shirlington Road, Suite 300
Arlington, VA 22206
www.acca.org
(703) 575-4477

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI Z21.10.3-2001 Gas Water Heaters, Volume 1, Storage Water Heaters with Input Ratings above 75,000 Btu/h (2001)

ANSI Z21.13-2000 Gas-Fired Low Pressure Steam and Hot Water Boilers (2000)

ANSI Z21.40.4-1996 Performance Testing and Rating of Gas-Fired, Air-Conditioning and Heat Pump Appliances (1996)

ANSI Z21.47-2001 Gas-Fired Central Furnaces (2001)

ANSI Z83.8-2002 Gas Unit Heaters and Gas-Fired Duct Furnaces (2002)

Available from: American National Standards Institute
25 West 43rd Street, 4th floor
New York, NY 10036
(212) 642-4900

ANSI/NSPI-5 2003 Residential Inground Swimming Pools (2003)

ANSI C82.6-2005 Ballasts for High-Intensity Discharge Lamps—Methods of Measurement

Available from: Association of Pool & Spas Professonals
2111 Eisenhower Ave.
Alexandria, VA 22314
(703) 838-0083

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (NATIONAL PUBLICATIONS)

ASHRAE
Standard 55 Thermal Environment Conditions for Human Occupancy

ASHRAE Handbooks

Applications Volume, Heating, Ventilating and Air-Conditioning Applications (2003)

Equipment Volume, Heating, Ventilating and Air-Conditioning Systems and Equipment (2000)

Fundamentals Volume, Fundamentals (2001)

Available from: American Society of Heating, Refrigerating and Air-Conditioning Engineers
1791 Tullie Circle N.E.
Atlanta, Georgia 30329
www.ashrae.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (REGIONAL PUBLICATION)

ASHRAE Climatic Data for Region X Arizona, California, Hawaii, Nevada, Publication SPCDX, 1982, ISBN #20002196 and Supplement, 1994, ISBN #20002596

Available from: Order Desk
Building News
10801 National Boulevard
Los Angeles, CA 90064
(800) 873-6397 or (310) 474-7771
http://www.bnibooks.com/

ASTM INTERNATIONAL

ASTM C 55-01 Standard Specifications for Concrete Brick (2001)

ASTM C 177-97 Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus (1997)

ASTM C 272-01 Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions (2001)

ASTM C 335-95 Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation (1995)

ASTM C 518-02 Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus (2002)

ASTM C 731-00 Standard Test Method for Extrudability, After Package Aging, of Latex Sealants (2000)

ASTM C 732-01 Standard Test Method for Aging Effects of Artificial Weathering on Latex Sealants (2001)

ASTM C 836-05 Standard Specification for High Solids Content, Cold Liquid-Aplied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course (2005)

ASTM C 1167-96 Standard Specification for Clay Roof Tiles

ASTM C 1371-98 Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers (1998)

ASTM C 1583-04 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method) (2004)

ASTM D 522-93A (2001) Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings (2001)

ASTM D 822-01 Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings (2001)

ASTM D 1003-00 Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics (2000)

ASTM D 1653-03 Standard Test Methods for Water Vapor Transmission of Organic Coating Films (2003)

ASTM D 2370-98 (2002) Standard Test Method for Tensile Properties of Organic Coatings (2002)

ASTM D 2824-02 Standard Specification for Aluminum-Pigmented Asphalt Roof Coatings, Nonfibered, Asbestos Fibered, and Fibered without Asbestos, 2002

ASTM D 3468-99 Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polythylene Used in Roofing and Waterproofing (1999)

ASTM D 3805-97 Standard Guide for Application of Aluminum-Pigmented Asphalt Roof Coatings, 1997 (reapproved 2003)

ASTM D 4798-01 Standard Test Method Accelerated Weathering Test Conditions and Procedures for Bituminous Materials (Xenon-Arc Method) (2001)

ASTM D 5870-95 (2003) Standard Practice for Calculating Property Retention Index of Plastics (2003)

ASTM D 6083-05e1 Standard Specification for Liquid Applied Acrylic Coating Used in Roofing (2005)

ASTM D 6694-01 Standard Specification for Liquid-Applied Silicone Coating Used in Spray Polyurethane Foam Roofing (2001)

ASTM E 96-00 Standard Test Methods for Water Vapor Transmission of Materials

ASTM E 283-91 Standard Test Method for Determining the (1999) Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E 408-71 Standard Test Methods for Total Normal (2002) Emittance of Surfaces Using Inspection-Meter Techniques (2002)

Available from: ASTM International
100 Barr Harbor Drive West
Conshohocken, Pennsylvania
19428-2959
(610) 832-9500

CALIFORNIA BUILDING STANDARDS COMMISSION

2007 *California Electrical Code*

2007 *California Plumbing Code*

2007 *California Mechanical Code*

2007 *California Building Code*

Available from: California Building Standards Commission
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833-2936
(916) 263-0916
www.bsc.ca.gov

CALIFORNIA ENERGY COMMISSION

Appliance Efficiency Regulations

Nonresidential Alternative Calculation Method (ACM) Manual

Nonresidential Compliance Manual

Residential Alternative Calculation Method (ACM) Manual

Residential Compliance Manual

Available from: California Energy Commission
1516 Ninth Street
Sacramento, CA 95814
(916) 654-5106 or
(800) 772-3300 (in California)
http://www.energy.ca.gov/title24

CALIFORNIA DEPARTMENT OF CONSUMER AFFAIRS

Standards for Insulating Material

Available from: California Department of Consumer Affairs
Bureau of Home Furnishings and Thermal Insulation
3485 Orange Grove Avenue
North Highlands, CA 95660
(916) 574-2041

CODE OF FEDERAL REGULATIONS

21 Code of Federal Regulations, Section 1002.12 (1996)

47 Code of Federal Regulations, Parts 2 and 15 (1996)

Available from: Department of Energy
Washington, D.C. 20585

COOLING TECHNOLOGY INSTITUTE

CTI ATC-105-00 Acceptance Test Code for Water Cooling Towers (2000)

CTI STD-201-02 Standard for the Certification of Water-Cooling Tower Thermal Performance (2004)

Available from: Cooling Technology Institute
2611 FM 1960 West, Suite A101
Houston, Texas 77068-3730

PO Box 73383
Houston, Texas 77273-3383
(281) 583-4087

COOL ROOF RATING COUNCIL

CRRC-1 Product Rating Program Manual (2007)

Available from: Cool Roof Rating Council
1610 Harrison Street
Oakland, CA 94612
(866) 465-2523
www.coolroofs.org

HYDRONICS INSTITUTE

HI Heating Boiler Standard 86, 6th Edition (1989)

Available from: Hydronics Institute
35 Russo Place, P.O. Box 218
Berkeley Heights, New Jersey 07922
(908) 464-8200

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA

The IESNA Lighting Handbook, Ninth Edition (2000)

Available from: IESNA
120 Wall Street, 17th Floor
New York, New York 10005-4001
(212) 248-5000
Email: iesna@iesna.org

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS

2007 *California Mechanical Code*

Available from: International Association of Plumbing and Mechanical Officials
2001 E. Walnut Drive South
Walnut, California 91789-2825
(800) 85-IAPMO (854-2766)
http//: www.iapmo.org

INTERNATIONAL CODE COUNCIL

2007 *California Building Code*

Available from: International Code Council Los Angeles District Office
5360 South Workman Mill Road
Whittier, California 90601-2298
(888) 422-7233
http//:www.iccsafe.org

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO-13256-1 Water-Source Heat Pumps-Testing and Rating for Performance-Part 1: Water-to-Air and Brine-to-Air Heat Pumps (1998)

Available from: ISO
1, rue de Varembe
Case postale 56
CH-1211
Geneve 20, Switzerland

NATIONAL FENESTRATION RATING COUNCIL

NFRC 100 Procedure for Determining Fenestration Product U-factors (2007)

NFRC 200 Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence (2007)

NFRC 400 Procedure for Determining Fenestration Product Air Leakage (2007)

Available from: National Fenestration Rating Council
6305 Ivy Lane, Suite 140
Greenbelt, Maryland 20770
(301) 589-1776
Email: info@nfrc.org

NSF INTERNATIONAL (formerly National Sanitation Foundation)

NSF/ANSI 50 2005 Circulation System Components and Related Materials for Swimming Pools, Spas/Hot Tubs (2005)

Available from: NSF International
PO Box 130140
Ann Arbor, MI 48113
(735) 769-8010

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION

Residential Comfort System Installation Standards Manual (1998)

Available from: Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
4201 Lafayette Center Drive
Chantilly, VA 20151-1209
(703) 803-2980
ww.smacna.org

UNDERWRITERS LABORATORIES

UL 181 Standard for Safety for Factory-made Air Ducts and Connectors (1996)

UL 181A Standard for Safety for Closure Systems for Use with Rigid Air Ducts and Air Connectors (1994)

UL 18IB Standard for Safety for Closure Systems for Use with Flexible Air Ducts and Air Connectors (1995)

UL 723 Standard for Test for Surface Burning Characteristics of Building Materials (1996)

UL 727 Standard for Oil-Fired Central Furnaces (1994)

UL 731 Standard for Oil-Fired Unit Heaters (1995)

UL 1598 Standard for Luminaires (2000)

Available from: Underwriters Laboratories
333 Pfingsten Road
Northbrook, Illinois 60062-2096
(847) 272-8800

HISTORY NOTE APPENDIX

CALIFORNIA ENERGY CODE

(Title 24, Part 6, California Code of Regulations)

For prior history, see History Note Appendix to the 2001 *California Energy Code,* effective October 1, 2005.

1. The 2005 building energy efficiency standards were brought forward unamended into the 2007 *California Energy Code,* effective with other parts of Title 24 on January 1, 2008.

2. (CEC 01/07)Update of 2007 building energy efficiency standards in response to AB 32 (Nuñez, Chap. 488, Stats. of 2006) and SB 1 (Murray, Chap. 132, Stats. of 2006), approved by the California Building Standards Commission on September 11, 2008; filed with the Secretary of State September 12, 2008, published January 1, 2009; effective August 1, 2009.