California Energy Commission

2019 Residential HVAC Overview

Kelly Morairty, Building Standards Office August 2020

Goals for this Training

- **Basic understanding of the following:**
  - Structure of Energy Code Application of mandatory requirements
  - Differences between prescriptive and performance compliance
  - Residential mechanical forms
- **General understanding of following:**
  - Mandatory requirements related to residential HVAC
  - Residential HVAC prescriptive requirements
- **Clarify the Energy Code requirements for low-rise residential HVAC systems**

QUESTIONS…

- **If you have questions, please feel free to ask at anytime:**
  - During class
  - During breaks
  - End of class
  - After class

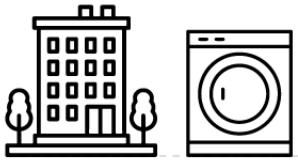
Energy Code Background

CALIFORNIA ENERGY COMMISSION WARREN-ALQUIST BUILDING

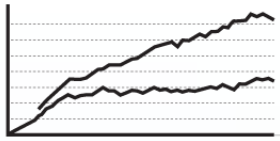
Source: http://www.durabilityanddesign.com/news/?fuseaction=view&id=7805&nl_versionid=2060

1974: WARREN-ALQUIST ACT PASSED

Created the Energy Commission



Set building and appliance efficiency standards

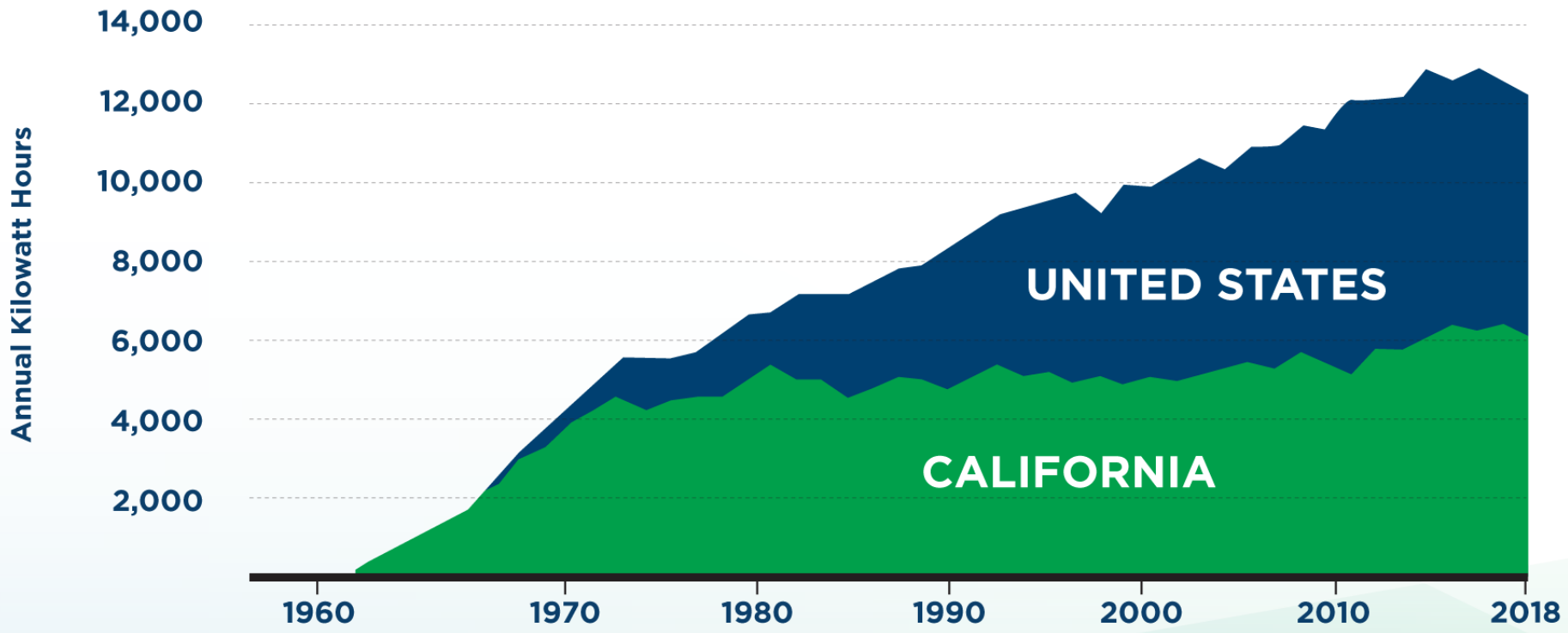


Forecast electricity demand

Support R&D into non-conventional energy sources

CA VS. U.S. ENERGY USE

Californians use **half** the per capita electricity as the rest of the U.S.

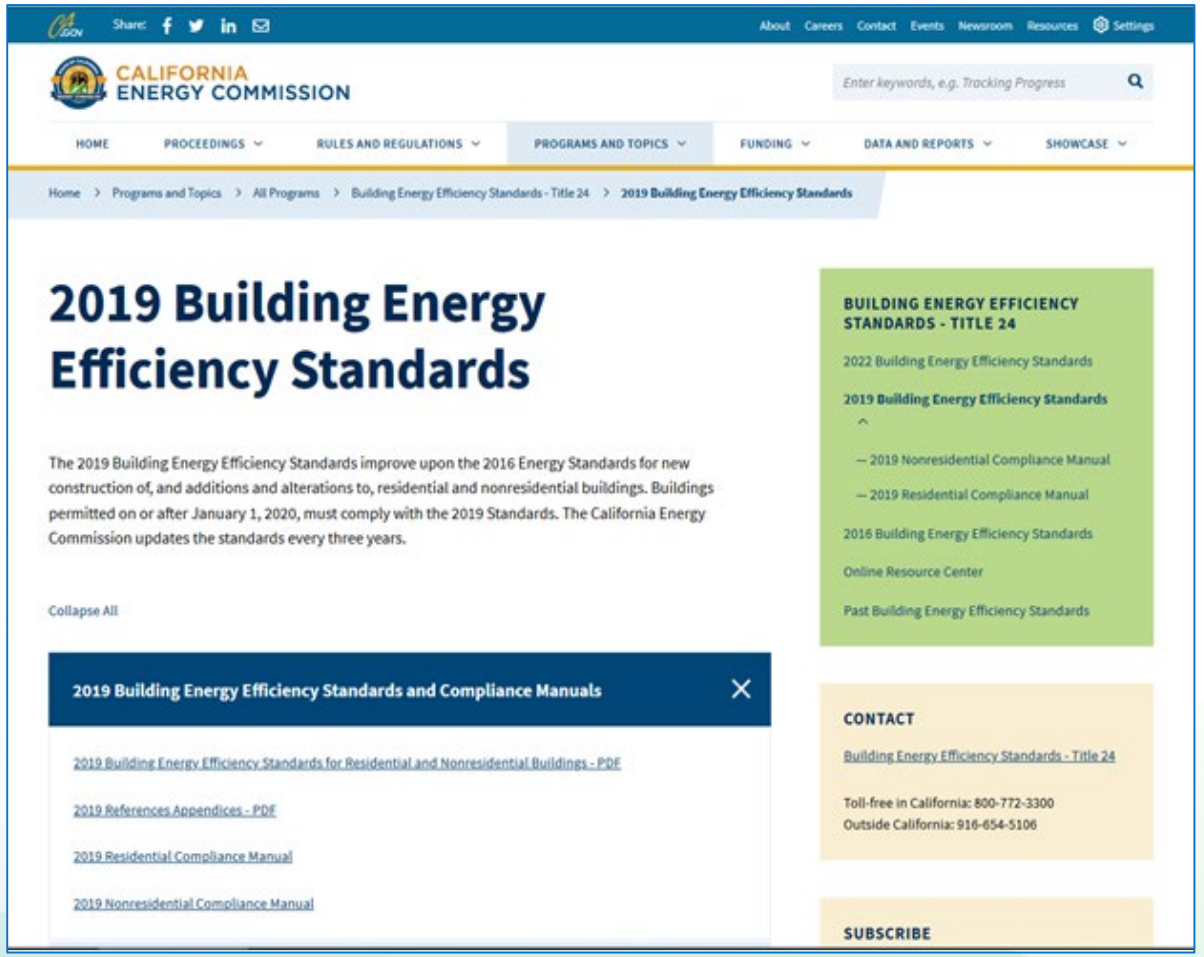


Source: California Energy Commission

2019 Documents

- Building Energy Efficiency Standards
- Residential Compliance Manual
- Reference Appendices
- Residential and Nonresidential Manuals
- All documents available online at:

  www.energy.ca.gov/title24



QUESTIONS…

About CEC or Energy Code ?

Energy Code Foundation

Energy Code Foundation

- **Mandatory Measures**
- **Prescriptive Compliance Approach**
- **Performance Compliance Approach**
- **Navigating the Code** Structure of Energy Code Part 1 and Part 6)
  - Navigation features in electronic PDF
- **Demonstrating Compliance**
  - Types of forms
  - When are they required
  - Dynamic and smart form features

Energy Code Requirements

- **Mandatory measures**
  - Minimum efficiency requirements must always be met
  - Can never be traded off NOT trade-off
- **Prescriptive measures**
  - Predefined efficiency requirements
  - May supersede mandatory measures
  - Different requirements for newly constructed buildings, additions, and alterations

Source: http://clipart-library.com/clipart/864003.htm

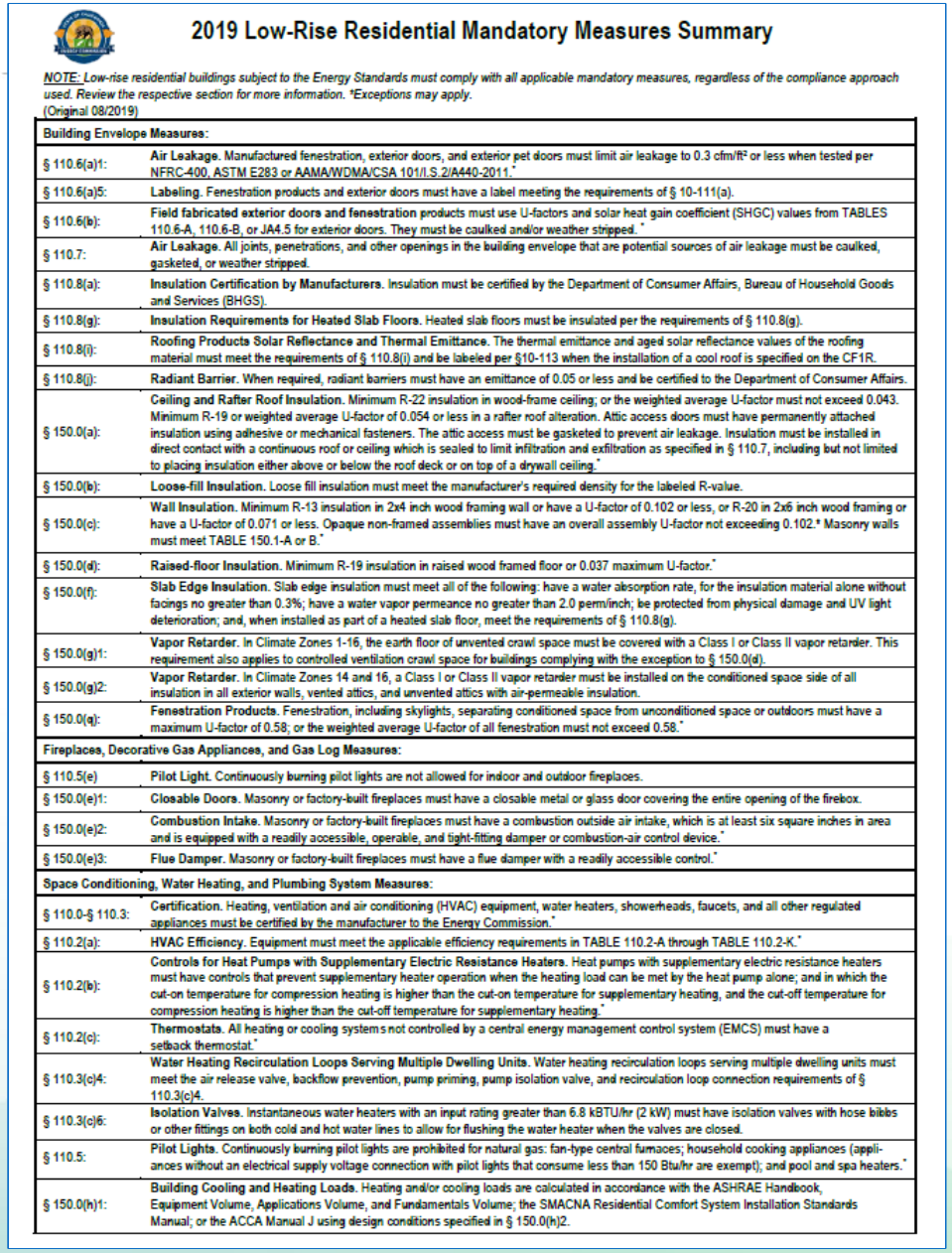
Compliance Approaches

- **Prescriptive Approach**
  - Simple approach, no trade-offs
  - Mostly used for alterations
  - Standard building baseline

- **Performance Approach**
  - Most flexible approach, allows for trade-offs
  - Must meet all mandatory requirements
  - Requires the use of CEC-approved software
  - Efficiency EDR proposed ≤ standard efficiency EDR
  - Total EDR (including PV) ≤ standard total EDR
  - Mostly used for newly constructed homes and additions

2019 Residential Mandatory Measures Summary

- **Available now**
- **Summary of residential mandatory measures**
- **Not a form – note blocks**
  - Designers can choose to include applicable requirements on plans
  - Enforcement agencies may require them on plans



2019 Low-Rise Residential Mandatory Measures Summary

*NOTE: Low-rise residential buildings subject to the Energy Standards must comply with all applicable mandatory measures, regardless of the compliance approach used. Review the respective section for more information. *Exceptions may apply.*
(Original 08/2019)

Building Envelope Measures:	
§ 110.6(a)1:	**Air Leakage.** Manufactured fenestration, exterior doors, and exterior pet doors must limit air leakage to 0.3 cfm/ft² or less when tested per NFRC-400, ASTM E283 or AAMA/WDMA/CSA 101/I.S.2/A440-2011.*
§ 110.6(a)5:	**Labeling.** Fenestration products and exterior doors must have a label meeting the requirements of § 10-111(a).
§ 110.6(b):	**Field fabricated exterior doors and fenestration** products must use U-factors and solar heat gain coefficient (SHGC) values from TABLES 110.6-A, 110.6-B, or JA4.5 for exterior doors. They must be caulked and/or weather stripped.*
§ 110.7:	**Air Leakage.** All joints, penetrations, and other openings in the building envelope that are potential sources of air leakage must be caulked, gasketed, or weather stripped.
§ 110.8(a):	**Insulation Certification by Manufacturers.** Insulation must be certified by the Department of Consumer Affairs, Bureau of Household Goods and Services (BHGS).
§ 110.8(g):	**Insulation Requirements for Heated Slab Floors.** Heated slab floors must be insulated per the requirements of § 110.8(g).
§ 110.8(i):	**Roofing Products Solar Reflectance and Thermal Emittance.** The thermal emittance and aged solar reflectance values of the roofing material must meet the requirements of § 110.8(i) and be labeled per §10-113 when the installation of a cool roof is specified on the CF1R.
§ 110.8(j):	**Radiant Barrier.** When required, radiant barriers must have an emittance of 0.05 or less and be certified to the Department of Consumer Affairs.
§ 150.0(a):	**Ceiling and Rafter Roof Insulation.** Minimum R-22 insulation in wood-frame ceiling; or the weighted average U-factor must not exceed 0.043. Minimum R-19 or weighted average U-factor of 0.054 or less in a rafter roof alteration. Attic access doors must have permanently attached insulation using adhesive or mechanical fasteners. The attic access must be gasketed to prevent air leakage. Insulation must be installed in direct contact with a continuous roof or ceiling which is sealed to limit infiltration and exfiltration as specified in § 110.7, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling.*
§ 150.0(b):	**Loose-fill Insulation.** Loose fill insulation must meet the manufacturer's required density for the labeled R-value.
§ 150.0(c):	**Wall Insulation.** Minimum R-13 insulation in 2x4 inch wood framing wall or have a U-factor of 0.102 or less, or R-20 in 2x6 inch wood framing or have a U-factor of 0.071 or less. Opaque non-framed assemblies must have an overall assembly U-factor not exceeding 0.102.* Masonry walls must meet TABLE 150.1-A or B.*
§ 150.0(d):	**Raised-floor Insulation.** Minimum R-19 insulation in raised wood framed floor or 0.037 maximum U-factor.*
§ 150.0(f):	**Slab Edge Insulation.** Slab edge insulation must meet all of the following: have a water absorption rate, for the insulation material alone without facings no greater than 0.3%; have a water vapor permeance no greater than 2.0 perm/inch; be protected from physical damage and UV light deterioration; and, when installed as part of a heated slab floor, meet the requirements of § 110.8(g).
§ 150.0(g)1:	**Vapor Retarder.** In Climate Zones 1-16, the earth floor of unvented crawl space must be covered with a Class I or Class II vapor retarder. This requirement also applies to controlled ventilation crawl space for buildings complying with the exception to § 150.0(d).
§ 150.0(g)2:	**Vapor Retarder.** In Climate Zones 14 and 16, a Class I or Class II vapor retarder must be installed on the conditioned space side of all insulation in all exterior walls, vented attics, and unvented attics with air-permeable insulation.
§ 150.0(q):	**Fenestration Products.** Fenestration, including skylights, separating conditioned space from unconditioned space or outdoors must have a maximum U-factor of 0.58; or the weighted average U-factor of all fenestration must not exceed 0.58.*
Fireplaces, Decorative Gas Appliances, and Gas Log Measures:	
§ 110.5(e)	**Pilot Light.** Continuously burning pilot lights are not allowed for indoor and outdoor fireplaces.
§ 150.0(e)1:	**Closable Doors.** Masonry or factory-built fireplaces must have a closable metal or glass door covering the entire opening of the firebox.
§ 150.0(e)2:	**Combustion Intake.** Masonry or factory-built fireplaces must have a combustion outside air intake, which is at least six square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device.*
§ 150.0(e)3:	**Flue Damper.** Masonry or factory-built fireplaces must have a flue damper with a readily accessible control.*
Space Conditioning, Water Heating, and Plumbing System Measures:	
§ 110.0-§ 110.3:	**Certification.** Heating, ventilation and air conditioning (HVAC) equipment, water heaters, showerheads, faucets, and all other regulated appliances must be certified by the manufacturer to the Energy Commission.*
§ 110.2(a):	**HVAC Efficiency.** Equipment must meet the applicable efficiency requirements in TABLE 110.2-A through TABLE 110.2-K.*
§ 110.2(b):	**Controls for Heat Pumps with Supplementary Electric Resistance Heaters.** Heat pumps with supplementary electric resistance heaters must have controls that prevent supplementary heater operation when the heating load can be met by the heat pump alone; and in which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.*
§ 110.2(c):	**Thermostats.** All heating or cooling systems not controlled by a central energy management control system (EMCS) must have a setback thermostat.*
§ 110.3(c)4:	**Water Heating Recirculation Loops Serving Multiple Dwelling Units.** Water heating recirculation loops serving multiple dwelling units must meet the air release valve, backflow prevention, pump priming, pump isolation valve, and recirculation loop connection requirements of § 110.3(c)4.
§ 110.3(c)6:	**Isolation Valves.** Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2 kW) must have isolation valves with hose bibbs or other fittings on both cold and hot water lines to allow for flushing the water heater when the valves are closed.
§ 110.5:	**Pilot Lights.** Continuously burning pilot lights are prohibited for natural gas: fan-type central furnaces; household cooking appliances (appliances without an electrical supply voltage connection with pilot lights that consume less than 150 Btu/hr are exempt); and pool and spa heaters.*
§ 150.0(h)1:	**Building Cooling and Heating Loads.** Heating and/or cooling loads are calculated in accordance with the ASHRAE Handbook, Equipment Volume, Applications Volume, and Fundamentals Volume; the SMACNA Residential Comfort System Installation Standards Manual; or the ACCA Manual J using design conditions specified in § 150.0(h)2.

Navigating the Energy Code

Title 24 – California Building Standards Code

- **Part 1 (Administrative Code)**
  - Chapter 10: the administrative requirements
- **Part 6 (Energy Code)**
  - Subchapters 1 through 9
  - Referred to by Section numbers
  - Includes technical requirements

BSC Title 24 Code Books

Title 24, Part 6

Subchapter	Subchapter Title	Sections
1	**All Occupancies** - General Provisions	§100.0 - §100.2
2	All Occupancies - **Mandatory** Requirements for the Manufacture, Construction and Installation of Systems, Equipment, and Building Components	§110.0 - §110.12
3	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies and Covered Processes - **Mandatory** Requirements	§120.0 - §120.9
4	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies - **Mandatory** Requirements for Lighting Systems and Equipment, and Electrical Power Distribution Systems	§130.0 - §130.5
5	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies - **Performance and Prescriptive Compliance Approaches** for Achieving Energy Efficiency	§140.0 - §140.9
6	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies - **Additions, Alterations, and Repairs**	§141.0 - §141.1
7	Low-Rise Residential Buildings - **Mandatory** Features and Devices	§150.0
8	Low-Rise Residential Buildings - **Performance and Prescriptive Compliance Approaches**	§150.1
9	Low-Rise Residential Buildings - **Additions and Alterations** to Existing Low-Rise Residential Buildings	§150.2

Part 6 Section Numbers - Residential

- **§110.0 – 110.12 as applicable**
  - Cover both residential and nonresidential
- **§150.0 for residential mandatory measures**
- **§150.1 for ALL prescriptive requirements**
  - Newly constructed buildings
- **§150.2 for additions and alterations**

TABLE 100.0-A APPLICATION OF STANDARDS

Occupancies	Application	Mandatory	Prescriptive	Performance	Additions/Alterations
General Provisions for All Buildings		100.0, 100.1, 100.2, 110.0			
Nonresidential, High-Rise Residential, And Hotels/Motels	General	120.0	140.0, 140.2	140.0, 140.1	141.0
	Envelope (conditioned)	110.6, 110.7, 110.8,120.7	140.3		
	Envelope (unconditioned process spaces)	N.A.	140.3(c)		
	HVAC (conditioned)	110.2, 110.5, 120.1, 120.2, 120.3, 120.4, 120.5, 120.8	140.4		
	Water Heating	110.3, 120.3, 120.8, 120.9	140.5		
	Indoor Lighting (conditioned, process spaces)	110.9, 120.8, 130.0, 130.1, 130.4	140.3(c), 140.6		
	Indoor Lighting (unconditioned and parking garages)	110.9, 120.8, 130.0, 130.1, 130.4	140.3(c), 140.6	N.A.	
	Outdoor Lighting	110.9, 130.0, 130.2, 130.4	140.7		
	Electrical Power Distribution	110.11, 130.5	N.A.		
	Pool and Spa Systems	110.4, 110.5, 150.0(p)	N. A.		141.0
	Solar Ready Buildings	110.10	N.A.		141.0(a)
Covered Processes[1]	Envelope, Ventilation, Process Loads	110.2, 120.6	140.9	140.1	120.6, 140.9
Signs	Indoor and Outdoor	130.0, 130.3	140.8	N.A.	141.0, 141.0(b)2H
Low-Rise Residential	General	150.0	150.1(a, c)	150.1(a), 150.1(b)	150.2(a), 150.2(b)
	Envelope (conditioned)	110.6, 110.7, 110.8, 150(a), 150.0(b), 150.0(c), 150.0(d), 150.0(e), 150.0(g)			
	HVAC (conditioned)	110.2, 110.5, 150.0(h), 150.0(i), 150.0(j), 150.0(m), 150.0(o)			
	Water Heating	110.3, 150.0(j, n)			
	Indoor Lighting (conditioned, unconditioned and parking garages)	110.9, 130.0, 150.0(k)			
	Outdoor Lighting	110.9, 130.0,150.0(k)			
	Pool and Spa Systems	110.4, 150.0(p)	N. A.	N.A.	150.2(a), 150.2(b)
	Solar Ready Buildings	110.10	N. A.	N.A.	N.A.

[1] Nonresidential, high-rise and hotel/motel buildings that contain covered processes may conform to the applicable requirements of both occupancy types listed in this table.

Navigation Features

- **Easy Navigation Features Added**
  - Section and Table references hyperlinked throughout Energy Standards Code
  - TABLE 100.0-A separated with section hyperlinks
  - Chapter hyperlinks in Residential Compliance Manual
  - Links work both online and in the downloaded version

Source: https://tyrgroupllc.com/land-navigation-level-i-course-2-day

Demonstrating Compliance

How To to Demonstrate Compliance

- **Compliance demonstration starts with compliance documents (forms)**
- **Completed by designers, consultants, builders, contractors, HERS raters**
- **Submitted to enforcement agencies for verification:**
  - Certificate of Compliance (CF1R)
  - Certificate of Installation (CF2R)
  - Certificate of Verification (CF3R)

What is the CF1R?

- **Residential Certificate of Compliance**
  - Required with or on plans at permit
  - Demonstrates compliance at design phase
  - Completed by designer, architect, energy consultant, engineer
  - Plans Examiner verifies CF1R matches specs on plans

STATE OF CALIFORNIA
ALTERATIONS TO SPACE CONDITIONING SYSTEMS
CEC-CF1R-ALT-02-E (Revised 01/19)
CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE — CF1R-ALT-02-E
Alterations to Space Conditioning Systems — (Page 1 of 5)
Project Name: | Date Prepared:

A. General Information
CF1R-ALT-02 is applicable to multiple space conditioning systems contained within a single dwelling unit. When multiple dwelling units must be documented, use one CF1R-ALT-02 document for each dwelling unit.

01	Project Name:		02	Date Prepared:	
03	Project Location:		04	Building Type:	
05	CA City:		06	Dwelling Unit Name:	
07	Zip Code:		08	Dwelling Unit CFA (ft²):	
09	Climate Zone:		10	Number of Space Conditioning (SC) Systems in this Dwelling Unit:	

B. Space Conditioning (SC) System Information

01	02	03
SC System ID/Name	SC System Description of Area Served	CFA served by this SC System (ft²):

C. Extension of Existing Duct System, Greater Tha

01	02	03
SC System ID/Name	SC System Description of Area Served	Required New Duct R-Value

Required Documentation:
CF2R-MCH-01-E - Space Conditioning Systems
-Duct insulation requirement for the new portions of su
CF2R & CF3R-MCH-20-H – Duct Leakage Test
-Leakage rate compliance: ≤ 15%, or ≤ 10% leakage to
Exceptions:
Existing duct systems constructed, insulated or sealed w

Registration Number:
CA Building Energy Efficiency Standards - 2019 Res

STATE OF CALIFORNIA
NEWLY CONSTRUCTED BUILDINGS
CEC-CF1R-NCB-01-E (Revised 01/19)
CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE — CF1R-NCB-01-E
Prescriptive Newly Constructed Buildings — (Page 1 of 9)
Project Name: | Date Prepared:

A. General Information

01	Project Name:		02	Date Prepared:	
03	Project Location:		04	Building Front Orientation (deg or cardinal):	
05	CA City:		06	Number of Dwelling Units:	
07	Zip Code:		08	Fuel Type:	
09	Climate Zone:		10	Total Conditioned Floor Area (ft²):	
11	Building Type:		12	Slab Area (ft²):	
13	Project Scope:		14	Exceptions to Fenestration U-factor & SHGC 150.1(c)3A:	

B. Opaque Surface Details – Framed Walls/ Framed Floors/Concrete Raised Floors (Section 150.1(c)1)

01	02	03	04	05	06	07	08	09	10	11	12
					Proposed					Required	
Tag/ID	Assembly Type	Frame Type	Frame Depth (inches)	Frame Spacing (inches)	Cavity R-value	Continuous Insulation R-value	U-Factor	Appendix JA4 Reference: Table	Appendix JA4 Reference: Cell	U-Factor from Table 150.1-A or B	Comments

C. Opaque Surface Details – Nonframed (Section 150.1(c)1)

01	02	03	04	05	06	07	08	09	10
			Proposed					Required	
Tag/ID	Assembly Materials	Thickness (inches)	Core Insulation R-value	Continuous Insulation R-value	U-Factor	Appendix JA4 Reference: Table	Appendix JA4 Reference: Cell	U-Factor from Table 150.1-A or B	Comments

Registration Number: | Registration Date/Time: | HERS Provider:
CA Building Energy Efficiency Standards - 2019 Residential Compliance | January 2019

What is the CF2R?

- **Residential Certificate of Installation**
  - Required for Final Inspection
  - Confirms compliance at installation
  - Completed by builder or installing contractor
  - Field Inspector verifies efficiency and components match installed equipment and systems

STATE OF CALIFORNIA
SPACE CONDITIONING SYSTEMS, DUCTS, AND FANS
CEC-CF2R-MCH-01-H (Revised 01/19)
CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION	CF2R-MCH-01-E
Space Conditioning Systems Ducts and Fans	(Page 1 of 9)

Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. General Information

01	Dwelling Unit Name		02	Climate Zone	
03	Dwelling Unit Total Conditioned Floor Area (ft²)		04	Number of Space Conditioning Systems in this Dwelling Unit	
05	Certificate of Compliance Type		06	Method Used to Calculate HVAC Loads	
07	Calculated Dwelling Unit Sensible Cooling Load (Btu/h)		08	Calculated Dwelling Unit Heating Load (Btu/h)	
09	Dwelling Unit Number of Bedrooms				

MCH-01a – Space Conditioning Systems Ducts and Fans - For use wi

B. Design Space Conditioning (SC) System Component Specification
This table reports the space conditioning system features that were specifie

01	02	03	04	05
Zone Name	SC System ID/Name from CF1R	SC System Type	Heating System Type	Cooling System Ty

Notes:

Registration Number:
CA Building Energy Efficiency Standards - 2019 Residential Compliance

STATE OF CALIFORNIA
DUCT LEAKAGE DIAGNOSTIC TEST
CEC-CF2R-MCH-20-H (Revised 01/19)
CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION	CF2R-MCH-20-H
Duct Leakage Diagnostic Test	(Page 1 of 3)

Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. System Information

01	Space Conditioning System Identification or Name	
02	Space Conditioning System Location or Area Served	
03	Indoor Unit Name	
04	Building Type from CF1R	
05	Verified Low Leakage Ducts in Conditioned Space (VLLDCS) Credit from CF1R?	
06	Verified Low Leakage Air-handling Unit Credit from CF1R?	
07	Duct System Compliance Category	
08	Any portions of Duct Located in Garage?	

MCH-20a - Completely New Duct System

B. Duct Leakage Diagnostic Test

01	Air-Handling Unit Airflow (AHU Airflow) Determination Method	
02	Condenser Nominal Cooling Capacity (ton)	
03	Indoor Unit Nominal Cooling Capacity	
04	Heating Capacity (kBtu/h)	
05	Conditioned Floor Area Served by this HVAC System (ft²)	
06	Measured AHU Airflow (cfm)	
07	Duct Leakage Test Conditions	
08	Duct Leakage Test Method	
09	Leakage Factor	
10	Calculated Target Allowable Duct Leakage Rate (cfm)	
11	Actual Duct Leakage Rate from Leakage Test Measurement (cfm)	
12	Compliance Statement:	

What is the CF3R?

- **Residential Certificate of Verification**
  - Required for Final Inspection
  - Confirms compliance with HERS testing requirements at installation (duct leakage, airflow, refrigerant charge)
  - Completed by certified HERS rater, and forms must be registered with approved HERS Provider
  - Field Inspector verifies testing and forms are complete, signed, and registered when required

STATE OF CALIFORNIA
SPACE CONDITIONING SYSTEM AIRFLOW RATE
CEC-CF3R-MCH-23-H (Revised 01/19) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION	CF3R-MCH-23-H
Space Conditioning System Airflow Rate	(Page 1 of 3)

Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. Ducted Cooling System Information		
01	Space Conditioning System Identification or Name	
02	Space Conditioning System Description of Area Served	
03	Indoor Unit Name	
04	System Installation Type	
05	Nominal Cooling Capacity (tons) o	
06	Condenser Speed Type	
07	Cooling System Zonal Control Type	
08	Central Fan Integrated (CFI) Ventil	
09	System Bypass Duct Status	
10	Date of System Airflow Rate Meas	
11	Airflow Rate Protocol Utilized	
12	Central Fan Ventilation Cooling Sy	

B. Hole for the placement of a Static Pre	
Procedures for installing HSPP or PSPP a	
01	Method Used to Demonstrate Cor

C. Airflow Rate Measurement Apparatu	
Instrument Specifications are given in RA	
01	Airflow Rate Measurement Type U
02	Manufacturer of Airflow Measure
03	Model number of Airflow Measur
04	Certification Status of the Airflow

MCH-23a Forced Air System Airflow Rat

STATE OF CALIFORNIA
DUCT LEAKAGE DIAGNOSTIC TEST
CEC-CF3R-MCH-20-H (Revised 01/19) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION	CF3R-MCH-20-H
Duct Leakage Diagnostic Test	(Page 1 of 3)

Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

A. System Information		
01	Space Conditioning System Identification or Name	
02	Space Conditioning System Location or Area Served	
03	Indoor Unit Name	
04	Building Type from CF1R	
05	Verified Low Leakage Ducts in Conditioned Space (VLLDCS) Credit from CF1R?	
06	Verified Low Leakage Air-handling Unit Credit from CF1R?	
07	Duct System Compliance Category	
08	Any portions of Duct Located in Garage?	

MCH-20a - Completely New Duct System

B. Duct Leakage Diagnostic Test		
01	Air-Handling Unit Airflow (AHU Airflow) Determination Method	
02	Condenser Nominal Cooling Capacity (ton)	
03	Indoor Unit Nominal Cooling Capacity	
04	Heating Capacity (kBtu/h)	
05	Conditioned Floor Area Served by this HVAC System (ft^2)	
06	Measured AHU Airflow (cfm)	
07	Duct Leakage Test Conditions	
08	Duct Leakage Test Method	
09	Leakage Factor	

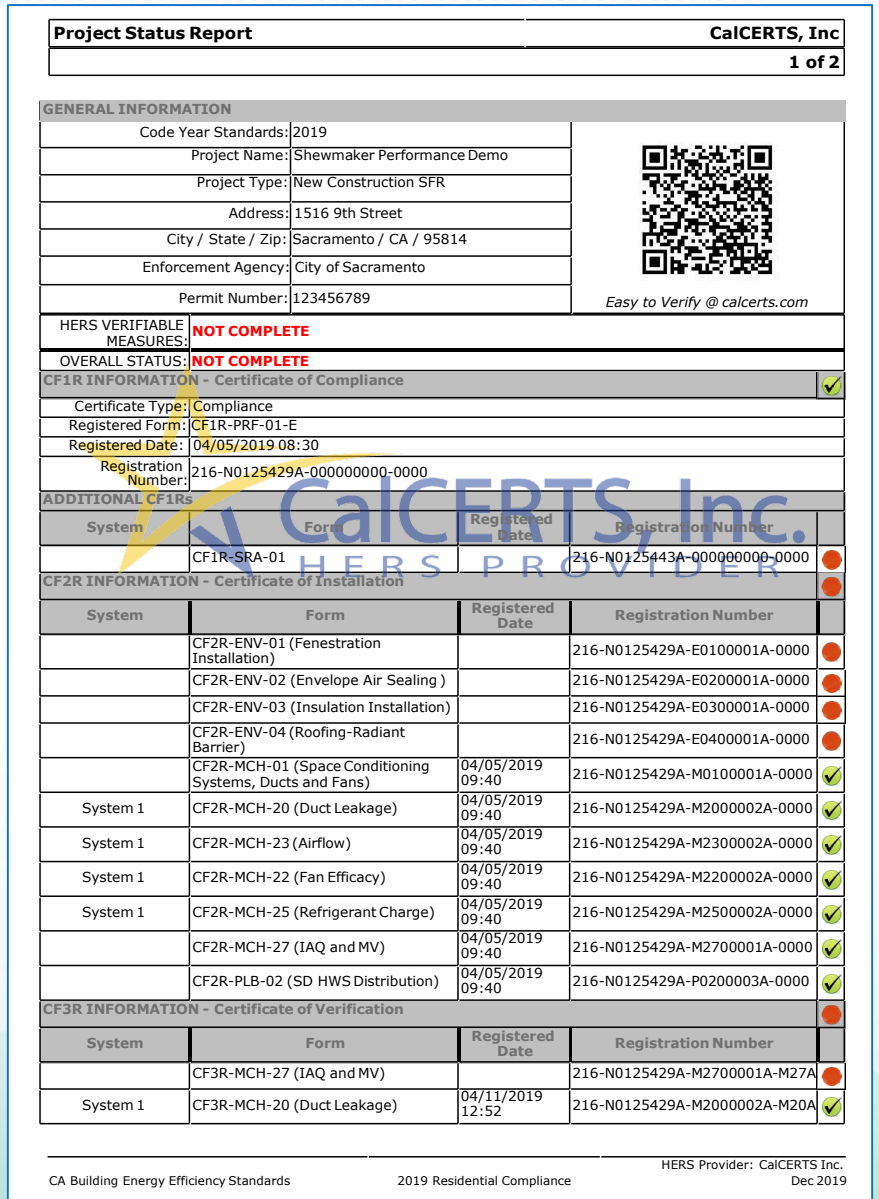
Where can I find forms?

https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/online-resource-center

https://energycodeace.com/residentialforms

Residential Project Status Report (PSR)

- **Summarizes status of ALL forms**
- **Available for any project in HERS provider registry**
- **“Overall” and “HERS” should be marked Complete**
  - Can access directly in registry
  - Can request as a hard copy in lieu of a stack of forms



Project Status Report — **CalCERTS, Inc** — **1 of 2**

GENERAL INFORMATION

Code Year Standards:	2019
Project Name:	Shewmaker Performance Demo
Project Type:	New Construction SFR
Address:	1516 9th Street
City / State / Zip:	Sacramento / CA / 95814
Enforcement Agency:	City of Sacramento
Permit Number:	123456789

Easy to Verify @ calcerts.com

HERS VERIFIABLE MEASURES:	NOT COMPLETE
OVERALL STATUS:	NOT COMPLETE

CF1R INFORMATION - Certificate of Compliance

Certificate Type:	Compliance
Registered Form:	CF1R-PRF-01-E
Registered Date:	04/05/2019 08:30
Registration Number:	216-N0125429A-000000000-0000

ADDITIONAL CF1Rs

System	Form	Registered Date	Registration Number	
	CF1R-SRA-01		216-N0125443A-000000000-0000	●

CF2R INFORMATION - Certificate of Installation ●

System	Form	Registered Date	Registration Number	
	CF2R-ENV-01 (Fenestration Installation)		216-N0125429A-E0100001A-0000	●
	CF2R-ENV-02 (Envelope Air Sealing)		216-N0125429A-E0200001A-0000	●
	CF2R-ENV-03 (Insulation Installation)		216-N0125429A-E0300001A-0000	●
	CF2R-ENV-04 (Roofing-Radiant Barrier)		216-N0125429A-E0400001A-0000	●
	CF2R-MCH-01 (Space Conditioning Systems, Ducts and Fans)	04/05/2019 09:40	216-N0125429A-M0100001A-0000	✓
System 1	CF2R-MCH-20 (Duct Leakage)	04/05/2019 09:40	216-N0125429A-M2000002A-0000	✓
System 1	CF2R-MCH-23 (Airflow)	04/05/2019 09:40	216-N0125429A-M2300002A-0000	✓
System 1	CF2R-MCH-22 (Fan Efficacy)	04/05/2019 09:40	216-N0125429A-M2200002A-0000	✓
System 1	CF2R-MCH-25 (Refrigerant Charge)	04/05/2019 09:40	216-N0125429A-M2500002A-0000	✓
	CF2R-MCH-27 (IAQ and MV)	04/05/2019 09:40	216-N0125429A-M2700001A-0000	✓
	CF2R-PLB-02 (SD HWS Distribution)	04/05/2019 09:40	216-N0125429A-P0200003A-0000	✓

CF3R INFORMATION - Certificate of Verification ●

System	Form	Registered Date	Registration Number	
	CF3R-MCH-27 (IAQ and MV)		216-N0125429A-M2700001A-M27A	●
System 1	CF3R-MCH-20 (Duct Leakage)	04/11/2019 12:52	216-N0125429A-M2000002A-M20A	✓

CA Building Energy Efficiency Standards — 2019 Residential Compliance — HERS Provider: CalCERTS Inc. Dec 2019

Code Quiz:

1. **What are the numbers and names of the three compliance forms?**
   a) CF1R – Certificate of Compliance
   b) CF2R – Certificate of Installation
   c) CF3R – Certificate of Verification

2. **Which compliance approach offers the ability to trade-off energy features?**
   a) Performance Compliance Approach
   b) Prescriptive Compliance Approach

3. **Can you trade-off mandatory measures for other higher efficiency features when using the Performance Approach?**
   a) Yes
   b) No
   c) Sometimes

QUESTIONS…

About CEC or Energy Code ?

Source: http://www.haveheroverfordinner.com/2011/05/grilled-ribeye-steaks-with-sour-cream.html

The Meat and Potatoes of Residential HVAC

Subchapter 2
All Occupancies
Mandatory Requirements for the Manufacture, Construction and Installation of Systems, Equipment and Building Components (§110.0 -§110.12)

All Occupancies Mandatory Requirements

Section	Topic
§110.1	Mandatory Requirements for Appliances
§110.2	Mandatory Requirements for Space-Conditioning Equipment
§110.5	Natural Gas Central Furnaces, Cooking Equipment, Pool and Spa Heaters, and Fireplaces: Pilot Lights Prohibited
§110.12	Mandatory Requirements for Demand Management

§110.1 – Mandatory Requirements for Appliances

Source: https://www.czyzsbrandsource.com/

Source: http://www.hvacdonewright.com/products.cfm

§110.1 – Mandatory Requirements for Appliances

- **Systems, equipment, and appliances may be installed only if they are certified and listed as follows:**
  - If the item is covered by Title 20, it must meet the Title 20 efficiency requirements and be listed in the Title 20 database
  - Items having efficiency requirements in Title 24, Part 6 must be listed in one of the following:
    - Title 20 database
    - Federal database
    - Approved trade association database such as AHRI or CTI
  - If the equipment cannot be listed, you must demonstrate efficiency conformance per the procedures outlined in Section 10-109 of Part 1

§110.2 - Mandatory Requirements for Space Conditioning Equipment

§110.2 - Mandatory Requirements for Space Conditioning Equipment

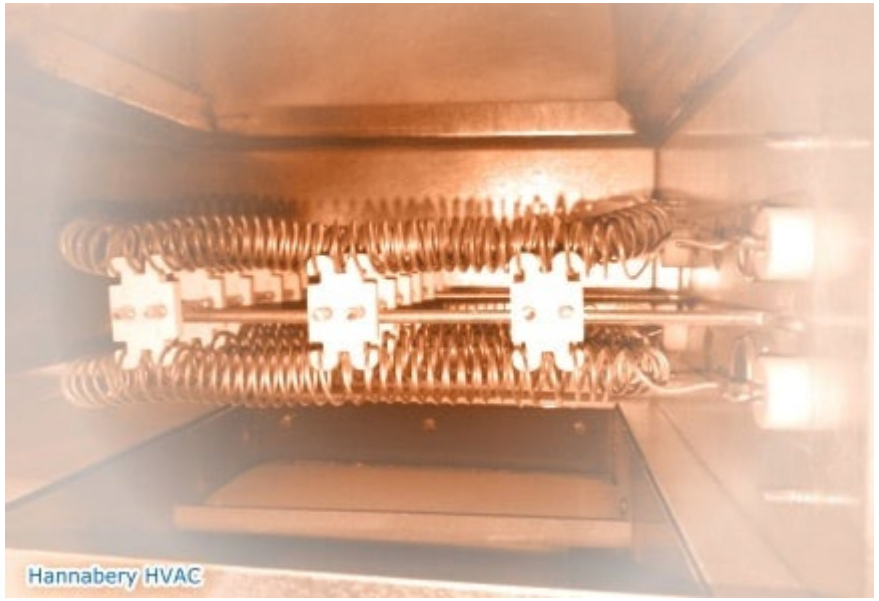
- **All equipment covered in this section must be certified by the manufacturer**
- **(a) All equipment listed in TABLE 110.2-A through TABLE 110.2-K must meet the applicable efficiencies when tested per the listed test procedure**

❖EXCEPTIONS:

✓ There are exceptions for some water chilling packages, some positive displacement chillers and equipment serving refrigerated warehouses or commercial refrigeration. See §110.2(a) for details

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(b) Heat pumps with supplementary electric resistance heaters must have controls that do the following:**
  - Prevent supplementary heater operation when the heating load can be met by the heat pump alone
  - Cut-on and cut-off temperatures for the electric resistance heating must be lower than the heat pump cut-on and cut-off temperatures



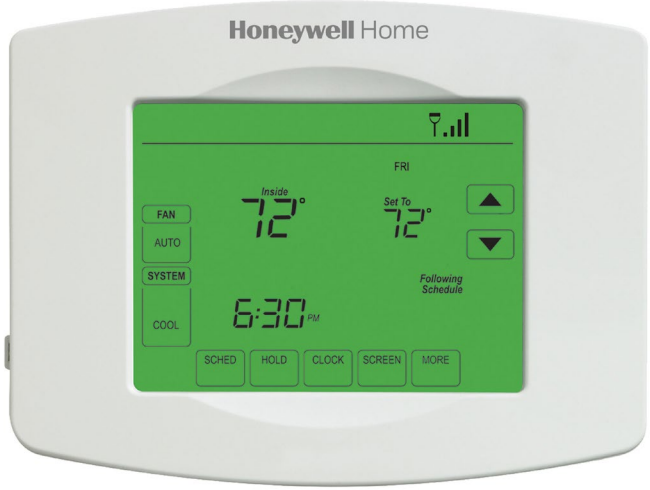
Source: https://www.hannabery.com/faq4.shtml

❖EXCEPTION:

✓ There are exceptions for defrost, transient periods, and room air conditioners het pumps

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(c) Thermostat Requirements**
  - All heating and cooling systems without an EMCS must have a setback thermostat that can be programed with at least four temperature setpoints within 24 hours
  - Thermostats for heat pumps must also control supplementary electric resistance heaters as discussed on the previous slide



Source: https://www.honeywellhome.com/us/en/products/air/thermostats/

❖EXCEPTION:

- ✓ Gravity gas wall heaters, gravity floor heaters, gravity room heaters, non-central electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps are not required to have setback thermostats

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(f) Low leakage air handler compliance credit:**
  - The air handler must be listed on the CEC's list of certified products
  - After installation, the system and attached ducts must be leak tested by a **HERS rater** and the documentation uploaded to the **HERS Registry**
  - Credit is only available when the performance method is used

Source: http://microcleanroom.com/index.html/air-handling-units.html

§110.5 - Natural Gas Central Furnaces, Cooking Equipment, Pool and Spa Heaters, and Fireplaces: Pilot Lights Prohibited

Source: https://www.wilsonoilandpropane.com/2019/02/27/does-my-gas-furnace-have-a-pilot-light/

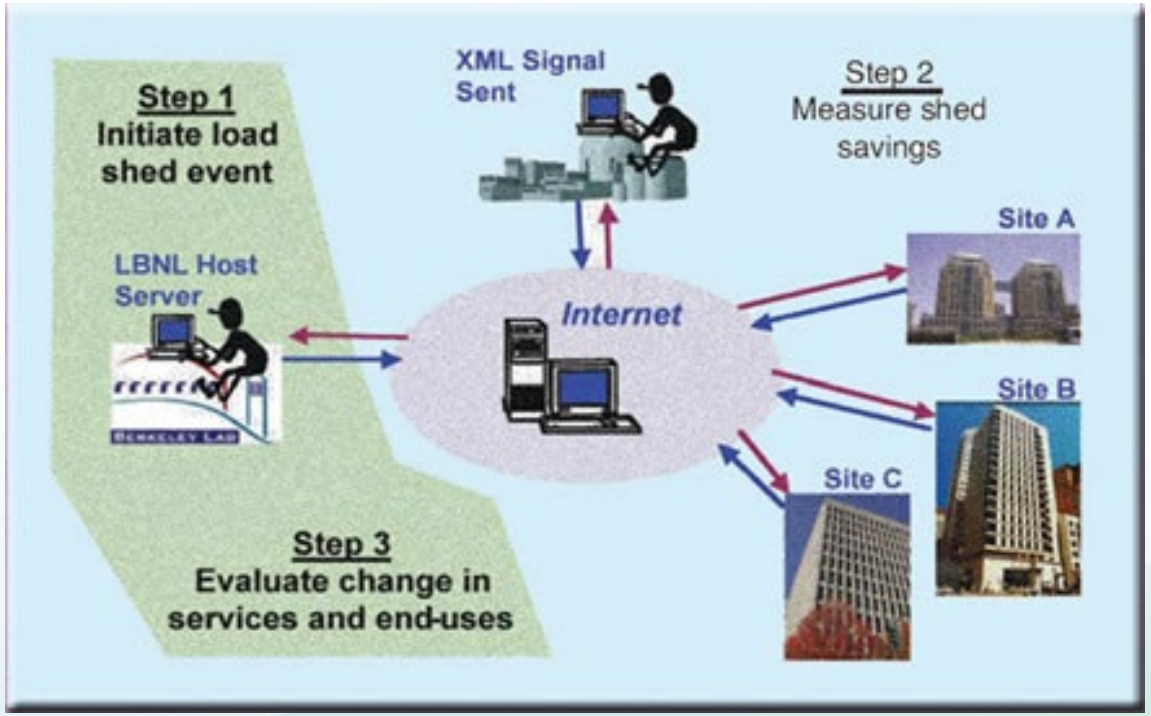
§110.5 - Natural Gas Central Furnaces, Cooking Equipment, Pool and Spa Heaters, and Fireplaces: Pilot Lights Prohibited

- **Any natural gas system or equipment listed below may be installed only if it does not have a continuously burning pilot light:**
  - Fan-type central furnaces
  - Household cooking appliances

    ❖EXCEPTION:
    - ✓ Household cooking appliances without an electrical supply voltage connection and each pilot consumes less than 150 Btu/hr

  - Pool heaters
  - Spa heaters
  - Indoor and outdoor fireplaces

§110.12
Mandatory requirements for Demand Management



Source: https://newscenter.lbl.gov/2004/02/02/multi-building-internet-demand-response-control-system-the-first-successful-test/

§110.12 - Mandatory Requirements for Demand Management

- **Demand Responsive Controls**
  - When meeting demand management requirements, thermostats must meet JA5 requirements, if no EMCS
  - Must be capable of communicating using one or more of the following: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring
  - Spells out communication protocols
    - Must be certified as Open ADR 2.0a or b Virtual End Node (VEN), certified and listed at https://products.openadr.org/, or
    - Must be capable of responding to open ADR 2.0b VEN, certified to CEC and listed at www.energy.ca.gov/title24/equipment_cert/

Code Quiz

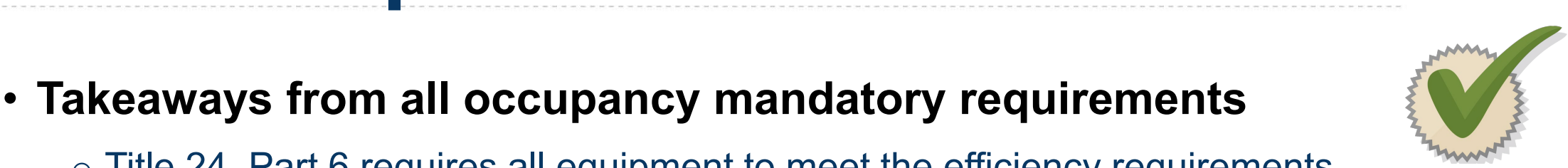
Source: https://classroomclipart.com/clipart-view/Clipart/People/man-scratching-head-with-question-clipart_jpg.htm

1. **Is this thermostat allowed per Section 110.2 for gravity gas wall heaters or room air conditioners?**
   - ✓ Yes

2. **Is it allowed for a forced air system?**
   - ✓ No

3. **In order to be legally installed in California, space-conditioning equipment with requirements in the Energy Code must…what?**
   a) Meet the listed efficiency requirements
   b) Be listed in an approved database
   c) Both a and b

§110 Series All Occupancies Mandatory HVAC Requirements



- **Takeaways from all occupancy mandatory requirements**
  - Title 24, Part 6 requires all equipment to meet the efficiency requirements in Title 20 and Title 24 and be listed in an approved database
  - Heat pumps must have controls limiting supplementary electric heaters
  - Central systems must have an EMCS or setback thermostat
  - Continuously burning pilot lights are prohibited on natural gas forced air furnaces, kitchen appliances, pool and spa heaters, and fireplaces
  - These requirements are mandatory and are applicable to all buildings
  - Always check for exceptions

Subchapter 7
Low-Rise Residential Buildings – Mandatory Features and Devices
(Section §150.0)

Low-Rise Res Buildings Mandatory Features/Devices

Section	Topic
§150.0(e)	Installation of Fireplaces and Decorative Gas Appliances
§150.0(h)	Space-Conditioning Equipment
§150.0(i)	Thermostats
§150.0(j)	Insulation for Piping and Tanks
§150.0(m)	Air-Distribution and Ventilation System Ducts, Plenums and Fans
§150.0(o)	Requirements for Ventilation and Indoor Air Quality

§150.0(e) - Installation of Fireplaces and Decorative Gas Appliances

- **Must have all the following:**
  - Closeable metal or glass doors covering the entire opening of the firebox
  - *A combustion air intake to draw air from the outside
    - At least 6 square inches
    - Equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device
  - *A flue damper with a readily accessible control

*Exceptions apply

§150.0(h) - Space-Conditioning Equipment

- **1 - Building Cooling and Heating Loads**
  - Heating and cooling loads are determined by using either ASHRAE, SMACNA, or ACCA
    - Heating systems must meet CBC minimum requirements

- **2 - Design Conditions**
  - Sizing HVAC
    - Indoor Temps (Heating: 68 ºF and Cooling: 75 ºF)
    - Outdoor Temps (Reference Joint Appendix JA2)

§150.0(h) - Space-Conditioning Equipment

- **3A - Outdoor Condensing Unit (AC or Heat Pump)**
  - Clearance
    - 5 feet from outlet of dryer vents

- **3B - Liquid line filter drier**
  - When required by manufacturer

§150.0(j)2B - Insulation for Piping and Tanks

- **Cooling & Heating Pipe Insulation**
  - Piping for space conditioning systems, and distribution piping for steam and hydronic heating system, must meet the requirements of §120.3(c)
  - Insulation is required on the following:
    - Space cooling: refrigerant suction, chilled water and brine lines
    - Space heating: all refrigerant, steam, steam condensate, and hot water distribution lines
  - Insulation levels are specified in TABLE 120.3-A
  - If the conductivity is outside the range listed in TABLE 120.3-A, the calculation method shown in §120.3(c)2 must be used (example on next slide)

§150.0(j)2B - Insulation for Piping and Tanks

Insulation Thickness Example per method shown in §120.3(c)2:

Question

What is the required thickness for calcium silicate insulation with a conductivity (from the manufacturers literature at 200°F) of 0.40 (Btu-in.)/(h-ft²-°F) on a 4 inches diameter pipe carrying a 300°F fluid?

Answer

PR = 2"
t = 4.5" (from the table for a 4" pipe with 300°F fluid)
K = 0.40 (Btu-in.)/(h-ft²-°F) (from calcium silicate insulation manufacturer's conductivity data at 200°F)
k = 0.29 (Btu-in.)/(h-ft²-°F) (the lower value of the range for conductivity for 300°F fluid)

$$T = PR[(1 + t/PR)^{K/k} - 1]$$

$$T = 2[(1 + 4.5/2)^{(0.40/0.29)} - 1]$$

T = 8.2 inches minimum

Table 120.3-A PIPE INSULATION THICKNESS

Fluid Operating Temperature Range (°F)	Insulation Conductivity: Conductivity (Btu·in/h·ft²·°F)	Insulation Conductivity: Mean rating Temperature (°F)		Nominal Pipe Diameter (in inches): < 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
Space heating and Service Water Heating Systems (Steam, Steam Condensate, Refrigerant, Space Heating, Service Hot Water)				**Minimum Pipe Insulation Required (Thickness in inches or R-value)**				
Above 350	0.32-0.34	250	Inches	4.5	5.0	5.0	5.0	5.0
			R-value	R 37	R 41	R 37	R 27	R 23
251-350	0.29-0.32	200	Inches	3.0	4.0	4.5	4.5	4.5
			R-value	R 24	R 34	R 35	R 26	R 22
201-250	0.27-0.30	150	Inches	2.5	2.5	2.5	3.0	3.0
			R-value	R 21	R 20	R 17.5	R 17	R 14.5
141-200	0.25-0.29	125	Inches	1.5	1.5	2.0	2.0	2.0
			R-value	R 11.5	R 11	R 14	R 11	R 10
105-140	0.22-0.28	100	Inches	1.0	1.5	1.5	1.5	1.5
			R-value	R 7.7	R 12.5	R 11	R 9	R 8
				Nominal Pipe Diameter (in inches)				
				< 1	**1 to <1.5**	**1.5 to < 4**	**4 to < 8**	**8 and larger**
Space cooling systems (chilled water, refrigerant and brine)				**Minimum Pipe Insulation Required (Thickness in inches or R-value)[1]**				
40-60	0.21-0.27	75	Inches	Nonres 0.5 / Res 0.75		Nonres 0.5 / Res 0.75		1.0	1.0	1.0
			R-value	Nonres R 3 / Res R 6		Nonres R 3 / Res R 5		R 7	R 6	R 5
Below 40	0.20-0.26	50	Inches	1.0		1.5		1.5	1.5	1.5
			R-value	R 8.5		R 14		R 12	R 10	R 9

Footnote to TABLE 120.3-A:
1. These thickness are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation or retarders or additional insulation.

§150.0(j)2B - Insulation for System Lines

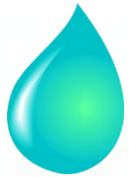
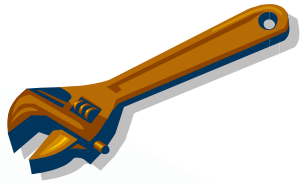
- **Exceptions to Pipe Insulation:**
  - Factory-installed piping within space-conditioning equipment certified under §110.1 or §110.2
  - Piping that penetrates framing members is not required to have insulation at the framing penetration. Metal piping must have grommets, plugs, wrapping, or other insulation to prevent contact with metal framing
  - Piping installed in interior or exterior walls if all requirements are met for compliance with Quality Insulation Installation (QII) as specified in the Reference Residential Appendix RA3.5
  - Piping surrounded with a minimum of 1 inch of wall insulation, 2 inches of crawlspace insulation, or 4 inches of attic insulation

§150.0(j)3 - Insulation Protection

- **Protection for Insulation**
  - Pipe insulation outside conditioned space must be protected from damage
  - Including damage due to:

- Sunlight
- Wind
- Moisture
- Equip. Maint.



  - Refrigerant suction lines located outside must have Class I or Class II vapor retardant

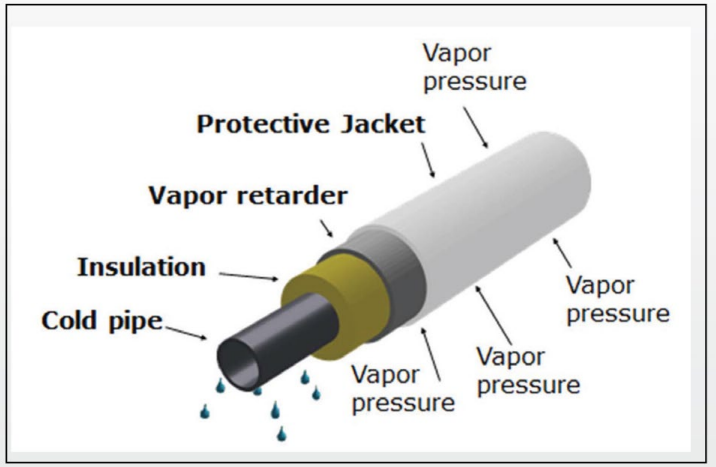


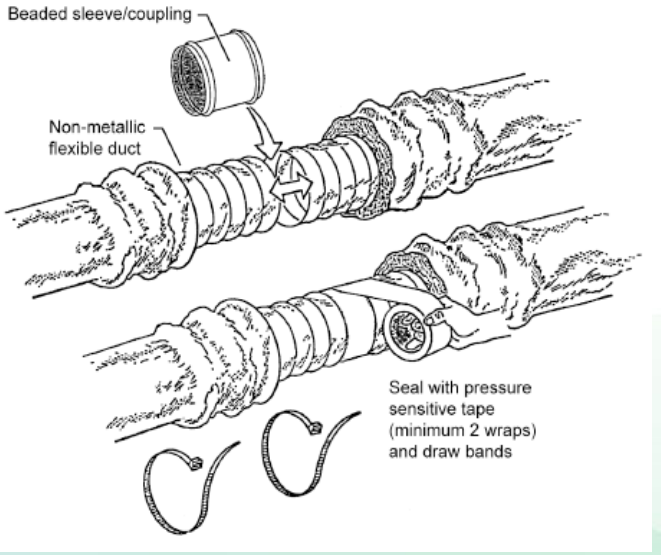
Figure 1. This drawing depicts an insulated and jacketed cold pipe, such as a chilled water (CHW) pipe, surrounded by a humid environment.

Source: http://insulation.org/io/articles/improvements-in-water-vapor-retarder-jacketing-for-use-over-mechanical-insulation/

§150.0(m)1 - Air-Distribution & Ventilation Systems

- **Duct System Installation Requirements**
  - Air Distribution Systems must meet the requirements of the CMC §§ 601.0, 602.0, 603.0, 604.0, 605.0, and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition
  - Connections & Sealing
    - Ducts connections must be mechanically fastened
    - Sealed with mastic, tape, or other duct closure system that meets UL requirements
  - Insulation (Supply & Return Ducts and Plenums)
    - R-6 or higher; or
    - R-4.2 or higher if entirely in conditioned space, HERS verified

Source: https://southern-energy.com/wrap-your-ducts-tighter-next-year/



§150.0(m)1 - Air-Distribution & Ventilation Systems

- **Insulation Exceptions**
  - The following portions of duct systems do not need to be insulated:
    - Portions of the duct system inside wall cavities if:
      - The cavity, duct, or plenum is located entirely inside the thermal envelope; and
      - All transitions into unconditioned space are air-sealed and insulated to R-6
    - Portions of the duct system completely exposed and surrounded by directly conditioned space
  - Ducts and fans integral to a wood heater or fireplace do not need insulation

§150.0(m)9 - Air-Distribution & Ventilation Systems

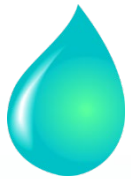
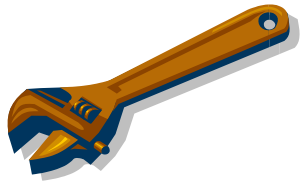
- **Duct Insulation Protection**
  - Protected from damage

Rare in single family

Seen in multifamily

- Sunlight
- Wind
- Moisture
- Equip. Maint.



  - Exposed insulation protection
    - Aluminum, sheet metal, painted canvas, plastic cover
    - Cellular foam can be protected by water retarding paint or one of the above listed methods

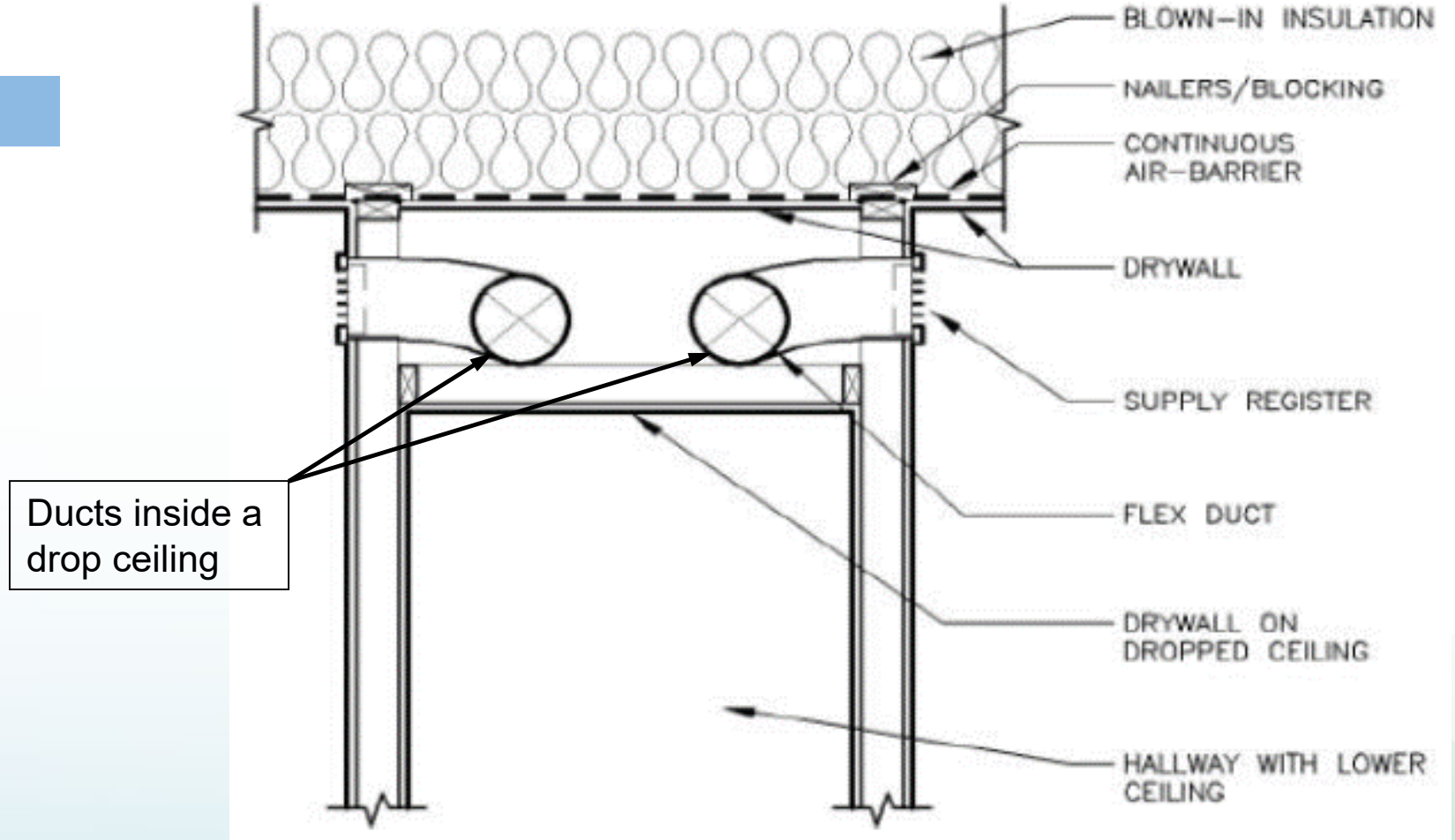
Code Quiz:

1. **What is the mandatory minimum allowed for the ducts shown?**

a) R-0

b) R-4.2

c) R-6



§150.0(m)11 - Air-Distribution & Ventilation Systems

- **Duct System Sealing & Leakage Testing**
  - Space conditioning systems with forced air ducts that supply conditioned air to an occupied space must be:
    - HERS verified to meet leakage requirements with duct leakage testing per Reference Residential Appendix RA3.1

Source: https://www.ductkings.com/aeroseal/

§150.0(m)11A, B - Air-Distribution & Ventilation Systems

- **Single Family Duct System Leakage Testing**
  - Single family dwellings & townhouses with air-handling unit (AHU) installed, ducts connected directly to air-handler
    - Total Leakage ≤ 5% of nominal system air handler airflow (RA3.1.4.3.1)
  - Single family dwellings & townhouses at rough-in stage of construction (prior to install of dwelling's interior finishing)
    - AHU installed: Total Leakage ≤ 5% of nominal system air handler airflow
    - AHU not installed: Total Leakage ≤ 4% of nominal system air handler airflow

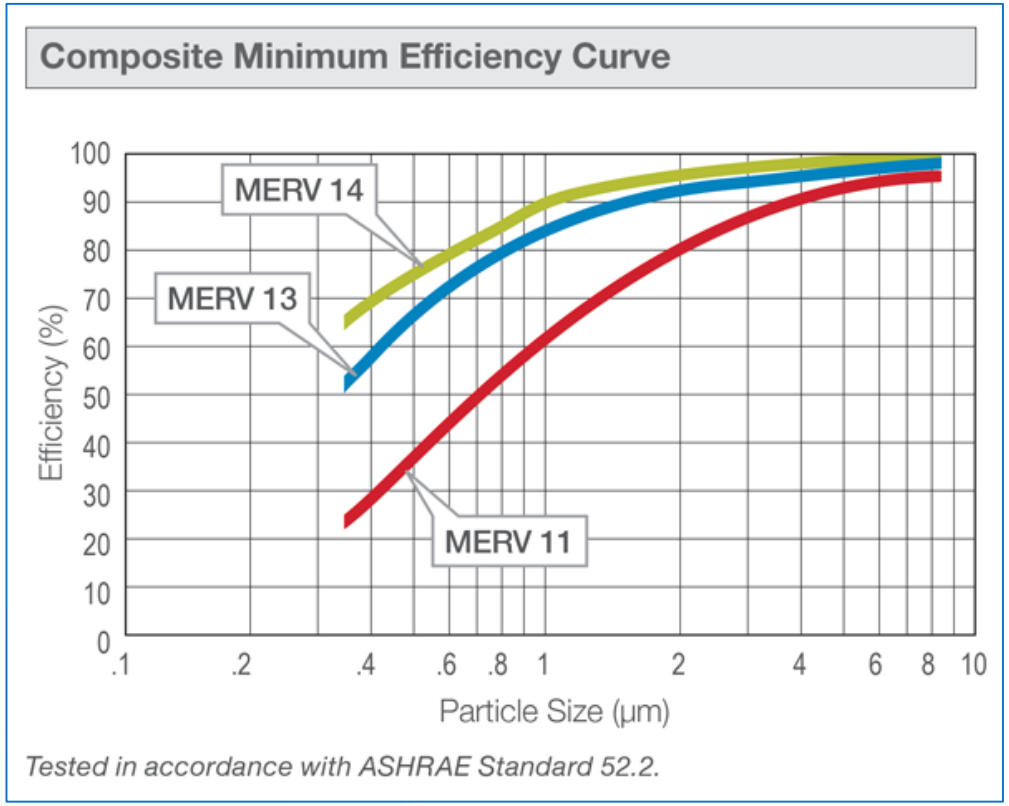
§150.0(m) - 11C Air-Distribution & Ventilation Systems

- **Multifamily Duct System Leakage Testing**
  - Multifamily dwellings with AHU installed & ducts connected directly to air-handler (regardless of duct system location)
    - Total leakage ≤ 12% of nominal system air handler airflow; or
    - Duct system leakage to outside ≤ 6% of nominal system air handler airflow

Source: http://www.greenhomeinspections.net/duct-leakage-testing.htm

§150.0(m)12 - Air-Distribution & Ventilation Systems

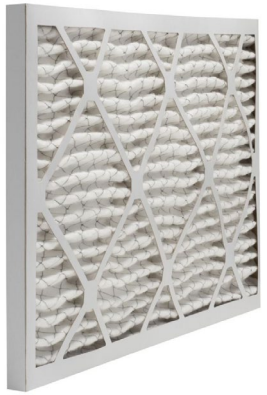
- **Air Filtration**
  - MERV 13 filter efficiency required
  - Filtration now required on supply side of ventilation systems before coil
  - HRV and ERV systems require filters
  - Space conditioning system air filters must be labeled with efficiency, and maximum pressure drop



Source: https://www.aafintl.com/en-gb/commercial/browse-products/commercial/box-filters/varicel-m-pak

§150.0(m)12 - Air-Distribution & Ventilation Systems

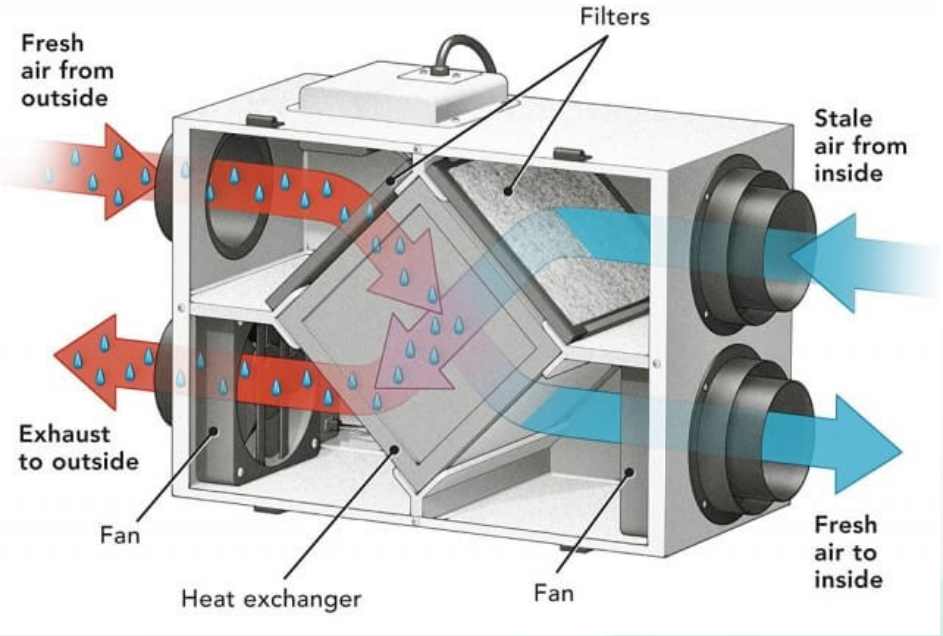
- **Air filtration is required for <u>space conditioning systems</u> with > 10 ft. of ducts:**
  - 2-inch depth filter: allowable pressure drop is determined by the system designer
  - 1-inch depth filter allowed if:
    - Maximum pressure drop 0.1 inches water at design airflow rate
    - Sized per Equation 150.0-A at ≤ 150 ft/min face velocity:
      - Equation 150.0-A: $A_{face} = Q_{filter} / V_{face}$
    - Where:
      - A_{face} = filter face (sf)
      - Q_{filter} = filter air flow (cfm)
      - V_{face} = face velocity (150 ft/min or less)



Source: https://www.airfiltersdelivered.com/24x28x2-merv13-p=P25S.022428

§150.0(m)12 - Air-Distribution & Ventilation Systems

- **Air filtration for supply side ventilation systems:**
  - No size requirements as there is for space conditioning system filters
  - Pressure drop is determined by the designer



§150.0(m)13 - Airflow Rate and Fan Efficacy

- **Hole for Static Pressure Probe (HSPP)**

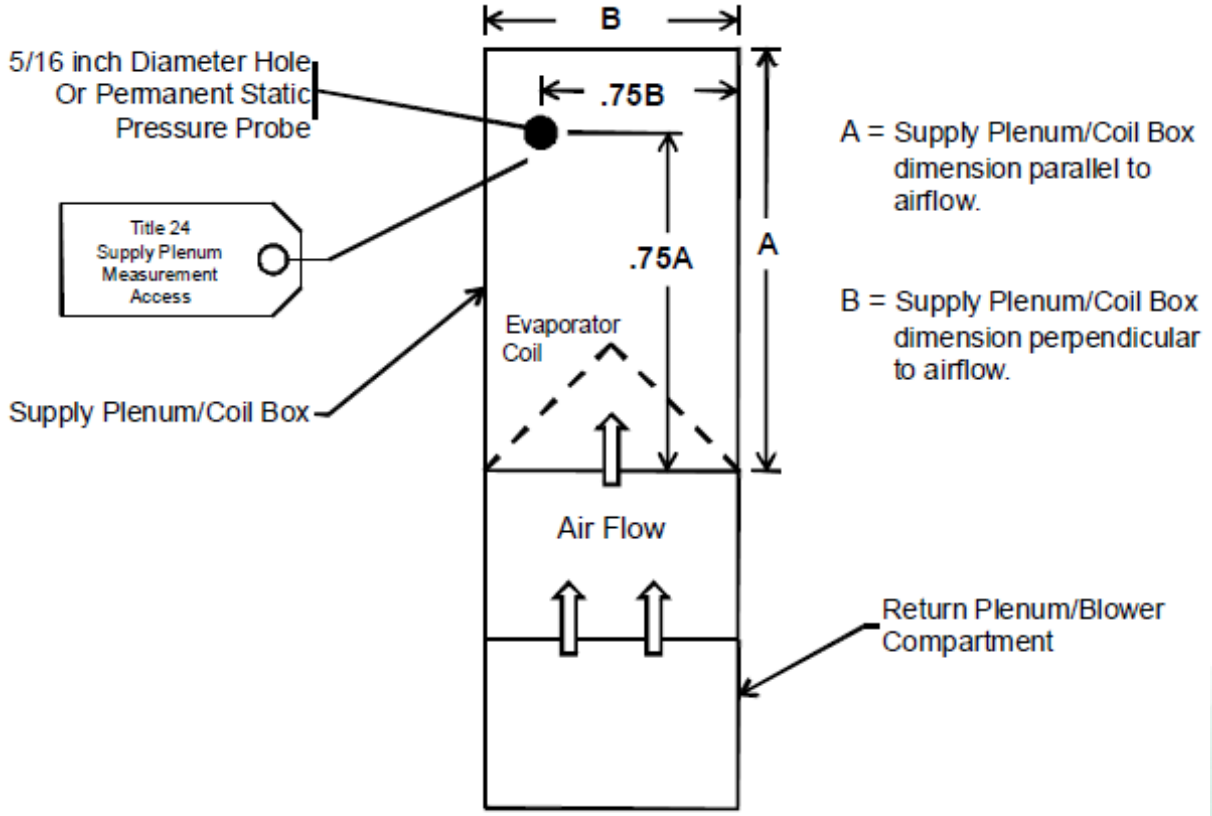


Figure RA3.3-1 Hole for the Placement of a Static Pressure Probe (HSPP) or Permanently Installed Static Pressure Probe (PSPP)

§150.0(m)13 = Airflow Rate and Fan Efficacy

- **Airflow Rate and Fan Efficacy**
  - Fan efficacy for systems supplying cooling with ducts
    - All single and multi-zone systems:
      - Airflow rate ≥ 350 cfm per ton of cooling
      - Systems with gas furnaces fan efficacy ≤ 0.45 W/cfm
      - All other air handlers must be ≤ 0.58 W/cfm
    - Small Duct High Velocity Systems requirements:
      - Airflow rate ≥ 250 cfm per ton of cooling
      - Fan efficacy ≤ 0.62 W/cfm
    - HERS verification required

§150.0(m)13 - Airflow Rate and Fan Efficacy

- **Airflow Rate and Fan Efficacy**
  - Alternative to airflow and watt draw: Returns can be sized per TABLES 150.0-B or C

TABLE 150.0-B: Return Duct Sizing for Single Return Duct Systems

Return duct length shall not exceed 30 feet and shall contain no more than 180° of bend. If the total bending exceeds 90°, one bend shall be a metal elbow.

Return grille devices shall be labeled in accordance with the requirements in Section 150.0(m)12Biv to disclose the grille's design airflow rate and a maximum allowable clean-filter pressure drop of 25 Pa (0.1 inches water) for the air filter when tested using ASHRAE Standard 52.2, or as rated in accordance with AHRI Standard 680 for the design airflow rate for the return grille.

System Nominal Cooling Capacity (Ton)*	Return Duct Minimum Nominal Diameter (inch)	Minimum Total Return Filter Grille Nominal Area (inch^2)
1.5	16	500
2.0	18	600
2.5	20	800

*Not applicable to systems with nominal cooling capacity greater than 2.5 tons or less than 1.5 ton

Code Quiz:

1. **MERV 13 filters are required on all ventilation systems.**
   a) True
   b) False

2. **MERV 13 filters are required on all space conditioning systems.**
   a) True
   b) False
   c) Maybe

Code Quiz:

1. **What is the fan efficacy requirement for small duct high velocity system?**
   a) 0.45 W/cfm
   b) 0.58 W/cfm
   c) 0.62 W/cfm

2. **When must an AC unit meet the 0.45 Watts/cfm fan power requirement?**
   a) When it has a furnace also
   b) When it has a heat pump for heating
   c) Either a or b

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **The requirements of ASHRAE 62.2-2016 apply except as amended by this section**
- **§150.0(o)1A and B - Amendments to ASHRAE 62.2**
  - Window operation is not a permissible method of providing the dwelling unit ventilation
  - Continuous operation of central system air handlers is not allowed for providing the dwelling unit ventilation airflow

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**
  - Higher ventilation rates for single family and multifamily buildings to meet ASHRAE 62.2-2016

2016 requirement: $Q_{tot} = 0.01 \times A_{floor} + 7.5 \times (N_{br} + 1)$

2019 requirement: $Q_{tot} = 0.03 \times A_{floor} + 7.5 \times (N_{br} + 1)$

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft^2

N_{br} = number of bedrooms (not to be less than 1)

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**
  - Airflow from infiltration must be accounted for in dwelling units not sharing a ceiling or floor
  - Required ventilation fan flow rate is calculated in the following 4 steps:
    1. Determine the total required ventilation rate, Q_{tot}
    2. Determine the building leakage at 50 Pa
       a. Option 1: Can be assumed to be 2 ACH at 50 Pa; or
       b. Option 2: Less than 2 ACH with HERs verified blower door test at 50 Pa
    3. Determine the Effective Average Annual Infiltration Rate
    4. Calculate required fan flow rate needed to meet Q_{tot}

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**

  1. Determine the total required dwelling unit ventilation rate, Q_{tot}

  Equation 150.0-B: $Q_{tot} = 0.03 \times A_{floor} + 7.5 \times (N_{br} + 1)$

  Where:

  Q_{tot} = total required ventilation rate, cfm

  A_{floor} = dwelling-unit floor area, ft^2

  N_{br} = number of bedrooms (not to be less than 1)

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**

  2. Determine the dwelling unit leakage at 50 Pa, Q_{50} Option 1:

     a. Assume 2 ACH_{50}, use Equation 150.0-C

Equation 150.0-C: $Q_{50} = V_{du} \times 2\ ACH_{50} / 60\ min$

Where:

Q_{50} = assumed leakage rate at 50 Pa, cfm

V_{du} = dwelling unit conditioned volume, ft^3

ACH_{50} = assumed air changes per hour at 50 Pa (0.2 inches water)

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**

  2. Determine the dwelling unit leakage at 50 Pa, Q_{50} Option 2:

     b. Determined ACH_{50} by HERS verified blower door test and Equation 150.0-D:

Equation 150.0-D: $Q_{50} = V_{du}$ x Verified ACH_{50} / 60 min

Where:

Q_{50} = leakage rate at 50 Pa in cfm

V_{du} = dwelling unit conditioned volume, ft^3

ACH_{50} = air changes per hour at 50 Pa (0.2 inch water), HERS verified

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**

3. Calculate the Effective Annual Average Infiltration Rate, Q_{inf}

Equation 150.0-E: $Q_{inf} = 0.052 \times Q_{50} \times wsf \times [H/H_r]^z$

Where:

Q_{inf} = effective annual infiltration rate, cfm (L/s)

Q_{50} = leakage rate at 50 Pa in cfm

wsf = weather and shielding factor from TABLE 150.0-D

H = vertical distance between the lowest and highest above-grade points within the pressure boundary, ft (m)

H_r = reference height, 8.2 ft (2.5 m)

z = 0.4 for the purpose of calculating the Effective Annual Average Infiltration Rate

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1C - Amendments to ASHRAE 62.2**

4. Calculate required fan flow rate needed to meet Q_{tot}

Equation 150.0-F: $Q_{fan} = Q_{tot} - \Phi\ (Q_{inf} \times A_{ext})$

Where:

Q_{fan} = required mechanical ventilation rate, cfm (L/s)

Q_{tot} = total required ventilation rate, cfm (L/s) from Equation 150.0-B.

Q_{inf} = effective annual average infiltration rate, cfm (L/s) from Equation 150.0-E

A_{ext} = 1 for single family detached homes, or the ratio of exterior envelope surface area that is not attached to garages or other dwelling units to total envelope surface area for attached dwelling units not sharing ceilings or floors with other dwelling units, occupiable spaces, public garages, or commercial spaces

Φ = 1 for balanced ventilation systems and Q_{inf}/Q_{tot} for all others

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1E - Amendments to ASHRAE 62.2**
  - Multifamily building dwelling unit ventilation airflow is determined with Equation 150.0-B:

Equation 150.0-B: $Q_{tot} = 0.03 \times A_{floor} + 7.5 \times (N_{br} + 1)$

Where:

Q_{tot} = total required ventilation rate, cfm

A_{floor} = dwelling-unit floor area, ft^2

N_{br} = number of bedrooms (not to be less than 1)

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1E - Amendments to ASHRAE 62.2**
  - Multifamily individual dwelling unit ventilation systems may be one of the following:
    - A balanced ventilation system; or
    - Continuously operating supply ventilation or exhaust ventilation systems and must also meet the following:
      - Dwelling-unit leakage is less ≤ 0.3 cubic feet per minute at 50 Pa (0.2 inches water) per ft^2 of dwelling unit envelope surface area
      - Confirmed by HERS Rater per Reference Residential Appendix RA3.8.
      - If this option is used, all dwelling units in the building must use this option

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1F - Amendments to ASHRAE 62.2**
  - If a central ventilation system is used to serve multiple dwelling-units:
    - Ventilation rate in each dwelling unit must be equal to the rate calculated using equation 150.0-B or up to 20% higher
    - The system must be a balanced system for each dwelling-unit
- **§150.0(o)1I - Amendments to ASHRAE 62.2**
  - Manual switches operating whole house ventilation systems must be labeled with the following or equivalent:

    "This switch controls the indoor air quality ventilation for the home. Leave it on unless the outdoor air quality is very poor."

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)1G - Amendments to ASHRAE 62.2**
  - Kitchen Range Hoods
    - Minimum airflow of 100 cfm
    - Maximum of 3 sones
      - Exception: May be rated for sound at a static pressure determined at working speed in accordance with HVI 916
    - Certified to the Home Ventilation Institute (HVI) or Association of Home Appliance Manufacturers (AHAM)
    - Needs HERS verification per Reference Nonresidential Appendix NA7.18.1

§150.0(o) - Requirements for Ventilation and Indoor Air Quality

- **§150.0(o)2 – Field Verification and Diagnostics**
  - Verification by HERS Rater
    - All new dwelling units require ventilation airflow in accordance with Reference Residential Appendix RA3.7
    - Kitchen range hood visual verification in accordance with Reference Residential Appendix RA3.7.4.3 to confirm the model is rated by HVI or AHAM to comply with the following requirements:
      - The minimum ventilation airflow rate specified in Section 5 of ASHRAE 62.2. (100 cfm)
      - The maximum sound rating specified in Section 7.2 of ASHRAE 62.2. (3 sones)

Code Quiz:

1. **Do single family dwelling units need to account for infiltration when calculating dwelling unit ventilation airflow?**
   a) Yes
   b) No

2. **If a multifamily building uses a continuous supply or exhaust ventilation system what HERS testing is required?**
   a) Ventilation airflow
   b) Blower door dwelling unit leakage
   c) Blower door building leakage
   d) a, b, and c
   e) a and b

3. **Kitchen Range Hoods require HERS flowrate testing per HVI.**
   a) True
   b) False

Takeaways for §150.0(h, i, j, m, o)

- Cooling and heating load calculations are mandatory
- Outdoor condensing units must have 5 ft clearance from dryer vents and have a liquid line filter drier (if manufacturer requires)
- Refrigerant and hydronic heating piping must be insulated and protected from outdoor conditions
- HVAC duct systems must be sealed and insulated, have duct leakage, airflow and fan watt draw HERS verification
- Space conditioning systems with > 10 feet of ducts must have ≥ MERV 13 filtration
- Ventilation systems supply side must have ≥ MERV 13 filtration
- Dwelling units must meet ventilation and IAQ requirements of ASHRAE 62.2 with amendments in this chapter
- Kitchen range hoods require HERS visual verification of airflow and sound rating in listed in the HVI or AHAM databases

§150.0 - Building Department

- **Plan Review**
  - Verify ventilation devices are called out in mechanical schedule
    - Check plans for local ventilation equipment in each bathroom
      - Continuous 20 cfm bathroom fan: or
      - Switched 50 cfm bathroom fan
    - Check plans for local ventilation equipment in each kitchen
      - 100 cfm range hood; or
      - Other exhaust fan with 300 cfm; or
      - In an enclosed kitchen an exhaust fan making 5 ACH
    - On the CF1R-PRF you can verify whole house ventilation fan types
  - Verify HVAC equipment listed on CF1R meets mandatory minimum efficiencies
  - Can ask for mandatory measures summary

§150.0 - Building Department

- **Inspection**
  - Visually verify duct insulation, condensing unit clearance and filter drier, ventilation (at rough frame and/or final)
  - Compare installed HVAC match HVAC used for compliance on CF1R
  - Confirm equipment on CF2R-MCH forms matches plans and installed equipment
  - The mandatory CF2R-MCH forms you should expect to see:
    - MCH-01: depending on scope: performance (01a), alteration (01b), or prescriptive (01c)
    - MCH-20: duct leakage
    - MCH-22: Fan efficacy (W/cfm)
    - MCH-23: Airflow (cfm/ton)
    - MCH-27: Ventilation
  - Confirm respective CF3R forms are complete
  - Use the PSR

Subchapter 8
Low-Rise Residential Buildings – Performance and Prescriptive Compliance Approaches
(§150.1)

§150.1 - Performance and Prescriptive Compliance Approaches

Section	Topic
§150.1(a)	Basic Requirements
§150.1(b)	Performance Standards
§150.1(c)	Prescriptive Standards/Component Package
§150.1(c)6	Heating System Type
§150.1(c)7	Space Heating and Space Cooling
§150.1(c)9	Space Conditioning Distribution System
§150.1(c)10	Central Fan Integrated Ventilation Systems
§150.1(c)12	Ventilation Cooling
§150.1(c)13	HVAC System Bypass Ducts

§150.1 - Performance and Prescriptive Compliance Approaches

- **§150.1(a) Basic Requirements**
  - Comply with:
    - §100.0
      Scope (General Provisions)
    - §110.0 – 110.12
      Mandatory Requirements
    - §150.0
      Mandatory Features
  - Comply with Performance or Prescriptive approach with the requirements of the Climate Zone

§150.1 - Performance and Prescriptive Compliance Approaches

- **§150.1(b) Performance Approach**
  - Compliance with Energy Budget (EB)
    - Energy Budget Rule
    - Trade offs allowed

$$EB_{\underline{\text{Standard}}\ \text{Design Building}} \geq EB_{\underline{\text{Proposed}}\ \text{Design Building}}$$

Explained in §150.1(b)1

Explained in §150.1(b)2

§150.1 - Performance and Prescriptive Compliance Approaches

- **§150.1(c) Prescriptive Approach**
  - Predefined efficiency requirements that must ALL be met or exceeded
  - Simplest approach, but less flexible
  - Establishes baseline for the Standard building budget under the Performance Approach
  - Located in §150.1
    - TABLE 150.1-A for Single Family
    - TABLE 150.1-B for Multifamily

§150.1(c) - Prescriptive Compliance

- **§150.1(c)7A - Refrigerant Charge**
  - Refrigerant Charge
    - Required in Climate Zones 2, and 8 – 15
    - Applies to ducted ACs and heat pumps (split or packaged), mini-splits, and small duct high velocity systems
    - Measurement access holes (MAH) per RA3.2.2.3
    - Refrigerant charge verified per RA 3.2
    - System airflow verification per RA 3.3
      - ≥ 350 cfm/ton for A/C and heat pump
      - ≥ 250 cfm/ton for small duct high velocity systems
    - HERS verified
    - Exceptions may apply

§150.1(c) - Prescriptive Compliance

- §150.1(c)7A – Measurement Access Hole (MAH)

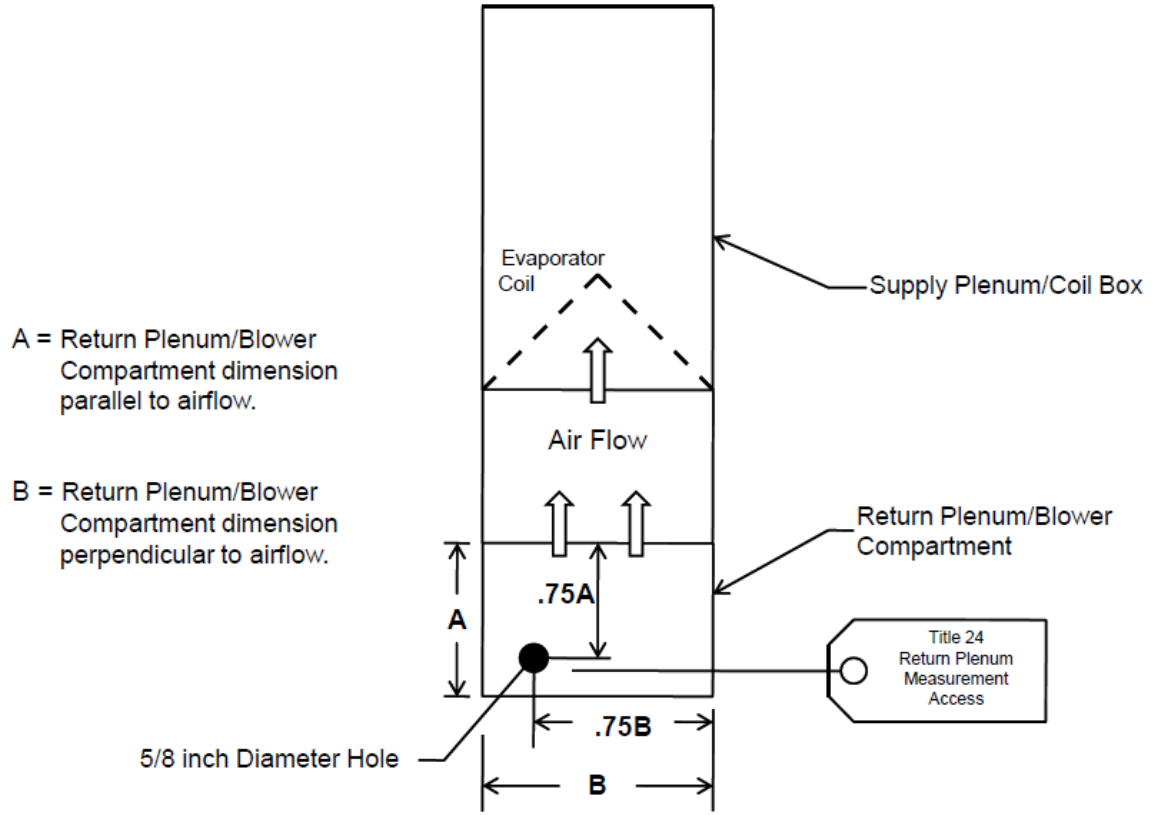


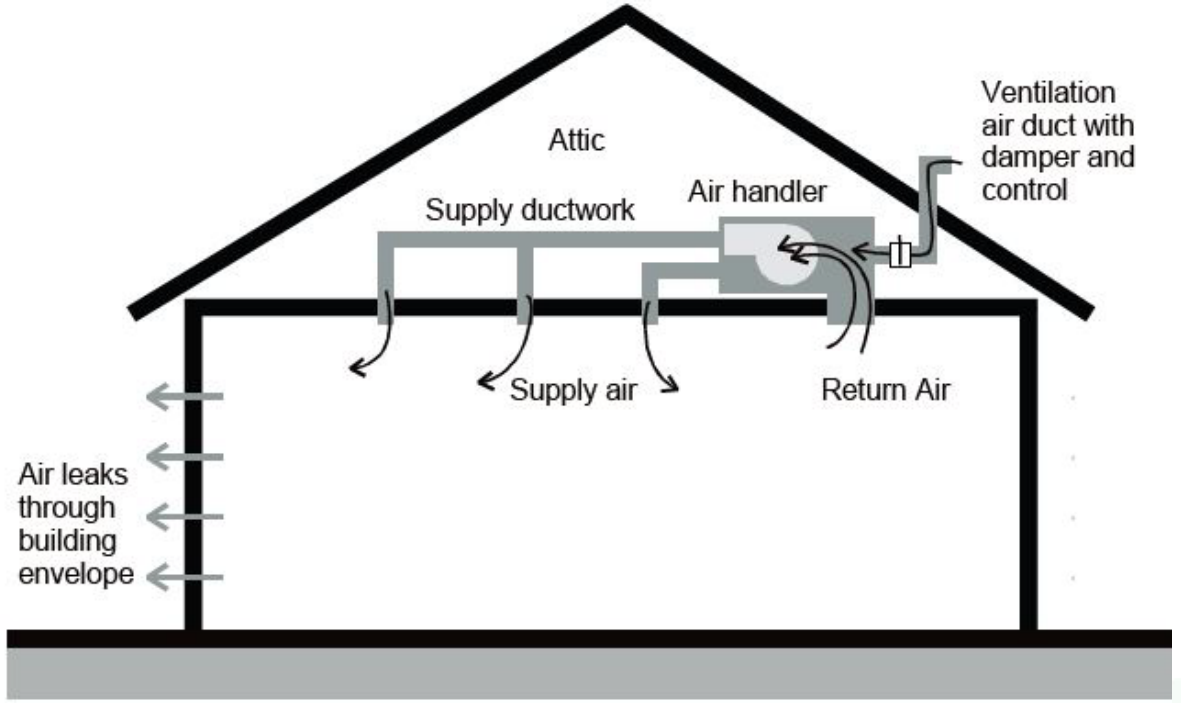
Figure RA3.2-1 Measurement Access Hole

§150.1(c) - Prescriptive Compliance

- **§150.1(c)9 Space Conditioning Distribution Systems**
  - Two options for duct insulation and location:
    - With a High Performance Attic (HPA) per §150.1(c)1Aii (AKA Option B):
      - Ducts can be located in the HPA
      - Insulation levels per Table 150.1-A or –B for the climate the zone
    - With only ceiling insulation per §150.1(c)1Aiii (AKA Option C):
      - Ducts and plenums must be inside conditioned space
      - Insulation levels per Table 150.1-A or -B for the climate zone
  - Table 150.1-A and -B

§150.1(c) - Prescriptive Compliance

- **§150.1(c)10 Central Fan Integrated Ventilation Systems**
  - In Air Distribution Mode
    - Fan efficacy: ≤ 0.58 W/CFM
    - With Furnace: ≤ 0.45 W/CFM
  - Continuous operation not allowed
  - HERS Verified
  - Must be certified to the CEC as Intermittent Ventilation Systems as specified in Reference Residential Appendix RA3.7.4.2

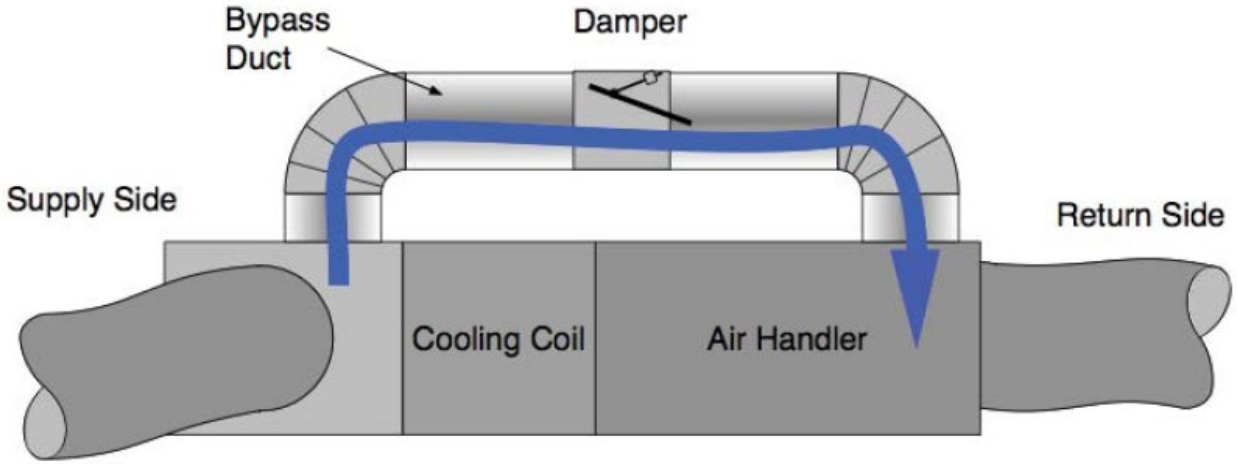


§150.1(c) - Prescriptive Compliance

- **§150.1(c)12 Ventilation Cooling**
  - Ventilation Cooling - Whole House Fan (WHF) for single family homes:
    - Required in Climate Zones 8 – 14 (Table 150.1-A)
  - WHF must meet these requirements:
    - Total air flow ≥ 1.5 CFM/ft^2 of conditioned floor area
    - Airflow rate must be listed in the CEC's Title 20 database
    - If not vented directly to the outside, attic vent free area must be the larger of:
      - At least ≥ 1 ft^2 for every 750 CFM of rated WHF Air Flow CFM; or
      - Manufacturers recommended free vent are
    - Provide 1 page "How to operate your whole house fan" sheet

§150.1(c) - Prescriptive Compliance

- **§150.1(c)13 HVAC System Bypass Ducts**
  - HVAC System Bypass Ducts
    - Not allowed prescriptively
  - When allowed?
    - Only with the Performance compliance approach
  - Additional Information?
    - Blueprint (July – August 2015)



Code Quiz:

1. **Refrigerant charge is prescriptively required in all climate zones for ducted systems.**
   a) True
   b) False
2. **Space conditioning system airflow testing is required in all climate zones?**
   a) True
   b) False
3. **Ducts are allowed in the attic with which prescriptive roof/ceiling insulation option(s)?**
   a) Option B
   b) Option C
   c) Both Option B and Option C

Code Quiz:

4. **Whole House Fans are required in all low-rise residential units.**
   a) True
   b) False

5. **Central Fan Integrated Ventilation Systems must be certified to the Commission.**
   a) True
   b) False

6. **Bypass ducts are allowed prescriptively.**
   a) True
   b) False
   c) Sometimes

Takeaways for §150.1(c)

- Refrigerant charge and airflow testing must be HERS verified for all ducted systems in Climate Zones 2, 8 – 15
- HVAC duct insulation level depends on Climate Zone and duct location
- HVAC duct location depends on HPA compliance
- ALL CFI ventilation systems must have fan efficacy HERS verified and be certified to the CEC Whole house fan is required for ventilation cooling in Climate Zones 8 – 14 and must be listed in the T20 MAEDbS database
- HVAC system bypass ducts are prohibited Prescriptively

§150.1 - Building Department

- **Plan Review**
  - Verify equipment on CF1R-NCB and CF1R-PRF match plans
    - Duct insulation and location
    - Cooling and heating equipment type and efficiencies
    - Whole house fan
    - Ventilation equipment and type (supply, exhaust, balanced)
  - Can ask for mandatory measures summary applicable to the project
  - Can require note block or HVAC schedule

§150.1 - Building Department

- **Inspection**
  - Verify installed equipment matches CF1R
  - Verify duct insulation and location, whole house fan, etc. (at rough frame and/or final)
  - Verify prescriptive forms CF2R-MCH-01, 2, 25, 30, 31 forms (use the PSR)
    - These forms may also be applicable if compliance credit is used for performance compliance method
  - Review HERS Measures section of CF1R-PRF and verify all HERS measures are completed and documented
  - Confirm on respective CF3R forms (use the PSR)
  - Review mandatory forms discussed earlier

Subchapter 9
Low-Rise Residential Buildings – Additions and Alterations to Existing Low-Rise residential Buildings
(§150.2)

§150.2 - Additions and Alterations to Existing Low-Rise Residential Buildings

Section	Topic
§150.2(a)	Additions
§150.2(a)1C	Mechanical Ventilation for Indoor Air Quality
§150.2(b)	Alterations
§150.2(b)1	Prescriptive Approach
§150.2(b)1C	Entirely New or Complete Replacement Space-Conditioning Systems
§150.2(b)1D	Altered Duct Systems - Duct Sealing
§150.2(b)1E	Altered Space-Conditioning System - Duct Sealing
§150.2(b)1F	Altered Space-Conditioning System - Mechanical Cooling
§150.2(b)1G	Altered Space-Conditioning System

§150.2(a) - Additions

- **Existing Building Additions**
  - New HVAC equipment installed to serve addition must meet applicable sections of:
    - §110.0 – 110.12 (Mandatory for all buildings)
    - §150.0 (Mandatory for low-rise residential)
    - §150.2(a)1 (Prescriptive approach)
    - §150.2(a)2 (Performance approach)
    - Treated like new construction

Exception(s) Apply

§150.2(a) - Additions

- **HVAC Exceptions to §150.2(a)**

Exception 1	Additions ≤ 1,000 ft^2 exempt from whole dwelling unit mechanical ventilation airflow per §150.0(o)1C, §150.0(o)1E, or §150.0(o)1F.
Exception 3	Existing inaccessible piping shall not require insulation as defined under §150.0(j)2Aiii.
Exception 4	When heating/cooling extended to an addition from the existing system(s), the existing heating/cooling equip does not need to comply with Part 6. Must meet heating system capacity requirements of CBC.
Exception 5	When ducts extend from an existing duct system to serve the addition, the existing duct system and extended ducts must meet applicable requirements of §150.2(b)1D.
Exception 6	Additions ≤ 1,000 ft^2 exempt from WHF ventilation cooling requirements of §150.1(c)12.

§150.2(a)1 - Prescriptive Approach for Additions

- **§150.2(a)1C - Mechanical Ventilation for Indoor Air Quality**
  - Additions > 1,000 sf to a dwelling unit must supply mechanical ventilation airflow based on the entire dwelling unit – existing plus addition space
  - New dwelling units added to an existing multifamily building must have ventilation airflow based on the floor area of the new dwelling unit

§150.2(a) - Additions - Building Department

- **Plan Review**
  - Prescriptive additions over 1,000 sf will use the CF1R-NCB
    - If the existing system is altered, you should also see a CF1R-ALT-02
    - Review is the same as a new building
  - Prescriptive additions 1,000 sf or less will use the CF1R-ADD-01
    - If existing system is altered, you should also see a CF1R-ALT-02
    - Verify local ventilation equipment is specified on the plans
    - Complete new or replacement ducts require filtration, fan watt draw and airflow testing
    - Verify minimum duct insulation levels R6 (CZ 1-10, 12 & 13) and R-8 (CZ 11 & 14-16)
    - Verify equipment efficiencies meet mandatory requirements
  - Performance addition of any size will use the CF1R-PRF At building department's discretion, CF1R-ALT-02 does not need to be registered at permit

§150.2(a) - Additions - Building Department

- **Inspection**
  - Additions over 1,000 sf
    - Verification is the same as a new building
  - Additions 1,000 sf or less
    - Whole house ventilation is not required
    - Local ventilation is still required
  - Expect to see the following forms
    - CF2R-MCH-01-E - Space Conditioning System Alterations
      - For existing duct systems, insulation for the new portions of supply-air, and return-air ducts or plenums: R6 (CZ 1-10, 12 & 13) and R-8 (CZ 11 & 14-16)
    - CF2R & CF3R-MCH-20-H Duct Leakage Test
    - CF2R & CF3R-MCH-22 Fan Efficacy on entirely new or replacement systems
    - CF2R & CF3R-MCH-23 Airflow Rate
    - CF2R & CF3R-MCH-25-H Refrigerant Charge (prescriptive in CZ 2, 8-15).
  - Use PSR to verify all forms are complete

§150.2(b) - Alterations

- **§150.2(b)1 - Prescriptive Approach**
  - Altered components and new installed equipment that serves the alteration must meet applicable requirements within:
    - §110.0 – 110.12
    - §150.0
    - §150.2(b)1C – G (as applicable)

What Type of Alterations Trigger Compliance?

- **When an entirely new space conditioning system is replaced or installed**
  - Equipment and ducting
- **When ducting is replaced or installed**
  - Duct testing for more than 40 feet added or replaced anywhere
  - Duct testing for any length of ducting in a garage
- **HVAC changeouts**
  - Equipment only
- **What is required for an alteration?**
  - 2019 HVAC Trigger Sheet developed by Energy Code Ace

What is Required for HVAC Alterations?

- **Depending on what is altered**
  - Minimum efficiency requirements for AC and furnace
  - Duct insulation
  - HERS Testing (Duct leakage, Refrigerant Charge, Airflow and Fan Watt Draw)
  - If HERS measures are applicable, CF1R must be registered with an approved HERS Provider
    - Per §10-103, Building Department may accept handwritten CF1R at permit; all registered forms must be submitted at Final inspection

§150.2(b)1C - Complete New or Replacement Space Conditioning System

- **Requirements when mechanical system and ducts are both completely replaced or newly installed**
  - Duct insulation per Tables 150.1-A and -B
  - Duct leakage testing required in ALL climate zones
  - Airflow and Fan Watt Draw required in ALL climate zones
  - Refrigerant charge required in Climate Zones 2, and 8 – 15 for split & packaged ACs and HPs, mini-split systems, and small duct high velocity systems
  - Existing natural gas or liquefied petroleum gas heating systems may be replaced with a heat pump heating system
  - Forms must be registered

§150.2(b)1C - Complete New/Replacement System and the Permit Process

- **CF1R-ALT-02 form**
  - Can require at Final
  - HERS tests/forms specified
- **Verification at Final:**
  - Duct insulation ≥ R-6.0 (R-8 in CZs 11, 14-16) (MCH-01)
  - Duct leakage (MCH-20)
  - Fan Watt Draw (MCH-22)
  - Airflow (MCH-23)
  - Refrigerant Charge (MCH-25) for CZ 2, and 8 – 15

Source: https://www.energyvanguard.com/blog/73906/What-s-That-Ice-Chest-Doing-in-This-Attic-Duct-System

§150.2(b)1D - Altered Duct System

- **§150.2(b)1Di – Duct Insulation**
  - Mandatory Insulation:
    - Unconditioned: Min. R-6
    - Indirectly Conditioned: Min R-4.2 with HERS verification
    - Completely inside directly conditioned space: None
    - Inside interior wall cavities: None
  - Prescriptive minimums for alterations in unconditioned space:
    - R-6 in Climate Zones 1-10, 12 and 13
    - R-8 for Climate Zones 11, 14-16

§150.2(b)1D - Altered Duct System

- **§150.2(b)1Diia – Entirely New or Complete Replacement Ducts**
  - 75% or more of the ducts are replaced
  - Duct Leakage testing is required in ALL CZs
    - Single Family
      - Leakage ≤ 5% of total air handler airflow
    - Multifamily
      - Leakage ≤ 12% of total air handler airflow; or
      - Leakage ≤ 6% to outside
  - MERV 13 filtration
  - Fan watt draw testing on systems with cooling:
    - Fan efficacy: ≤ 0.58 W/CFM
    - With Furnace: ≤ 0.45 W/CFM
  - Airflow testing on systems with cooling: 350 cfm/ton of cooling

Source: Anchors Aweigh Energy, LLC https://www.aae-hers.com/

§150.2(b)1D - Altered Duct System

- **§150.2(b)1Diib – Extension of an Existing Duct System (> 40 feet)**
  - Single Family and Multifamily duct leakage allowance:
    - Leakage ≤ 15% of total air handler airflow; or
    - Leakage ≤ 10% to outside; or
    - If unable to meet leakage requirements, a smoke test to verify all accessible leaks are sealed

Source: https://energyratersplus.com/duct-testing/

§150.2(b)1D - Altered Duct System

- **§150.2(b)1Diic – Duct Leakage**
  - Altered Ducts of **any length** or Duct System Components in Garages
    - Leakage ≤ 6% of air handler air flow; or
    - All accessible leaks are sealed and verified with a smoke test by a HERS Rater

Source: https://servicechampions.com/air-quality/ductwork/

§150.2(b)1E - Altered Space Conditioning System (HVAC Changeout)

- **Duct leakage testing applies when replacing the air handler, condensing unit of a split system air conditioner or heat pump, or cooling or heating coil (duct replacement not required)**
  - Duct leakage testing is required in ALL Climate Zones
    - ≤ 15% of total air handler airflow; or
    - ≤ 10% to outside; or
    - If unable to meet leakage requirements, a smoke test to verify all accessible leaks are sealed
    - Does not differentiate between location of ducts (whether conditioned or unconditioned space)
  - In a garage: ≤ 6% leakage or smoke test

§150.2(b)1F - Altered System with Mechanical Cooling (HVAC Changeout)

- **Requirements when installing or replacing a refrigerant-containing component:**
  - Setback thermostat must be installed
  - Airflow and Refrigerant charge is required in CZs 2, and 8 – 15
    - Small duct high velocity systems must be HERS tested to have 250 cfm per ton or greater of nominal cooling capacity
    - All other systems must be HERS tested to have 300 cfm per ton or greater of nominal cooling capacity
    - Refrigerant charge must be HERS verified using standard charge procedures, weigh in procedure, or have HERS verified fault indicator display (FID) device

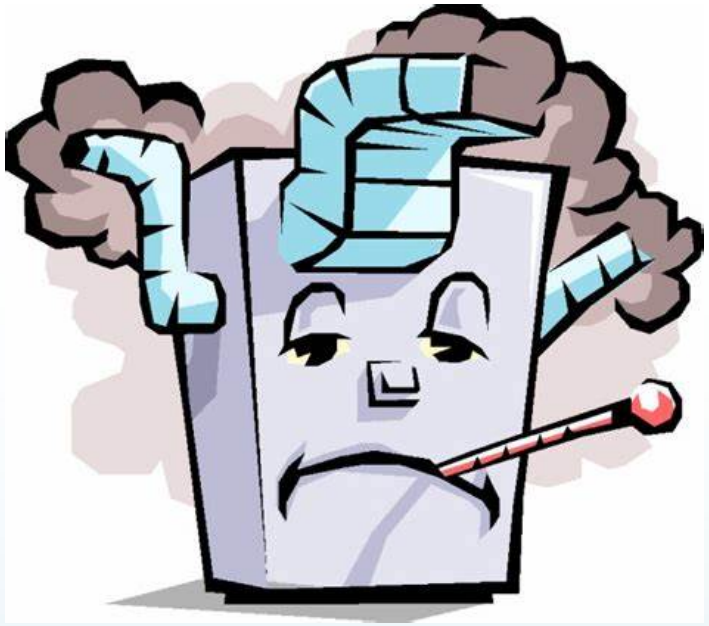
§150.2(b)1F - Altered System with Mechanical Cooling (HVAC Changeout) – cont.

Exceptions to §150.2(b)1F:

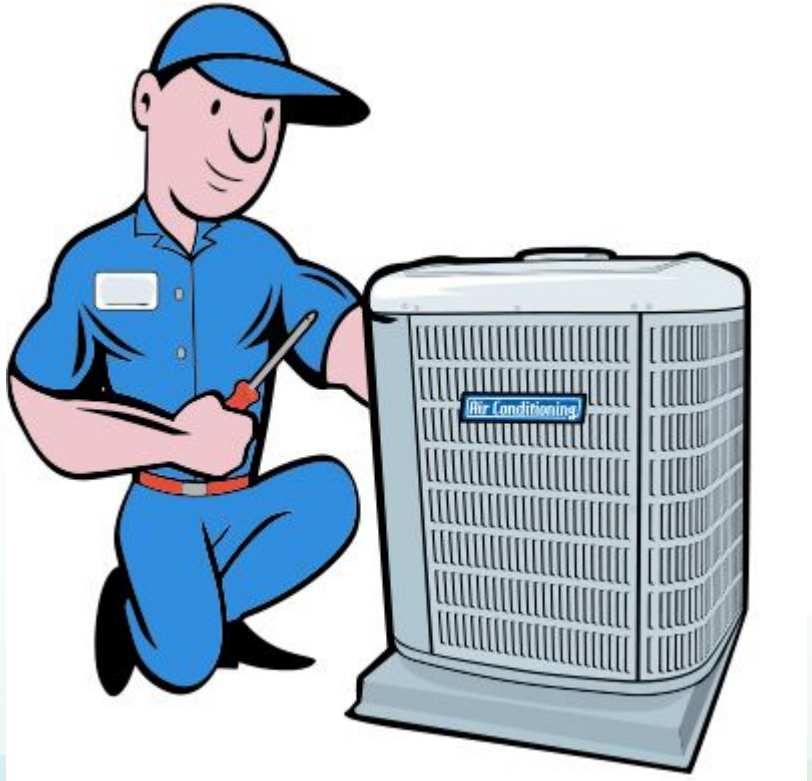
- If you can't meet airflow requirements you can go through remediation measures in RA3.3.3.1.5
- If you resize the intakes per Tables 150.0-A or 150.0-B you automatically comply with airflow
- If outside temperature below 55 F, weigh in procedure can be used by the installer and watched by a HERS Rater
- If refrigerant charge is verified at the factory and the installer does not make alterations that significantly affect the charge

§150.2(b)1G – Altered Space-Conditioning System (HVAC Changeout)

- Allows a furnace to be replaced with a heat pump system



Source: https://activerain.com/blogsview/1764527/making-improvements-to-heating--ventilation-and-air-conditioning-helps-to-sell-your-home



Source: https://www.pinterest.com/pin/315603886365351472/visual-search/?cropSource=6&h=370&w=500&x=10&y=10

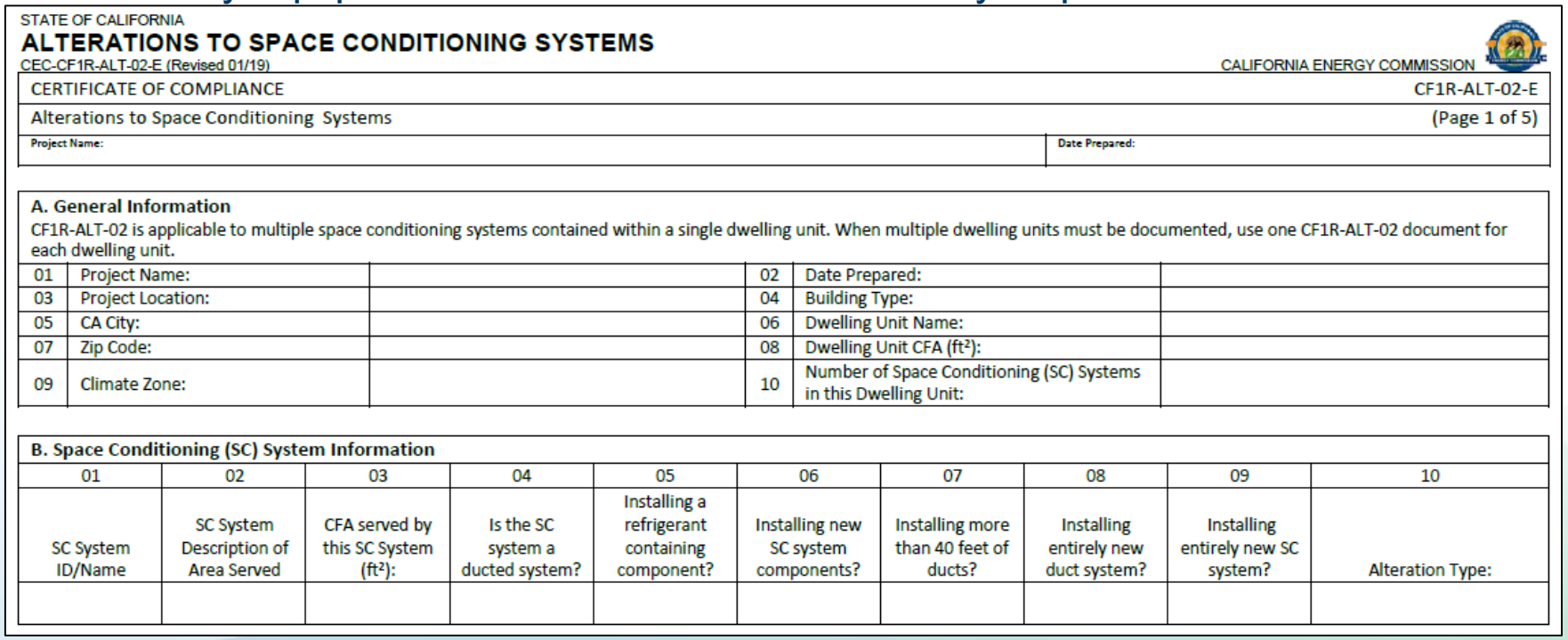
§150.2(b) Alterations - Building Department

- **CF1R-ALT-02 form**
  - Can request at Final
  - HERS tests/forms specified
- **Verify at Final:**
  - Duct leakage (MCH-20) (if applicable)
  - Fan Efficacy (MCH-22)
  - Airflow (MCH-23)
  - RC (MCH-25) in CZs 2, and 8 – 15

Source: https://www.homeadvisor.com/r/ac-condenser-repair-replacement/

§150.2(b) Alterations - Building Department

- **Plan Review**
  - CF1R-ALT-02 can be handwritten and does not need to be registered for permit but must be registered before final
    - Verify minimum duct insulation levels: R6 (CZ 1-10, 12 & 13) and R-8 (CZ 11 & 14-16)
    - Verify equipment efficiencies meet mandatory requirements



STATE OF CALIFORNIA
ALTERATIONS TO SPACE CONDITIONING SYSTEMS
CEC-CF1R-ALT-02-E (Revised 01/19) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	CF1R-ALT-02-E
Alterations to Space Conditioning Systems	(Page 1 of 5)
Project Name:	Date Prepared:

A. General Information
CF1R-ALT-02 is applicable to multiple space conditioning systems contained within a single dwelling unit. When multiple dwelling units must be documented, use one CF1R-ALT-02 document for each dwelling unit.

01	Project Name:		02	Date Prepared:	
03	Project Location:		04	Building Type:	
05	CA City:		06	Dwelling Unit Name:	
07	Zip Code:		08	Dwelling Unit CFA (ft²):	
09	Climate Zone:		10	Number of Space Conditioning (SC) Systems in this Dwelling Unit:	

B. Space Conditioning (SC) System Information

01	02	03	04	05	06	07	08	09	10
SC System ID/Name	SC System Description of Area Served	CFA served by this SC System (ft²):	Is the SC system a ducted system?	Installing a refrigerant containing component?	Installing new SC system components?	Installing more than 40 feet of ducts?	Installing entirely new duct system?	Installing entirely new SC system?	Alteration Type:

§150.2(b) Alterations - Building Department

- **Inspection**
  - Verify prescriptive forms match installed equipment and CF1R-ALT-02
    - CF2R-MCH-01 Space Conditioning Equipment details
      - Verify installed equipment efficiencies
      - Visually verify duct insulation: R6 (CZ 1-10, 12 & 13) and R-8 (CZ 11 & 14-16)
    - CF2R and CF3R-MCH-25 Refrigerant Charge
  - Verify mandatory form efficiency entries meet minimum requirements on CF2R and CF3R forms
    - MCH-20 Duct Leakage
    - MCH-22 Fan Efficacy
    - MCH-23 Airflow
  - Confirm on respective CF3R HERS forms (use the PSR)

PSR

Project Status Report — **CalCERTS, Inc**

GENERAL INFORMATION

Code Year Standards:	2019
Project Name:	Shewmaker Performance Demo
Project Type:	New Construction SFR
Address:	1516 9th Street
City / State / Zip:	Sacramento / CA / 95814
Enforcement Agency:	City of Sacramento
Permit Number:	123456789

Easy to Verify @ calcerts.com

HERS VERIFIABLE MEASURES:	NOT COMPLETE
OVERALL STATUS:	NOT COMPLETE

CF1R INFORMATION - Certificate of Compliance

Certificate Type:	Compliance
Registered Form:	CF1R-PRF-01-E
Registered Date:	04/05/2019 08:30
Registration Number:	216-N0125429A-000000000-0000

ADDITIONAL CF1Rs

System	Form	Registered Dat	Registration Number	
	CF1R-SRA-01		216-N0125443A-000000000-0000	

CF2R INFORMATION - Certificate of Installation

System	Form	Registered Date	Registration Number	
	CF2R-ENV-01 (Fenestration Installation)		216-N0125429A-E0100001A-0000	
	CF2R-ENV-02 (Envelope Air Sealing)		216-N0125429A-E0200001A-0000	
	CF2R-ENV-03 (Insulation Installation)		216-N0125429A-E0300001A-0000	
	CF2R-ENV-04 (Roofing-Radiant Barrier)		216-N0125429A-E0400001A-0000	
	CF2R-MCH-01 (Space Conditioning Systems, Ducts and Fans)	04/05/2019 09:40	216-N0125429A-M0100001A-0000	
System 1	CF2R-MCH-20 (Duct Leakage)	04/05/2019 09:40	216-N0125429A-M2000002A-0000	
System 1	CF2R-MCH-23 (Airflow)	04/05/2019 09:40	216-N0125429A-M2300002A-0000	
System 1	CF2R-MCH-22 (Fan Efficacy)	04/05/2019 09:40	216-N0125429A-M2200002A-0000	
System 1	CF2R-MCH-25 (Refrigerant Charge)	04/05/2019 09:40	216-N0125429A-M2500002A-0000	
	CF2R-MCH-27 (IAQ and MV)	04/05/2019 09:40	216-N0125429A-M2700001A-0000	
	CF2R-PLB-02 (SD HWS Distribution)	04/05/2019 09:40	216-N0125429A-P0200003A-0000	

CF3R INFORMATION - Certificate of Verification

System	Form	Registered Dat	Registration Number	
	CF3R-MCH-27 (IAQ and MV)		216-N0125429A-M2700001A-M27A	
System 1	CF3R-MCH-20 (Duct Leakage)	04/11/2019 12:52	216-N0125429A-M2000002A-M20A	

Code Quiz:

1. **A new 900 ft^2 dwelling unit added to an existing building requires which of the following?**
   a) Whole building ventilation
   b) Whole House Fan
   c) Both a and b
   d) Neither a or b
2. **Extending more than 40 feet of ducts triggers which of the following HERS tests?**
   a) Duct leakage testing
   b) Refrigerant charge in CZs 2, and 8 – 15
   c) Both a and b
3. **Changing a cooling coil triggers which of the following HERS requirements?**
   a) Refrigerant charge and airflow in CZs 2, and 8 – 15
   b) Duct leakage
   c) Both a and b

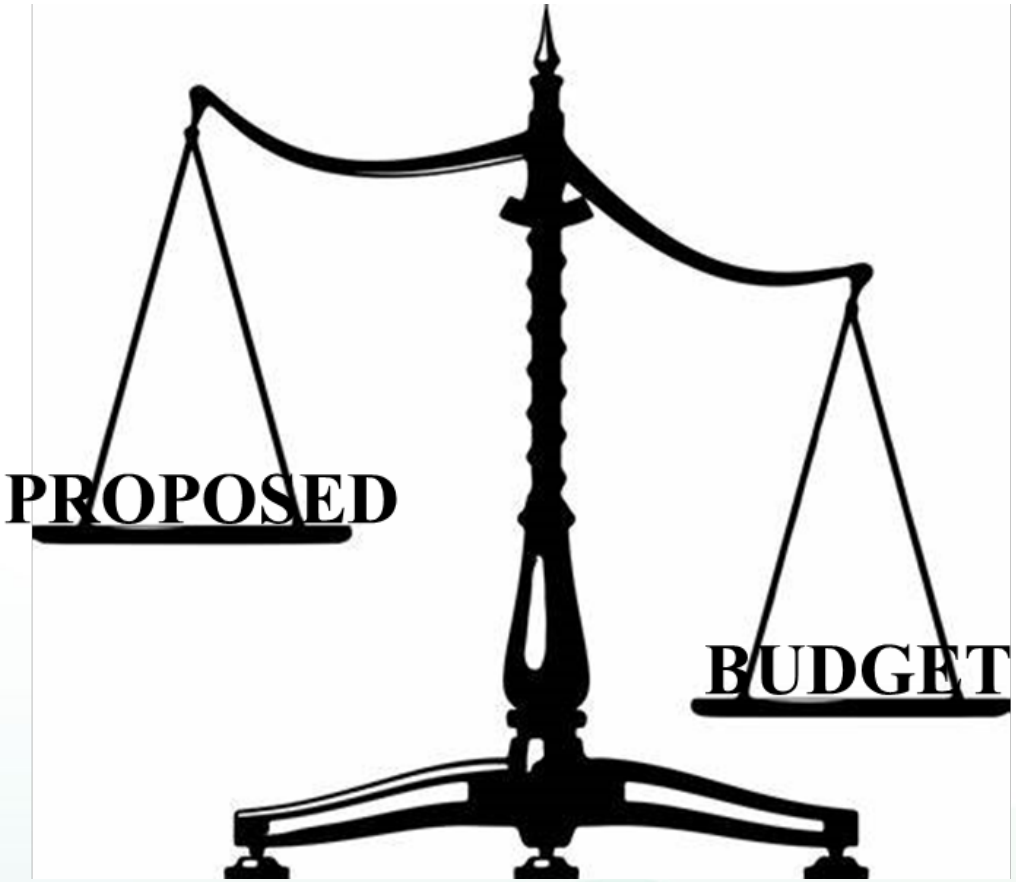
Takeaways for §150.2(a) and (b)

- **Additions ≤ 1,000 ft^2 exempt from WHF and ventilation**
- **Extending existing ducts to an addition triggers leakage testing (if more than 40 feet)**
- **Most HVAC alterations will trigger the Energy Code**
  - HVAC efficiency, duct insulation, etc.
- **Most HVAC alterations will require HERS testing**
  - Duct leakage for most, airflow and fan watt draw testing for new systems, and refrigerant charge testing for some
- **A furnace can be replaced with a heat pump**
- **Enforcement agencies may accept a handwritten CF1R-ALT-02 at permit**
  - All forms (including CF2Rs and CF3Rs) must be registered at final inspection

RESOURCES

Compliance Software

- **Used to demonstrate compliance with the Energy Code when using the Performance Approach**
- **For more information at and the approved software list is located at:** https://www.energy.ca.gov/title24/2019standards/2019_computer_prog_list.html



HERS Providers

- **CHEERS and CalCERTS are certified HERS provider for the 2019 Energy Code**

More information at:
https://www.energy.ca.gov/HERS/

Acceptance Test Technician Certification Providers (ATTCP)

- **Lighting ATTCPs**
  - California Advanced Lighting Controls Training Program (CALCTP)
  - National Lighting Contractors Association of America (NLCAA)
- **Mechanical ATTCPs**
  - National Energy Management Institute Committee (NEMIC)
  - National Environmental Balancing Bureau (NEBB)
  - California State Pipe Trades Council (CSPTC)
  - Refrigeration Service Engineers Society (RSES)

More information at: http://www.energy.ca.gov/title24/attcp/

Blueprint

- Email Newsletter
- Published quarterly
- Clarifications on frequently asked questions
- For more information go to: http://www.energy.ca.gov/efficiency/blueprint/

Issue 129 | January - March 2020

BLUEPRINT

CALIFORNIA ENERGY COMMISSION

EFFICIENCY DIVISION

IN THIS ISSUE

2019 Energy Code: Focus on Lighting

California's Building Energy Efficiency Standards (Energy Code) have continued to evolve since 1978. Statewide over the past 40 years, the Energy Code has not only helped save energy, but has also saved Californians billions of dollars on their utility bills.

The 2019 Energy Code went into effect on January 1, 2020, and brought some significant changes to residential and nonresidential buildings. For the first time, newly constructed homes are required to utilize a photovoltaic (PV) system to generate renewable energy. Overall, single-family homes will use 53 percent less energy than those built under the 2016 Energy Code, after accounting for more rigorous efficiency measures and renewable energy generation.

Nonresidential buildings will use 30 percent less energy than those built under the 2016 Energy Code. A significant portion of those savings are attributed to changes in the lighting requirements.

Nonresidential Lighting Changes

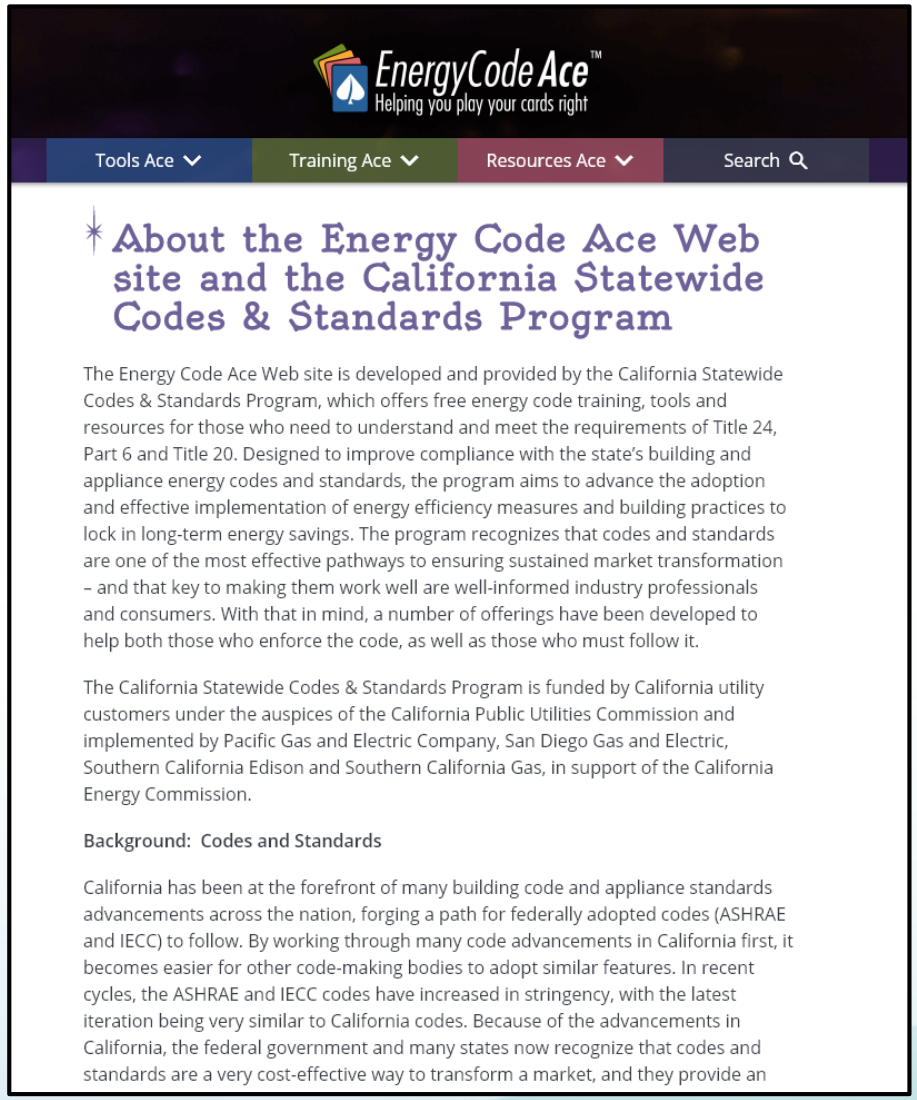
The biggest change is to the prescriptive indoor and outdoor lighting power allowances. Under the 2016 Energy Code, high performance T8 linear fluorescent lighting was used as the baseline for indoor lighting power density (LPD) calculations. Under the 2019 Energy Code, the baseline is LED lighting. The shift to LED lighting has significantly reduced LPDs. On average, indoor LPDs have been reduced by 28 percent when utilizing the area category method of compliance. This accounts for the single largest energy savings of all changes in the 2019 Energy Code. Because LED lighting is already widely used in the industry, this may not have a substantial effect on the way lighting systems are designed. It will, however, effect the overall energy consumption of these buildings, allowing less energy trade-offs between lighting and other aspects of the building, like the building envelope.

1

Online Resources Program (ORC)

For more information: http://www.energy.ca.gov/title24/orc/

Energy Code Ace



- **Forms & Resource tools**
- **Free training (in person and online)**
- **Checklists, Trigger Sheets for building departments**
- **For more information go to:** https://energycodeace.com/

Energy Hotline

- **Toll-free in California**
- **Open Monday through Friday**
  - 8:00 a.m. to noon, and 1:00 p.m. to 4:30 p.m.
- **Call at:**
  - 1-800-772-3300 (In CA)
  - (916) 654-5106 (Outside CA)
- **Email at:** Title24@energy.ca.gov

Email List Servers

- **Main conduit for communicating with stakeholders**
- **Sign up at:**
  - http://www.energy.ca.gov/listservers/
- **Subscribe to the following Efficiency List Servers :**
  - BuildingStandards
  - Blueprint
- **Respond to confirmation email within 24 hours**

THANK YOU!

Kelly Morairty

Building Standards Office
California Energy Commission

916-653-9085
kelly.morairty@energy.ca.gov