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California Title 24-2016 Attic insulation

California Title 24 standards have continued to adopt more aggressive measures to meet California rigorous goals of Zero Net Energy (ZNE) for all newly constructed residential buildings by the year 2020. The most recent update to the Title 24 Building Standards is the adoption of the 2016 standards, effective for new residential buildings on January 1, 2017.

In earlier version of the Title 24 standards incremental improvements were required to lighting and lighting controls, Heating Ventilation Air Conditioning equipment (HVAC) and their duct systems. In more recent versions improvements were required to the thermal enclosure – increased wall and roof R-values, including the requirement of an attic radiant barrier; ventilation and more stringent air sealing and leakage requirements were added to the standards.

In the most recent version of Title 24-2016 there is another round of thermal enclosure improvements in the mandatory prescriptive measures that make significant changes to the thermal properties of both the wall and roof systems in nearly every climate zone. Again not to loose perspective here, but the goal is to require new residential buildings in California to be ZNE ready by the year 2020. So, it is likely to assume another round of changes will be impact the constructors of residential buildings with the development of CA Title 24-2019 standards.

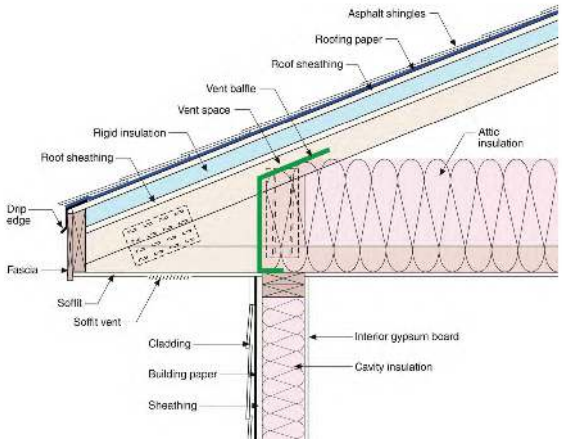
Regarding the prescriptive requirements for construction of “High Performance Attics” as indicated in the code language there are a number of obstacles seen in the eyes of the builders. In this short article our intent is to highlight the three key prescriptive assemblies and also outline several optional “performance based” alternatives. It is our goal in working with manufactures to further examine and model additional performance based assemblies. One of the biggest advantages in the code is currently using “Option C” to place ductwork inside the homes conditioned thermal enclosure, which we will explore further in the article.

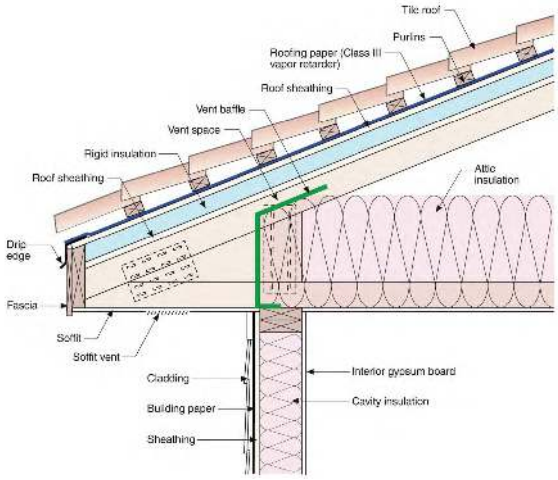
High Performance Prescriptive Vented Attic Options:

These options do not apply to CA Climate Zones 3, 5, 6 or 7

Option A – In CA Climate Zones 4 & 8 -16, construct a vented attic design assuming a slab on grade constructed home with the air handler and ductwork located inside the unconditioned attic. The typical insulation is placed on the flat attic ceiling at the prescribed R-Values (between R-30 and R-38). Install continuous insulation above the roof rafters or roof deck based on the type of roofing material installed. With a tile roof or roof that contains an airspace between underside of the roof cladding and roof structure an R-Value of 6 may be used. With tight fitting roof claddings, such as composite shingles with no airspace, a continuous insulation above the roof rafter with an R-Value of R-8 must be used.

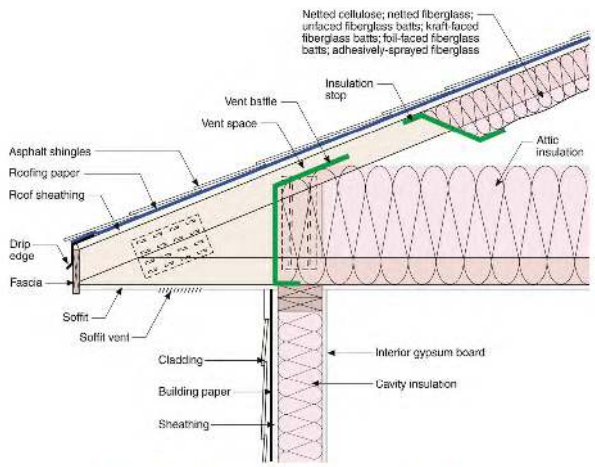
Below is a typical detail as provided by Building Science Corporation in research efforts for the California code. The details below indicate the typical “Option A” roof assemblies with R-8 insulation on top of the roof with composition shingles and R-6 with a vented tile roof.





Option B – In CA Climate Zones 4 & 8-16 construct a vented attic design assuming a slab on grade constructed home with the air handler and ductwork located inside the unconditioned attic. The typical insulation is placed on the flat attic ceiling at the prescribed R-Values (between R-30 and R-38). Install insulation directly below the roof deck or based on the type of roofing material installed. With a tile roof or roof that contains an airspace between underside of the roof cladding and roof structure an R-Value of 13 may be used. With tight fitting roof claddings, such as composite shingles with no airspace, a continuous insulation above the roof rafter with an R-Value of R-18 must be used.

Below is a typical detail as provided by Building Science Corporation in research efforts for the California code. This detail shows the "Option B" ventilated attic designs with R-18 and composition shingles on the left and R-13 with a ventilated tile roof.



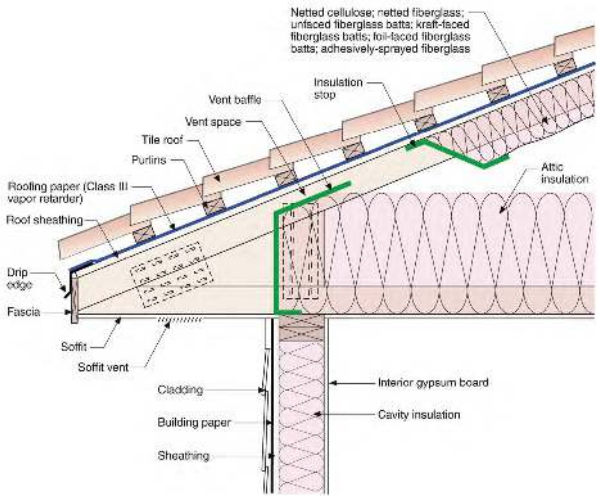
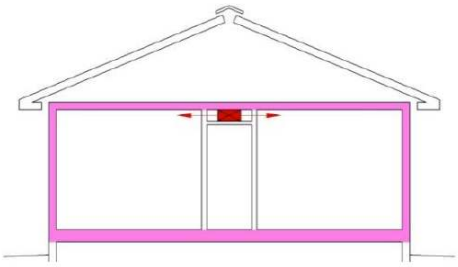
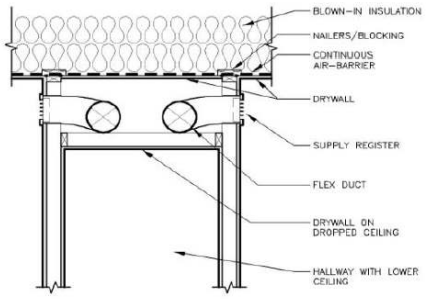


Figure 1: Venting Details for Modified Conventional Vented Attic

Option C – In all CA Climate Zones it is acceptable to construct a typical vented attic design as prescribed "Option C" and install all mechanical equipment and ductwork inside the homes thermal enclosure boundary (inside conditioned space). With this requirement it is possible to use typical blown attic insulation systems on the flat attic ceiling plane with additional requirements of installation of the attic radiant barrier application in Climate Zones 2-15. The only additional requirement is that a Home Energy Rater (HERS) professional verifies the location and installation of the homes mechanical and duct systems, including applicable duct leakage testing, if applicable.

Below is a basic diagram illustrating ducts inside the homes thermal enclosure from www.ductsinside.org





Placing ducts inside the homes thermal boundary will prove to be the most cost effective strategy for achieving the ZNE goals in California by 2020. Here are a few additional methods for builders to move mechanical systems inside:

- The installation of ductless or minimally ducted heat pump systems is a very cost effective and viable option.
- Using dropped ceilings or soffits to install ductwork while installing the air handler in a small closet within the homes conditioned space.
- On two story construction using a counterflow (downflow) furnace to move air into a duct system located between the homes 1st floor ceiling.
- Constructing trusses with an inverted soffit into the attic space for duct with the air handler located in a closet within the hoes conditioned space.
- Constructing over a sealed and conditioned crawl-space used to house ductwork and/or mechanical equipment.

Another version of the code language specifies “Deeply Buried Ducts” in the attic insulation, but it remains clear that this assembly would be quite difficult to construct. Essentially the same requirements for insulation and radiant barrier exist as in “Option C” with the air handler located in the homes thermal boundary. The ducts would need to be covered or buried within the attic insulation. Requirements indicate that the ductwork would need to be buried with at least R-25 insulation.

Other Title 24 Performance- Based Options have been identified which essentially place the mechanical systems and ductwork into the homes semi-conditioned or conditioned thermal boundaries. So essentially the CA Title 24 code has a 4th version of compliance, which also requires the home to have a Home Energy Rating System verification process. This is truly a “Performance Option” to the code and modeling of the home is required to predict energy use on par with a prescriptive home. The assembly consists of at least R-22 insulation applied directly to the underside of the roof deck. The insulation material can be either Spray Polyurethane Foam (SPF), netted and blown fibrous insulation materials (fiberglass or cellulose) or a combination of SPF and fibrous insulation.

Sealed and unvented attics: This is a strategy that has been in place for a number of years in various Climates Zones throughout the United States and Canada. Insulation materials are placed directly underneath the roof sheathing and there is no outside ventilation air to the attic. Terms used for this type of assembly are “Hot Roof”, “Sealed Attic”, and “Unvented Attics”.

Positive aspects of this assembly from a builder’s and energy perspective are:

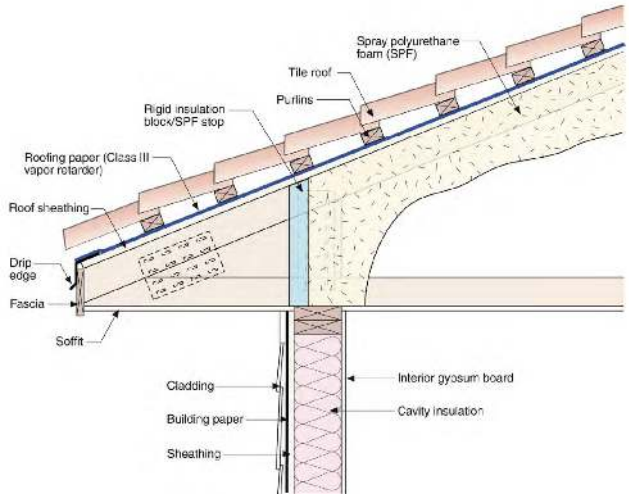
- There are no roof vents required
- A majority of duct leakage is contained within the homes conditioned space

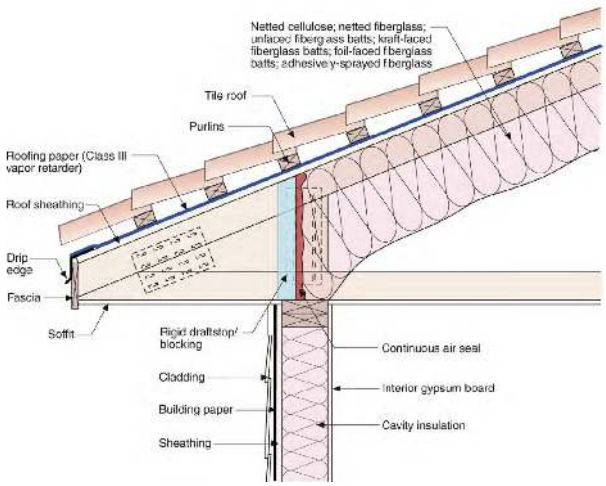
- Mechanical equipment located inside the homes conditioned space typically yields a reduction in cooling loads by at least 20% versus a typical vented attic design; so this equates to smaller HVAC equipment

Negative aspects of this assembly from a builder's and energy perspective are:

- Increased assembly cost $$
- Increased total thermal enclosure area
- Consistent field application of insulation materials and air sealing
- Additional costs to move beyond R-22 for the roof assembly. R-30 to R-40 would result improved thermal performance.

Below is a typical detail provided by Building Science Corporation in research efforts for the California code. The details below show a non-ventilated attic design using either SPF Insulation or netted and blown fibrous insulation systems.





California Title 24 Tabel 150.1-A : Attic Insulation Reference - OPTIONS A-B-C

Region		Option A			Option B			Option C			
Climate Zone	CA-Example City	Radiant Barrier Req'd Y / N	Attic Ceiling (flat) R-Value	Option A Above Rafter/ Deck Insulation No Air = Asphalt Air = Tile	Radiant Barrier Req'd Y / N	Below deck Insulation No Air = Asphalt Air = Tile	Attic Ceiling (flat) R-Value	Option C - Ducts and AHU In Cond. Space allowed Y / N	Radiant Barrier Req'd Y / N with opt C	Attic Ceiling (flat) R-Value	HER Rater Verify Y / N
1	Eureka Scotia Klamath Fort Bragg	N	38	No	N	N	38	Y	N	38	Y
2	Napa Ukiah Willits San Rafael	Y	38	No	Y	N	38	Y	Y	30	Y
3	Oakland / San Francisco	Y	30	No	Y	N	30	Y	Y	30	Y
4	San Jose Gilroy Sunnyvale Paso Robles	Y	38	No	N	No Air = 18 Air = 13	38	Y	Y	30	Y
5	Santa Maria San Luis Obispo Lompoc Pismo Beach	Y	30	No	Y	N	30	Y	Y	30	Y
6	Los Angeles X Santa Barbara Long Beach Torrance	Y	30	No	Y	N	30	Y	Y	30	Y

California Title 24 Tabel 150.1-A : Attic Insulation Reference - OPTIONS A-B-C

Region		Option A			Option B			Option C			
Climate Zone	CA-Example City	Radiant Barrier Req'd Y / N	Attic Ceiling (flat) R-Value	Option A Above Rafter/ Deck Insulation No Air = Asphalt Air = Tile	Radiant Barrier Req'd Y / N	Below deck Insulation No Air = Asphalt Air = Tile	Attic Ceiling (flat) R-Value	Option C - Ducts and AHU In Cond. Space allowed Y / N	Radiant Barrier Req'd Y / N with opt C	Attic Ceiling (flat) R-Value	HER Rater Verify Y / N
7	San Diego Oceanside Chula Vista La Mesa	Y	30	No	Y	N	30	Y	Y	30	Y
8	Long Beach Anaheim Tustin El Toro	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	30	Y
9	Los Angeles (Civic Center) Pasadena Burbank Pomona	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	30	Y
10	Riverside Redlands El Cajon San Bernadino	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	30	Y
11	Red Bluff Auburn Grass Valley Marysville	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	38	Y
12	Stockton Sacramento Merced Concord Lafayette	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	38	Y

California Title 24 Tabel 150.1-A : Attic Insulation Reference - OPTIONS A-B-C

Region		Option A			Option B			Option C			
Climate Zone	CA-Example City	Radiant Barrier Req'd Y / N	Attic Ceiling (flat) R-Value	Option A Above Rafter/ Deck Insulation No Air = Asphalt Air = Tile	Radiant Barrier Req'd Y / N	Below deck Insulation No Air = Asphalt Air = Tile	Attic Ceiling (flat) R-Value	Option C - Ducts and AHU In Cond. Space allowed Y / N	Radiant Barrier Req'd Y / N with opt C	Attic Ceiling (flat) R-Value	HER Rater Verify Y / N
13	Fresno Bakersfield Visalia Porterville	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	38	Y
14	Barstow Trona Palmdale Twentynine Palms	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	38	Y
15	Brawley Blythe El Centro Needles	Y	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	Y	38	Y
16	Bishop Sierra City Month Shasta Hetch Hetchy	N	38	No Air = 8 Air - 6	N	No Air = 18 Air = 13	38	Y	N	38	Y

Option A: A minimum R-value of continuous insulation installed above the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9A; or

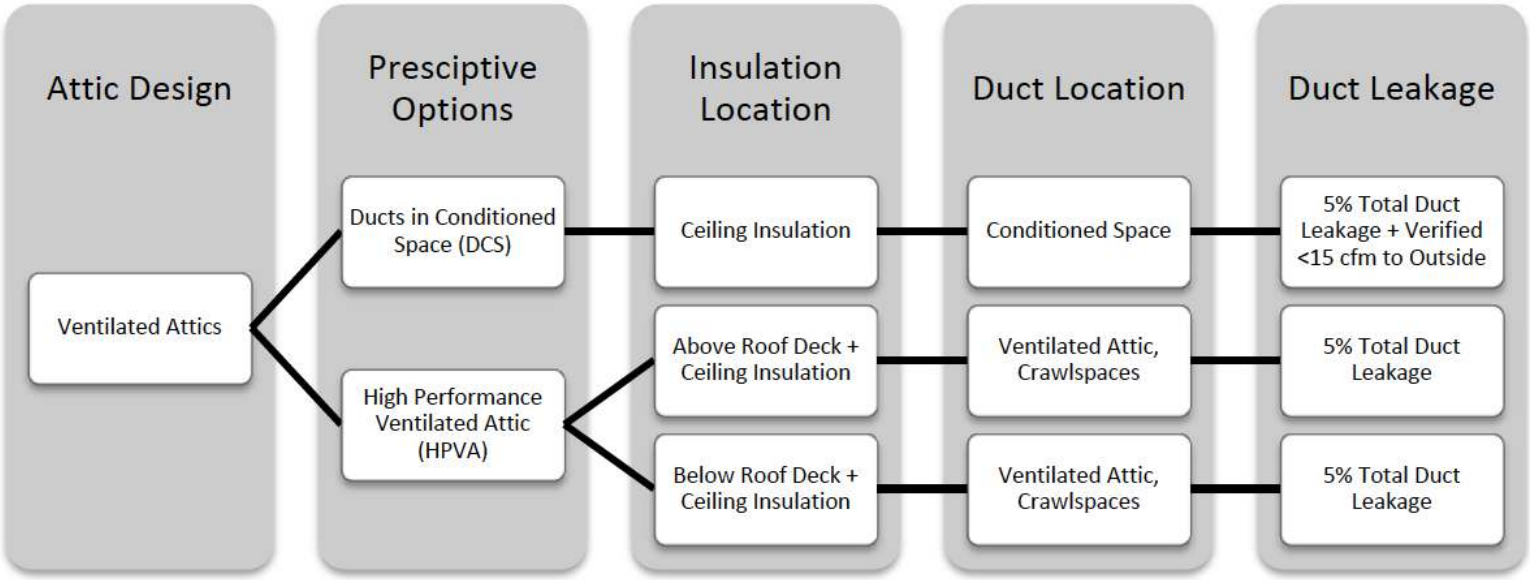
Option B: A minimum R-value of insulation installed between the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9A; or

California Title 24 Tabel 150.1-A : Attic Insulation Reference - OPTIONS A-B-C

Option C: A minimum R-value of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9B.
NOTE: Low rise residential single family and multi-family buildings with the ducts and air handler located in the conditioned space, as specified by Section 150.1(c)9B, need only comply with insulation requirements of Option C.

Below is a chart from the 2016 California Energy Commission - 2016 Building Energy Efficiency Standards

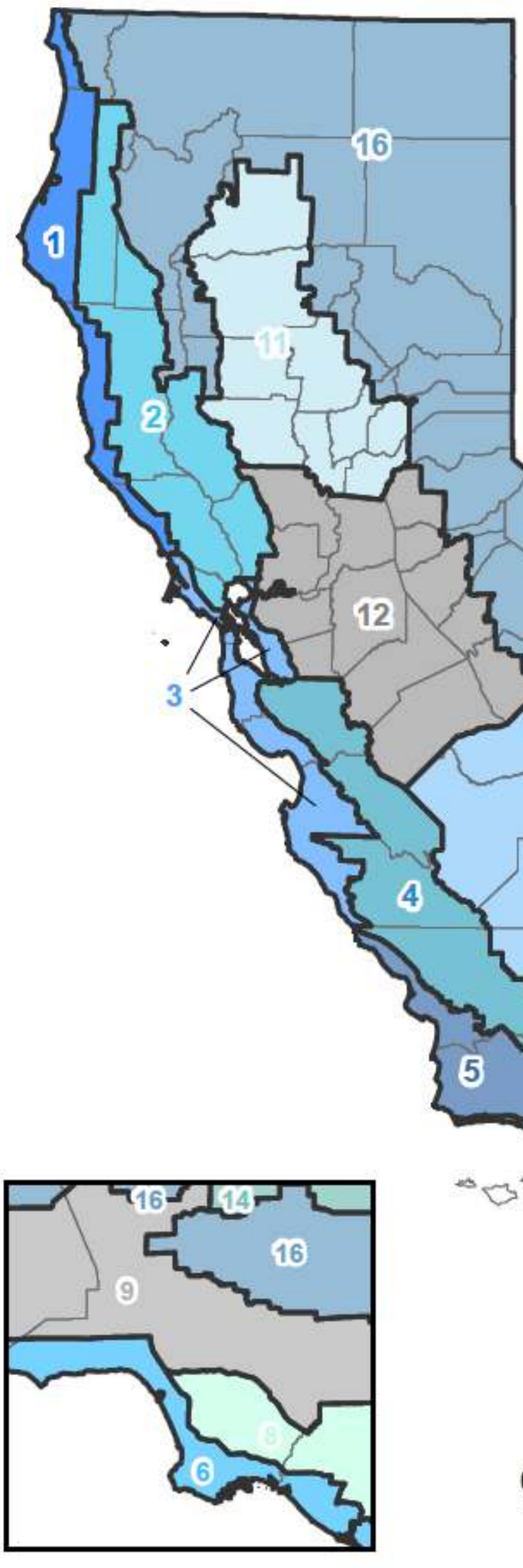
Figure 3-15: – Ventilated Attic Prescriptive Compliance Choices



High-Performance Ventilated Attic (HPVA) implements measures that minimize temperature difference between the attic space and the conditioned air being transported through ductwork in the attic. The package consists of insulation either below the roof deck or insulation above the roof deck in addition to insulation at the ceiling, R-8 ducts, and 5 percent total duct leakage of the nominal air handler airflow.

Building Climate Zones

California, 2015



Building Climate Zone

County Boundary

Source: California Energy Commission

0 100 200

Miles