SECTION 9

INSULATION

Building Envelope Measures (See Section 3, “Residential Energy Standards”)

The building envelope includes the foundation, floor, walls, doors, windows, roofs and skylights. An energy efficient building envelope will minimize the heat losses out of and heat gains in to the dwelling. As a result, the space conditioning system will use less energy to control indoor temperature and the indoor environment will be more comfortable. This section discusses the insulation and ventilation features needed to comply with the California Building Code and the Energy Efficiency Standards.

Ceiling Insulation [Appendix B section. 150(a) and 150(b), 2008 Energy Efficiency Standards]

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.

The insulation may be of greater insulating value in certain areas of the ceiling and of lesser insulating value in other areas of the ceiling provided that the overall weighted average U-factor does not exceed the equivalent R-19 wood framed value of 0.049 or the equivalent value for the package or performance analysis used.

Although R-19 insulation between wood framing members is the minimum mandatory level, the package or performance computation may require a higher R value.

Ceiling insulation should not block eave vents in attics or rafter cavities formed when the ceiling finish is applied directly to the underside of the rafters. A minimum of 1" air space shall be provided between the insulation and the roof sheathing. If the flow of air is blocked, water vapor may condense on the underside of the roof, reducing the effectiveness of the insulation and causing dryrot and fungus to grow on and damage the building materials.

To meet the intent of the ceiling insulation requirements, ceiling insulation should extend far enough to the outside walls to cover the top plate. However, insulation may be tapered at the wall where a roof slopes down; an elevated truss or similar treatment for full insulation depth at the outside of the wall is not required but may be desirable. If insulation is tapered for more than three feet from the outside wall, this must be reflected in a weighted average U-value calculation.

Luminaires in Insulated Ceilings [Sec 150 (k)12 2008 Energy Efficiency Standards]

Luminaires recessed in insulated ceilings must meet three requirements

1. Fixtures must be approved for zero-clearance insulation cover ("I.C. rated").

2. The fixture housing must be labeled as a certified airtight luminaire to prevent air movement between conditioned and unconditioned spaces.

3. Luminaires shall be sealed with a gasket or caulking between the luminaire housing and ceiling. All air leak paths between conditioned and non conditioned spaces shall be sealed with a gasket or caulk.

Installation of Insulation in Existing Attics [Sec. 118(d)1, 2008 Energy Efficiency Standards]

Insulation being installed in an existing, accessible attic must meet or exceed:

R-30 if the building is located in climate zone 2, or

R-38 if the building is located in climate zone 1 (coastal areas).

In addition, the Standards state "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 the 2010 CBC and Section R806.1 of the 2010 CRC."

Loose Fill Insulation [Sec. 150(b), 2008 Energy Efficiency Standards]

Loose fill insulation should be blown in evenly and documented in the Installation Certificate (CF6R). Insulation levels can be verified by checking that the depth of insulation conforms to the manufacturer's coverage chart for the listed R-value. The insulation must also meet the manufacturer's specified minimum weight per square foot for the corresponding R-value. Additionally, three criteria the installer must consider are: 1) roof slope, 2) ceiling slope and 3) clearance.

Where ceiling insulation is installed next to eave or soffit vents, a rigid baffle should be installed at the top plate to direct ventilation air up and over the ceiling insulation. The baffle should extend beyond the height of the ceiling insulation and should have sufficient clearance between the baffle and roof deck at the top. Baffles shall be in place at the time of the framing inspection.

Wall Insulation [Section 150 (c), 2008 Energy Efficiency Standards]

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 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.

The insulation may be of greater insulating value in certain areas of the wall and of lesser insulation value in other areas of the wall provided that the overall weighted average U-value does not exceed the equivalent R-13 wood framed value (0.102). Metal framed walls will require rigid insulation to achieve a maximum U value of 0.102.

Unframed walls such as concrete or masonry are not required to meet this minimum but may have other insulation requirements.

The package or performance calculation method may require the use of greater R value insulation.

If a vapor barrier is required it must face the conditioned space.

NOTE: Rim joists between the stories of a multi-story building are part of the wall and must be insulated to the same level as the wall.

Raised Floor Insulation [Sec. 150 (d), 2008 Energy Efficiency Standards]

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 cripple walls are insulated to meet the wall insulation minimums R-21 in Zone 1 or R-13 in Zone 2), 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.

The insulation may be of greater insulation value in certain areas of the raised floor and of lesser insulating value in other areas of the raised floor provided that the overall weighted average U-value does not exceed the equivalent R-13 framed value (that is, U-value = 0.045).

See the 2008 Residential Compliance Manual for the method to be used to document the insulation equivalency of any proposed alternate design.

The package or performance calculation may require the use of insulation with a higher R value.

Note: The computer methods provide a thermal credit equivalent to R-6 insulation in raised floors over crawl spaces. The maximum raised floor U-value of 0.045 cannot be met by including the effects of the R-6 crawl space.

Slab Edge Insulation [Sec. 118(g), 2008 Energy Efficiency Standards]

Slab edge insulation reduces heat loss through the slab perimeter. When slab edge insulation is installed, the material used must meet the following minimum specifications:

A water absorption rate no greater than 0.3 percent when tested according with Test Method A – 24-Hour-Immersion of ASTM-C-272; and,

A water vapor permeance no greater than 2.0 perm/inch when tested according to ASTM-E-96; and,

Concrete slab perimeter insulation must be protected from physical damage and ultraviolet light deterioration.

Slab edge insulation must be installed with heated slabs. This is not part of the mandatory requirements of the *Standards*, but rather is an eligibility criterion for hydronic heating systems with coils in the slab. Slab edge insulation installed with hydronic heating systems is considered energy neutral and is not modeled in performance calculations.

Pipe Insulation [Sec 150 (j) and 151 (f) 8 d, 2008 Energy Efficiency Standards]

Both hot and cold water lines within 5' of the water heater must be insulated to R-4, minimum. All 3/4" or larger hot water lines between the water heater and kitchen must be insulated to R-4. All recirculating water lines must be insulated. One inch thick insulation will provide the required R value.

If required by the energy compliance calculations, all other hot water lines may also need insulation.

Duct Insulation [Sec. 150 (m), 2008 Energy Efficiency Standards]

Unless ducts are enclosed entirely in conditional space, the minimum allowed duct insulation value is R-4.2. When using the prescriptive method of compliance, the minimum value is R-6.

Installation of Certified Insulating Material [Sec. 118, 2008 Energy Efficiency Standards]

Any insulation of the type and form listed below may be installed only if the manufacturer has certified that the insulation complies with the California Code of Regulations, Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.

TYPE	**FORM**
Aluminum foil	Reflective foil
Cellular glass	Board form

Cellulose fiber	Loose fill and spray applied
Mineral aggregate	Board form
Mineral fiber	Blankets, board form, loose fill
Perlite	Loose fill
Phenolic	Board form
Polystyrene	Board form, molded extruded
Polyurethane	Board form and field applied
Polyisocyanurate	Board form and field applied
Urea formaldehyde	Foam field applied
Vermiculite	Loose fill

California Quality Standards for Insulating Materials also require that all exposed installations of faced mineral fiber and mineral aggregate insulation must use fire retardant facings. Exposed installations are those where the insulation facings do not touch a ceiling, wall or floor surface, and faced batts on the underside of roofs with an air space between the ceiling and facing. These installations require insulation that has been tested and certified not to exceed a flame spread of 25 and a smoke density rating of 450.

Flame spread ratings and smoke density ratings are shown on the insulation or packaging material or may be obtained from the manufacturer.

Foam Plastic Insulation [Sec 2603, 2010 CBC]

Foam plastic insulation may only be installed in buildings when in conformance with Section 2603 of the 2010 CBC and the California Energy Efficiency Standards. Packages and containers of foam plastic insulation and foam plastic insulation components delivered to job sites shall bear the label of an approved agency showing the manufacturer's name, the product listing, product identification and information to show that the end use will comply with the code requirements.

Foam plastic insulation used in building construction shall have a flame-spread rating of not more that 75 and a smoke-developed rating of not more than 450 when tested in the maximum thickness intended for use according to ASTM E 84 or UL 723.

The interior of the building shall be separated from the foam plastic insulation by an approved thermal barrier of 1/2" thick gypsum wallboard. Other materials may be used only if documentation is provided to show that the material will limit the average temperature rise of the unexposed surface to not more than 250°F after 15 minutes of fire exposure under test method ASTM E 119 or UL 263. The thermal barrier shall be installed in such a manner that it will remain in place for 15 minutes based on approved diversified tests.

Note: This thermal barrier is not required on a wall if ALL of the following conditions are met:
1. it is an exterior wall, and
2. the building is one story, and
3. the flame spread index of the insulation is 25 or less, and

4. the thickness of the insulation is 4" or less, and
5. the insulation is covered with min. 0.032" thick aluminum or 0.016" thick corrosion-resistant steel,
6. the building is equipped with fire sprinklers.

Foam plastic insulation may be used as part of a roof-covering assembly provided the assembly with the foam plastic insulation is a Class A roofing assembly tested according to FM 4450 or UL 1256. If foam plastic insulation is installed under a roof assembly or roof covering installed in accordance with the code and manufacturer's instructions, it shall be separated from the interior of the building by wood structural panel sheathing not less than ½" in thickness, bonded with exterior glue, with edges supported by blocking, tongue-and-groove joints or other approved type of edge support, or an equivalent material. The thermal barrier requirement is waived.

Within an attic or crawl space where entry is made only for service of utilities, foam plastic insulation shall be protected against ignition with min. 1.5" thick mineral fiber insulation, 0.25" thick wood structural panel or particleboard, 3/8" gypsum wallboard, or 0.016" corrosion-resistant steel.

Attic Ventilation and Ventilation of Insulated Enclosed Rafter and Joist Cavities [Sec 1203, 2010 CBC]

All enclosed attics and enclosed rafter spaces shall have cross-ventilation by eave vents. The net clear open area of these vents shall be 1/300 of the area of the space ventilated, with 50 percent of the required ventilating area provided by ventilators located in the upper portion of the space to be ventilated at least 3' above the eave vents with the balance of the required ventilation provided by eave vents. Providing this required ventilation in enclosed insulated rafter and joist cavities becomes more difficult. The required net clear open area must be provided for the full width and length of the rafter or joist space between the insulation and the roof sheathing to prevent condensation. The minimum depth of this open space is 1".

Many insulation manufacturers supply cathedral batt insulation designed to be used in these rafter and joist cavities without as much ventilation. The manufacturers of these special cathedral batts have published data that recommends allowing a reduced ventilation space between the batts and the roof sheathing.

Alternatively, rafter cavities and joist cavities that are completely filled by closed cell foam insulation shall be allowed to be unvented. Unvented rafter cavities should be constructed using fully dried lumber and not be exposed to rain or inclement weather during construction in order to assure that moisture will not be trapped in these cavities. Also, be aware that foam insulation is tested and approved with a maximum allowed thickness. Check this limitation before specifying that "rafter cavities are to be filled". See the section on Foam Plastic Insulation in this manual for a complete discussion on using this material.

See Appendix 5 of this manual or CBC Chapter 7A for a discussion on the limitations on attic vent locations within the Wildland Urban Interface.