AIAOC

PART 1:

Code Seminar- The Architectural Headaches of Energy Codes and Inspections issues for Contractor

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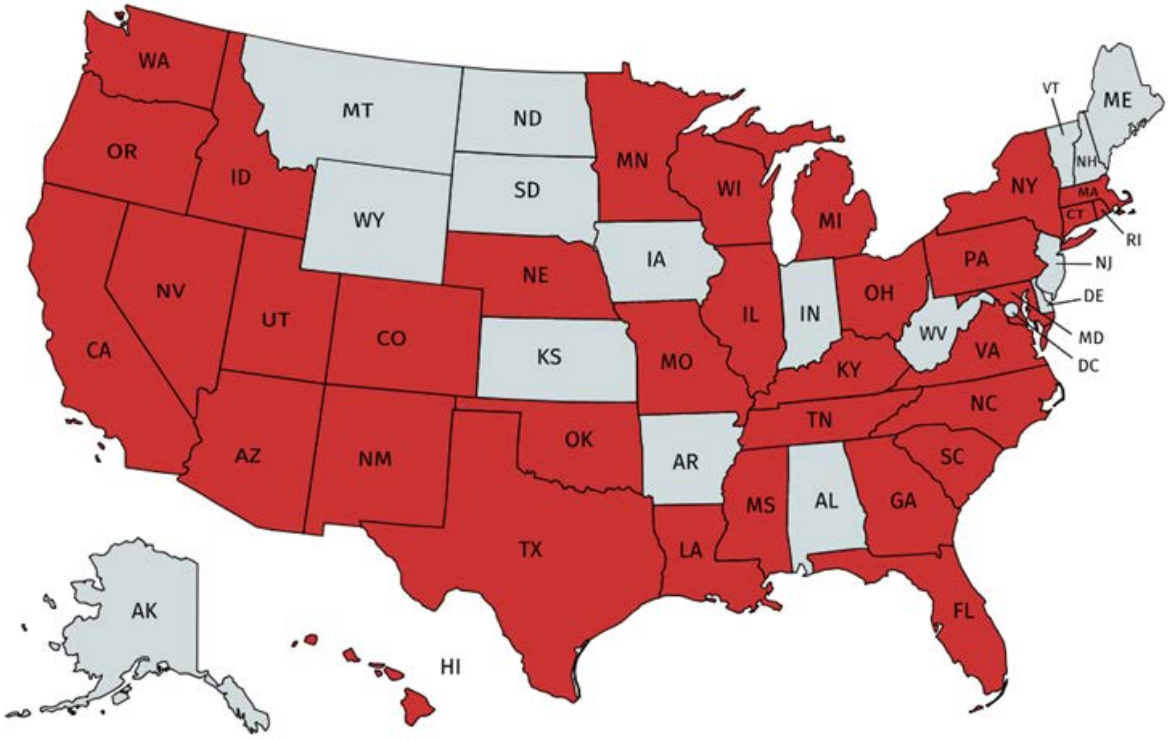
Covering the Nation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Part 1:

This seminar breaks the codes into components. In Part I, the insulation, the walls, the roofing materials are fully engaged and analyzed. In examining both residential and commercial issues the architectural detailing, constructability, and the inspectors are issues and elements addressed. Concerns that may arise in future must be addressed during the rough construction stage before they escalate to issues causing valuable construction time spent in correcting such issues.

Learning Objectives:

-Attendees will learn about how new California energy code changes impact their architectural firm projects as it relates to wall and roof design systems.

-Attendees will learn how to interact with contractors during construction inspections as they relate to the new energy codes. What is learned in this meeting can be used to mentor staff.

-Attendees will examine with the instructor how to achieve California energy laws in their initial project design.

-Attendees will learn how to address construction issues related to energy during rough construction so as not to cause overrun costs and project delays further along in the construction process.

Title-24

(Inception 1973)

>>>>>>>>>>>>>>>>>>>>>>>>>>>

Green Code

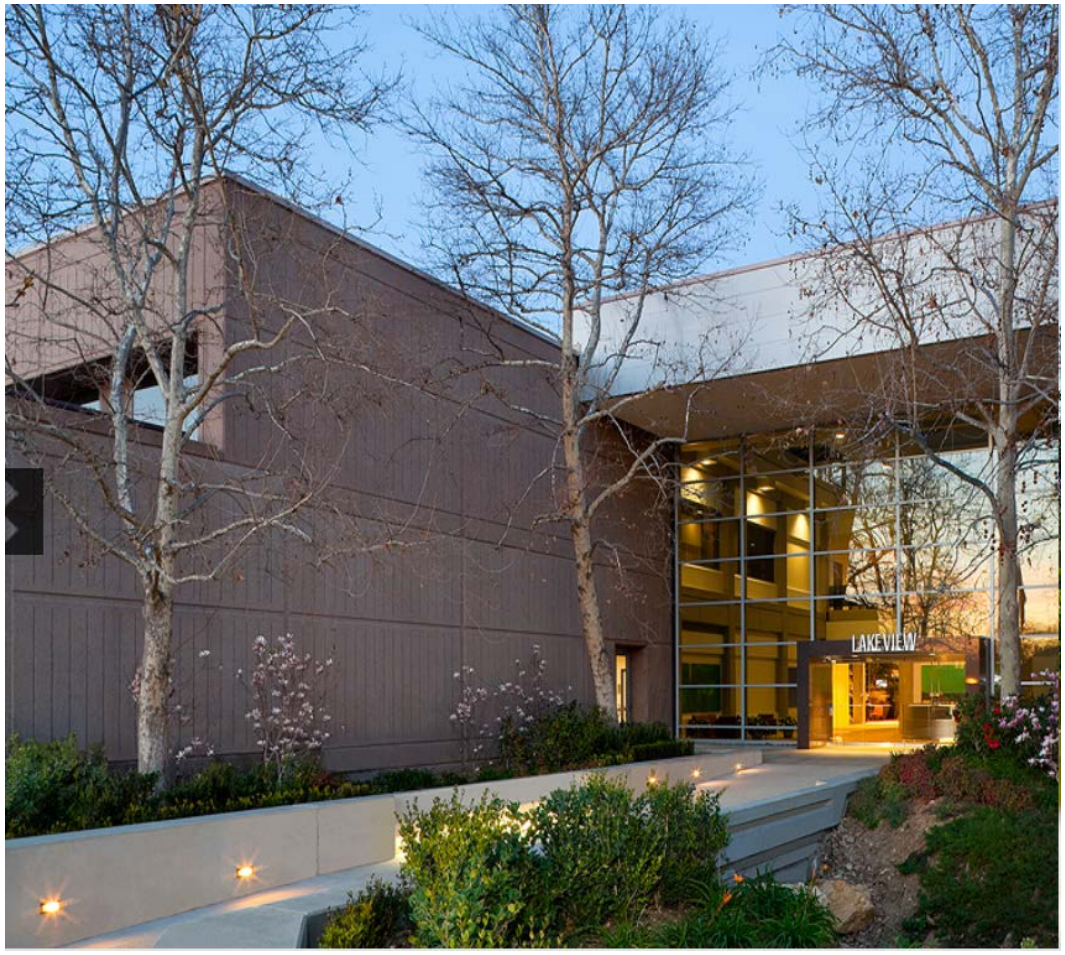
(Inception 2008)

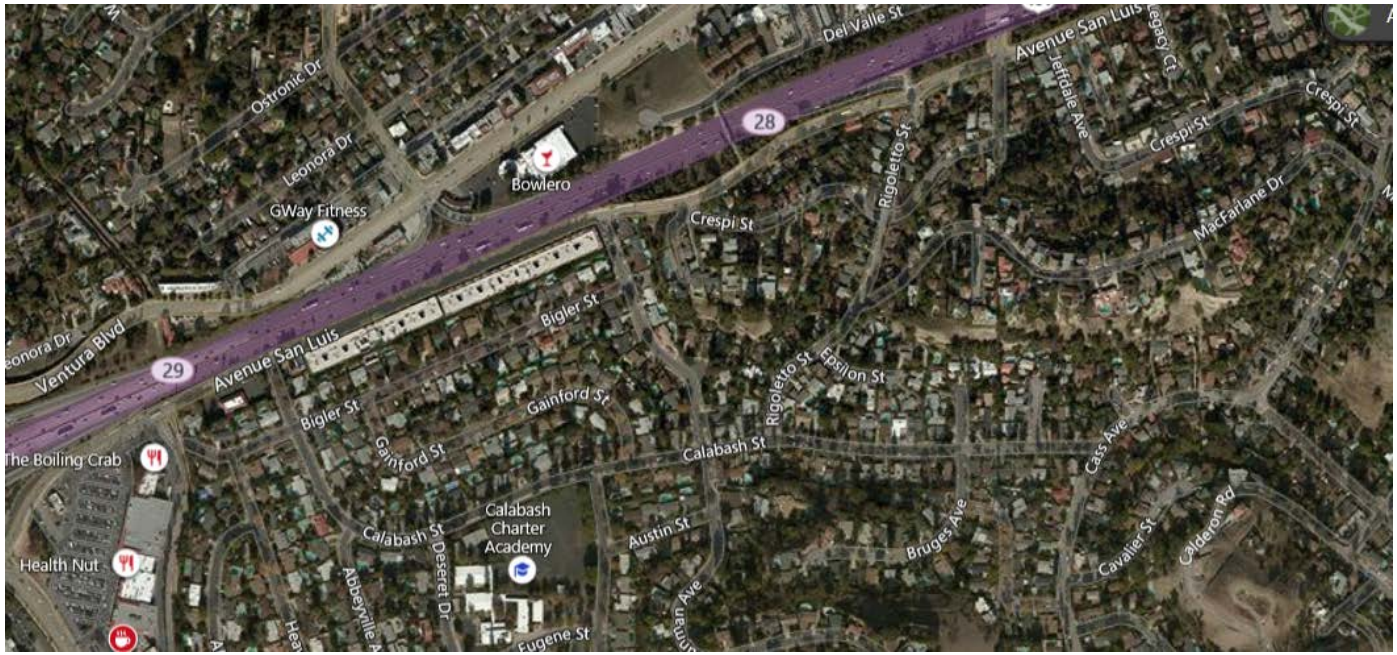
Year-in-Effect	Windows	Walls	Ceilings
1978	dual-pane R-1.5?	R-6	R-20
1980	?	R-6	R-20
1982 (pg 62)	R-0.9	R-11	R-20
1984 (pg. 149)	R-0.9	R-11	R-19
1986 (pg. 182)	R-0.9	R-11	R-19
1988 (pg. 182)	R-0.9/R-1.5	R-11	R-19/R-30
1992 (pg. 175)	R-0.9/R-1.5	R-13	R-19/R-30
1995 (pg. 179)	R-0.9/R-1.5	R-13	R-19/R-30
2001 (pg. 175)	R-0.9/R-1.5	R-13	R-19/R-30
2010 “2008” (pg. 143)	?	R-13	R-

Conservation Measure	Before 1978	1978 to 1983	1984 to 1991	1992 to 1998	1999 to 2000	2001 to 2003	2004 to 2005	2006 to 2013	2014 to ~~2016~~ Present
INSULATION U-FACTOR									
Cool Roof	0.10	0.10	0.10	0.10	0.10	0.10	0.10	Table 150.1-A or B	Table 150.1-A or B
Radiant Barrier	None	None	None	None	None	None	Table 150.1-A or B	Table 150.1-A or B	Table 150.1-A or B
Roof/Ceiling	0.079	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.031
Wall	0.356	0.110	0.110	0.102	0.102	0.102	0.102	0.102	0.102
Raised Floor –Crawl Space	0.099	0.099	0.099	0.049	0.049	0.049	0.049	0.049	0.037
Raised Floor-No Crawl Space	0.238	0.238	0.238	0.064	0.064	0.064	0.064	0.064	0.049
Slab Edge F-factor	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Ducts	R-2.1	R-2.1	R-2.1	R-4.2	R-4.2	R-4.2	R-4.2	Table 150.1-A or B	Table 150.1-A or B
LEAKAGE									
Building (ACH50)	7.7	7.7	7.7	7.7	7.7	7.7	7.7	6.8	5.0
Duct Leakage (%)	15%	15%	15%	15%	15%	15%	15%	15%	6%
FENESTRATION									
U-factor	Use Energy Standards Table 110.6-A , §110.6 for all Vintages								
SHGC	Use Energy Standards Table 110.6-B , §110.6 for all Vintages								
Shading Devices	Interior: Assumed to have draperies (not user editable). Exterior: Assumed to have 50% bugscreens, model actual overhangs.								
SPACE HEATING EFFICIENCY									
Gas Furnace (Central) AFUE	0.75	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Gas Heater (Room) AFUE	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Hydronic/Comb Hydronic	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
Heat Pump HSPF	5.6	5.6	6.6	6.6	6.8	6.8	6.8	7.4	7.7
Electric Resistance HSPF	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413	3.413
Electric Resistance Radiant HSPF	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.55	3.413

Ca wild Fires

assessments for unincorporated Sonoma Co are in: 3,819 destroyed parcels, $2.019 Billion. When Santa Rosa is combined, damage estimates top $3 billion


LAKEVIEW



Ventilation, Workforce, … Stops!

Codes:

Safe for People

Safe for Property

Safe for Environment

Big Bold Energy Efficiency Strategy (BBEES)

1. All new residential construction in California will be zero net energy **or equivalent to zero net energy by 2020**;

2. All new commercial construction in California will be zero net energy or **equivalent to zero net energy by 2030**;

‡Equivalency allows goal to be applicable to all buildings – even those unable to produce all net energy needs on site.

‡Equivalency builds on Title 24 concept of prescriptive standard and a performance calculation that results in equivalent energy consumption.

‡Equivalency in original intent reflected by original BBEES existing buildings goal:

"50 percent of **existing buildings** will be equivalent to zero net energy buildings by 2030 through achievement of deep levels of energy efficiency and clean distributed generation.

Zero Net Energy (ZNE) definition:

The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building.

Steps towards the ZNE:

Minimum Building Load>

Siting, configuration, envelope, ventilation, etc.

Optimized System Efficiency>

HVAC, Lighting, Hot Water, Controls, Process, etc.

Highest Efficient Appliances>

Refrigeration, washer/dryer, computers, entertainment, plug loads, etc.

Optimized Building Operations>

Occupancy, outside air, setpoints, fan schedules, Off Hour, Operations, etc.

Optimized Occupant Behaviors>

Lights, windows, hot water, cooking, plug loads, etc.

Renewable Power Generation….

Onsite, Remote, etc.

Every 3 years, the CEC's team has to find 20-30% energy savings that: Payback within 30 years Industry won't veto Buildable Technology is ready CASE teams propose changes Stakeholder meetings CEC evaluates CASE reports

California Green Code

AIA California Council

Downloads are (*Hyperlinks*):

California Green Building Codes

PDF Format

Click here for Residential checklist in PDF format.

Click here for Non-Residential checklist in PDF format

DWG Format

Click here for Residential checklist in DWG format.

Click here for Non-Residential checklist in DWG format.

2016 CalGreen Residential PDFs Download Page

- Click here to download Residential checklist 1 in PDF format.
- Click here to download Residential checklist 2 in PDF format.

Our Goal:

Ca Title 24 2019 energy save?

Residential

Single-family homes: 7 percent less energy due to energy efficiency measures

With rooftop solar electricity generation is factored: 53 percent less energy

Reduce greenhouse gas emissions: 700,000 metric tons over three years, equivalent to taking 115,000 fossil fuel cars off the road.

Cost added 2019 standards for new home?

On average: increase the cost of constructing a new home by about $9,500

Savings: $19,000 in energy and maintenance costs over 30 years.

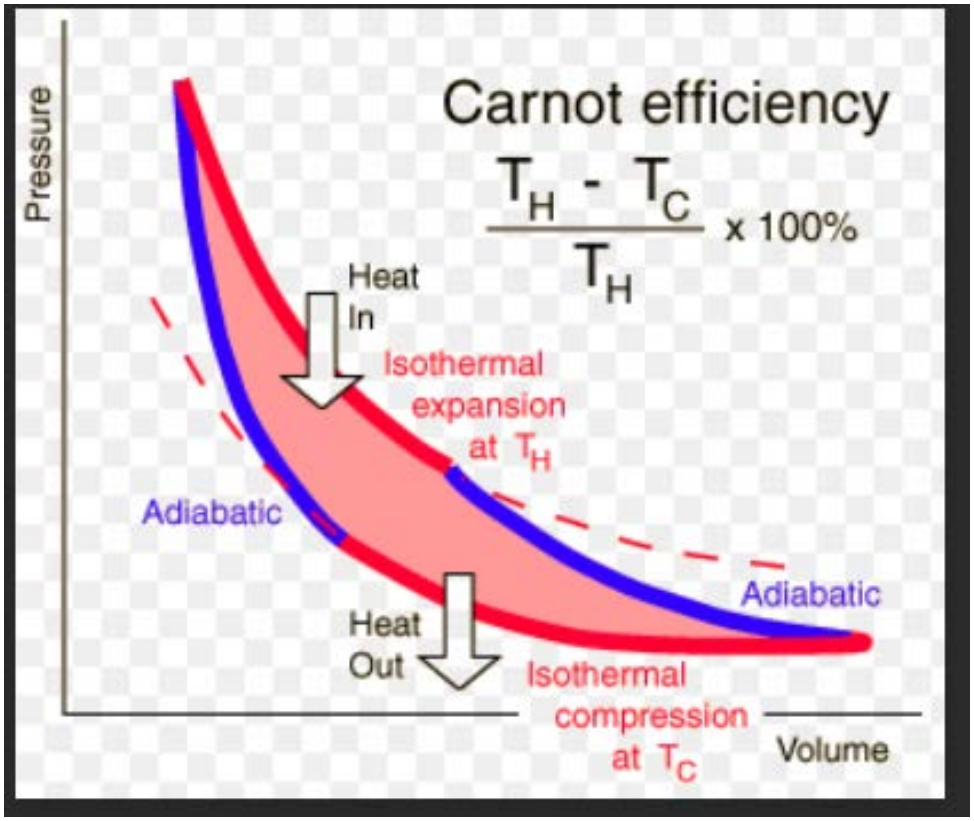
Based on a 30-year mortgage, the Energy Commission estimates that the standards:

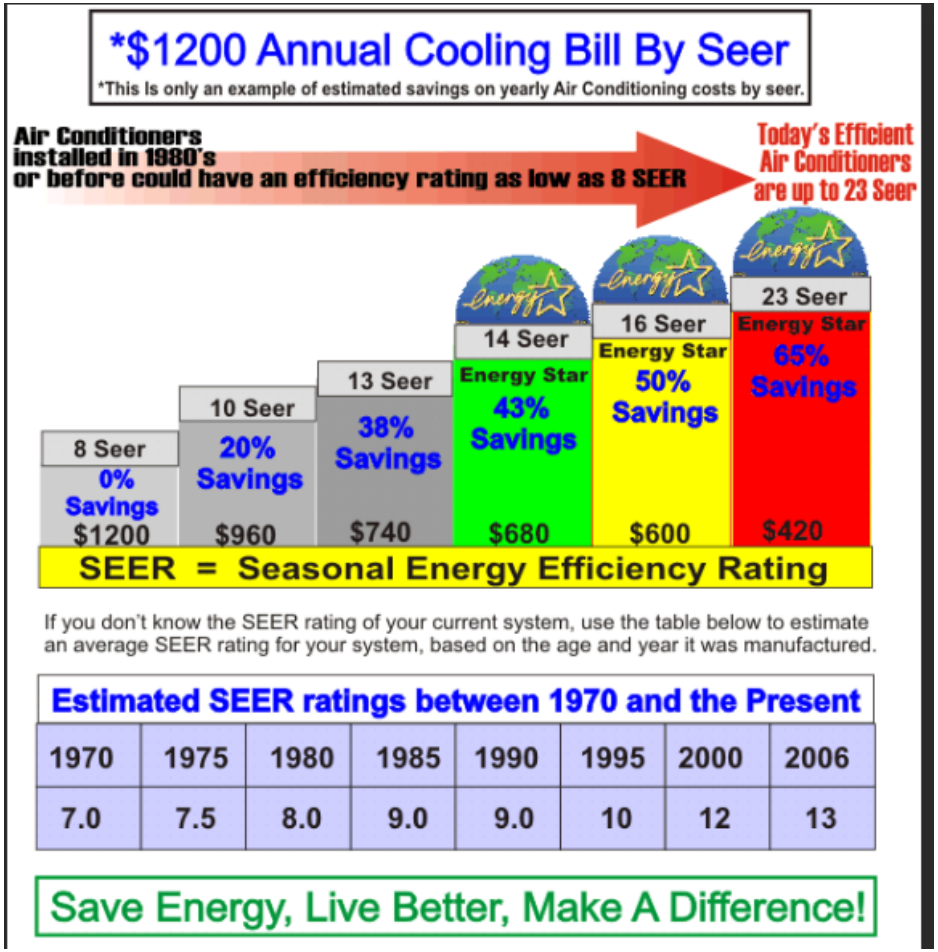
- add about $40 per month for the average home, but
- save consumers $80 per month on heating, cooling and lighting bills.

Nonresidential

buildings will use about 30 percent less energy due mainly to lighting upgrades

Why not HVAC?


Carnot efficiency
$\frac{T_H - T_C}{T_H}$ x 100%
Pressure
Heat In
Isothermal expansion at T_H
Adiabatic
Adiabatic
Heat Out
Isothermal compression at T_C
Volume


*$1200 Annual Cooling Bill By Seer
*This Is only an example of estimated savings on yearly Air Conditioning costs by seer.
Air Conditioners installed in 1980's or before could have an efficiency rating as low as 8 SEER
Today's Efficient Air Conditioners are up to 23 Seer
8 Seer
0% Savings
$1200
10 Seer
20% Savings
$960
13 Seer
38% Savings
$740
14 Seer
Energy Star
43% Savings
$680
16 Seer
Energy Star
50% Savings
$600
23 Seer
Energy Star
65% Savings
$420
SEER = Seasonal Energy Efficiency Rating
If you don't know the SEER rating of your current system, use the table below to estimate an average SEER rating for your system, based on the age and year it was manufactured.
Estimated SEER ratings between 1970 and the Present
1970 1975 1980 1985 1990 1995 2000 2006
7.0 7.5 8.0 9.0 9.0 10 12 13
Save Energy, Live Better, Make A Difference!

APPLIANCE	TYPE	SEER Effective Before 1/1/2015	SEER Effective 1/1/2015	EER Effective 1/1/2015
Central Air Conditioners	Split System <45,000 Btuh	13.0	14	12.2
	Split System ≥45,000 Btuh	13	14	11.7
	Single Package	13	14	11
Central Air Source Heat Pumps	Split System	13	14	NR
	Single Package	13	14	NR
Space Constrained Air Conditioner	Split System	12	12	NR
	Single Package	12	12	NR
Space Constrained Heat Pump	Split System	12	12	NR
	Single Package	12	12	NR
Through-The-Wall Air Conditioner	Split System	10.9	10.9	NR
	Single Package	10.6	10.6	NR
Through-The-Wall Heat Pump	Split System	10.9	10.9	NR
	Single Package	10.6	10.6	NR
Smal Duct, High Velocity Air Conditioner	All	13	13	NR
Smal Duct, High Velocity Heat Pump	All	13	13	NR

Issues and Players in 2019 T24

- 1: Housing affordability
- 2: Photovoltaic costs
- 3: Photovoltaic system maintenance costs
- 4: Photovoltaic mandate
- 5: Rooftop solar vs utility-scale system
- 6: Excess midday solar capacity
- 7: Statewide electricity rate assumptions
- 8: Solar system lifespan
- 9: Emissions reduction benefits
- 10: Net energy metering and cost effectiveness
- 11: Battery storage benefits
- 12: Stakeholder input

- What does T24 do every three years? California enhances its energy code: get 20-30% more efficient 7%?
- What is unique about 2019 California energy code? This code cycle will be known as the "net-zero code cycle."
- What is "net-zero code cycle"? All new homes and multifamily units must have PV panels installed to produce electricity on-site.
- Why? To offset their use of energy.
- Batteries are now incorporated in the solar systems.

- Batteries ..... Hmmmmmmmmm?!
- Warning from Saum:

- **There are many Architectural/Engineering issues in Batteries.**

Payback for any work: 30 years

- If technology is available, code will adhere it – with push back from users!
- Hospitals are now part of Title-24.
- There is more…. ! But first.

- Little history of prescriptive Wall Insulation: Prior to 2008, 2x4 walls were R11, in 2008 became R13, 2013 added R5 continuous exterior u=insulation, in 2016 assumed walls are 2x6 R16 plus continuous R5, and in 2019, value increased to R21 + R5 continuous insulation.

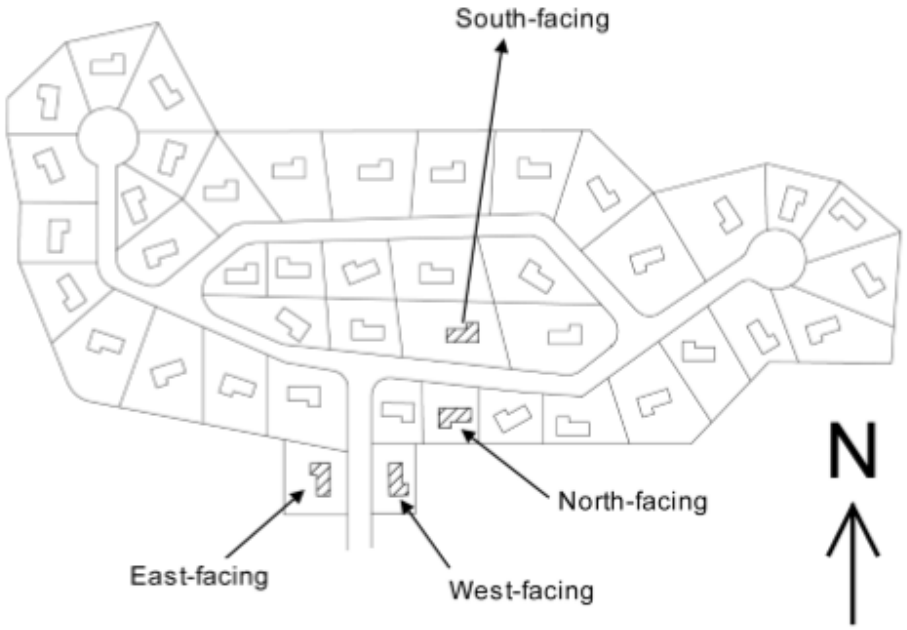
- Are push backs by industry effective?
- Air impermeable space- Story. Foam.
- Fan Watts changed from 0.58 Watts/cfm to 0.45 Watts/cfm
- Door U factors are now insulated 0.5 to 0.2

- Prescriptive vs Performance
- If you run a house with 2016 vs 2019 program. The house will not comply.

Not fully engaged in industry…..

Let’s implement this for a ….

Figure 8-2: Subdivisions and Master Plans Compliance Option



Demonstrate Compliance for Each Cardinal Orientation for Each Basic Model Type

For compliance, submit certificate of compliance documentation of the energy budgets for each of the four orientations to the enforcement agency. Only one CF1R form that documents compliance for all four orientations is required to be submitted to the enforcement agency for each unique or reverse plan.

- Now the roof like front elevations must be universal and altered… to have same savings.

- Metal framing is now in residential. Not in state program.

- Unvented Attic Insulation

……

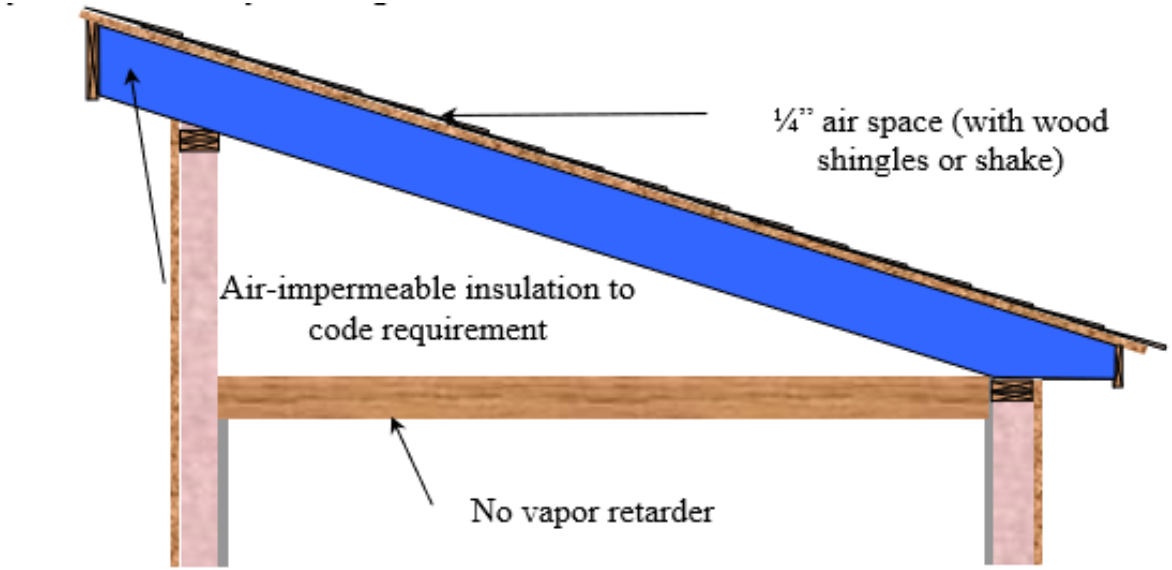
Unvented Attic Assemblies Factsheet WSU Energy Program May 22, 2009

The Washington State University Energy Program (WSUEP) has received a number of questions regarding the Washington State Building Code Council's (SBCC) approval of an Energy Code change allowing unvented attics. The code change will go into effect on July 1, 2010, barring any additional changes prior to that time. The new language is an exception to WSEC Section 502.1.6.3, and is underlined below.

502.1.6.3 Roof/Ceilings: Roof/ceiling assemblies where the ventilation space above the insulation is less than an average of 12 inches shall be provided with a vapor retarder. Faced batt insulation where used as a vapor retarder shall be face stapled. Single rafter joist vaulted ceiling cavities shall be of sufficient depth to allow a minimum one inch vented air space above the insulation.

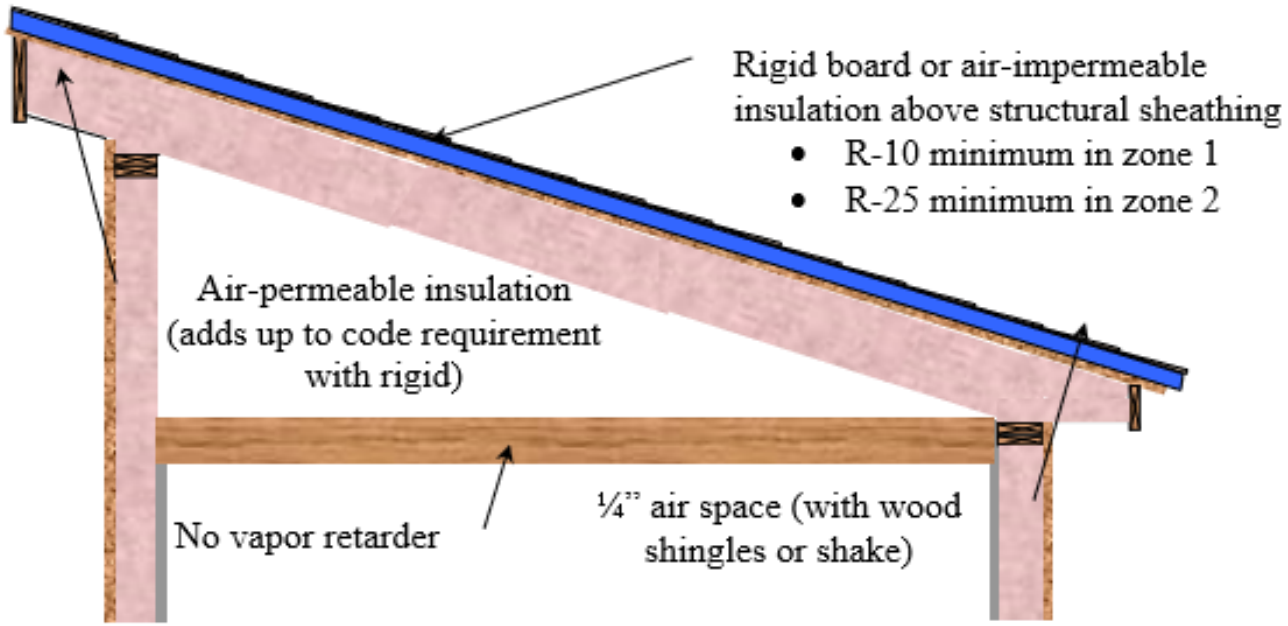
EXCEPTION: Unvented attic assemblies (spaces between the ceiling joists of the top story and the roof rafters) shall be permitted if all the following conditions are met: 1. The unvented attic space is completely contained within the building thermal envelope. 2. No interior vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly. 3. Where wood shingles or shakes are used, a minimum 1/4 inch (6 mm) vented air space separates the shingles or shakes and the roofing underlayment above the structural sheathing. 4. Any air-

impermeable insulation shall be a vapor retarder, or shall have a vapor retarder coating or covering in direct contact with the underside of the insulation. 5. Either Items a, b or c shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing. a. Air-impermeable insulation only. Insulation shall be applied in direct contact to the underside of the structural roof sheathing.



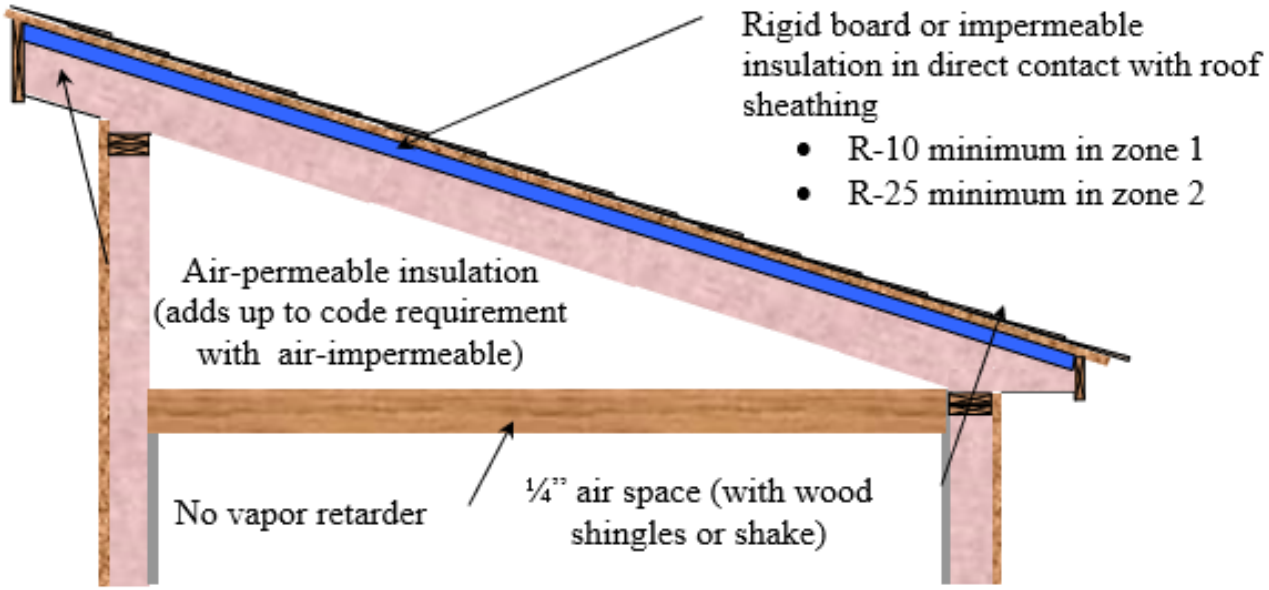
Exception 5. a – air impermeable insulation only, in direct contact with roof sheathing

b. Air-permeable insulation only. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing as specified per WA Climate Zone for condensation control. i. Climate Zone #1 - R-10 minimum rigid board or air-impermeable insulation R-value. ii. Climate Zone #2 - R-25 minimum rigid board or air-impermeable insulation R-value.



Exception 5. b – air permeable insulation interior, air impermeable exterior.

c. Air-impermeable and air-permeable insulation. The air-impermeable insulation shall be applied in direct contact to the underside of the structural roof sheathing as specified per WA Climate Zone for condensation control. The air-permeable insulation shall be installed directly under the airimpermeable insulation. i. Climate Zone #1 - R-10 minimum rigid board or air-impermeable insulation R-value. ii. Climate Zone #2 - R-25 minimum rigid board or airimpermeable insulation R-value.



Exception 5. c – air impermeable and air permeable insulation interior

This code change is effective on 7/1/10. Some jurisdictions have allowed builders to use this exception prior to its official adoption date. We recommend that the applicant closely follow the manufacturer's installation instructions. In addition, builders should be aware that you may be taking on additional liability since this code change has not officially gone into effect.

- Know what type of product you are using. Is it rigid sheet foam, open cell (usually 0.5 to 0.8lb/ft3) or closed cell (usually 2 lb/ft3) spray applied product? What is its R-value per inch? Look at its ICC Evaluation Service report (http://www.icc-es.org/); does its listing allow it to be applied to WSEC required levels, or are there limitations due to flame spread? What will its installed vapor permeance be?

- In traditional vented attics, the vast amount of moisture intrusion into attic spaces is via air leaks in the ceiling, through light fixtures and other penetrations. As such, air sealing details present in the WSEC are critical in avoiding moisture problems in that space. However, with the unvented attic assembly approach, the unvented attic space is designed and expected to operate close to the temperature and humidity levels of the living space below; as such, no special air sealing at the ceiling is needed.

- The requirement that there be no vapor retarder on the interior ceiling of the unvented attic assembly is primarily intended to avoid trapping warm moist air in the attic area in warm humid climates (not an issue in Washington) but also to make it clear that a vapor retarder is not needed at the ceiling level for the unvented attic assembly application anywhere

• Exceptions 5a and 5c will be used for spray foam application directly to the underside of the roof sheathing. This application can result in reduced building enclosure air leakage. If ducts are installed in the attic, it will minimize impacts of duct leaks.

• Exceptions 5b and 5c allow for combinations of air-impermeable and air permeable insulations in unvented attic assemblies. These are commonly referred to as “hybrid systems”. The potential problem with this type of system is creating a condensing surface where an air impermeable layer transitions to an air permeable one. Indoor vapor could migrate through the air permeable layer and be stopped by the interior surface of the air impermeable layer. If the minimum rigid board or air-impermeable insulation R-value requirements are not met, this surface may be cold enough to be a condensing surface, potentially leading to mold and rot.

Good Discussion

https://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-04-04_forum/presentations/High_Performance_Attics/Owens_Corning_ORNL_KB Homes_Collaborative_Study_Unvented_Attics_Building.pdf

R values of 80

- Moisture in above and below roof deck insulation
- Impact of vented and non-vented attics on moisture in attics
- Performance Result

Change in the program in the middle of the cycle?!

What is HPA?

HP=

High Performance

High Performance Attics (HPA) implements measures that minimize temperature difference between the attic space and the conditioned air being transported through ductwork in the attic. Ducts in Conditioned Space (DCS), locates ducts and air handlers in the building's thermal and air barrier envelope.

http://title24stakeholders.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_HPA_Final_September-2017.pdf

2.3 Summary of Proposed Changes to Code Documents

The sections below provide a summary of how each Title 24, Part 6 documents would be modified by the proposed change. See Section 7 of this report for detailed proposed revisions to code language.

2.3.1 Standards Change Summary

This proposal would modify the sections of the Building Energy Efficiency Standards described below. See Section 7.1 of this report for the detailed proposed revisions to the code language.

SECTION 150.1 – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR LOW-RISE RESIDENTIAL BUILDINGS

TABLE 150.1-A COMPONENT PACKAGE-A STANDARD BUILDING DESIGN: The proposed code change increases the Option A and B insulation R-value prescriptive requirements for certain climate zones. The existing Table 150.1-A is expanded to more thoroughly convey

differences in the prescriptive insulation requirements between single family and low-rise multifamily buildings.

SECTION 150.2 – ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS TO EXISTING LOW-RISE RESIDENTIAL BUILDINGS

Section 150.2(a)1Aiii is added to clarify that the prescriptive requirements for additions greater than 700 ft2 would not change from the 2016 prescriptive requirements.

2.3.2 Reference Appendices Change Summary

The HPA measure is associated with the quality insulation installation (QII) measure, which is also a proposed prescriptive requirement for the 2019 Title 24, Part 6 update. As part of the refinement of the HPA below-deck measure, the Statewide CASE Team is proposing modifications and enhancements to section 3.5 of the Residential Reference Appendices to clarify QII inspection procedures. Proposed

code language changes related to this can be found in the QII CASE Report.

2.3.3 Alternative Calculation Method (ACM) Reference Manual Change Summary

This proposal modifies the sections of the Residential Alternative Calculation Method (ACM) Reference Manual as outlined below. See Section 7.3 of this report for the detailed proposed revisions to the text of the Residential ACM Reference Manual.

SECTION 2 – The Proposed Design and Standard Design

2.5.6.1 (Ceilings Below Attics): The proposed change increases the above and below deck insulation requirements.

2.2.3 (PV Credit): The Statewide CASE Team's understanding is that the Energy Commission will eliminate the PV Credit available under the 2016 Title 24, Part 6 code as outlined in section

2.2.3. 2.3.4 Compliance Manual Change Summary

The proposed code change modifies Section 3.6.2.1: Roof/Attic of the Residential Compliance Manual, which covers new construction prescriptive requirements related to HPA.

2.3.5 Compliance Documents Change Summary

The compliance documents related to specification of below-deck insulation configuration (CF2R-ENV03-E).

Table 3: Existing 2016 Title 24, Part 6 Residential Prescriptive HPA Requirements

TABLE 150.1-A COMPONENT PACKAGE-A STANDARD BUILDING DESIGN

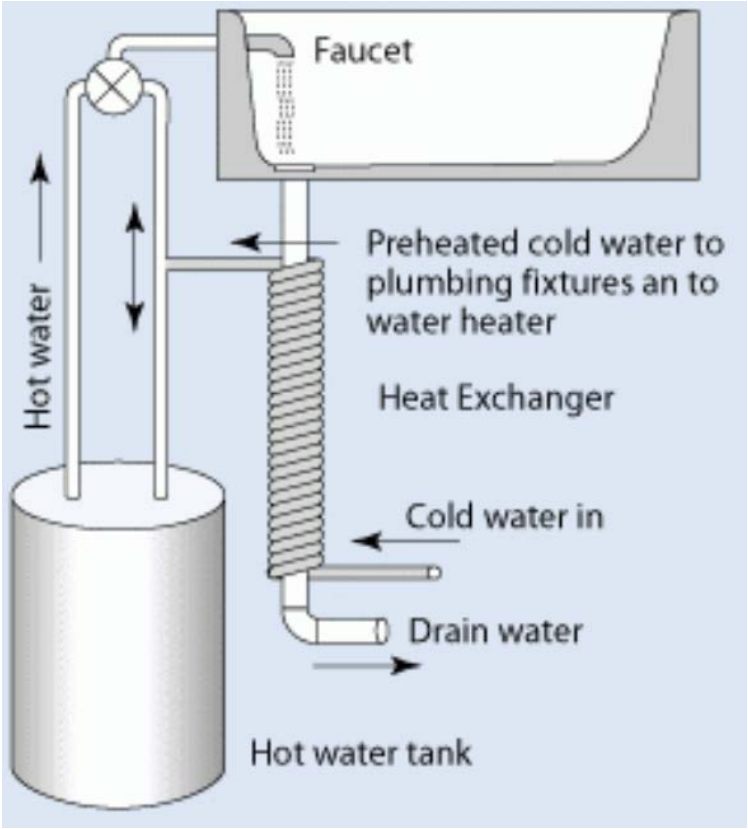
						Climate Zone															
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Building Envelope Insulation	Roofs/Ceilings	Option A (meets §150.1(c)9A)	Continuous Insulation Above Roof Rafter	Roofing Type	No Air Space[1]	NR	NR	NR	R 8	NR	NR	NR	R 8	R 8	R 8	R 8	R 8	R 8	R 8	R 8	R 8
					With Air Space[2]	NR	NR	NR	R 6	NR	NR	NR	R 6	R 6	R 6	R 6	R 6	R 6	R 6	R 6	R 6
				Ceiling Insulation		R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
				Radiant Barrier		NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Option B (meets §150.1(c)9A)	Below Roof Deck Insulation[3]	Roofing Type	No Air Space	NR	NR	NR	R 18	NR	NR	NR	R 18	R 18	R 18	R 18	R 18	R 18	R 18	R 18	R 18
					With Air Space	NR	NR	NR	R 13	NR	NR	NR	R 13	R 13	R 13	R 13	R 13	R 13	R 13	R 13	R 13
				Ceiling Insulation		R 38	R 38	R 30	R 38	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38	R 38
				Radiant Barrier		NR	REQ	REQ	NR	REQ	REQ	REQ	NR	NR	NR	NR	NR	NR	NR	NR	NR
		Option C (meets §150.1(c)9B)		Ceiling Insulation		R 38	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 30	R 38	R 38	R 38	R 38	R 38	R 38
				Radiant Barrier		NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR

CONTINUED: TABLE 150.1-A COMPONENT PACKAGE-A STANDARD BUILDING DESIGN (CONTINUED)

				Climate Zone															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HVAC SYSTEM	Space Heating[11]	Electric-Resistance 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[9]		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
		Refrigerant Charge Verification or Fault Indicator Display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR
		Whole House Fan[10]		NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR	NR
	Central System Air Handlers	Central Fan Integrated Ventilation System Fan Efficacy		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Ducts[12]	Roof/Ceiling Options A & B	Duct Insulation	R-8	R-8	R-6	R-8	R-6	R-6	R-6	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
			§150.1(c)9A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Roof/Ceiling Option C	Duct Insulation	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6	R-6
			§150.1(c)9B	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Water Heating	All Buildings			System Shall meet Section 150.1(c)8															

Reduced glazing, window shading

Drain Water Heat Recovery? !



3%

How It Works

Drain-water heat recovery technology works well with all types of water heaters, especially with demand and solar water heaters. Drain-water heat exchangers can recover heat from the hot water used in showers, bathtubs, sinks, dishwashers, and clothes washers. They generally have the ability to store recovered heat for later use. You'll need a unit with storage capacity for use with a dishwasher or clothes washer. Without storage capacity, you'll only have useful energy during the simultaneous flow of cold water and heated drain water, like while showering.

Some storage-type systems have tanks containing a reservoir of clean water. Drain water flows through a spiral tube at the bottom of the heat storage tank. This warms the tank water, which rises to the top. Water heater intake water is preheated by circulation through a coil at the top of the tank.

Non-storage systems usually have a copper heat exchanger that replaces a vertical section of a main waste drain. As warm water flows down the waste drain, incoming cold water flows through a spiral copper tube wrapped tightly around the copper section of the waste drain. This preheats the incoming cold water that goes to the water heater or a fixture, such as a shower.

By preheating cold water, drain-water heat recovery systems help increase water heating capacity. This increased capacity really helps if you have an undersized water heater. You can also lower your water heating temperature without affecting the capacity.

Cost and Installation

Prices for drain-water heat recovery systems range from $300 to $500. You'll need a qualified plumbing and heating contractor to install the system. Installation will usually be less expensive in new home construction. Paybacks range from 2.5 to 7 years, depending on how often the system is used.

Battery credit subs for efficiency & PV


TESLA
TESLA

Batteries:

Need ventilation

Spill Control

H2 Generation

Life Expectancy

AIAOC

PART 2:

Code Seminar- The Architectural Headaches of Energy Codes and Inspections issues for Contractor

December 5, 2018

"Dr. Saum K. Nour, Ph.D."
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Covering the Nation

Review:

HPA, HPW

New:

Conventional Wall

vs

HPW

Began in 2016

High Performance Walls

One of the challenges in the 2016 energy code is the increased energy requirements of wall construction, termed High Performance Walls. The 2016 Standard Energy Design Budget bases wall construction on 2x6 framing with an exterior insulation. While on paper, it is easy for an energy consultant to show this type of construction, application in the field is quite a different story.

Here are links to articles written by Joseph W. Lstiburek, Ph.D., P. Eng., of *Building Science Corporation*. According to an article in the Winter 2017 CABEC Newsletter, written by Eric Werling (from Building Technologies Office, Department of Energy), "*Dr. Lstiburek has worked for decades helping builders improve the thermal performance and durability of their buildings. Dr. Joe knows building envelopes — the good, the bad, and the ugly*".

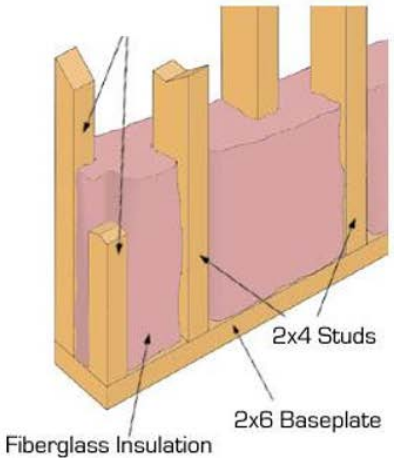
These articles address choosing the right materials, differences in climate zones, moisture problems and so forth.

- **RR-0406: Face Sealed vs. Drainable EIFS**
- **BSD-146: EIFS — Problems and Solutions**
- **ETW: Wall — Exterior Insulation Finish Systems (EIFS) Wall Construction**

Proposed U-factor = 0.05
□Continuous Insulation
□Staggered Stud Wall
□2x6 construction

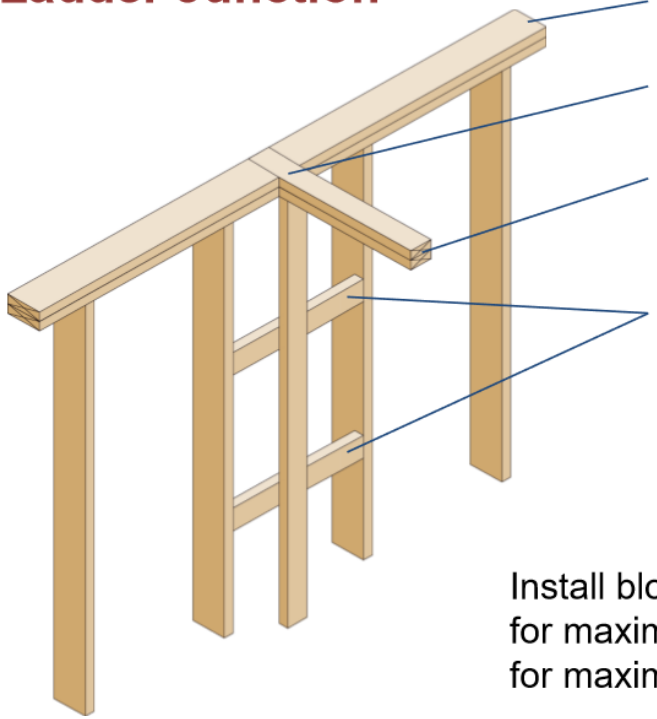

Styrofoam

Staggered Studs




Windows fall on 2-ft. layout
Stacked framing
Headers sized properly
2x6 studs 24 in. on center

Ladder Junction



Double top plate

3" x 6" x 0.036" galvanized steel plate

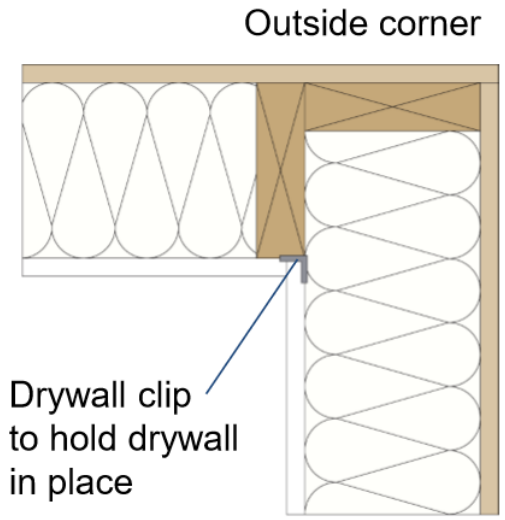
Interior wall

2x ladder blocking at 24"o.c.

Install blocking with wide face vertical
for maximum backing to wall finish and
for maximum insulation in exterior walls.

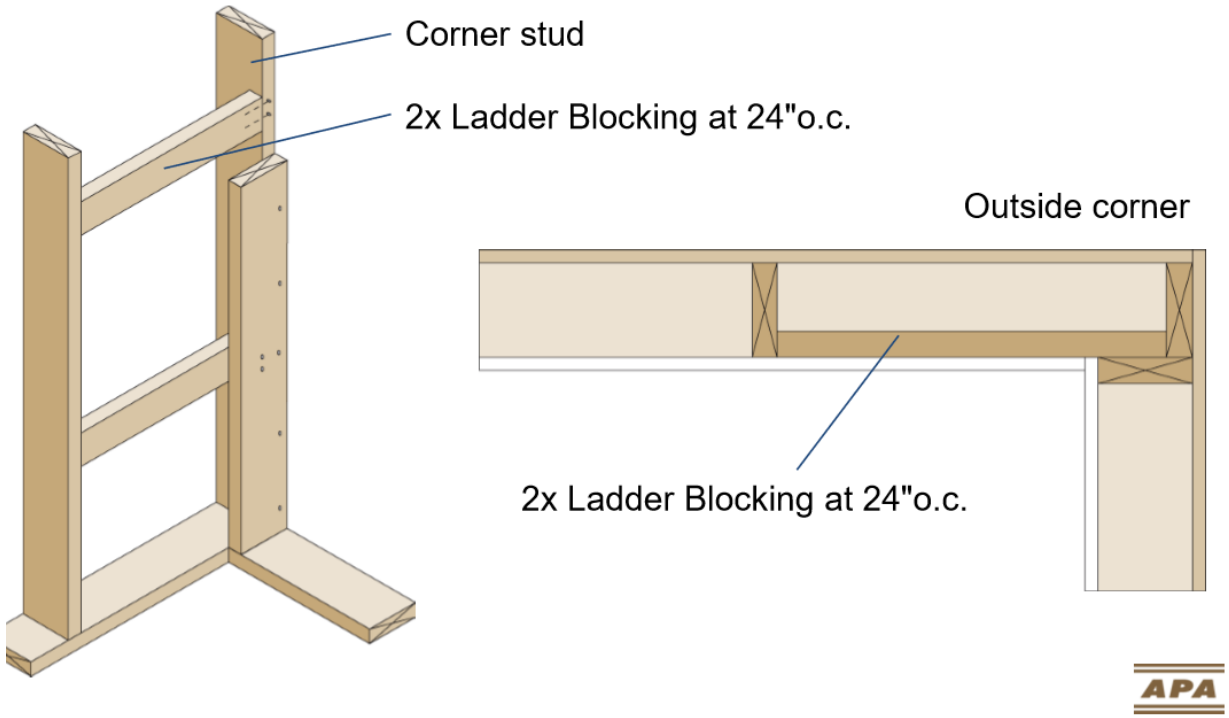
1. Switch to 2x6 studs to increase cavity insulation depth.
2. Change wall framing module from 16" o.c. to 24" o.c. (The use of double top plates avoids the need for in-line framing.)
3. Incorporate other techniques:
   - Ladder blocking at intersecting wall
   - Energy efficient corners (begin with 3-stud corners)
   - Implement energy-efficient headers and
   - High Performance attic detailing

Two-stud Corner (with Drywall Clips)

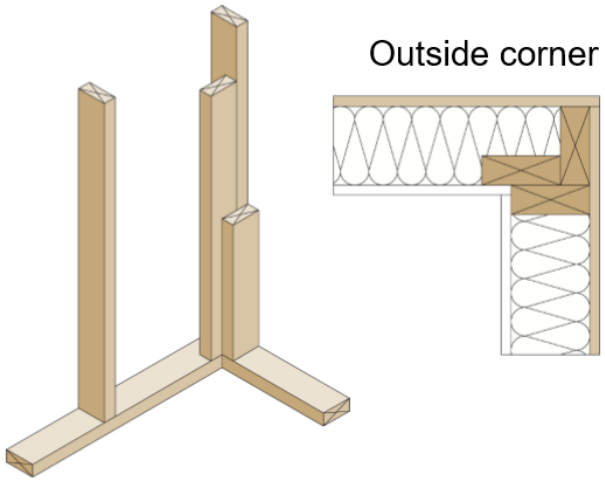


Alternatives 2012 IRC, Figure R602.3(2) FRAMING DETAILS

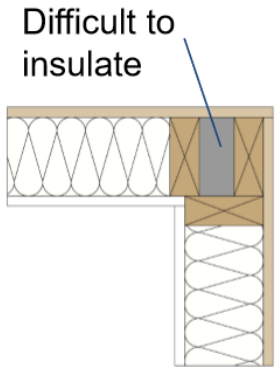
Note: A third stud and/or partition backing stud shall be permitted to be omitted through the use of wood back-up cleats, metal drywall clips, or other approved devices that will serve as adequate backing for facing materials.


Corner stud
2x Ladder Blocking at 24"o.c.
Outside corner
2x Ladder Blocking at 24"o.c.
APA

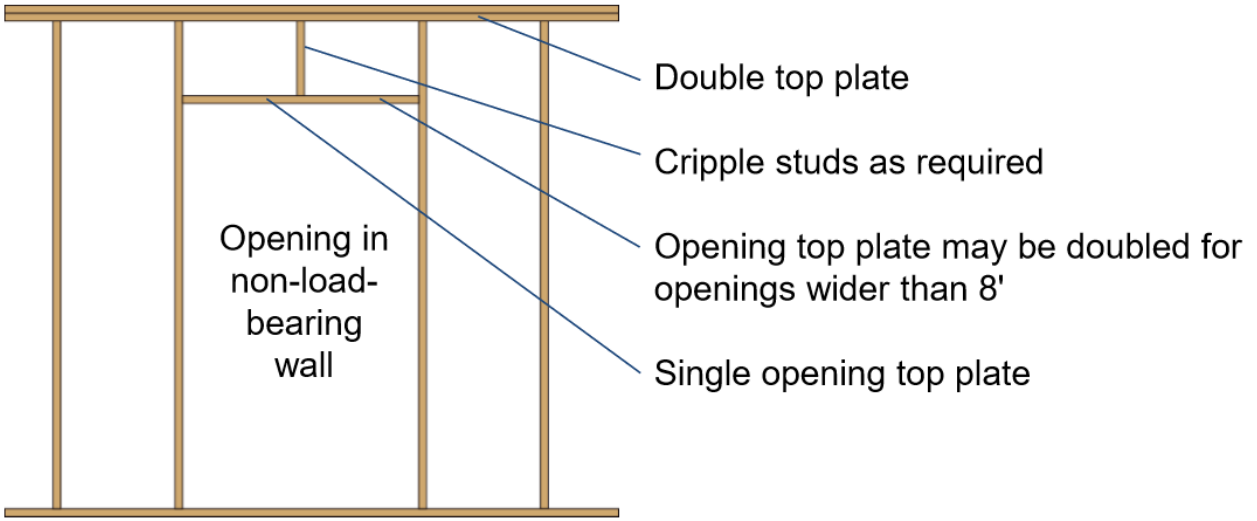
Insulated Three-stud Corner (California Corner)



Traditional Corner



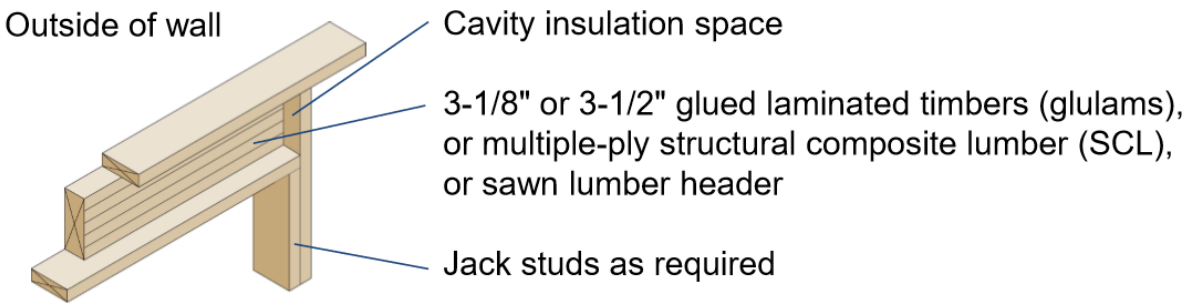
Conventional Headers Not Required



Note: Use jack studs as required.

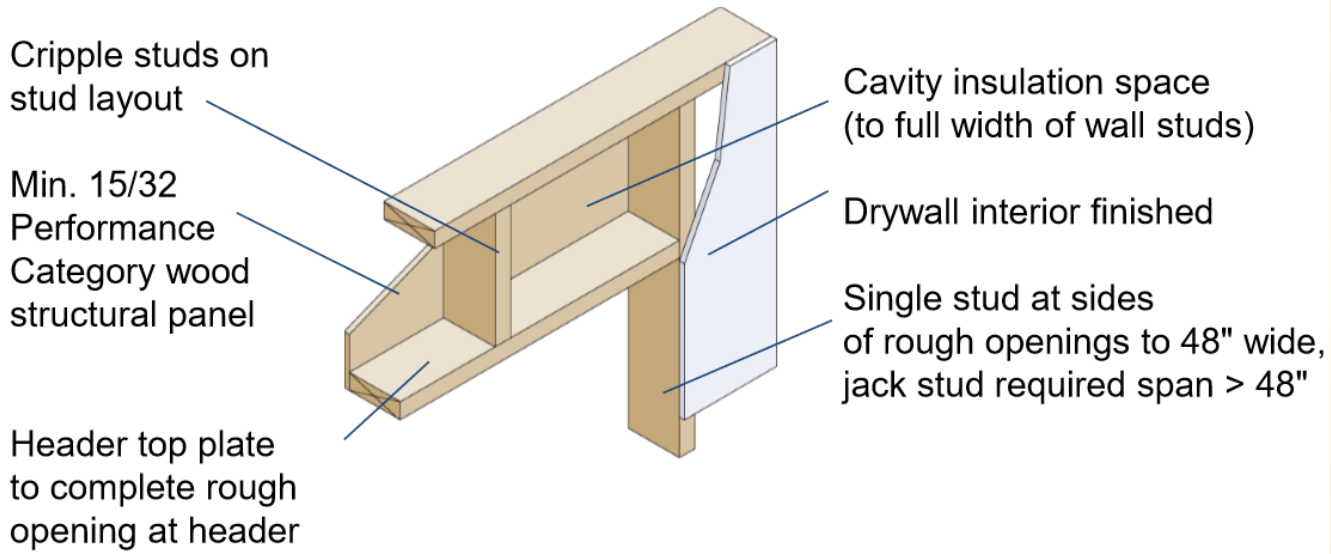
Prefabricated Insulated Headers

Single Ply Headers



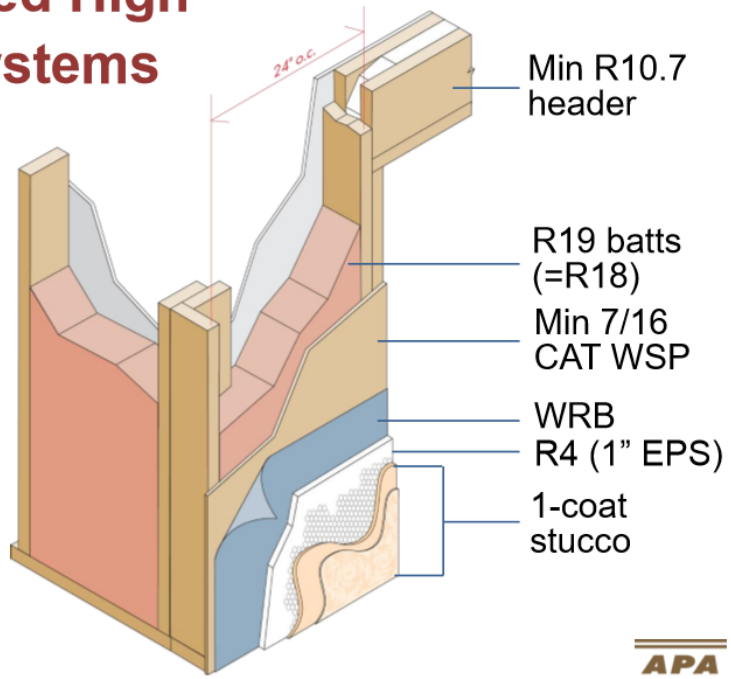
Prefabricated Insulated Headers

One-sided Wood Structural Panel Box Header



2016 Title 24 Proposed High Performance Wall Systems

- 2x6 Studs
- 2x6 Advanced Framing



Energy Enhancements:

- Double roof: SIP with Radiant Barrier Sheathing below
- Ducts in conditioned space

Table 4.1.1 U-Factor Calculations for Wood Framed Assembly

	Assembly Type: Wall 2x4 16 in. o.c	R-Value	
	Framing Material: Wood		
	Assembly Components	**Cavity (R_c)**	**Frame (R_f)**
	Outside air film	0.17	0.17
1	3/8 inch 2-coat stucco	0.08	0.08
2	1 inch, R-4 EPS insulating sheathing	4.0	4.0
3	Building paper (felt)	0.06	0.06
4	R-15 insulation	15	--
5	2x4 inch doug fir framing @ R-0.99 per inch	--	3.47
6	0.50 inch gypsum board	0.45	0.45
	Inside air film	0.68	0.68
	Subtotal	**20.44**	**8.91**

	1/Rc	X (1–(Frame% / 100))]	+ [	(1/Rf)	X	(Frame% / 100)]	Assembly U-Factor
	[(1/20.44)	X (1- (25/100))]	+ [	(1/8.91)	X	(25/100)]	**0.065**

[1/Rc x (1 – (Frame% / 100))] + [(1/Rf) x (Frame% / 100)] = Assembly U-Factor

Where: Frame percentage (%) determined by Table 4.1.6

JA4.2 Roofs and Ceilings

Table 4.2.1 – U-factors of Wood Framed Attic Roofs

Truss Spacing	R-value of Attic Insulation		Rated R-value of Continuous Insulation[1] None	R-2	R-4	R-6	R-7	R-8	R-10	R-14
			A	B	C	D	E	F	G	H
16 in. OC	None	1	0.300	0.187	0.136	0.107	0.097	0.088	0.075	0.058
	R-11	2	0.079	0.068	0.060	0.053	0.051	0.048	0.044	0.037
	R-13	3	0.071	0.062	0.055	0.050	0.047	0.045	0.041	0.036
	R-19	4	0.049	0.045	0.041	0.038	0.037	0.035	0.033	0.029
	R-21	5	0.042	0.039	0.036	0.034	0.032	0.031	0.030	0.026
	R-22	6	0.043	0.039	0.037	0.034	0.033	0.032	0.030	0.027
	R-25	7	0.038	0.035	0.033	0.031	0.030	0.029	0.028	0.025
	R-30	8	0.032	0.030	0.028	0.027	0.026	0.025	0.024	0.022
	R-38	9	0.026	0.024	0.023	0.022	0.022	0.021	0.020	0.019
	R-44	10	0.021	0.020	0.019	0.019	0.018	0.018	0.017	0.016
	R-49	11	0.020	0.019	0.019	0.018	0.018	0.017	0.017	0.016
	R-60	12	0.017	0.016	0.016	0.015	0.015	0.015	0.014	0.013
24 in. OC	None	13	0.305	0.189	0.137	0.108	0.097	0.089	0.075	0.058
	R-11	14	0.076	0.066	0.058	0.052	0.050	0.047	0.043	0.037
	R-13	15	0.068	0.060	0.054	0.048	0.046	0.044	0.041	0.035
	R-19	16	0.048	0.043	0.040	0.037	0.036	0.034	0.032	0.029
	R-21	17	0.043	0.040	0.037	0.034	0.033	0.032	0.030	0.027
	R-22	18	0.041	0.038	0.036	0.033	0.032	0.031	0.029	0.026
	R-25	19	0.037	0.034	0.032	0.030	0.029	0.028	0.027	0.024
	R-30	20	0.031	0.029	0.028	0.026	0.025	0.025	0.024	0.022
	R-38	21	0.025	0.024	0.023	0.022	0.021	0.021	0.020	0.018
	R-44	22	0.021	0.020	0.019	0.019	0.018	0.018	0.017	0.016
	R-49	23	0.019	0.019	0.018	0.017	0.017	0.017	0.016	0.015
	R-60	24	0.016	0.016	0.015	0.015	0.014	0.014	0.014	0.013

Notes:

1. Continuous insulation shall be located at the ceiling, below the bottom chord of the truss and be uninterrupted by framing.
2. In climate zones 1 and 16 the insulating R-value of continuous insulation materials installed above the roofs waterproof membrane shall be multiplied by 0.8 before choosing the table column for determining assembly U-factor.

Table 4.2.5 – U-factors of Metal Framed Rafter Roofs

Spacing	R-Value of Insulation Between Framing	Nominal Framing Size		Rated R-value of Continuous Insulation							
				R-0	R-2	R-4	R-6	R-7	R-8	R-10	R-14
				A	B	C	D	E	F	G	H
16 in. OC	None	Any	1	0.325	0.197	0.141	0.110	0.099	0.090	0.076	0.059
	R-11[2]	2x4	2	0.129	0.103	0.085	0.073	0.068	0.063	0.056	0.046
	R-13[2]	2x4	3	0.121	0.097	0.082	0.070	0.066	0.061	0.055	0.045
	R-15[2]	2x4	4	0.115	0.093	0.079	0.068	0.064	0.060	0.053	0.044
	R-19[2,3]	2x4	5	0.121	0.097	0.082	0.070	0.066	0.061	0.055	0.045
	R-11	2x6	6	0.123	0.099	0.082	0.071	0.066	0.062	0.055	0.045
	R-13	2x6	7	0.115	0.093	0.079	0.068	0.064	0.060	0.053	0.044
	R-15[2]	2x6	8	0.101	0.084	0.072	0.063	0.059	0.056	0.050	0.042
	R-19[2]	2x6	9	0.100	0.083	0.071	0.063	0.059	0.056	0.050	0.042
	R-19[2]	2x8	10	0.096	0.081	0.069	0.061	0.057	0.054	0.049	0.041
	R-21	2x8	11	0.093	0.078	0.068	0.060	0.056	0.053	0.048	0.040
	R-25	2x10	12	0.084	0.072	0.063	0.056	0.053	0.050	0.046	0.039
	R-30[4]	2x10	13	0.079	0.068	0.060	0.054	0.051	0.048	0.044	0.038
	R-30	2x12	14	0.076	0.066	0.058	0.052	0.050	0.047	0.043	0.037
	R-38[4]	2x12	15	0.071	0.062	0.055	0.050	0.047	0.045	0.042	0.036
	R-38[4]	2x14	16	0.068	0.060	0.053	0.048	0.046	0.044	0.040	0.035
24 in. OC	None	Any	22	0.322	0.196	0.141	0.110	0.099	0.090	0.076	0.058
	R-11[2]	2x4	23	0.111	0.091	0.077	0.067	0.062	0.059	0.053	0.043
	R-13[2]	2x4	24	0.102	0.085	0.072	0.063	0.060	0.056	0.050	0.042
	R-15[2]	2x4	25	0.096	0.081	0.069	0.061	0.057	0.054	0.049	0.041
	R-19[2,3]	2x4	26	0.102	0.085	0.072	0.063	0.060	0.056	0.050	0.042
	R-11	2x6	27	0.107	0.088	0.075	0.065	0.061	0.058	0.052	0.043
	R-13	2x6	28	0.099	0.083	0.071	0.062	0.058	0.055	0.050	0.041
	R-15[2]	2x6	29	0.086	0.073	0.064	0.057	0.054	0.051	0.046	0.039
	R-19[2]	2x6	30	0.083	0.071	0.062	0.055	0.052	0.050	0.045	0.038
	R-19[2]	2x8	31	0.080	0.0690	0.061	0.054	0.051	0.049	0.044	0.038
	R-21	2x8	32	0.076	0.066	0.058	0.052	0.050	0.047	0.043	0.037
	R-25	2x10	33	0.068	0.060	0.053	0.048	0.046	0.044	0.040	0.035
	R-30[4]	2x10	34	0.063	0.056	0.050	0.046	0.044	0.042	0.039	0.033
	R-30	2x12	35	0.061	0.054	0.049	0.045	0.043	0.041	0.038	0.033
	R-38[4]	2x12	36	0.055	0.050	0.045	0.041	0.040	0.038	0.035	0.031
	R-38[4]	2x14	37	0.053	0.048	0.044	0.040	0.039	0.037	0.035	0.030

JA4.3 Walls

Table 4.3.1 – U-factors of Wood Framed Walls

Spacing	Cavity Insulation	Nominal Framing Size		Rated R-value of Continuous Insulation [2]						
				R-0	R-2	R-4	R-5	R-6	R-7	R-8
				A	B	C	D	E	F	G
16 in. OC	None	Any	1	0.356	0.209	0.146	0.127	0.113	0.101	0.092
	R-11	2x4	2	0.110	0.088	0.074	0.068	0.064	0.060	0.056
	R-13	2x4	3	0.102	0.082	0.069	0.064	0.060	0.056	0.053
	R-15 [1]	2x4	4	0.095	0.077	0.065	0.060	0.056	0.053	0.050
	R-19	2x6	5	0.074	0.063	0.055	0.051	0.049	0.046	0.044
	R-21 [1]	2x6	6	0.069	0.059	0.051	0.048	0.046	0.043	0.041
	R-22	2x6	7	0.072	0.062	0.054	0.051	0.048	0.045	0.043
	R-19	2x8	8	0.065	0.057	0.051	0.048	0.045	0.043	0.041
	R-22	2x8	9	0.061	0.053	0.047	0.045	0.043	0.041	0.039
	R-25	2x8	10	0.057	0.050	0.044	0.042	0.040	0.038	0.037
	R-30 [1]	2x8	11	0.056	0.049	0.044	0.041	0.040	0.038	0.036
24 in. OC	None	Any	12	0.362	0.211	0.148	0.128	0.114	0.102	0.092
	R-11	2x4	13	0.106	0.086	0.072	0.067	0.062	0.059	0.055
	R-13	2x4	14	0.098	0.079	0.067	0.062	0.058	0.055	0.052
	R-15	2x4	22	0.091	0.074	0.063	0.059	0.055	0.052	0.049
	R-19	2x6	15	0.071	0.061	0.053	0.050	0.048	0.045	0.043
	R-21 [1]	2x6	16	0.066	0.057	0.050	0.047	0.045	0.042	0.040
	R-22	2x6	17	0.069	0.060	0.052	0.049	0.047	0.044	0.042
	R-19	2x8	18	0.063	0.055	0.049	0.047	0.045	0.043	0.041
	R-22	2x8	19	0.058	0.051	0.046	0.044	0.042	0.040	0.038
	R-25	2x8	20	0.055	0.048	0.043	0.041	0.039	0.037	0.036
	R-30 [1]	2x8	21	0.054	0.047	0.042	0.040	0.038	0.037	0.035

Notes

1. Higher density fiberglass batt is required in these cases.
2. Continuous insulation may be installed on either the inside or the exterior of the wall, or both.

Wall Cladding

TABLE R703.15.1
CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT[a]

CLADDING FASTENER THROUGH FOAM SHEATHING	CLADDING FASTENER TYPE AND MINIMUM SIZE[b]	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING[c] (inches)					
			16" o.c. Fastener Horizontal Spacing			24" o.c. Fastener Horizontal Spacing		
			Cladding Weight:			Cladding Weight:		
			3 psf	11 psf	35 psf	3 psf	11 psf	35 psf
Wood Framing (minimum 1½-inch penetration)	0.113" diameter nail	6	2	1	DR	2	0.75	DR
		8	2	1	DR	2	0.5	DR
		12	2	0.5	DR	2	DR	DR
	0.120" diameter nail	6	3	1.5	0.5	3	0.75	DR
		8	3	1	DR	3	0.5	DR
		12	3	0.5	DR	2	DR	DR
	0.131" diameter nail	6	4	2	0.75	4	1	DR
		8	4	1.5	0.5	4	0.75	DR
		12	4	0.75	DR	2	0.5	DR
	0.162" diameter nail	6	4	4	1.5	4	2	1
		8	4	3	1	4	1.5	0.75
		12	4	2	0.75	4	1	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.
DR = Design required.
o.c. = on center

a. Wood framing shall be Spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWC NDS.
b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.
c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

Windows:

Prescriptive Requirements

The Prescriptive requirements for fenestration vary by climate zone and the type and area

of the fenestration:

More than 75 ft2

additional fenestration area or more than 16 ft2

of skylight areaA

Climate Zones U-FactorE SHGCB,E

TOTAL

FenestrationC

Area % of CFAD

WEST-facingC

Area % of CFAD

1, 3, 5 0.32 or lower na 20% or less na

2, 4, 6-16 0.32 or lower 0.25 or lower 20% or less 5% or less

75 ft2

or less additional fenestration area or more than 75 ft2

replacement

fenestration A

Climate Zones U-FactorE SHGCB,E

1, 3, 5 0.32 or lower na

2, 4, 6-16 0.32 or lower 0.25 or lower

16 ft2

or less additional skylight area or replacement skylights

1, 3, 5 0.55 or lower na

2, 4, 6-16 0.55 or lower 0.30 or lower

75ft2

or less replacement fenestration

1,3,5 0.40 or lower na

2,4,6-16 0.40 or lower 0.35 or lower

A Fenestration area is the glass plus the frame. For doors with glass area less than 50% of total door area,

consider the “frame” to be two inches on all sides of the glass. For doors with glass area 50% or more of

the total door area, count the entire door area as glazing. B If the fenestration has qualifying exterior shading (e.g., a permanent awning) the SHGC may be

calculated taking that shading into consideration. If you use exterior shading to meet the SHGC

requirement, you must submit a CF1R-ENV-03-E: “Solar Heat Gain Coefficient (SHGC) Worksheet.” C “TOTAL fenestration” is all new fenestration plus existing fenestration that remains after the alteration.

See “Orientation and West-facing Fenestration” (below) for a definition of west-facing fenestration. D “CFA” is conditioned floor area; see Section 100.1 “Definitions and Rules of Construction” in the

Standards for details. E Maximum area-weighted average values.

See Exception 3 to Section 150.1(c)3A for fenestration containing chromogenic glazing. (Chromogenic

glazing is high performance glazing that is able to vary its transmittance appropriately in response to

automatic controls based on the solar intensity. This means it has the potential to improve building

energy efficiency compared to standard low-e glazing.)

Table 1: Prescriptive Requirements

Orientation & West-facing Fenestration

"Orientation" refers to the direction that the fenestration faces.

West-facing fenestration – a consideration in climate zones 2, 4 & 6 - 16 – includes:

- A window (or a door with glass) that faces from ≤45° north of true west to

<45° south of true west.

- Skylights tilted:

– To the west (from ≤45° north of true west to <45° south of true west)

– In any direction when the pitch is less than 1:12

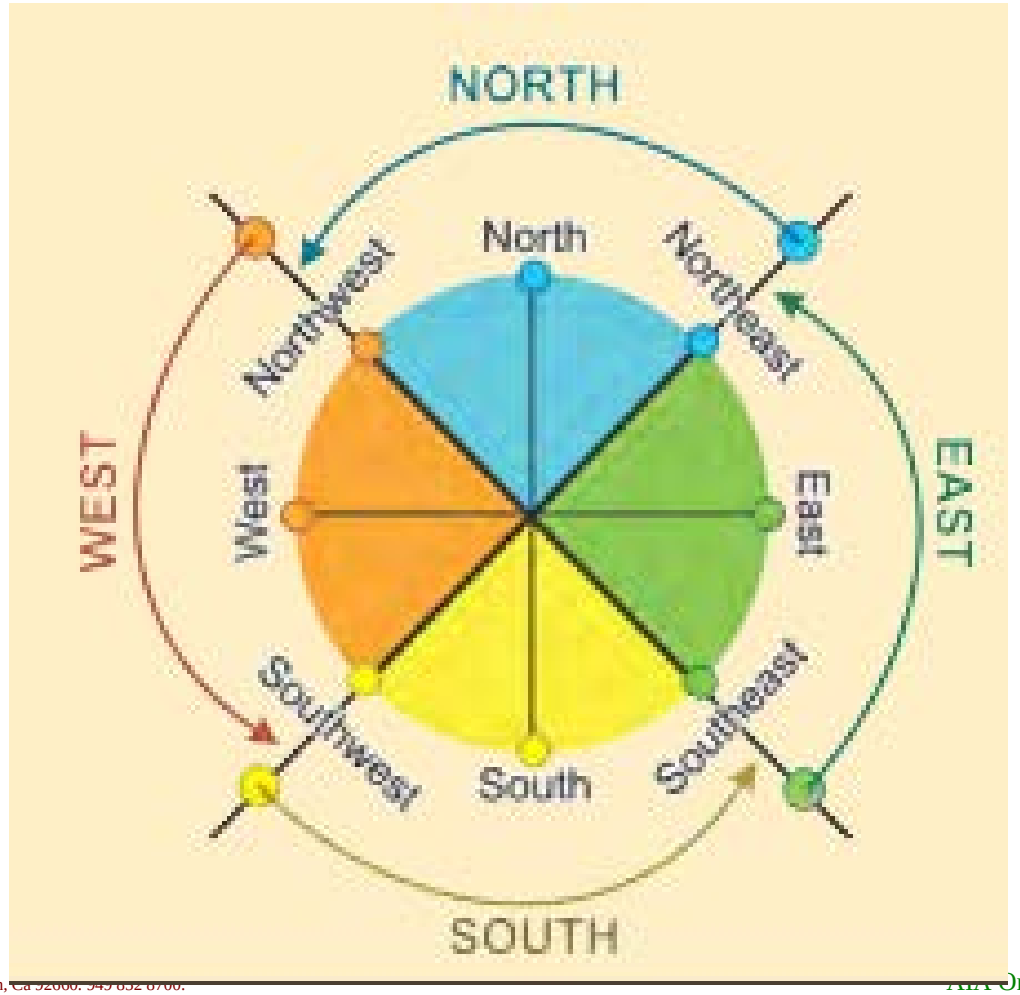
Actual Orientation… …Is Considered

45° east of north to 44° west of north North-facing

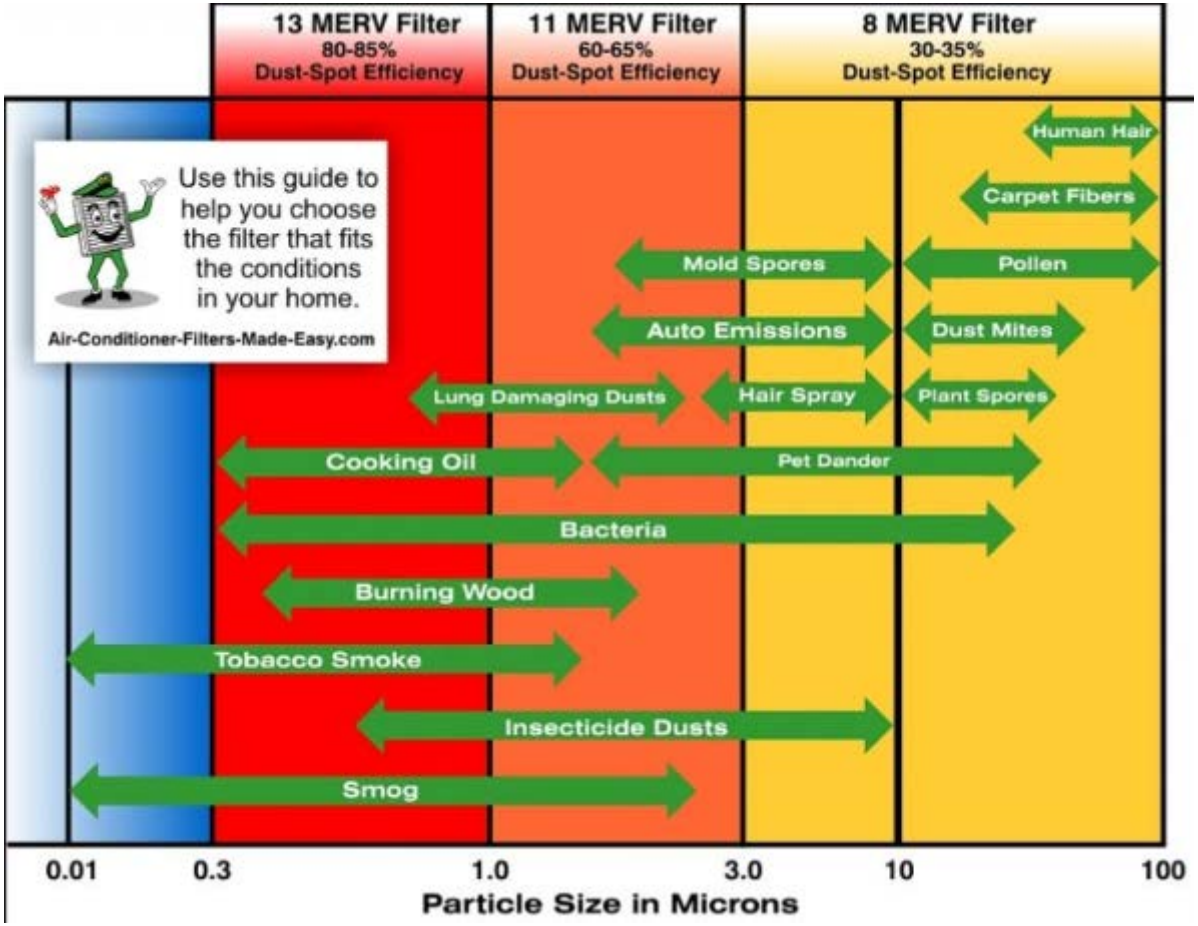
45° north of west to 44° south of west West-facing

45° west of south to 44° east of south South-facing

45° south of east to 44° north of east East-facing


NORTH
North
Northeast
Northwest
WEST
West
East
EAST
Southwest
Southeast
South
SOUTH

- **MERV 13 air filtration to pull smaller particulates out of the air, including pm2.5 related to diesel emissions**


13 MERV Filter
80-85%
Dust-Spot Efficiency
11 MERV Filter
60-65%
Dust-Spot Efficiency
8 MERV Filter
30-35%
Dust-Spot Efficiency
Use this guide to help you choose the filter that fits the conditions in your home.
Air-Conditioner-Filters-Made-Easy.com
Human Hair
Carpet Fibers
Mold Spores
Pollen
Auto Emissions
Dust Mites
Lung Damaging Dusts
Hair Spray
Plant Spores
Cooking Oil
Pet Dander
Bacteria
Burning Wood
Tobacco Smoke
Insecticide Dusts
Smog
0.01
0.3
1.0
3.0
10
100
Particle Size in Microns

LED lighting wattages now the standard for

nonresidential lighting allowances

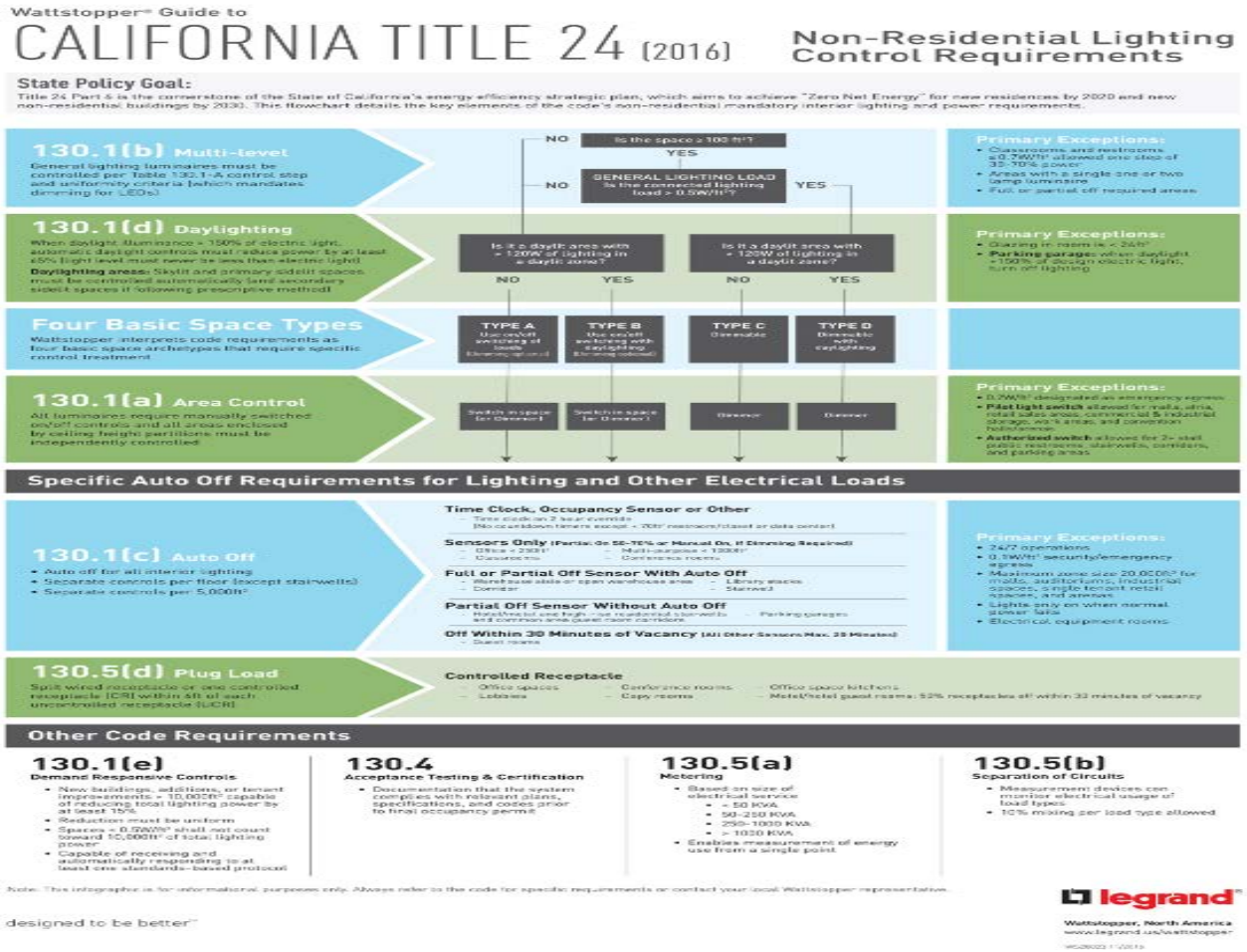
High Impact

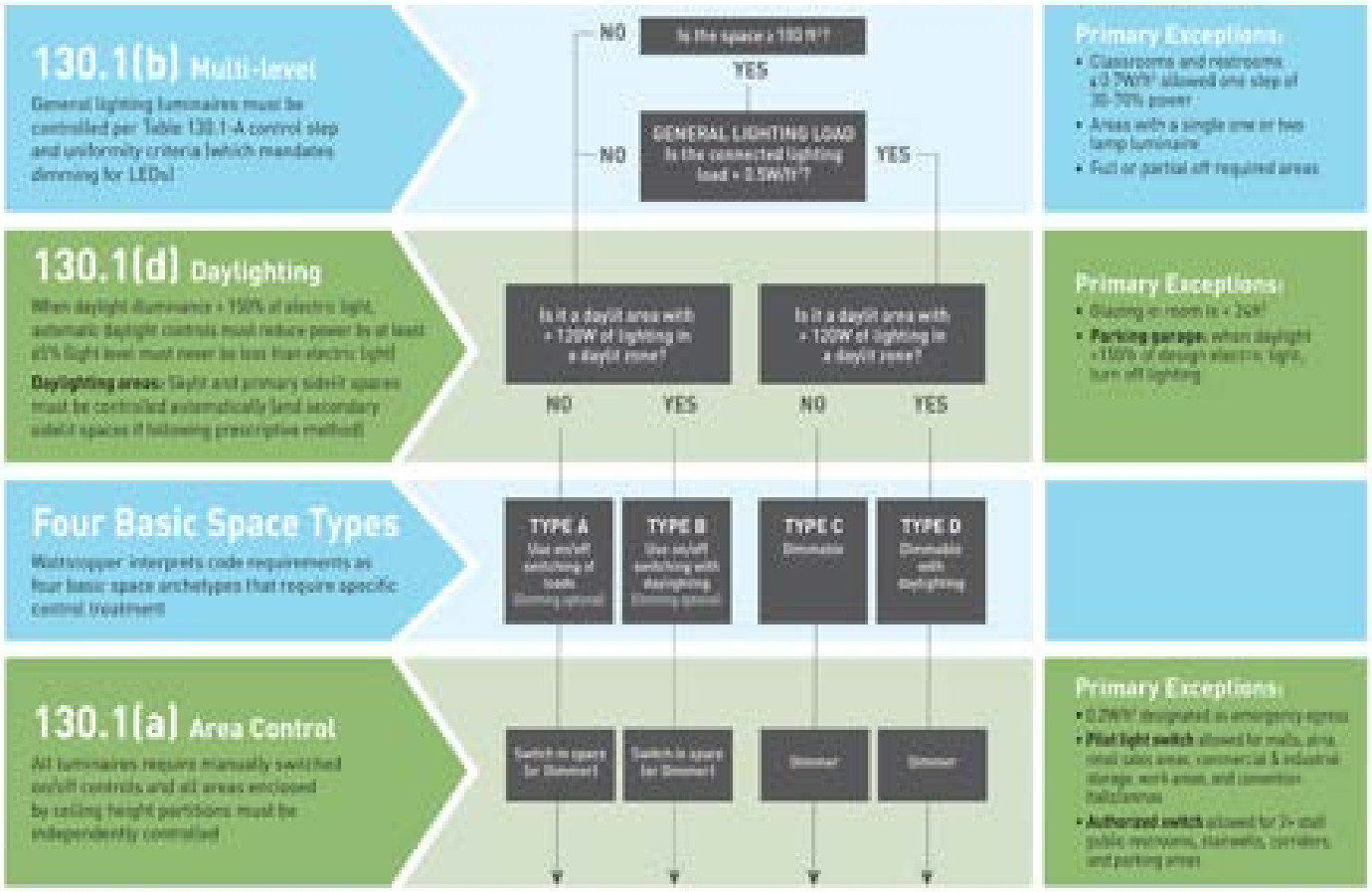
Table 10: Existing Table 140.6-B Complete Building Method Lighting Power Density Values

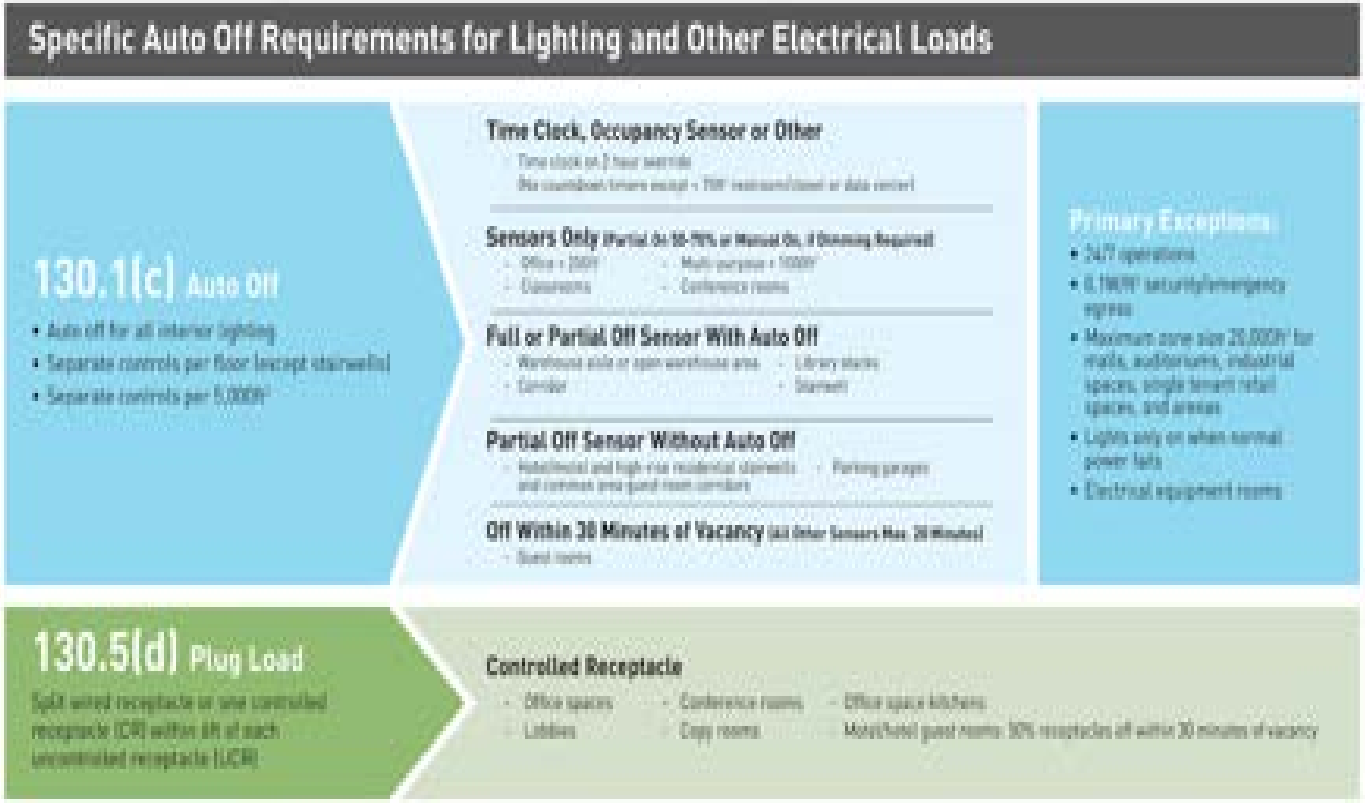
~~TYPE OF BUILDING~~	~~ALLOWED LIGHTING POWER DENSITY (WATTS PER SQUARE FOOT)~~
~~Auditorium Building~~	~~1.4~~
~~Classroom Building~~	~~1.1~~
~~Commercial and Industrial Storage Building~~	~~0.60~~
~~Convention Center Building~~	~~1.0~~
~~Financial Institution Building~~	~~1.0~~
~~General Commercial Building/Industrial Work Building~~	~~1.00~~
~~Grocery Store Building~~	~~1.50~~
~~Library Building~~	~~1.2~~
~~Medical Building/Clinic Building~~	~~1.0~~
~~Office Building~~	~~0.80~~
~~Parking Garage Building~~	~~0.20~~
~~Religious Facility Building~~	~~1.5~~
~~Restaurant Building~~	~~1.1~~
~~School Building~~	~~0.95~~
~~Theater Building~~	~~1.3~~
~~All others buildings~~	~~0.50~~

Table 11: Proposed Table 140.6-B Complete Building Method Lighting Power Density Values

TYPE OF BUILDING	ALLOWED LIGHTING POWER DENSITY (WATTS PER SQUARE FOOT)
Auditorium	0.70
Civic Center	0.70
Convention center	0.65
Courthouse	0.70
Financial Institution	0.65
Grocery Store	0.95
Gym/Exercise Center	0.65
Hospital	0.90
Industrial/ Manufacturing facility	0.60
Library	0.70
Medical/Healthcare Clinic	0.70
Motion picture theater	0.60
Office	0.65
Parking Garage	0.13
Performing arts theater	0.80
Religious Facility	0.70
Restaurant	0.70
Retail Store	0.90
School and/or university	0.65
Service facility	0.60
Sports arena	0.75
Warehouse	0.45
All other buildings	0.40


Wattstopper® Guide to
CALIFORNIA TITLE 24 (2016)
Non-Residential Lighting Control Requirements
State Policy Goal:
130.1(b) Multi-level
130.1(d) Daylighting
Four Basic Space Types
130.1(a) Area Control
Specific Auto Off Requirements for Lighting and Other Electrical Loads
130.1(c) Auto Off
130.5(d) Plug Load
Other Code Requirements
130.1(e)
130.4
130.5(a)
130.5(b)
legrand
designed to be better™


130.1(b) Multi-level
NO
YES
GENERAL LIGHTING LOAD
NO
YES
Primary Exceptions:
130.1(d) Daylighting
Is it a daylit area with
Is it a daylit area with
NO
YES
NO
YES
Primary Exceptions:
Four Basic Space Types
TYPE A
TYPE B
TYPE C
TYPE D
130.1(a) Area Control
Primary Exceptions:


Specific Auto Off Requirements for Lighting and Other Electrical Loads
130.1(c) Auto Off
Time Clock, Occupancy Sensor or Other
Sensors Only
Full or Partial Off Sensor With Auto Off
Partial Off Sensor Without Auto Off
Off Within 30 Minutes of Vacancy
Primary Exceptions
130.5(d) Plug Load
Controlled Receptacle

Other Code Requirements

130.1(e)

Demand Responsive Controls

- New buildings, additions, or tenant improvements > 10,000ft² capable of reducing total lighting power by at least 15%
- Reduction must be uniform
- Spaces < 0.5W/ft² shall not count toward 10,000ft² of total lighting power
- Capable of receiving and automatically responding to at least one standards-based protocol

130.4

Acceptance Testing & Certification

- Documentation that the system complies with relevant plans, specifications, and codes prior to final occupancy permit

130.5(a)

Metering

- Based on size of electrical service
  - < 50 KVA
  - 50-250 KVA
  - 250-1000 KVA
  - > 1000 KVA
- Enables measurement of energy use from a single point

130.5(b)

Separation of Circuits

- Measurement devices can monitor electrical usage of load types
- 10% moving per load type allowed

Table 4: Summary of Mandatory DR-Related Requirements for Nonresidential Buildings in Title 24, Part 6

Building System	New Construction or Alteration	When DR Requirement Applies	Required Automatic Response to DR Signal	Equipment Needed for Compliance	Relevant Section(s) of 2016 Title 24, Part 6 Standards		Relevant Section(s) of 2016 Compliance Manual		Compliance Document
					Standards	Appendices	Standards	Acceptance Test	
Lighting	New construction	• Building area > 10,000 square feet • Spaces where lighting power density > 0.5 watts/square foot	Reduce lighting power ≥ 15%	• Lighting control system or EMCS with appropriate programming • Dimmable lighting system	• 100.1 (definitions) • 130.1(e) • 140.6(a)(2)(K)	• NA7.6.3 • NA7.7.2 (EMCS)	5.4 – 5.6	13.8.4	NRCI-LTI-02-E
HVAC *(with DDC to zone level)*	New construction	Non-critical zones	Adjust temperature setpoints ≥ 4° F	EMCS with appropriate programming and interface or dry contact	• 100.1 (definitions) • 120.2(b) • 120.2(h)	NA7.5.10	4.5.1.7	13.7.22	NRCA-MCH-11-A
HVAC *(without DDC)*	New construction	Non-temperature-sensitive processes		DR Thermostat (JA5-compliant) or EMCS with appropriate programming	• 100.1 (definitions) • 110.10(b)(1) • 110.2(c) • 120.2(b)	JA5	• 4.2.5 • 4.5.1.1	N/A	• For project compliance: N/A • For manufacturers certifying JA5-compliant thermostats: JA5 declaration document
HVAC	Alterations (prescriptive)	When a space-conditioning system is altered by the installation or replacement of space-conditioning system equipment (including replacement of the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil)	Defined in JA5	• Altered units: must install DR Thermostat (JA5-compliant) • New units that require thermostats: Thermostat (JA5-compliant)	• 100.1 (definitions) • 141.0(b)2E	JA5	4.9.4.3	N/A	

Building System	New Construction or Alteration	When DR Requirement Applies	Required Automatic Response to DR Signal	Equipment Needed for Compliance	Relevant Section(s) of 2016 Title 24, Part 6 Standards		Relevant Section(s) of 2016 Compliance Manual		Compliance Document
					Standards	Appendices	Standards	Acceptance Test	
Electronic Messaging Centers	New construction	• Electronic Message Centers only • Connected load ≥ 15kW	Reduce lighting ≥ 30%	Lighting control system or EMCS with appropriate programming	• 100.1 (definitions) • 130.3(a)(3)	N/A	7.3.3	N/A	NRCC-LTS-01-E
Electrical Power Distribution Systems	New construction	DR controls for electrical distribution systems	If installed, DR control system must use standards-based messaging protocol	N/A	130.5(e)	N/A	8.5.2	N/A	N/A

Source: (Energy Solutions; ASWB Engineering 2014)

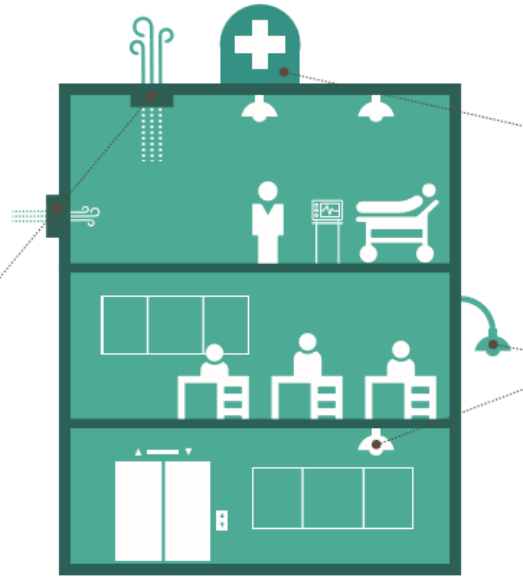
Hospitals now covered for the first time by Title 24

CALIFORNIA'S 2019 NONRESIDENTIAL

BUILDING ENERGY EFFICIENCY STANDARDS

CALIFORNIA ENERGY COMMISSION

The state's energy efficiency standards for new buildings and appliances have saved consumers billions in lower electricity and natural gas bills. The 2019 Building Energy Efficiency Standards for nonresidential buildings include better lighting and ventilation. The standards also extend requirements for the first time to newly constructed healthcare facilities.



HEALTHCARE FACILITIES

For the first time, energy efficiency standards extend to newly constructed healthcare facilities and incorporates the appropriate application of standards.

HEALTHY INDOOR AIR QUALITY

Enable using highly efficient filters that trap hazardous particulates from both outdoor air and cooking and improve kitchen ventilation systems. Moving air around and in and out of the home while filtering out allergens and other particles helps improve the health of a building. The standards add airflow requirements specific to small duct, high velocity systems, and sets, sensor control requirements.

LIGHTING

Update indoor and outdoor lighting values to assume the use of LED lighting. LED lights use little energy and will save money on monthly electricity bills meaning smaller operating budgets for commercial buildings. Maintenance costs are reduced because bulbs do not need to be changed as often. The standards also add occupancy sensing requirements for restrooms.

Indoor Air Quality

VENTILATION AND INDOOR AIR QUALITY IN NEW HOMES

CALIFORNIA ENERGY COMMISSION

PIER COLLABORATIVE REPORT

California Environmental Protection Agency
AIR RESOURCES BOARD

November 2009
CEC-500-2009-085

2019 Energy Code Appendices

Parent Directory

- **Efficiency Characteristics and Opportunities for New California Homes** TN-222338 Submitted 1/23/2018.
- **Caifornia's Energy Efficiency Standards and Indoor Air Quality 1994** TN-222339 Submitted 1/23/2018.
- **Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings** TN-222340 Submitted 1/23/2018.
- **Indoor Air Quality References List** TN-222341 Submitted 1/23/2018.
- **Indoor Air Pollution In California** TN-222342 Submitted 1/23/2018.
- **Indoor Air Quality Residential Cooking Exposures** TN-222343 Submitted 1/23/2018.
- **Ventilation and Indoor Air Quality in New Homes** TN-222344 Submitted 1/23/2018.
- **Energy Implications of In-Line Filtration in California** TN-222345 Submitted 1/23/2018.
- **Unique Multifamily Buildings Proposed Energy Code Measures** TN-222349 Submitted 1/23/2018.
- **A Field Study of Airflow in Mid to High-Rise Multi-Unit Residential Buildings** TN-222355 Submitted 1/24/2018.
- **List of Indoor Air Quality Documents Relied Upon** TN-222366 Submitted 1/25/2018.

You now in Hot Water!

CALIFORNIA ENERGY COMMISSION | EFFICIENCY DIVISION

Water Heater Efficiency Guide

These tables list the minimum uniform energy factors required by federal regulations for some of the most common types and sizes of water heaters.

Consumer Gas-Fired Instantaneous (> 50,000 Btu/h, ≤ 200,000 Btu/h) - Minimum UEF

Volume (gallons)	Max Rating 0 ≤ GPM < 1.7	Max Rating 1.7 ≤ GPM < 2.8	Max Rating 2.8 ≤ GPM < 4.0	Max Rating GPM ≥ 4.0
≤ 2	0.80	0.81	0.81	0.81

Consumer Gas-Fired Storage (≤ 75,000 Btu/h) - Minimum UEF

Volume (gallons)	0 ≤ FHR < 18	18 ≤ FHR < 51	51 ≤ FHR < 75	FHR ≥ 75
30	0.29	0.54	0.60	0.65
40	0.27	0.52	0.58	0.64
50	0.25	0.50	0.56	0.63
55	0.24	0.49	0.55	0.62
60	0.61	0.74	0.77	0.79
75	0.60	0.73	0.76	0.78
80	0.60	0.73	0.76	0.78

Residential-Duty Commercial Gas-Fired Storage (> 75,000 Btu/h, ≤ 105,000 Btu/h) - Minimum UEF

Volume (gallons)	0 ≤ FHR < 18	18 ≤ FHR < 51	51 ≤ FHR < 75	FHR ≥ 75
50	0.22	0.48	0.55	0.61
60	0.21	0.46	0.53	0.61
75	0.2	0.45	0.52	0.59
80	0.2	0.44	0.51	0.59

Consumer Electric Instantaneous (≤ 12 kW) - Minimum UEF

Volume (gallons)	Max Rating 0 ≤ GPM < 1.7	Max Rating 1.7 ≤ GPM < 2.8	Max Rating 2.8 ≤ GPM < 4.0	Max Rating GPM ≥ 4.0
≤ 2	0.91	0.91	0.91	0.92

Residential-Duty Commercial Electric Instantaneous (> 12 kW, ≤ 58.6 kW) - Minimum UEF

Volume (gallons)	Max Rating 0 ≤ GPM < 1.7	Max Rating 1.7 ≤ GPM < 2.8	Max Rating 2.8 ≤ GPM < 4.0	Max Rating GPM ≥ 4.0
≤ 2	0.80	0.80	0.80	0.80

Btu/h British thermal units per hour
kW Kilowatt
GPM Gallons Per Minute
FHR First Hour Rating
UEF Uniform Energy Factor

Consumer Electric Storage - Minimum UEF				
Volume (gallons)	0 ≤ FHR < 18	18 ≤ FHR < 51	51 ≤ FHR < 75	FHR ≥ 75
30	0.86	0.92	0.92	0.93
40	0.85	0.91	0.92	0.93
50	0.84	0.91	0.92	0.93
55	0.84	0.91	0.92	0.93
60	1.86	1.98	2.05	2.18
75	1.84	1.96	2.03	2.16
80	1.84	1.96	2.03	2.15

Tabletop - Minimum UEF				
Volume (gallons)	Max Rating 0 ≤ GPM < 1.7	Max Rating 1.7 ≤ GPM < 2.8	Max Rating 2.8 ≤ GPM < 4.0	Max Rating GPM ≥ 4.0
30	0.46	0.83	0.89	0.94
40	0.40	0.79	0.87	0.92

Heat pump water heaters that meet the UEFs listed in the Water Heater Replacements table may be used to replace existing water heaters. This applies only to prescriptive alterations to single dwelling units. The UEF depends on the climate zone where the water heater will be installed. The water heater being replaced can be of any fuel type – natural gas, propane, or electric.

Northwest Energy Efficiency Alliance (NEEA) Tier 3 or higher heat pump water heaters may be installed as described above in climate zones 1-15. If these water heaters are installed in climate zone 16, the solar water heating requirements described in the table must be met.

Per **Section 150.2(b)1Giid**, the California Energy Commission used the performance compliance approach to determine the minimum UEF needed to be able to prescriptively replace an existing water heater with a heat pump water heater. These heat pump water heaters have been precalculated to comply with the prescriptive water heating alteration requirements when serving a single dwelling unit, with or without natural gas connection. These are only a few of many possible combinations that will comply using the performance compliance approach.

Water Heater Replacements (New Heat Pump Water Heater)	
Climate Zone	Minimum UEF
1	2.82
2	2.82
3	2.82
4	2.87
5	2.82
6	2.47
7	2.61
8	2.47
9	2.47
10	2.47
11	2.61
12	2.87
13	2.61
14	2.61
15	2.47
16	≥ 3, plus a solar water heating system with solar saving fraction ≥ 0.4

Can't find your water heater type or volume?

Table 5-3 – Summary of Acceptable Vent Material by Appliance Category

Appliance Venting Category	Vent Pressure	Condensing or Non-Condensing	Common Vent Pipe Material
Category I: An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent	Non-positive; atmospheric vented; gravity vented; most common category of gas-fired water heaters.	Non condensing (typically less than 82% efficiency)	Metal double wall "B" vent
Category II: An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent	Non-positive	Condensing	Special venting material per the product manufacturer
Category III: An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent	Positive (usually created by a blower motor); generally cannot be adjoined to gravity-vented water heater.	Non condensing (typically less than 82% efficiency)	Stainless Steel; these usually require 3" clearance to combustibles and the joints must be sealed air tight.
Category IV: An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent	Positive (usually created by a blower motor); generally cannot be adjoined to gravity-vented water heater.	Condensing	Plastic pipe (PVC, CPVC, ABS, etc.)

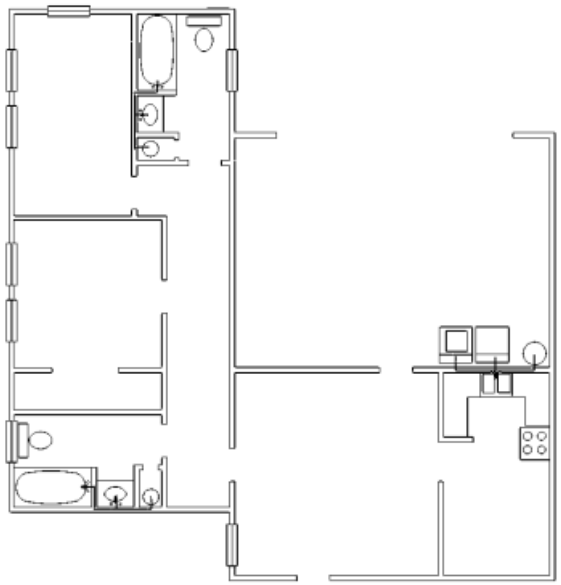


Table 5-4 – Point of Use Distribution System

Size Nominal, Inch	Length of Pipe (feet)
3/8"	15
1/2"	10
3/4"	5

Wasted Heat Factor

$$f_{wh} = WF \times DLM$$

$$DLM = 1 + (SDLM - 1) \times DSM$$

$$SDLM = 1.004 + 2.02 \cdot 10^{-4} \times CFA + 2.31 \cdot 10^{-8} \times CFA^2$$

WF = hot water waste factor
- 0.9 for within-dwelling-unit pumped circulation
- 1.0 otherwise

DLM = distribution loss multiplier

SDLM = standard distribution loss multiplier

DSM = distribution system multiplier

CFA = dwelling unit conditioned floor area (ft^2)
- capped at 2,500 ft^2

Distribution System Multipliers

Distribution System Types	Assigned Distribution System Multiplier
No HERS Inspection Required	
Trunk and Branch -Standard (STD)	1
Pipe Insulation (PIC)	0.9
Central Parallel Piping (PP)	1.05
Point of Use (POU)	0.3
Recirculation: Non-Demand Control Options (R-ND)	9
Recirculation with Manual Demand Control (R-DRmc)	1.6
Recirculation with Motion Sensor Demand Control (R-DRsc)	2.4
Optional Cases: HERS Inspection Required	
Pipe Insulation (PIC-H)	0.8
Central Parallel Piping with 5' maximum length (PP-H)	0.95
Compact Design (CHWDS-H)	0.7
Recirculation with Manual Demand Control (R-DRmc-H)	1.45
Recirculation with Motion Sensor Demand Control (RDRsc-H)	2.2
Non-Compliant Installation Distribution Multiplier	1.2

Wasted Heat Factor

WF = hot water waste factor

0.9 for within-dwelling-unit pumped circulation

1.0 otherwise

DLM = distribution loss multiplier

SDLM = standard distribution loss multiplier

DSM = distribution system multiplier

CFA = dwelling unit conditioned floor area (ft^2)

capped at 2,500 ft^2

What is Domestic Hot Water (DHW)?

Domestic hot water is potable hot water that is consumed for domestic purposes including food preparation, cleaning, and personal hygiene. The 2016 Building Energy Efficiency Standards (Energy Standards) regulate hot water appliances, insulation and systems for residential applications. Water

heating energy use is based on the number of dwelling units, fuel type, distribution system, water heater type, and conditioned floor area. The water heating system is defined by the tank type, heater element type, distribution type, multifamily central water heating distribution, efficiency (either energy factor (or equivalent uniform energy factor) or recovery efficiency with the standby loss), tank volume, exterior insulation R-value (only for indirect) and rated input.

Why? Water heating energy use is an important end use in low-rise residential buildings. Roughly

90% of California households use natural gas-fueled water heaters, these are typically storage tank

systems with volumes of 40 to 50 gallons. Roughly 6% of households use electricity to heat water

and a few percent use propane (liquefied petroleum gas, or LPG). Standby loss associated with the

center flue design represents about 25-35% of a typical gas storage water heater system's annual

energy use.

Relevant Code Sections

2016 California Building Energy Efficiency Standards, Title 24, Part 6:

- Section 110.1 – Mandatory Requirements for Appliances
- Section 110.3 – Mandatory Requirements for Service Water-heating Systems and Equipment
- Section 150.0(j) – Water System Piping and Insulation for Piping, Tanks, and Cooling System Lines
- Section 150.0(n) – Water Heating System

- **Section 150.1(b) – Performance Standards**
- **Section 150.1(c)8 – Prescriptive Standards/Component Package for Domestic Water-Heating Systems**
- **Section 150.2(a)1D – Additions Prescriptive Approach for Water Heaters**
- **Section 150.2(b)1G – Alterations Prescriptive Approach for Water-Heating System**

Relevant Compliance Forms

- **CF1R-ADD-01-E: Prescriptive Additions Compliance Form**

- **CF1R-ADD-02-E: Prescriptive Additions Non-HERS Compliance Form**
- **CF1R-ALT-01-E: Prescriptive Alterations Compliance Form**
- **CF1R-ALT-05-E: Prescriptive Alterations Non-HERS Compliance Form**
- **CF1R-NCB-01-E: Prescriptive Newly Constructed Building Compliance Form**
- **CF1R-PLB-01-E: Hydronic Heating System Worksheet**
- **CF1R-STH-01-E-OG300: Solar Water Heating Systems Worksheet**

- **CF1R-STH-02-E-OG100: Solar Water Heating Systems Worksheet**
- **CF2R-ADD-02-E: Prescriptive Additions Non-HERS Installation Compliance Form**
- **CF2R-ALT-05-E: Prescriptive Alterations Non-HERS Installation Compliance Form**
- **CF2R-PLB-01: Non-HERS Multifamily Central Hot Water System Distribution Installation Compliance Form**

- **CF2R-PLB-02: Non-HERS Single Dwelling Unit Hot Water System Distribution Installation Compliance Form**
- **CF2R-PLB-21: HERS Multifamily Central Hot Water System Distribution Installation Compliance Form**
- **CF2R-PLB-22: HERS Single Dwelling Unit Hot Water System Distribution Installation Compliance Form**
- **CF2R-STH-01: Solar Water Heating System Installation Compliance Form**
- **CF3R-EXC-20-H: HERS Verification of Existing Conditions for Alterations**

- **CF3R-PLB-21: HERS Verification of Multifamily Central Hot Water System Distribution**
- **CF3R-PLB-22: HERS Verification of Single Dwelling Unit Hot Water System**

Mandatory Requirements

Mandatory requirements set forth in Sections 110.1 and 110.3 of the Energy Standards

apply to all DHW appliances, whether the project is newly constructed, an addition or an

alteration. These sections establish the requirements for the manufacture, construction,

and installation of certain DHW systems, equipment, appliances and building components.

Section 150.0 includes Mandatory requirements for residential DHW systems and

insulation.

Minimum Water Heater Efficiency

Minimum efficiency requirements are based on the type and size of the water heater.

Both small and large units are regulated by federal efficiency standards and California's

Appliance Efficiency Regulations (Title 20). The California Energy Commission maintains an

Appliance Efficiency Database that includes regulated equipment certified to comply with

Title 20.

Figure 1: Example search for a water heater in the Energy Commission's Appliance Efficiency Database

The delineation between small and large units is determined by the energy input for the

type of unit. Small gas-fired units have a maximum input of 75,000 Btu/hr for storage

type units and 200,000 Btu/hr for instantaneous units. Table 1 outlines the minimum

efficiencies for common gas water heater types.

Water Heater Size and Type Energy Factor (EF)/Thermal Efficiency

Small Gas Storage (≤55 gallons, ≤75 kBtu/hr input) EFA = 0.675 – (0.0015*Volume)

Small Gas Storage (> 55 gallons, ≤75 kBtu/hr input) EFA = 0.8012 – (0.00078*Volume)

Small Gas Instantaneous (≤200 kBtu/hr input) EFA = 0.82 – (0.0019*Volume)

Large Gas Storage (any size volume but with an input-to-volume ratio of < 4,000 Btu/hr/gal) Thermal Efficiency = 0.80

Large Gas Instantaneous (≥4,000 Btu/hr/gal) Thermal Efficiency = 0.80

Additionally, large gas storage units and large gas instantaneous units with a volume of 10 or

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Installation Requirements

Section 110.3 includes Mandatory installation requirements for outlet temperature

controls, distribution system controls and storage tank insulation, and requirements

related to multifamily and state buildings.

Tank and Pipe Insulation Requirements

Insulation for storage tanks must comply with Section 150.0(j)1

:

• Unfired tanks (such as storage tanks for solar hot water systems or boilers) shall have

either a minimum R-12 external wrap or a minimum internal insulation of R-16. Internal

insulated tanks must include a label on the exterior of the tank showing the R-value

Pipe insulation shall comply with Section 150.0(j)2. The thickness of the pipe insulation

corresponds to the temperature of the water as described in Table 120.3-A. For DHW

systems with fluid temperatures 105°F -140°F, pipe insulation thickness ranges from

1-1.5 inches depending on the diameter of the pipe. Pipe insulation is a Mandatory

requirement in the following cases: • The first 5 feet of hot & cold water pipes from storage tank • All hot water piping with a nominal diameter of 3/4 inch or larger • All piping associated with a domestic hot water recirculation system regardless

of the pipe diameter

• Piping from heating source to storage tank or between tanks • Piping buried below grade • All hot water pipes from heating source to kitchen fixtures

See Section 150.0(j)2 for exceptions to pipe insulation requirements.

Section 150.0(j)3 contains requirements for insulation protection, including requirements

around pipes exposed to weather and vapor retarders for chilled water or refrigerant

suction piping.

Water Heater System Requirements

Systems using gas or propane water heaters to serve individual dwelling units shall

include the following components: • A 120V electrical receptacle that is within 3 feet from the water heater and accessible

to the water heater with no obstructions and

• A Category III or IV vent, or a Type B vent with straight pipe between the outside

termination and the space where the water heater is installed and

• A condensate drain that is no more than 2 inches higher than the base of the installed

water heater, and allows natural draining without pump assistance and

- A gas supply line with a capacity of at least 200,000 Btu/hr

See Section 150.0(n) for more information.

Prescriptive Requirements

Domestic Water Heating Systems (Individual Dwelling Units)

If using the Prescriptive compliance path, DHW equipment serving individual dwelling

units (detached single-family homes, low-rise multifamily buildings) must comply with one

of the following options, per Section 150.1(c)8

:

- Storage Type Water Heaters: A gas or propane fired unit with an input of

105,000 Btu/hr or less, and a volume of 55 gallons or less, that meets the requirements

for Quality Insulation Installation, and has either a field verified compact hot water

distribution system or all DHW piping is insulated and field verified

- Storage Type Water Heaters: A gas or propane fired unit with an input of more than