California Energy Commission

Title: 2019 Nonresidential HVAC Overview

Presenter: Kelly Morairty

Date:

Training Outline

- Training Goals
- Standards Background
  - CEC History
  - 2019 Standards overview
  - Future energy and GHG goals
- Energy Standards Foundation
  - Mandatory requirements overview
  - Compliance overview
  - Navigating The Standards
  - Demonstrating Compliance
- Nonresidential HVAC Meat and Potatoes
  - Mandatory Requirements
  - Prescriptive and Performance Requirements
  - Additions and Alterations
- Enforcement Agency
- Resources

Goals for this Training

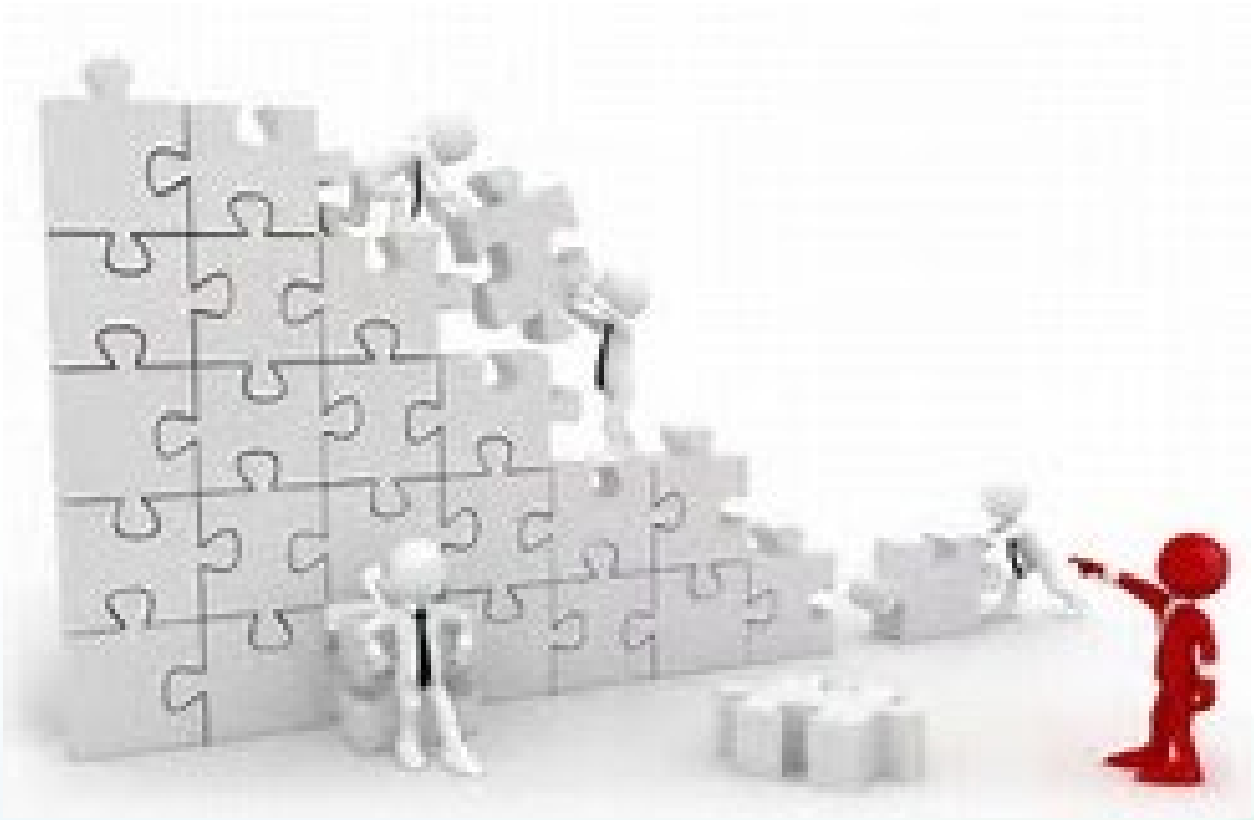
- **Basic understanding of the following:**
  - Structure of the Standards
  - Application of mandatory requirements
  - The differences between prescriptive and performance compliance
  - Nonresidential mechanical forms

- **General understanding of the following:**
  - Mandatory requirements related to nonresidential HVAC
  - Nonresidential HVAC prescriptive requirements

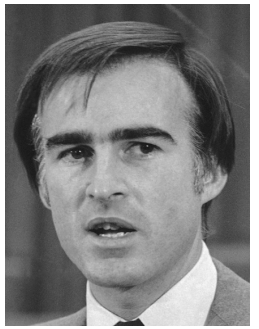
QUESTIONS…

- **If you have questions please feel free to ask at anytime:**
  - During class
  - During breaks
  - The end of class; or
  - After class

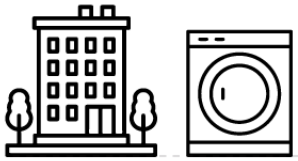
Energy Standards Background



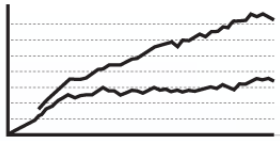
1974: WARREN-ALQUIST ACT PASSED



Created the Energy Commission



Set building and appliance efficiency standards

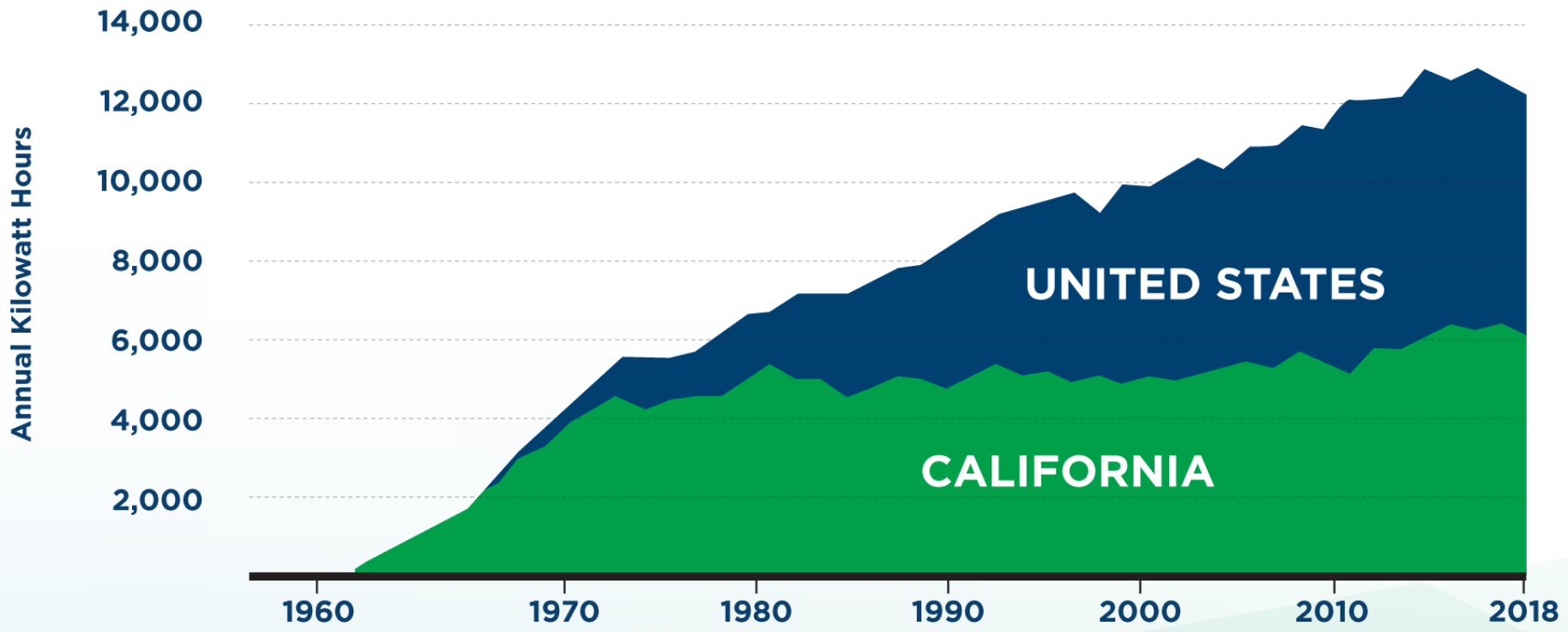


Forecast electricity demand

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

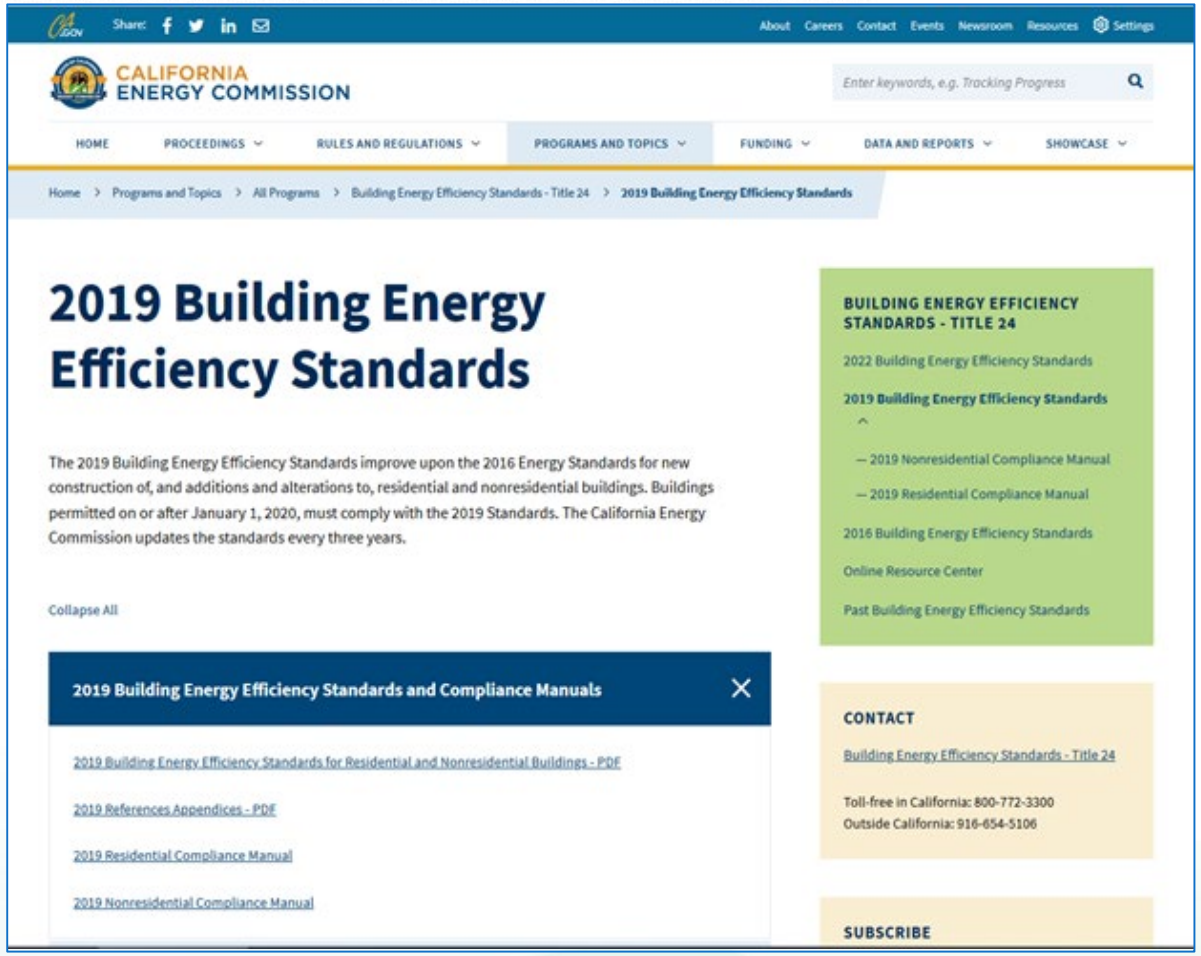
2019 Nonresidential Energy Savings

- 30% more efficient than 2016 Standards
- Savings due mainly to lighting upgrades
- LED lighting first year savings of 480 GWh of energy

2019 Documents

- The Energy Code
- Reference Appendices
- Residential and Nonresidential Manuals
- All docs. available online at:

  www.energy.ca.gov/title24



Summary of 2019 Major Changes

- **Added healthcare facilities to the Scope**
- **Updated ATTCP QA requirements (§10-103.2)**
- **Aligns equipment efficiencies with ASHRAE 90.1**
- **New Mandatory Indoor Air Quality Measures**
  - Aligns indoor air quality with ASHRAE 62.1 and 62.2 with California amendments
  - Aligns Natural ventilation with ASHRAE 62.1
- **Requirements for economizers and FDD are expanded**
- **New fan system power requirements**
- **Some reorganizing to make the code easier to understand**

QUESTIONS…

About CEC or Energy Code?

Energy Code Foundation

Energy Code Foundation Topics

- **Mandatory Measures**
- **Prescriptive Measures**
- **Prescriptive Compliance Approach**
- **Performance Compliance Approach**
- **Navigating The Standards**
  - Structure of the code (Part 1 and Part 6)
  - Navigation features in the electronic PDF
- **Demonstrating Compliance**
  - What type of forms are there?
  - When are they required?
  - Dynamic and smart form features

Energy Code Requirements

- **Mandatory measures**
  - Minimum efficiency requirements must always be met3
  - Can never trade off

- **Prescriptive measures**
  - Predefined efficiency requirements
  - May supersede mandatory measures
  - Different requirements for newly constructed buildings, additions, and alterations

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

Navigating The Energy Code

Title 24 – The California Building Standards Code

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

CBC Title 24 Code Books

Title 24, Part 1, Chapter 10

Section Title	Section #
Scope	10-101
Definitions	10-102
Permit, Certificate, Informational , and Enforcement Requirements for Designers, Installers, Builders. Manufacturers, and Suppliers	10-103
Nonresidential Lighting Controls Acceptance Test Training and Certification	10-103.1
Nonresidential Mechanical Acceptance Test Training and Certification	10-103.2
Exceptional Designs	10-104
Enforcement by the Commission	10-105
Locally Adopted Energy Standards	10-106
Interpretations	10-107

Subchapter Title	Section #
Exemption	10-108
Compliance Software, Alternative Component Packages, Exceptional Methods, Data Registries and Data Input Software, Alternative Residential Field Verification Protocols, and Electronic Document Repositories	10-109
Procedures for Consideration of Applications Under Sections 10-104, 10-106, 10-108, and 10-109	10-110
Certification and Labeling of Fenestration Product U-Factors, Solar Heat Gain Coefficients, Visible Transmittance and Air Leakage	10-111
Criteria for Default Tables	10-112
Certification and Labeling of Roofing Product Reflectance and Emittance	10-113
Determination of Outdoor Lighting Zones and Administrative Rules for Use	10-114
Community Shared Solar Electric Generation System or Community Shared Battery Storage System Compliance Option for On-Site Solar Electric Generation or Battery Storage Requirements	10-115

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

Navigation Features

- **Easy Navigation Features Added**
  - Section and Table references hyperlinked throughout Energy Standards
  - TABLE 100.0-A separated with section hyperlinks
  - Chapter hyperlinks in Nonresidential 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 Demonstrate Compliance

- **Compliance demonstration starts with compliance documents (forms)**
  - Completed by designers, consultants, builders, contractors, technicians, HERS raters, and ATTs
  - Submitted to enforcement agencies for verification at different stages of construction
  - There are four form categories.
    - Certificate of Compliance (NRCC)
    - Certificate of Installation (NRCI)
    - Certificate of Acceptance (NRCA)
    - Certificate of Verification (NRCV)
  - There are several sub-categories of each related to the building component –MCH, CXR, PLB, ENV, LTI, LTO, LTS, ELC, PRC, and SRA

What is the NRCC?

- **Nonresidential Certificate of Compliance**
  - Used to demonstrate compliance of the design
  - Completed by designer, architect, energy consultant, engineer, etc.
  - Required with or on plans at permit
  - Plans Examiner verifies NRCC matches specs on plans

STATE OF CALIFORNIA
Mechanical Systems
NRCC-MCH-E (Created 2/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE	NRCC-MCH-E
This document is used to demonstrate compliance for mechanical systems that are within the scope of the permit application and are demonstrating compliance using the prescriptive path outlined in §140.4, or §141.0(b)2 for alterations.	
Project Name:	Report Page: Page 1 of 7
Project Address:	Date Prepared:

A. GENERAL INFORMATION

01	Project Location (city)		04	Total Conditioned Floor Area	
02	Climate Zone		05	Total Unconditioned Floor Area	
03	Occupancy Types Within Project:		06	# of Stories (Habitable Above Grade)	

☐ Office (B)	☐ Retail (M)	☐ Non-refrigerated Warehouse (S)
☐ Hotel/ Motel Guest Rooms (R-1)	☐ School (F)	☐ Healthcare Facility (H)

What is the NRCI?

- **Nonresidential Certificate of Installation**
  - Confirms compliance at installation
  - Completed by builder or installing contractor
  - Required for Final Inspection
  - Field Inspector verifies installed equipment and efficiencies meet design documentation (NRCC forms) and plans

STATE OF CALIFORNIA
MECHANICAL
CEC-NRCI-MCH-01-E (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		NRCI-MCH-01-E
Mechanical		(Page 1 of 2)
Project Name:	Enforcement Agency:	Permit Number:
Project Address:	City:	Zip Code:

A. GENERAL INFORMATION			
DATE OF BUILDING PERMIT:			
BUILDING TYPE	☐ Nonresidential	☐ High-Rise Residential	☐ Hotel/Motel

What is the NRCA?

- **Nonresidential Certificate of Acceptance**
  - Confirms compliance with acceptance testing requirements at installation (HVAC & Lighting)
  - Completed by builder/installing contractor, OR an Acceptance Test Technician (ATT) when required
  - Required for Final Inspection
  - Field Inspector verifies applicable tests and forms are complete and accurate

STATE OF CALIFORNIA

OUTDOOR AIR ACCEPTANCE

CEC-NRCA-MCH-02-A (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF ACCEPTANCE		NRCA-MCH-02-A
Outdoor Air Acceptance		(Page 1 of 3)
Project Name:	Enforcement Agency:	Permit Number:
Project Address:	City:	Zip Code:
System Name or Identification/Tag:	System Location or Area Served:	

What is the NRCV?

- **Nonresidential Certificate of Verification**
  - Confirms compliance with HERS testing requirements at installation (duct leakage & hot water piping)
  - Completed by certified HERS rater, and forms must be registered with an approved HERS Provider
  - Required for Final Inspection
  - Field Inspector verifies testing and forms are completed, signed, and registered

STATE OF CALIFORNIA

INDOOR AIR QUALITY AND MECHANICAL VENTILATION

CEC-NRCV-MCH-27b-H (Revised 01/19) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF VERIFICATION		NRCV-MCH-27-H
Indoor Air Quality and Mechanical Ventilation		(Page 1 of 5)
Project Name:	Enforcement Agency:	Permit Number:
Dwelling Address:	City:	Zip Code:

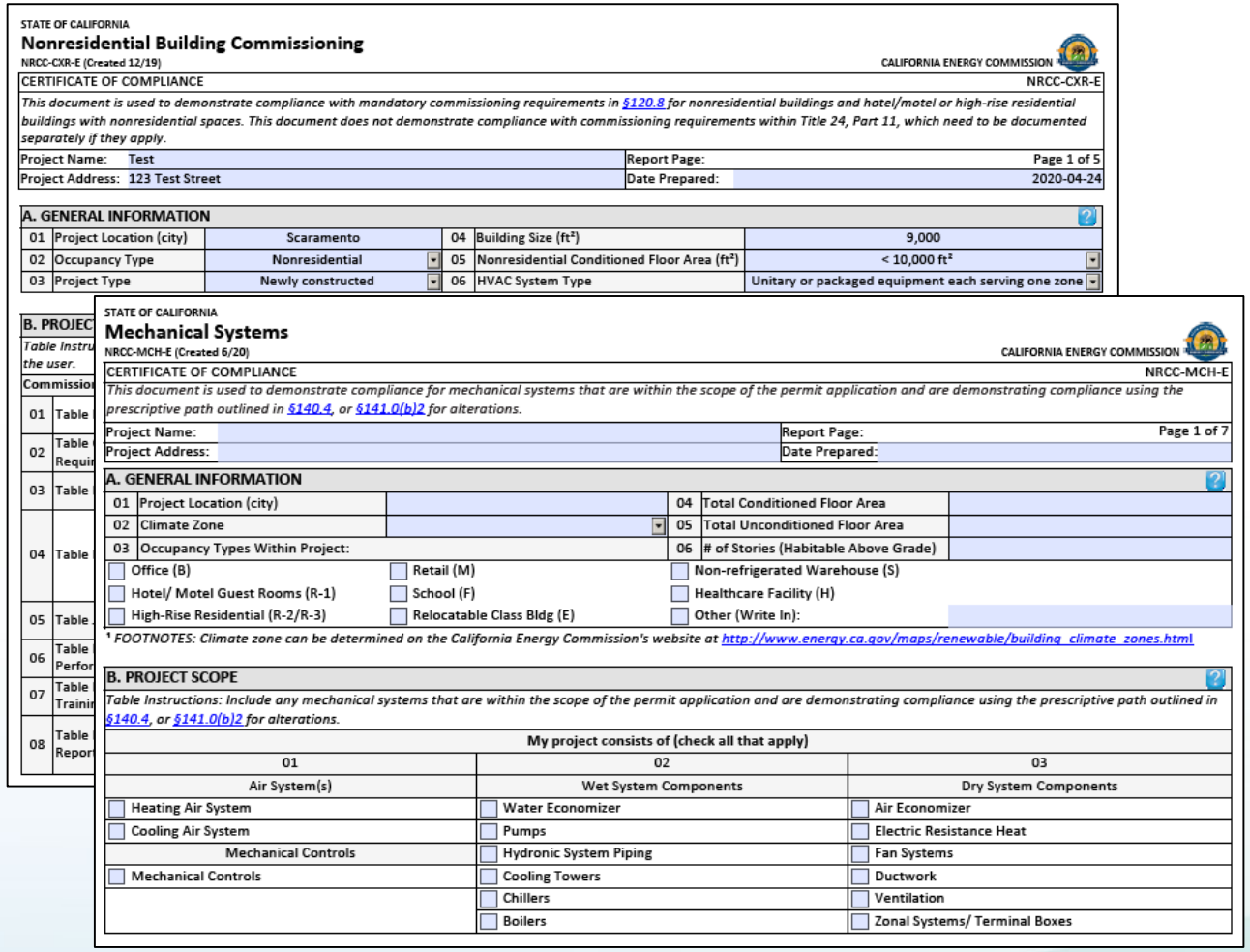
Title 24, Part 6, Section 120.1(b)2 **Attached Dwelling Unit** (Ventilation)**.** All dwelling units shall meet the requirements of ANSI/ASHRAE Standard 62.2-2016 Ventilation and Acceptable Indoor Air Quality in Residential Buildings subject to the amendments specified by Title 24, Part 6, Section

Where can I find the forms?

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

https://energycodeace.com/nonresidentialforms

Dynamic “Smart” Forms



STATE OF CALIFORNIA
Nonresidential Building Commissioning
NRCC-CXR-E (Created 12/19)
CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE — NRCC-CXR-E

This document is used to demonstrate compliance with mandatory commissioning requirements in §120.8 for nonresidential buildings and hotel/motel or high-rise residential buildings with nonresidential spaces. This document does not demonstrate compliance with commissioning requirements within Title 24, Part 11, which need to be documented separately if they apply.

Project Name:	Test	Report Page:	Page 1 of 5
Project Address:	123 Test Street	Date Prepared:	2020-04-24

A. GENERAL INFORMATION

01	Project Location (city)	Scaramento	04	Building Size (ft²)	9,000
02	Occupancy Type	Nonresidential	05	Nonresidential Conditioned Floor Area (ft²)	< 10,000 ft²
03	Project Type	Newly constructed	06	HVAC System Type	Unitary or packaged equipment each serving one zone

B. PROJEC

Table Instru
the user.

Commissio	
01	Table
02	Table Requir
03	Table
04	Table
05	Table
06	Table Perfor
07	Table Trainir
08	Table Repor

STATE OF CALIFORNIA
Mechanical Systems
NRCC-MCH-E (Created 6/20)
CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE — NRCC-MCH-E

This document is used to demonstrate compliance for mechanical systems that are within the scope of the permit application and are demonstrating compliance using the prescriptive path outlined in §140.4, or §141.0(b)2 for alterations.

Project Name:		Report Page:	Page 1 of 7
Project Address:		Date Prepared:	

A. GENERAL INFORMATION

01	Project Location (city)		04	Total Conditioned Floor Area	
02	Climate Zone		05	Total Unconditioned Floor Area	
03	Occupancy Types Within Project:		06	# of Stories (Habitable Above Grade)	

☐ Office (B) ☐ Retail (M) ☐ Non-refrigerated Warehouse (S)
☐ Hotel/ Motel Guest Rooms (R-1) ☐ School (F) ☐ Healthcare Facility (H)
☐ High-Rise Residential (R-2/R-3) ☐ Relocatable Class Bldg (E) ☐ Other (Write In):

[1] *FOOTNOTES: Climate zone can be determined on the California Energy Commission's website at http://www.energy.ca.gov/maps/renewable/building_climate_zones.html*

B. PROJECT SCOPE

Table Instructions: Include any mechanical systems that are within the scope of the permit application and are demonstrating compliance using the prescriptive path outlined in §140.4, or §141.0(b)2 for alterations.

My project consists of (check all that apply)

01	02	03
Air System(s)	Wet System Components	Dry System Components
☐ Heating Air System	☐ Water Economizer	☐ Air Economizer
☐ Cooling Air System	☐ Pumps	☐ Electric Resistance Heat
Mechanical Controls	☐ Hydronic System Piping	☐ Fan Systems
☐ Mechanical Controls	☐ Cooling Towers	☐ Ductwork
	☐ Chillers	☐ Ventilation
	☐ Boilers	☐ Zonal Systems/ Terminal Boxes

- **ALL 2019 NR NRCC forms are “dynamic” and “fillable”**
- **Some auto fill and conduct simple math calculations**
- **Interactive instructions**
- **Add and delete table rows**

Nonresidential Data Registry

- **§10-103 requires all nonresidential forms to be registered**
  - Contingent upon approval of a nonresidential data registry
  - To date, no such registry has been approved
  - This means that registration is not required at this time

Code Quiz

1. **What are the four types of forms and in what order are they typically used?**
   a) NRCC – Certificate of Compliance.
   b) NRCI – Certificate of Installation.
   c) NRCA – Certificate of Acceptance
   d) NRCV – 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 Nonresidential HVAC

Title 24, Part 6

Subchapter	Subchapter Title	Sections
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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 Nonresidential HVAC Sections

Subchapter	Subchapter Title	Section	Section Title
2	**All Occupancies** - **Mandatory** Requirements for the Manufacture, Construction and Installation of Systems, Equipment, and Building Components	§110.1	Mandatory requirements for Appliances
		§110.2	Mandatory requirements for Space-Conditioning Equipment
		§110.5	Pilot Lights Prohibited
		§110.12	Mandatory Requirements for Demand Management
3	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies and Covered Processes - **Mandatory** Requirements	§120.1	Requirements for Ventilation
		§120.2	Required Controls for Space-Conditioning Systems
		§120.3	Requirements for Pipe Insulation
		§120.4	Requirements for Air Distribution Systems, Ducts and Plenums
		§120.5	Required Nonresidential Mechanical System Acceptance
		§120.8	Nonresidential Building Commissioning
		§120.9	Mandatory Requirements for Commercial Boilers
5	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies - **Performance and Prescriptive Compliance** Approaches for Achieving Energy Efficiency	§140.0	Performance and Prescriptive Compliance Approaches
		§140.1	Performance Approach: Energy Budget
		§140.2	Prescriptive Approach
		§140.4	Prescriptive Requirements for Space Conditioning Systems
6	Nonresidential, High-Rise Residential, Hotel/Motel Occupancies - **Additions, Alterations, and Repairs**	§141.0	Additions, Alterations, and Repairs to Existing Nonresidential, High-Rise Residential, and Hotel/Motel Buildings

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

§110 Series All Occupancies Mandatory HVAC Requirements

- §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 (MAEDBS)
  - 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

Sources: https://www.carrier.com/commercial/en/us/products/packaged-outdoor/

§110.2 - Mandatory Requirements for Space Conditioning Equipment

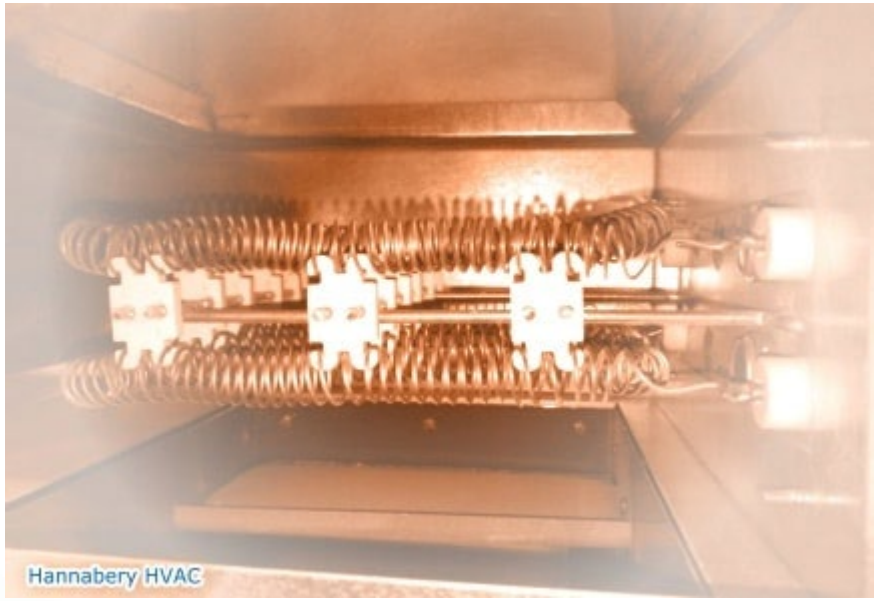
- **All equipment covered in this section must be certified by the manufacturer**
- **(a) All equipment listed in TABLE 110.2-A through TABLE 110.2-k must meet the applicable efficiencies when tested per the listed test procedure**

❖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
  - The cut-on and cut-off temperatures for the electric resistance heating must be lower than the heat pump cut-on and cut-off temperatures



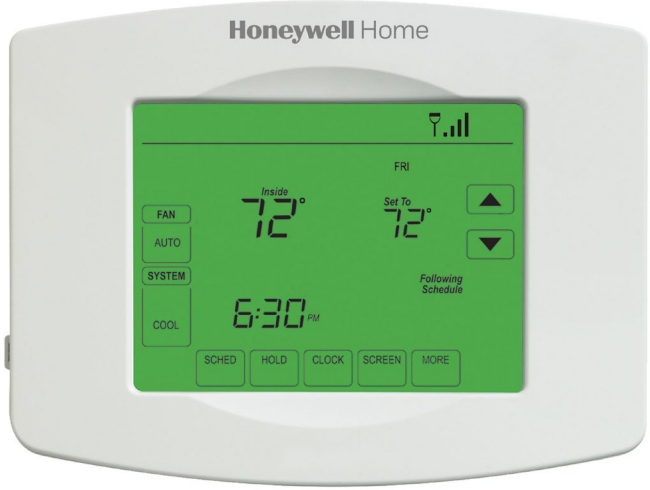
Source: https://www.hannabery.com/faq4.shtml

❖ EXCEPTION:

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

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(c) Thermostat Requirements**
  - All unitary 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:

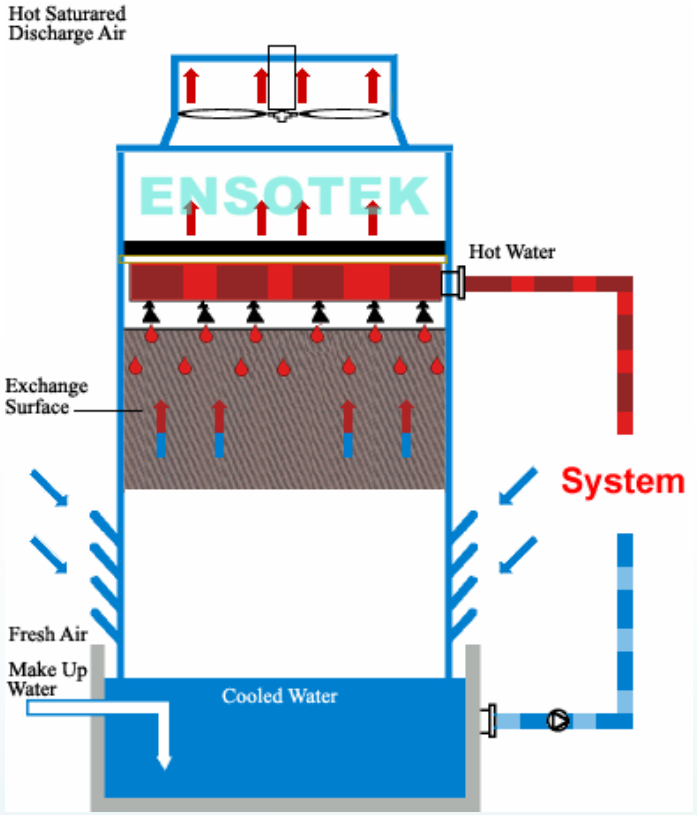
- ✓ Gravity gas wall heaters, gravity floor heaters, gravity room heaters, non-central electric heaters, fireplaces or decorative gas appliances, wood stoves, room air conditioners, and room air-conditioner heat pumps are not required have to have setback thermostats.

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(d) Gas- and Oil-Fired Furnaces ≥ 225,000 Btu/h must have controls to limit Standby Loss:**
  - They must have an **intermittent ignition or interrupt device** (IID)
  - They must have either **power venting** or a **flue damper**
  - A **vent damper** is permissible with furnaces using combustion air from the conditioned space
  - All furnaces not located within the conditioned space must have **jacket heat losses** not exceeding 0.75 percent of the input rating

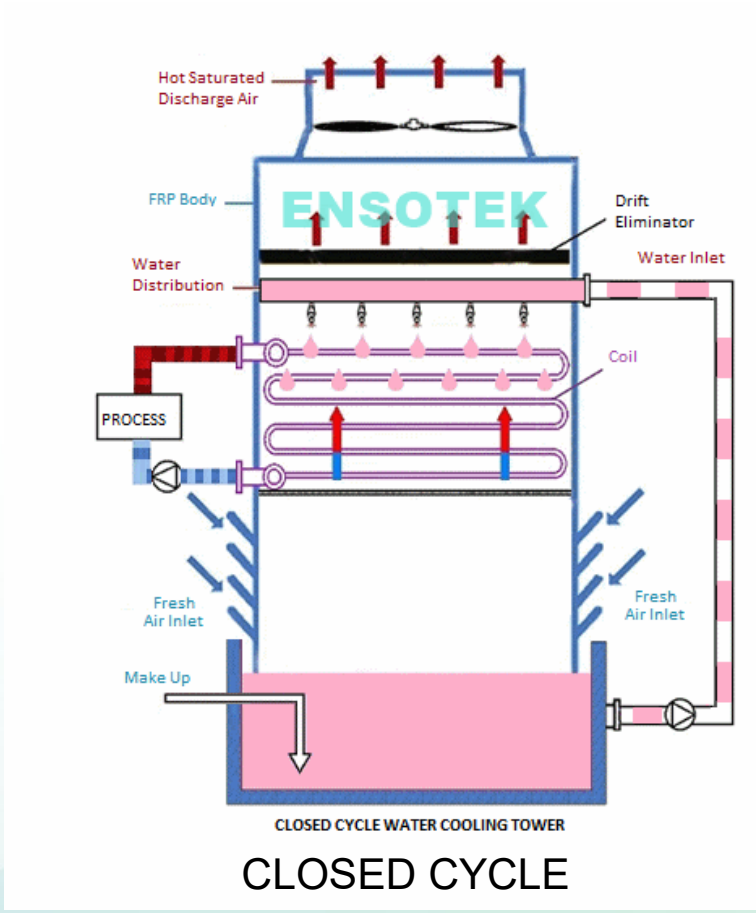
§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **Two types of cooling towers**



OPEN CYCLE

Source: http://www.ensotek.com.tr/index.php?lg=en

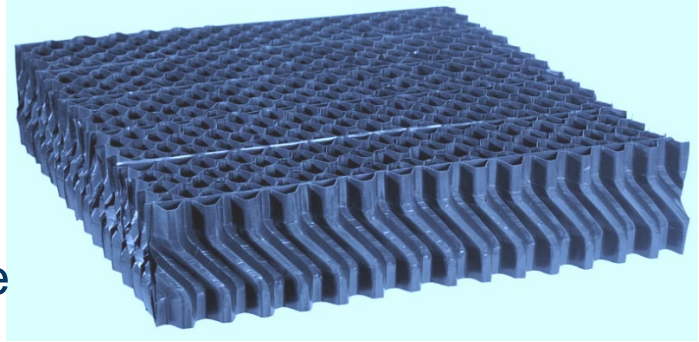


CLOSED CYCLE

Source: http://www.ensotek.com.tr/index.php?lg=en

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(e) Cooling towers ≥ 150 tons must have the following:**
  - Conductivity or Flow-based controls that **maximize cycles of concentration** based on local water quality and an approved calculator using a **Langelier Saturation Index** (LSI) of 2.5 or less
    - The NRCC-MCH-E, Table M is used to document this and must be signed by a Professional Engineer (PE)
  - A **flow meter** with an analog output for flow either hardwired or available through a gateway on the makeup water line and have an **overflow alarm**
  - Equipped with **Drift Eliminators** with drift reduction to 0.002% of the circulated water volume for counter-flow towers and 0.005% for cross-flow towers
  - Nonresidential Manual chapter 4.6.1.1 is a good resource for cooling tower water conservation information



Source: http://innovek.co.th/product-36683-drift-eliminator.html

§110.2 - Mandatory Requirements for Space Conditioning Equipment

- **(f) Low leakage air handler compliance credit:**
  - The air handler must be listed on the Energy Commission'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 if 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/

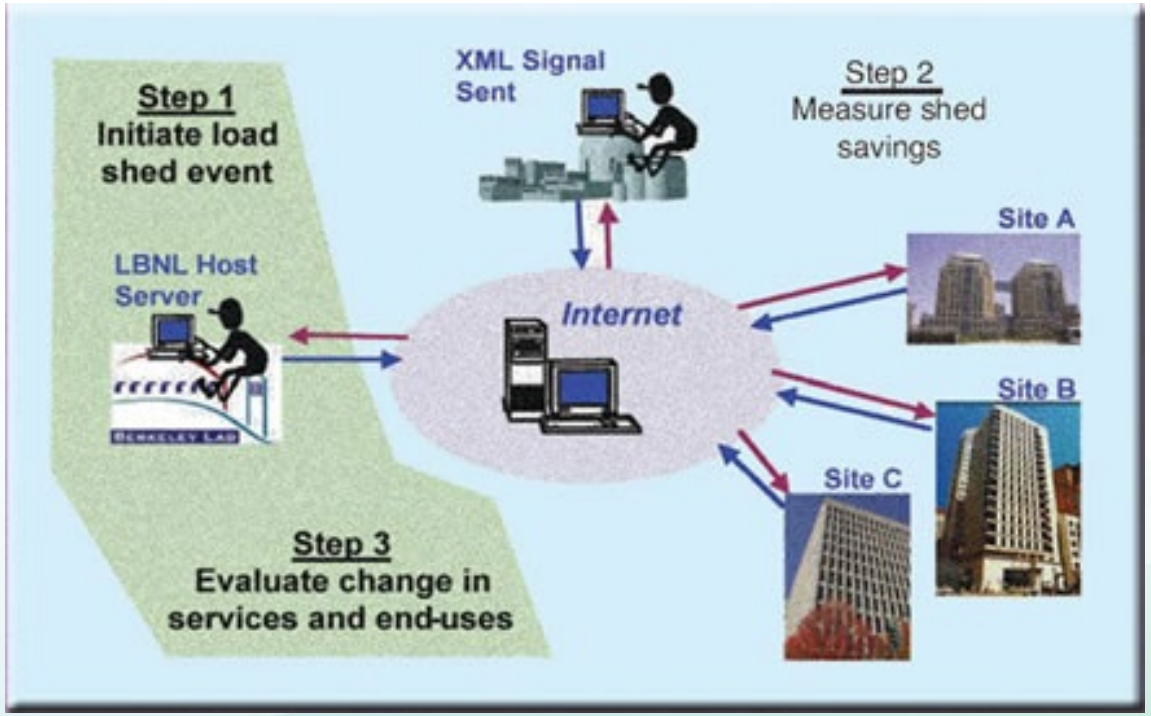
§110.5 - Natural Gas Central Furnaces, Cooking Equipment, Pool and Spa Heaters, and Fireplaces: Pilot Lights Prohibited

- **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
  - Spelled 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/

§110.12 - Mandatory Requirements for Demand Management

- **Demand Responsive Zonal HVAC Controls**
  - Systems with DDC to the Zone shall be programmed to allow centralized demand shed for noncritical zones as follows:
    - A centralized contact or software point within an Energy Management Control System (EMCS) must have the following remote capabilities:
      - Increase the operating cooling temperature set points by 4° or more
      - Decrease the operating heating temperature set points by 4° or more
      - Must reset the temperatures in all to the original operating levels
    - The controls must provide an adjustable rate of change for the temperature increase, decrease, and reset.
    - The controls shall have the following features:
      - Can be disabled by authorized facility operators; and
      - Allow manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS

Code Quiz

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 Standards 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 listed 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
  - Gas- and Oil-Fired Furnaces must have controls to limit Standby Losses
  - Cooling towers ≥ 150 tons are required to have water saving controls for maximum cycles of concentration, overflow, and water drift loss
  - 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 3
Nonresidential, High-Rise Residential, Hotel/Motel Occupancies, and Covered Processes – Mandatory Requirements
(§120.0 - §120.9)

§120 Series Nonresidential, High-Rise Residential, Hotel/Motel Occupancies Mandatory Requirements

- §120.1 - Requirements for Ventilation
- §120.2 - Required Controls for Space-Conditioning Systems
- §120.3 - Requirements for Pipe Insulation
- §120.4 - Requirements for Air Distribution Systems, Ducts and Plenums
- §120.5 - Required Nonresidential Mechanical System Acceptance
- §120.8 - Nonresidential Building Commissioning
- §120.9 - Mandatory Requirements for Commercial Boilers

§120.1 - Requirements for Ventilation

Ventilation Background

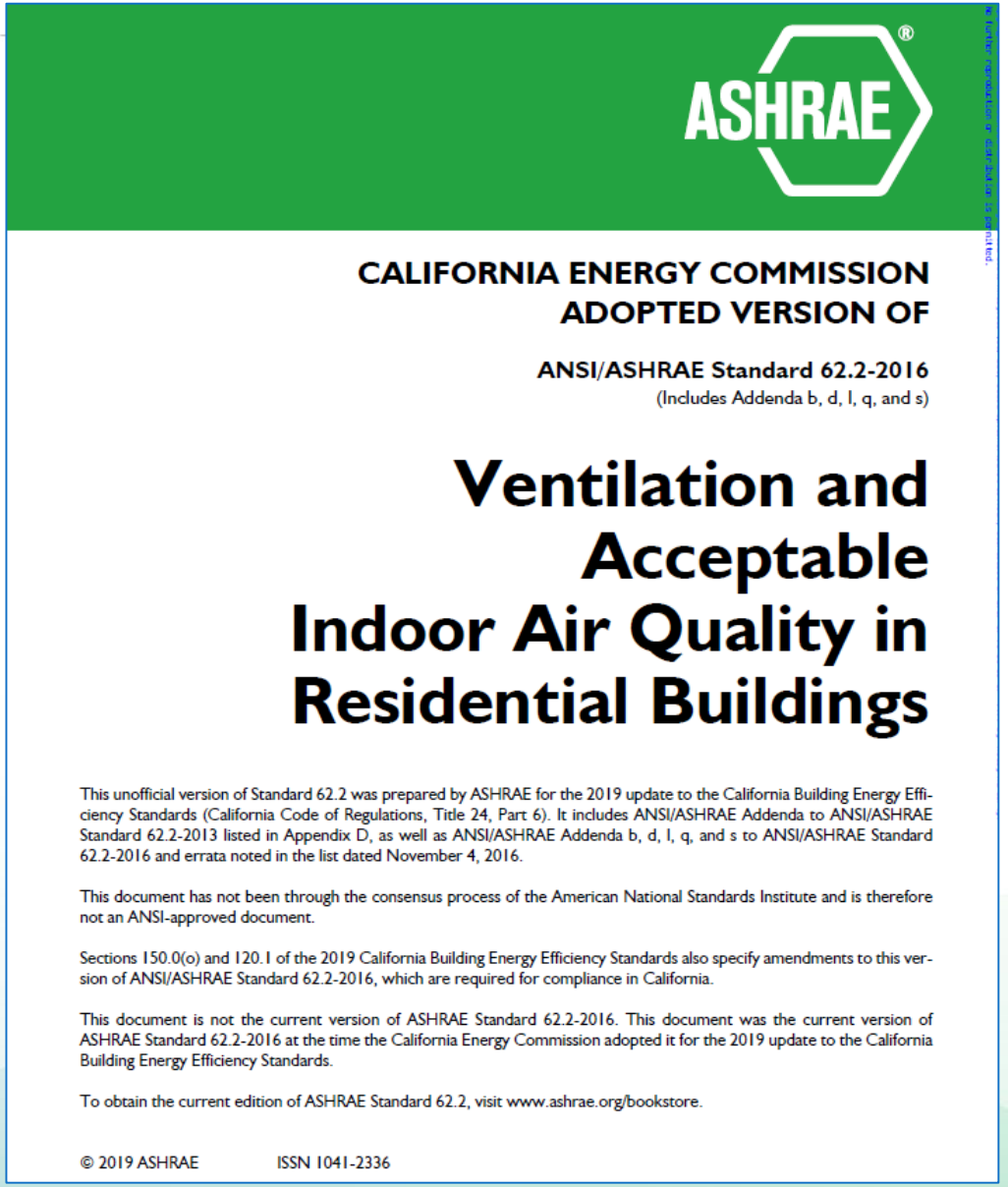
- CEC is required by law to ensure building standards are consistent with Health and Safety Code §105400 and §105410
- These requirements are not part of to the Warren Alquist Act (PRC25402) which created the Energy Code
- Ventilation requirements are the only requirements in Part 6 not necessarily required to be cost effective

§120.1 - Ventilation and Indoor Air Quality

- **Summary of 2019 ventilation changes**
  - Ventilation system requirements are broken out by building type:
    - §120.1(b) - high-rise residential (ASHRAE 62.2)
    - §120.1(c) - nonresidential, hotel/motel (ASHRAE 62.1)
  - Filtration required for central space conditioning systems and supply side of ventilation systems
  - MERV 13 filter efficiency required

§120.1(b) - High-Rise Residential Buildings

- §120.1(b)1 – Air Filtration
- §120.1(b)2 – Attached Dwelling Units (ventilation)



ASHRAE®

CALIFORNIA ENERGY COMMISSION
ADOPTED VERSION OF

ANSI/ASHRAE Standard 62.2-2016
(Includes Addenda b, d, l, q, and s)

Ventilation and Acceptable Indoor Air Quality in Residential Buildings

This unofficial version of Standard 62.2 was prepared by ASHRAE for the 2019 update to the California Building Energy Efficiency Standards (California Code of Regulations, Title 24, Part 6). It includes ANSI/ASHRAE Addenda to ANSI/ASHRAE Standard 62.2-2013 listed in Appendix D, as well as ANSI/ASHRAE Addenda b, d, l, q, and s to ANSI/ASHRAE Standard 62.2-2016 and errata noted in the list dated November 4, 2016.

This document has not been through the consensus process of the American National Standards Institute and is therefore not an ANSI-approved document.

Sections 150.0(o) and 120.1 of the 2019 California Building Energy Efficiency Standards also specify amendments to this version of ANSI/ASHRAE Standard 62.2-2016, which are required for compliance in California.

This document is not the current version of ASHRAE Standard 62.2-2016. This document was the current version of ASHRAE Standard 62.2-2016 at the time the California Energy Commission adopted it for the 2019 update to the California Building Energy Efficiency Standards.

To obtain the current edition of ASHRAE Standard 62.2, visit www.ashrae.org/bookstore.

 ISSN 1041-2336

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)1 – Air Filtration**
  - Filters for **space conditioning systems**:
    - MERV 13
    - 2-inch depth filter: allowable pressure drop 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 120.1-A at ≤ 150 ft/min face velocity:

Equation 120.1-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)

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)1 – Air Filtration – cont.**
  - **Space conditioning system** filters must be labeled by the manufacturer with:
    - Design airflow rate
    - Maximum allowable clean-filter pressure drop at the design airflow rate.
  - Filter **location** must be labeled
    - Minimum design airflow rate
    - Maximum allowable clean-filter pressure drop
    - Labels must be permanent, legible, and visible to the person replacing the filter

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)1 – Air Filtration – cont.**
  - Filters for **ventilation systems**:
    - Must be MERV 13
    - Filter pressure drop determined by the system designer
  - Filter location must be labeled
    - Minimum design airflow rate
    - Maximum allowable clean-filter pressure drop
    - Labels must be permanent, legible, and visible to the person replacing the filter

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)1 – Air Filtration – cont.**
  - Filter location label example from Nonresidential Compliance Manual (NCM):

Figure 4-2: Example of Installer's Filter Grille Sticker

Air Filter Performance Requirement		Maintenance Instructions
Airflow Rate (CFM) Must be greater than or equal to the value shown	**Initial Resistance (IWC)** Must be less than or equal to the value shown	Use only replacement filters that are rated to simultaneously meet both of the performance requirements specified on this sticker.
750	0.1	

  - Filter label example from NCM:

Figure 4-3: Example Manufacturer's Filter Label

MERV	(µm) PSE (%)	0.30-1.0	1.0-3.0	3.0-10	Airflow Rate (CFM)	615	925	1230	1540	2085*	*Max Rated Airflow
13		62	87	95	Initial Resistance (IWC)	0.07	0.13	0.18	0.25	0.38	

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)2 – Attached Dwelling Units (ventilation)**
  - Dwelling unit ventilation rates and indoor air quality aligned with ASHRAE 62.2 with California Amendments:
    - Window operation is not allowed for providing whole building ventilation airflow
    - Continuous operation of the central system air handlers used in central fan integrated ventilation systems is not allowed
    - Ventilation system must be one of the following:
      - Balanced ventilation system; or
      - Continuously operating supply or exhaust ventilation systems are allowed if the **dwelling unit envelope** leakage is verified by a HERS Rater to be ≤ 0.3 cfm

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)2 - Attached Dwelling Units - cont.**
  - Mechanical ventilation rate for each dwelling unit is determined by Equation 120.1-B:

Equation 120.1-B: $Q_{tot} = \mathbf{0.03} \times A_{floor} + 7.5 \times (N_{br} + 1)$

  - 2016 code required $0.01 \times A_{floor}$ based on ASHRAE 62.2-2010.
  - 2019 code equation aligns with ASHRAE 62.2-2016

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)2 - Attached Dwelling Units - cont.**
  - **Central** ventilation systems serving multiple dwelling-units:
    - System must be balanced so that the ventilation rate in **each** dwelling unit is no less than the rate calculated using Equation 120.1-B
    - Each unit must be within 20% of the design airflow for that unit
  - All dwelling unit ventilation systems must be tested in accordance with Reference Nonresidential Appendix NA7.18.1
  - Manual switches operating ventilation systems must be labeled with 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."

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)2 - Attached Dwelling Units - cont.**
  - Kitchen Range Hoods:
    - Minimum airflow of 100 cfm
    - Maximum of 3 sones
      - Exception to sound rating per ASHRAE 62.2, paragraph 7.2.2: Fans exceeding 400 cfm
    - Certified to the Home Ventilation Institute (HVI) or Association of Home Appliance Manufacturers (AHAM)
    - Needs HERS verification per Reference Nonresidential Appendix NA7.18.1

§120.1(b) - High-Rise Residential Buildings

- **§120.1(b)2 - Attached Dwelling Units - cont.**
  - Field verification and acceptance testing
    - **Dwelling unit ventilation** airflow tested in accordance with Reference Nonresidential Appendix NA7.18.1.
    - **Kitchen Range Hoods** must be confirmed by a HERS rater that the model is rated by HVI or AHAM to comply with the following requirements:
      - The maximum sound rating specified in Section 7.2 of ASHRAE 62.2. (3 sones or 400 cfm)
      - The minimum ventilation airflow rate specified in Section 5 of ASHRAE 62.2. (100 cfm)

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- §120.1(c)1 – Air Filtration
- §120.1(c)2 – Natural Ventilation
- §120.1(c)3 – Mechanical Ventilation

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(c)1 – Air Filtration**
  - Filters required for both **space conditioning and ventilation systems**:
    - MERV 13
    - 2-inch depth filter: allowable pressure drop determined by the system designer.
    - 1-inch depth filter allowed if:
      - Sized per equation 120.1-A at ≤ 150 ft/min face velocity:

$$A_{face} = Q_{filter} / V_{face}$$

Where:
A_{face} = filter face area (sf)
Q_{filter} = filter air flow (cfm)
V_{face} = face velocity (150 ft/min or less)

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(c)2 - Natural Ventilation**
  - Requirements aligned with ASHRAE 62.1.
  - Maximum distance from operable openings is based on location, number of openings, and ceiling height.
  - Size of openings must be **≥ 4%** of ventilated floor area.
  - Adjoining rooms without outside air openings must have a permanently opened area ≥ 8% of the unventilated area but not less than 25 sf.

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(c)2 - Natural Ventilation - cont.**
  - If a natural ventilation system is used, there must also be a mechanical system per 120.1(c)3.
    - Exceptions where mechanical ventilation is not required:
      - If natural ventilation openings are permanently open; or
      - If there are controls preventing ventilation openings from closing during times of expected occupancy; or
      - In zones not served by a space conditioning system

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(c)3 – Mechanical Ventilation**
  - Outdoor ventilation rate is determined by Equation 120.1-F:

$$\textit{Equation 120.1-F}: \quad V_z = R_a \times A_z$$

Where:

V_z = Required outdoor airflow rate (cfm)

R_a = Outdoor airflow rate per unit area from Table 120.1-A (cfm/sf)

A_z = The net floor area of the ventilation zone (sf)

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(c)3 – Mechanical Ventilation – cont.**
  - Spaces with an expected number of occupants or fixed seating use Equation 120.1-G:

$$Equation\ 120.1\text{-}G:\ V_z = R_p \times P_z$$

Where:

V_z = Required outdoor airflow rate (cfm)

R_p = 15 cubic feet per minute of outdoor airflow per person

P_z = The expected number of occupants as specified by the building designer, or for spaces with fixed seating, as determined by the California Building Code

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(c)3 – Mechanical Ventilation – cont.**
  - Transfer air is allowed but there are new requirements based on the transfer air quality classification (Aligns with ASHRAE 62.1)
- **§120.1(c)4 – Exhaust Ventilation**
  - New exhaust ventilation rate requirements are listed in Table 120.1-B (Aligns with ASHRAE 62.1)

Table 120.1-B – Minimum Exhaust Rates

[ASHRAE 62.1: TABLE 6.5]

Occupancy Category	Exhaust Rete, cfm/unit	Exhaust Rate, cfm/ft²	Air Class	Notes
Arenas	-	0.50	1	B
Art classrooms	-	0.70	2	
Auto repair rooms	-	1.5	2	A
Barber shops	-	0.50	2	
Beauty and nail salons	-	0.60	2	
Cells with toilet	-	1.00	2	
Copy, printing rooms	-	0.50	2	

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(g) - Air Classification and Recirculation Limitations**
  - There are limits on the recirculation or transfer of air based on the occupancy air classification
    - Table 120.1-A, -B, and –C designates the air class for each occupancy as: 1, 2, 3, or 4
    - The lower the number, the higher the air quality. For example:
      - Class 1 air can be recirculated or transferred to any space
      - Class 4 air cannot be recirculated or transferred to any other space
    - This aligns with ASHRAE 62.1

§120.1(c) - Nonresidential and Hotel/Motel Buildings

- **§120.1(d)1, 2 – Operation and Control Requirements**
  - The minimum outdoor air must be supplied at all times **unless**:
    - The space is intermittently occupied and controlled with an **Occupancy Sensor** (OS) or **Demand Control Ventilation** (DCV)
    - A temporary reduction is allowed for up to 30 minutes at a time if the average rate for each hour is ≥ the required rate
  - A preoccupancy purge is required in the hour prior to occupancy. The **lesser** of the following must be provided to the entire building:
    - The minimum required rate of outdoor air
    - Three complete air changes

§120.1(d) - Operation and Control Requirements

- **§120.1(d)3 – Required Demand Control Ventilation**
  - DCV is required if the system serving the space has one of the following:
    - An air economizer; or
    - Modulating outside air control; or
    - A design outdoor airflow rate is > 3,000 cfm

Source: https://us.vwr.com/store/product/8891787/vernier-carbon-dioxide-gas-sensor

❖ EXCEPTIONS:

✓ There are several exceptions to demand control ventilation (§120.(c)3.) related to airborne contaminates, space type, occupant density, exhaust rate, and space size.

§120.1(d) - Operation and Control Requirements

- **§120.1(d)4 – Demand Control Ventilation Devices**
  - Requirements for DCV systems with **CO_2 Sensors**
    - CO_2 sensors are required in **each room** with no less than **one per 10,000 ft²**.
    - When a zone or space is served by more than one sensor, **a high CO_2 signal from any sensor** in the zone or space must increase ventilation
    - CO_2 sensors must be located between 3 ft and 6 ft above the floor or at the anticipated height of the occupants heads
    - CO_2 must be maintained to **600 ppm or less plus the outdoor air CO_2** concentration **-** space ventilation rate does not have to be exceeded
    - Outdoor air CO_2 can be assumed to be 400 ppm, or measured with a CO_2 sensor located within 4 feet of the outdoor air intake

CO_2 CONCENTRATIONS MUST BE LESS THAN OR EQUAL TO:

600 PPM + Outdoor CO_2 Concentrations

§120.1(d) - Operation and Control Requirements

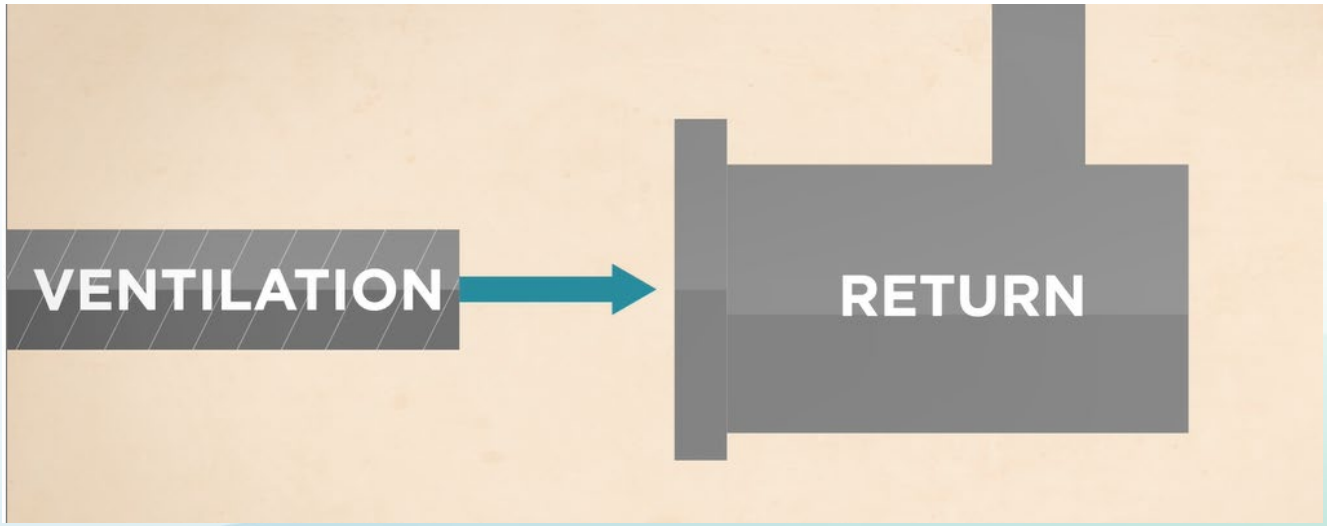
- **§120.1(d)5 – Occupant Sensor Ventilation Control Devices**
  - Occupancy sensors are required for ventilation control when also required for space conditioning systems per §120.2(e)3
  - Airflow to spaces with occupancy sensors can be shut off indefinitely during scheduled occupancy if:
    - The space is in occupied-standby mode, and
    - Allowed per note F in Table 120.1-A

§120.1(d) - Operation and Control Requirements

- **§120.1(d)5 – Occupant Sensor Ventilation Control Devices – cont.**
  - Sensors must be placed so they can detect occupants in the entire space
  - Where occupant sensors **control lighting,** the ventilation signal must be independent of daylighting and manual controls
  - Single zone damper or a **single zone system serving multiple rooms** must have a sensor in each room
  - A zone is not considered vacant until all rooms in the zone are vacant

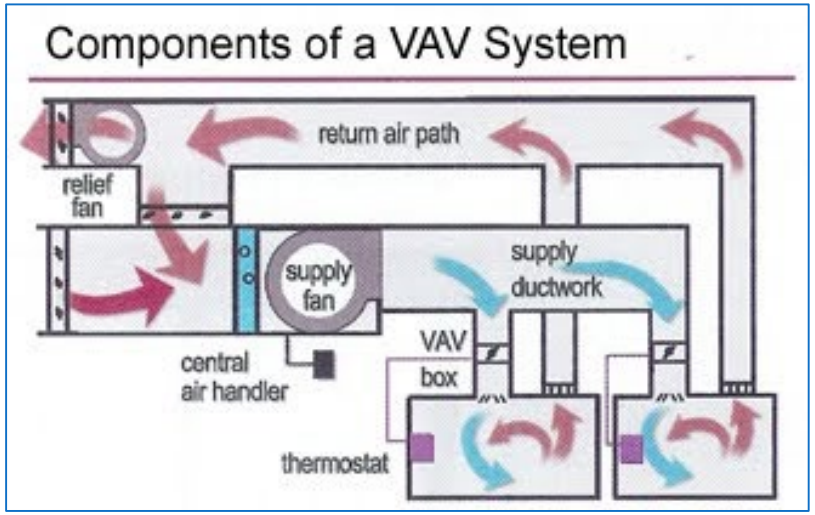
§120.1(e) - Ducting for Zonal Heating and Cooling Units

- **§120.1(e) – Ducting for Zonal Units**
- **Where a return plenum is used to supply outdoor air, the outdoor air should be ducted to discharge either:**
  - Within 5 feet of the intake; or
  - If the velocity is ≥ 500 feet per minute, it can be up to 15 feet away if it is directed substantially toward the intake



§120.1(f) - Design and Control Requirements for Quantities of Outdoor Air

- **§120.1(f) – Design and Control Requirements for Quantities of Outdoor Air**
- **Systems must have ductwork, dampers, and controls to supply the larger of:**
  - (1) the required outside air rates; or
  - (2) the rate required for make-up of all exhaust systems that are required for processes, control of odors, or the removal of contaminants
- **VAV systems must have dynamic controls to maintain measured outside air ventilation rates within 10% of the required rate**
- **Constant volume ventilation and space-conditioning systems must be within 10 percent of the required outside air rate**



Source: https://sites.google.com/site/ae391hvaca4/hvac-alternates-and-selection

Code Quiz

1. **MERV 13 filters are required on all ventilation and space conditioning systems.**

   a) True
   b) False

2. **How many CO_2 sensors are required in a 15,000 ft² open space with demand control ventilation?**

   a) One
   b) Two
   c) Three

Code Quiz

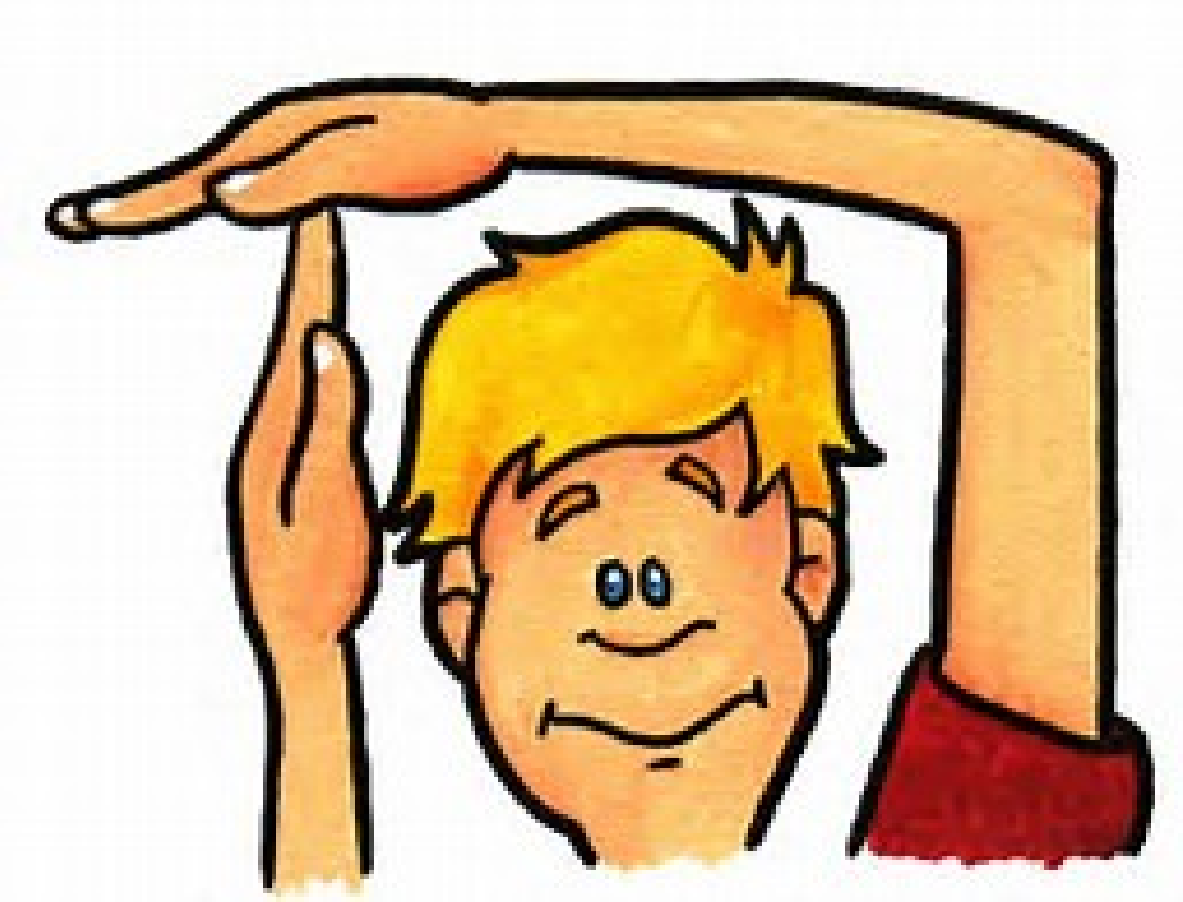
1. **Can transfer air be the only source of ventilation air for a space?**
   a) Yes
   b) No

2. **When is ventilation to a space NOT required?**
   a) When a space is scheduled to be unoccupied.
   b) Intermittently with occupancy sensors.
   c) Ventilation is always required.
   d) a), and b).

§120.1 – Requirements for Ventilation

- **Takeaways for Ventilation**
  - MERV 13 filters are required for HVAC systems
  - Ventilation rates are found in Table 120.1-A
  - There are limits on the recirculation or transfer of air based on the occupancy air classification in Tables 120.1-A, -B, and –C
  - There are exhaust requirements for occupancies listed in Table 120.1-B
  - All rooms in a demand control ventilation zone must have CO2 sensors
  - Occupant sensors for ventilation control are required when required for space conditioning per §120.2(e)3 and all occupancies in the zone have Note F in Table 120.1-A.
  - All rooms within the ventilation zone must have occupancy sensors
  - There are function and location requirements for CO2 and occupant sensors
  - A preoccupancy purge is required before scheduled occupation

Time for a Break?



§120.2 – Required Controls for Space Conditioning Equipment

Source: https://fmlink.com/articles/ahr-expo-2019-hvac-innovation-awards/

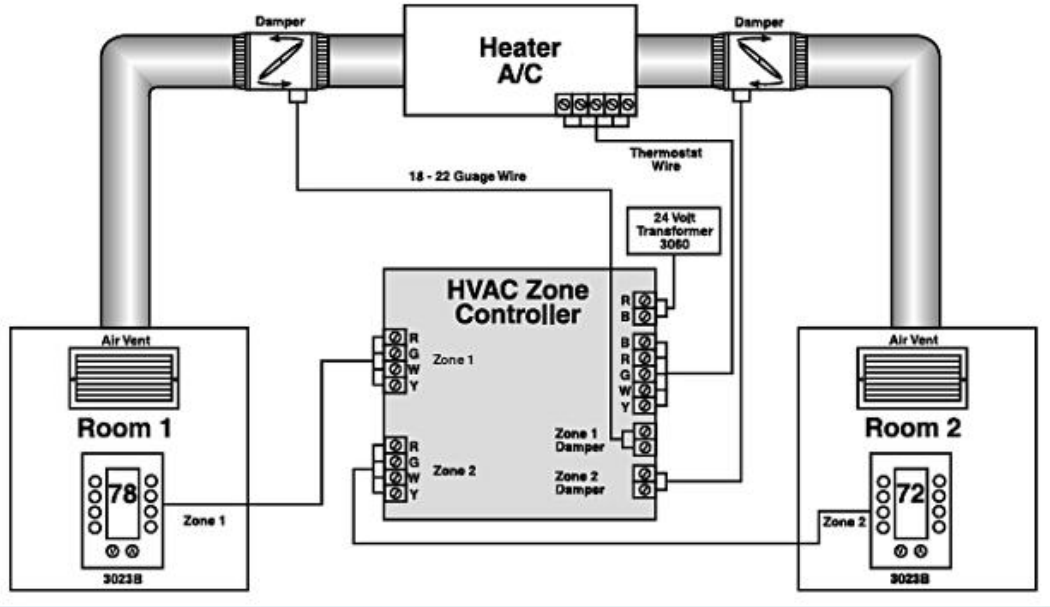
§120.2 – Required Controls for Space Conditioning Equipment

- **§120.2 is applicable to nonres, high-rise res, and hotel/motel buildings for the following controls types:**

  - ✓ Zonal Thermostatic Controls
  - ✓ Hotel/Motel Guest Room and High-rise Residential Dwelling Unit Thermostats
  - ✓ Heat Pump Controls
  - ✓ Shut-off and Reset Controls
  - ✓ Isolation Area Devices
  - ✓ Dampers for Air Supply and Exhaust Equipment
  - ✓ Automatic Demand Shed Controls
  - ✓ Economizer Fault Detection and Diagnostics (FDD)
  - ✓ Direct Digital Controls (DDC)
  - ✓ Optimum Start/Stop Controls

§120.2 – Required Controls for Space Conditioning Equipment

- **(a) Thermostatic Controls for Each Zone**
  - Each zone or dwelling unit must have an individual thermostatic control or be controlled by an Energy Management Control System (EMCS)



Source: https://www.alsplumbing.com/hvac-zoning/

❖ EXCEPTION:

✓ There is an exception that allows for an independent perimeter heating or cooling system to serve more than one zone without individual thermostatic controls. See Exception to 120.2(a) for details.

§120.2 – Required Controls for Space Conditioning Equipment

- **(b) Criteria for Zonal Thermostatic Controls**
  - Thermostats must be able to set temperatures to the following:
    - Down to 55°F or lower for heating
    - Up to 85°F or higher for cooling
  - If used for both heating and cooling it must also have a **dead band** of at least 5°F where space conditioning is shut off or reduced to a minimum

❖ EXCEPTIONS:

- ✓ Systems with thermostats that require manual changeover between heating and cooling modes do not need a dead band.
- ✓ Exception from dead band requirement for healthcare facilities.

§120.2 – Required Controls for Space Conditioning Equipment

- **(b) Criteria for Zonal Thermostatic Controls – cont.**
  - **Single zone** systems must have one of the following controls:
    - An **Occupant Controlled Smart Thermostat** (OCST) that meets setback requirements of §110.2(c) and demand response signal requirements in §110.12(a) and certified to the Commission per requirements in JA5
    - And if system has DDC to the zone, the OCST must also meet the demand response control requirements in §110.12(b)

❖ EXCEPTIONS:

- ✓ Healthcare facilities and systems serving exempt process loads that must have constant temperatures to prevent degradation of materials, process, plants or animals.
- ✓ Package terminal air conditioners, package terminal heat pumps, room air conditioners, and room air-conditioner heat pumps.

§120.2 – Required Controls for Space Conditioning Equipment

- **(c) Hotel/Motel and High-rise Res. Dwelling Unit Thermostats**
  - **Hotel/motel guest room** thermostats must have all the following:
    - Must be an EMCS or setback thermostat.
    - Numeric temperature setpoints in °F and °C
    - Setpoint stops that prevent guest room occupants from adjusting the setpoint more than ±5°F (±3°C)

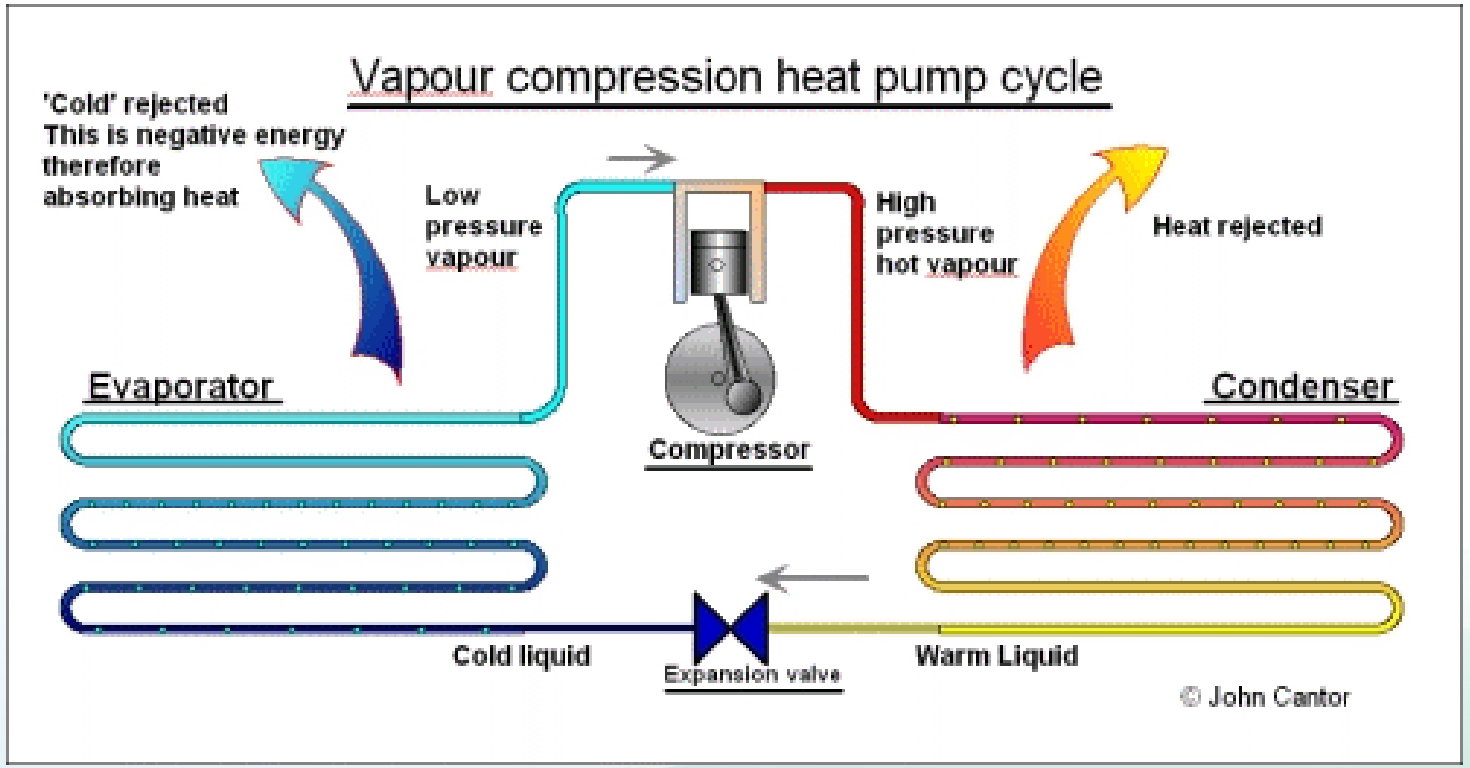
❖ EXCEPTION:

✓ Hotel/Motel guestroom thermostats that are integrated into the room heating and cooling equipment.

  - **High-rise residential** dwelling units must have an OCST or EMCS that allow the occupants to program the setback times and temperatures

§120.2 – Required Controls for Space Conditioning Equipment

- **(d) Heat Pump Controls**
  - All heat pumps with supplementary electric resistance heaters must have controls that comply with Section 110.2(b)



Source: https://heatpumps.co.uk/heat-pumps-types/heat-pump-work/

§120.2 – Required Controls for Space Conditioning Equipment

- **(e)1 Shut-off and Reset Controls**
  - The controls must be able to automatically shut off the system during periods of nonuse and must have **one** of the following:
    - An **occupancy sensor**; or
    - A **4-hour timer** that can be manually operated; or
    - An **automatic time switch control** listed in the Title 20 database (MAEDBS), with an accessible manual override for up to 4 hours

❖ EXCEPTION:

✓ Mechanical systems serving retail stores and associated malls, restaurants, grocery stores, churches, and theaters equipped with 7-day programmable timers.

§120.2 – Required Controls for Space Conditioning Equipment

- **(e)2 Shut-off and Reset Controls – cont.**
  - When turning the system on after a shutdown, controls must automatically restart the system to maintain:
    - A setback heating thermostat setpoint; and
    - A setup cooling thermostat setpoint

❖ EXCEPTIONS:

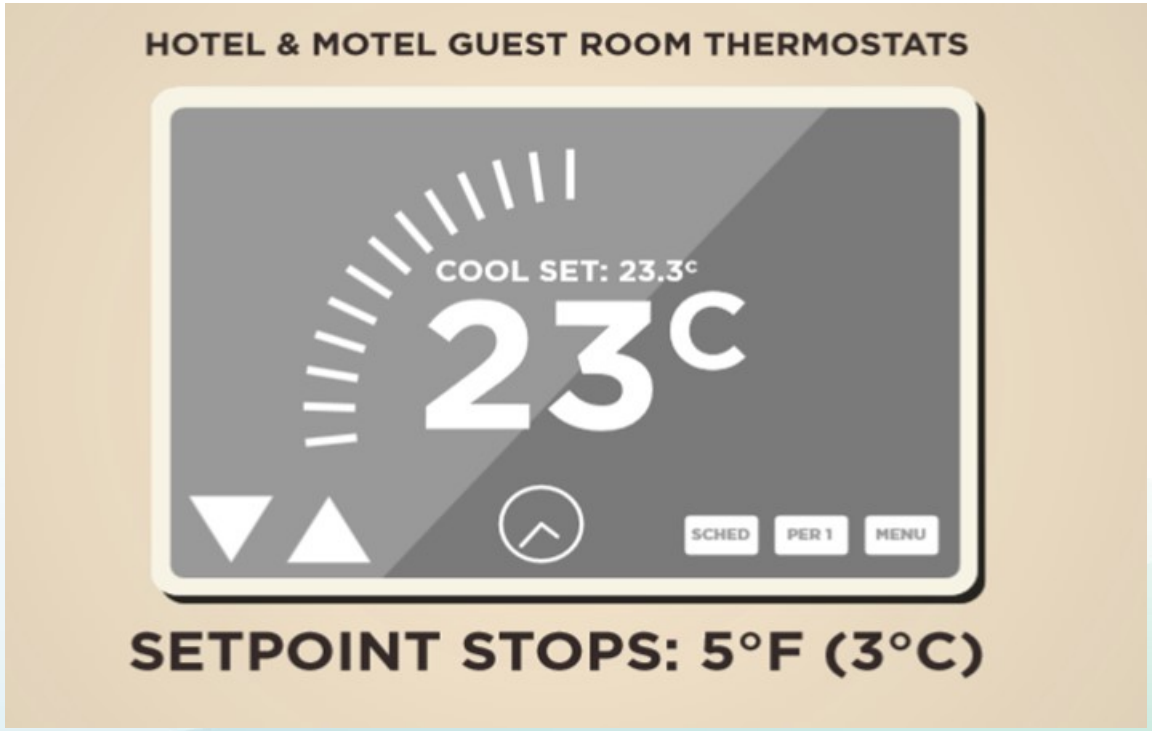
- ✓ Not required for cooling where the Summer Design Dry Bulb 0.5 percent temperature per JA2 is less than 100°F.
- ✓ Not required for heating where the Winter Median of Extremes outdoor air temperature per JA2 is greater than 32°F.

§120.2 – Required Controls for Space Conditioning Equipment

- **(e)3 Shut-off and Reset Controls – cont.**
  - Occupancy sensors are mandatory for HVAC control when:
    - Required for lighting in §130.1(c)5, 6, or 7; and
    - Where Table 120.1-A allows the occupancy category ventilation to be reduced to zero
  - After 5 minutes in occupied standby mode, the temperature must be reset
  - For multiple zone systems with (DDC) to the zone, setup and setback temperatures by 0.5°F or more
  - During occupied-standby mode, all air must be turned off if zone temperature is between setpoints

§120.2 – Required Controls for Space Conditioning Equipment

- **(e)4 Shut-off and Reset Controls – cont.**
  - **Hotel and motel guest rooms** must have captive card key, occupancy sensing, or automatic controls that adjust setpoints by 5°F, within 30 minutes after vacancy



§120.2 – Required Controls for Space Conditioning Equipment

- **(f) Dampers for Air Supply and Exhaust Equipment**
  - Outdoor air supply and exhaust equipment must have **dampers that automatically close** upon fan shutdown

❖EXCEPTIONS:

- ✓ When the equipment serves an area that must operate continuously.
- ✓ When it is a gravity type or other nonelectrical equipment with readily accessible manual damper controls.
- ✓ At combustion air intake and shaft vents.
- ✓ When it is prohibited by other provisions of law.

Source: https://www.indiamart.com/proddetail/motorized-fire-damper-15802631197.html

§120.2 – Required Controls for Space Conditioning Equipment

- **(g) Isolation Area Devices**
  - Each zone, or any combination of zones not exceeding 25,000 ft^2, is considered a separate isolation area
  - Each isolation area must have isolation devices, such as valves or dampers that control heating or cooling independently of other isolation areas
  - Each isolation area must have shut-off and reset controls such as an automatic time switch, occupancy sensor, or a 4 hour manual timer

❖EXCEPTION:

✓ Zones designed to be conditioned continuously.

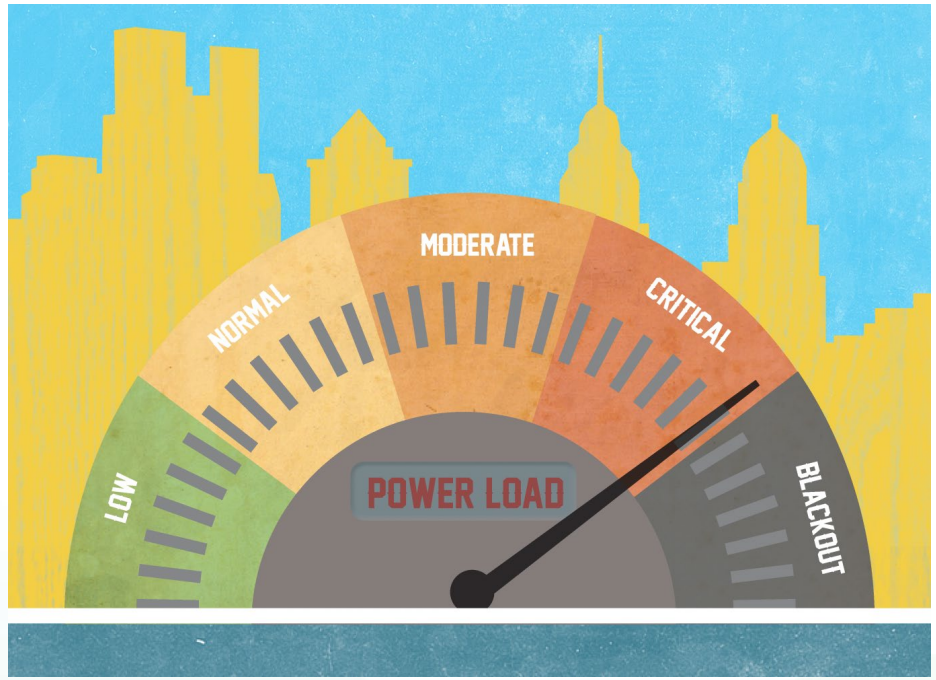
Code Quiz:

1. **A 100,000 ft^2 building needs to have 80,000 ft^2 continuously conditioned. How many isolation zones are required?**
   a) One
   b) Two
   c) Three
   d) Four

2. **When are Occupancy Sensors required?**
   a) When required for space conditioning control.
   b) When required for lighting control.
   c) When Table 120.1-A allows the occupancy of the space to go to zero in occupied standby mode.
   d) All of the above.

§120.2 – Required Controls for Space Conditioning Equipment

- **(h) Automatic Demand Shed Controls**
  - All HVAC systems must comply with the applicable demand responsive control requirements of Section 110.12
    - Certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN); or
    - Certified as capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node
  - Does not have to be implemented but the controls must have these capabilities



§120.2 – Required Controls for Space Conditioning Equipment

- **(i) Economizer Fault Detection and Diagnostics (FDD)**
  - Economizer FDD is required for all newly installed air handlers with the following:
    - Cooling capacity greater than 54,000 Btu/hr; and
    - An air economizer
  - Temperature sensors must be permanently installed to monitor:
    - Outside air
    - Supply air
    - Return air
  - Temperature sensors must have an accuracy of ±2°F in the range of 40°F to 80°F.
  - The controller must be capable of displaying the value of **each** sensor

§120.2 – Required Controls for Space Conditioning Equipment

- **(i) Economizer Fault Detection and Diagnostics (FDD) – cont.**
  - The controller must provide system status by indicating the following conditions:
    - Free cooling available;
    - Economizer enabled;
    - Compressor enabled;
    - Heating enabled, if the system is capable of heating; **and**
    - Mixed air low limit cycle active
  - The **unit** controller must allow **manual initiation** of each operating mode so that the **operation** of cooling system, economizers, fans, and heating systems can be **independently** tested and verified

§120.2 – Required Controls for Space Conditioning Equipment

- **(i) Economizer Fault Detection and Diagnostics (FDD) – cont.**
  - Faults must be reported in **one** of the following ways:
    - Reported to an EMCS that is monitored by facility personnel
    - Reported to a fault management application which automatically provides notification of the fault to a remote HVAC service provider
    - Display the fault on one or more zone thermostats, or a device or sign within five (5) feet of zone thermostat(s), clearly visible, and meeting the following requirements:
      - Display instructions to contact appropriate building personnel or an HVAC technician; and
      - In buildings with multiple tenants, the display must either be within the property management offices or in a common space accessible to the facilities manager

§120.2 – Required Controls for Space Conditioning Equipment

- **(i) Economizer Fault Detection and Diagnostics (FDD) – cont.**
  - The FDD system must detect the following faults:
    - Air temperature sensor failure/fault;
    - Not economizing when it should be;
    - Economizing when it should not be;
    - Damper not modulating; and
    - Excess outdoor air

  - The FDD systems must be **certified** to the Energy Commission as meeting all of these requirements

❖EXCEPTION to FDD:

✓ FDD algorithms based in Direct Digital Control systems are not required to be certified to the Energy Commission.

§120.2 – Required Controls for Space Conditioning Equipment

- **(j) Direct Digital Controls (DDC)**
  - DDC must be provided as specified in Table 120.2-A.

BUILDING STATUS	APPLICATIONS	QUALIFICATIONS
Newly Constructed Buildings	Air-handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
Newly Constructed Buildings	Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h (87.9 kW) and larger
Newly Constructed Buildings	Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	Zone terminal unit such as VAV box	Where existing zones served by the same air-handling, chilled water, or hot water systems that have DDC
Additions or Alterations	Air-handling system or fan coil	Where existing air-handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC
Additions or Alterations	New air-handling system and all new zones served by the system	Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new
Additions or Alterations	New or upgraded chilled water plant	Where all chillers are new and plant design cooling capacity is 300 kBtu/h (87.9 kW) and larger
Additions or Alterations	New or upgraded hot water plant	Where all boilers are new and plant design heating capacity is 300 kBtu/h (87.9 kW) and larger

§120.2 – Required Controls for Space Conditioning Equipment

- **(j) Direct Digital Controls (DDC) – cont.**
  - The DDC system must meet control logic requirements for ventilation in 120.1(d) and demand shed requirements in 120.2(h), and the following:
    - **Monitoring zone and system demand** for fan pressure, pump pressure, heating and cooling;
    - **Transferring demand information** from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;
    - Automatically **detecting** the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;
    - Allow for **operator removal** of zones(s) from the reset algorithm;
    - For new buildings, **trending and graphical displaying** of input and output points

§120.2 – Required Controls for Space Conditioning Equipment

- **(k) Optimum Start/Stop Controls**
  - Space conditioning systems with **DDC to the zone** level must have optimum start/stop controls
  - The control algorithm must, **as a minimum**, be a function of the difference between occupied space temperature setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy
  - Mass radiant floor slab systems must also incorporate **floor temperature** into the optimum start algorithm

❖EXCEPTION:

✓ Systems that must operate continuously.

Code Quiz:

1. **Economizer FDD is required for all newly installed air-cooled packaged direct-expansion units?**

   a) True

   b) False

   ❖Required only if it has an economizer and the air handler cooling is greater than 54,000 BTU/h (4.5 tons).

2. **Automatic demand shed controls per §110.12 are only required for systems with DDC to the zone.**

   a) True

   b) False

§120.2 – Required Controls for Space Conditioning Equipment

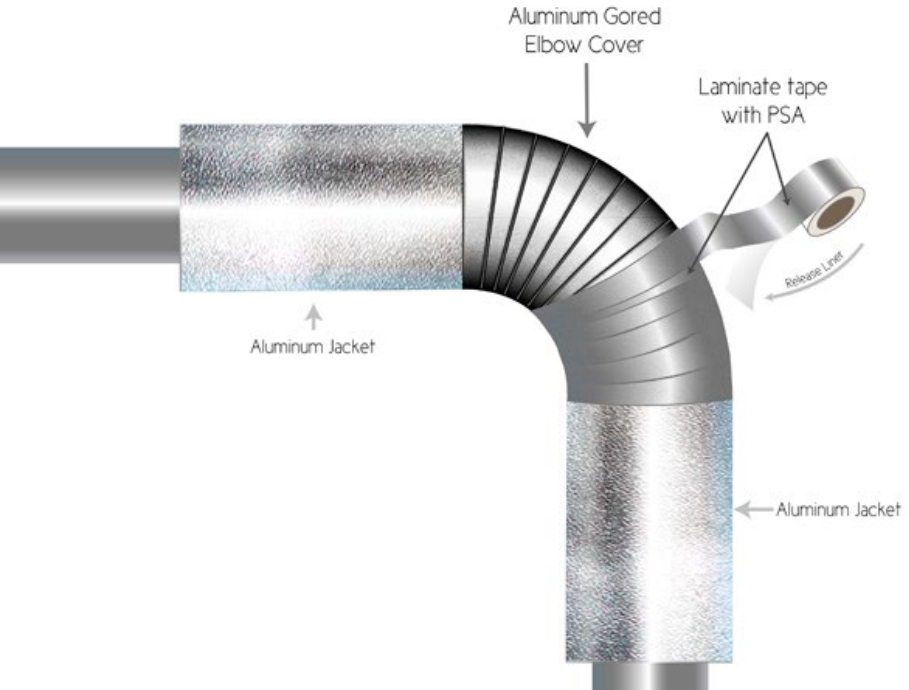
- **Takeaways for Required Controls**
  - **High-rise Residential dwellings** must have:
    - Setback capabilities
    - Must be an EMCS or JA5 OCST with demand shed controls per §110.12
  - **Hotel/Motel guest rooms** must have the following controls:
    - EMCS with setback capabilities, DDC with setback capabilities, or a setback thermostat, unless the thermostat is integrated into the room unit
    - Allow guests to adjust setpoint no more than ±5°F
    - Captive card or occupancy sensing that automatically adjusts setpoint 5°F within 30 minutes of vacancy

§120.2 – Required Controls for Space Conditioning Equipment

- **Takeaways for Required Controls – cont.**
  - **Nonresidential** systems must have the following controls:
    - Each zone must have a JA5 certified OCST or DDC to the zone with demand shed controls per §110.12
    - DDC to the zone controls are required on systems 300 kBtu/h and larger
    - Systems with DDC to the zone are required to have Demand Shed capabilities
    - Controls to automatically shut off the system during periods of non-use
    - Controls must restart the system to normal operations after shut down
    - Occupancy sensors if required for lighting and Note F in Table 120.1-A
    - Air supply and exhaust equipment need dampers
    - Isolation area devices are required on spaces larger than 25,000 ft^2
    - On systems larger than 54,000 Btu/hr, economizers are required to have FDD

❖ Always check for exceptions

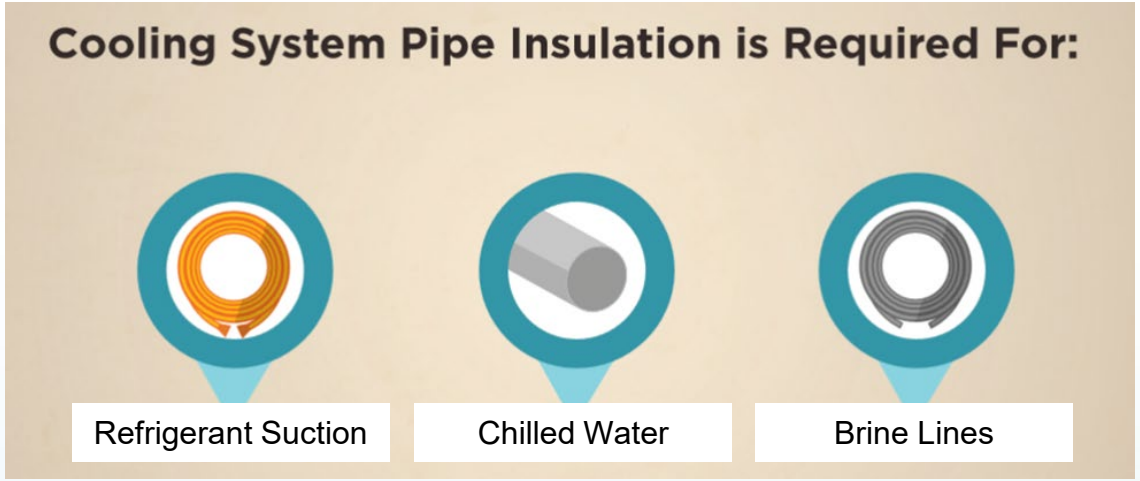
§120.3 – Requirements for Pipe Insulation

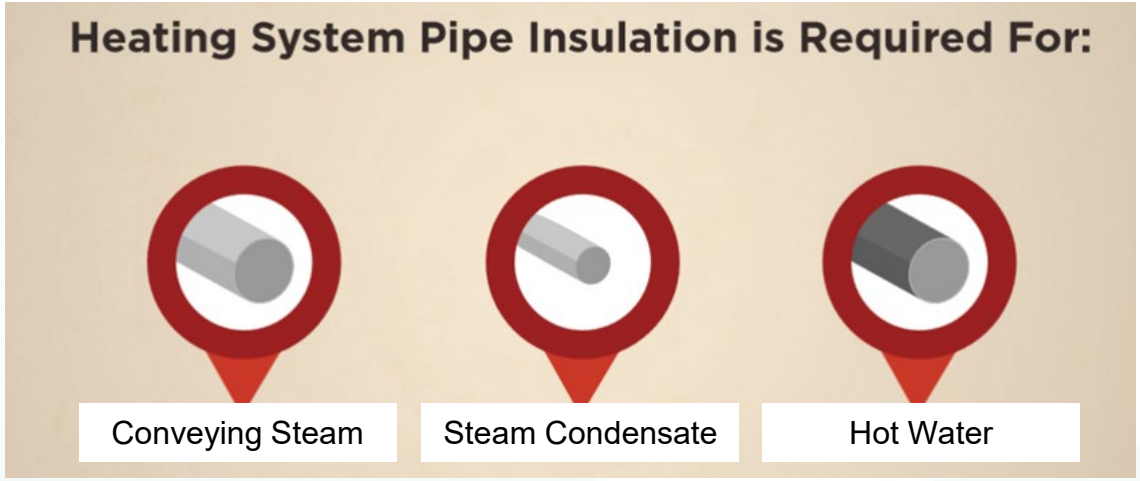


Source: http://www.wisatakuliner.xyz/exterior-pipe-insulation/unique-exterior-pipe-insulation-3-industrial-steam-pipe-insulation/

§120.3 – Requirements for Pipe Insulation

- **General Requirements**
  - Insulation is required on the following:
    - Space cooling refrigerant suction, chilled water and brine lines.
    - Space heating systems steam, steam condensate and hot water lines





  - Insulation thickness 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

§120.3 – Requirements for Pipe Insulation

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

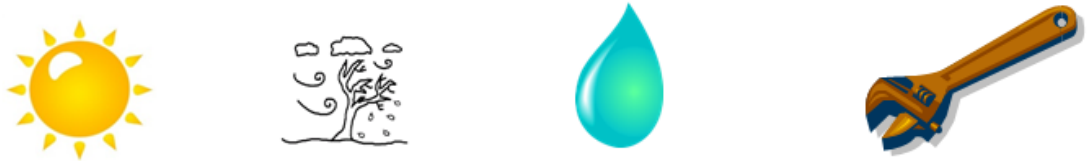
Fluid Operating Temperature Range (°F)	Insulation Conductivity: Conductivity (Btu·in/h·ft²·°F)	Insulation Conductivity: Mean rating Temperature (°F)		Nominal Pipe Diameter (in inches): < 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
Space heating and Service Water Heating Systems (Steam, Steam Condensate, 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.

§120.3 – Requirements for Pipe Insulation

- **Insulation Protection**
  - Insulation must be protected from damage, including that due to sunlight, moisture, equipment maintenance, and wind

▪ Sunlight ▪ Wind ▪ Moisture ▪ Equip. Maint.



  - Insulation exposed to weather must be **water retardant** and provide **shielding from solar radiation** that can cause degradation of the material
  - Insulation covering **chilled water piping and refrigerant suction piping** located outside the conditioned space must have a **Class I or Class II vapor retarder**
  - All penetrations and joints must be sealed
  - Pipe insulation buried below grade must be installed in a water proof and non-crushable casing or sleeve

§120.3 – Requirements for Pipe Insulation

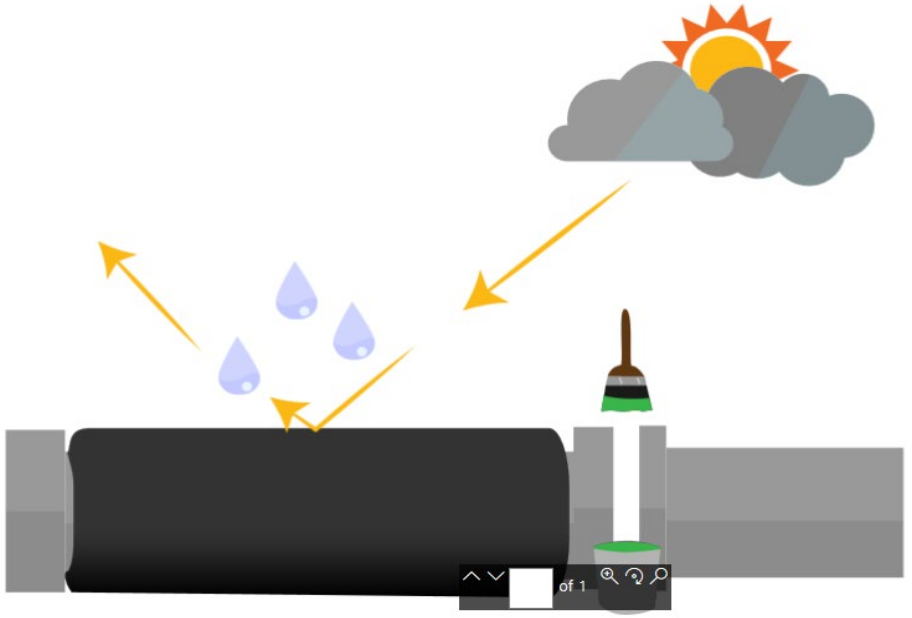
- **Exceptions to §120.3 pipe insulation requirements**

❖EXCEPTIONS:

- ✓ Factory-installed piping within space-conditioning equipment certified under Section 110.1 or 110.2
- ✓ Piping with a design operating temperature range between 60°F and 105°F
- ✓ Where the heat gain or heat loss to or from piping without insulation will not increase building source energy use
- ✓ Piping that penetrates framing members is not be required to have pipe insulation for the distance of the framing penetration. Metal piping that penetrates metal framing must have grommets, plugs, wrapping or other insulation to prevent contact with the metal framing

§120.3 – Requirements for Pipe Insulation

- **Takeaways**
  - Insulation is required on HVAC lines outside the range of 60°F to 105°F
  - Thickness is based on Table 120.3-A or the calculation method shown in §120.3(c)2
  - Outdoor insulation must be protected from the elements



§120.4 - Requirements for Ducts and Plenums

Source: https://www.flickr.com/photos/baillindustrie/4897728891

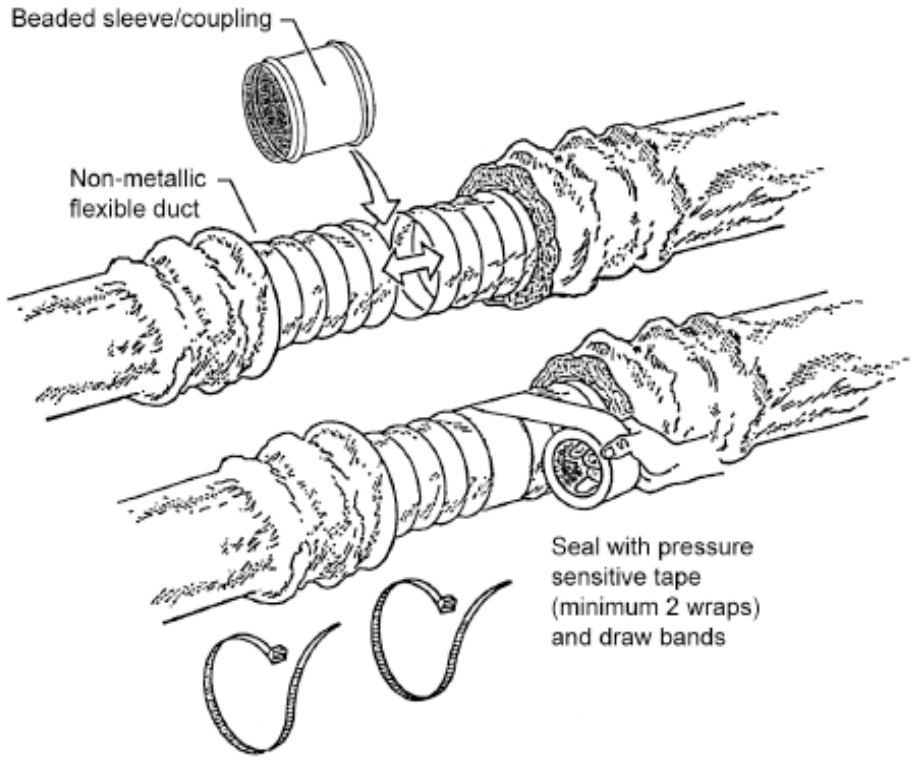
§120.4 - Requirements for Ducts and Plenums

- **Duct Insulation and Sealing**
  - All air distribution systems must be installed, sealed and insulated to meet the requirements of the California Mechanical Code (CMC) and ANSI/SMACNA-006-2006 HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition
  - This includes the following:
    - Ducts
    - Plenums
    - Building cavities
    - Mechanical closets
    - Air-handler boxes
    - Support platforms used as ducts or plenums

Source: https://mehvac-blog.com/is-duct-leakage-testing-really-just-smoke-mirrors/

§120.4 - Requirements for Ducts and Plenums

- **Duct Insulation and Sealing – cont.**
  - Connections of metal ducts and the inner core of flexible ducts must be mechanically fastened
  - Openings must be sealed with mastic, tape, aerosol sealant, or other duct-closure system that meets the requirements of UL 181, 181A, or 181B
  - If mastic or tape is used to seal openings greater than 1/4 inch, the combination of mastic and either mesh or tape must be used

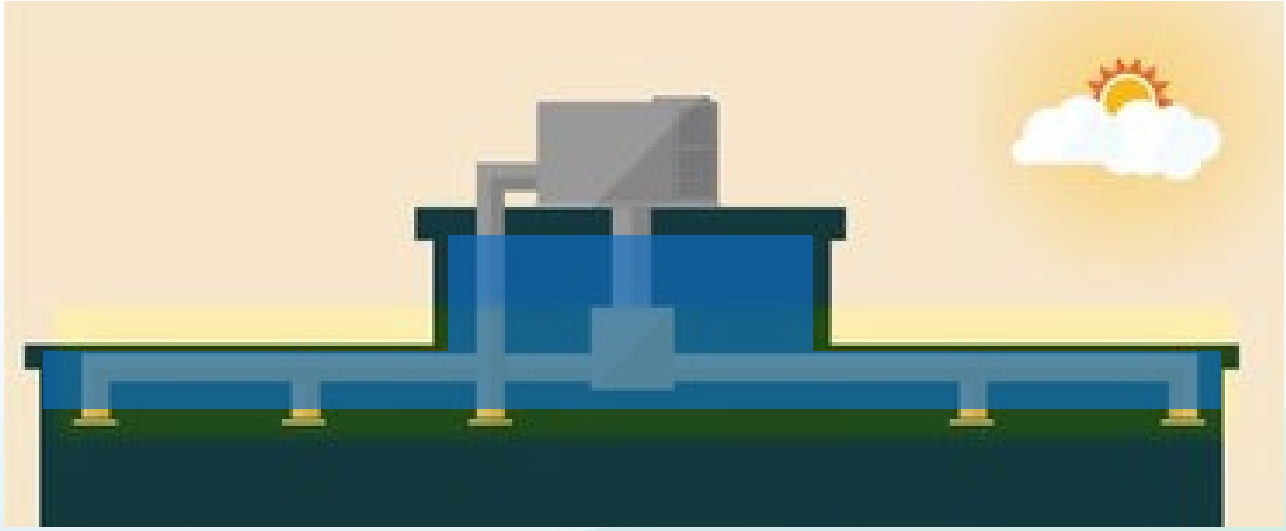


§120.4 - Requirements for Ducts and Plenums

- **Duct Insulation and Sealing – cont.**
  - Supply and return ducts located in the following spaces must be insulated to a minimum of R-8:
    - Outdoors
    - In a space between the roof and an insulated ceiling
    - Directly under a roof with fixed vents or openings to the outside or unconditioned spaces
    - In an unconditioned crawlspace
    - In other unconditioned spaces
  - Parts of the supply ducts not located in one of these spaces, including buried in concrete slab, must be insulated to a minimum of R-4.2
  - Parts of the supply ducts enclosed inside directly conditioned spaces do not need to be insulated

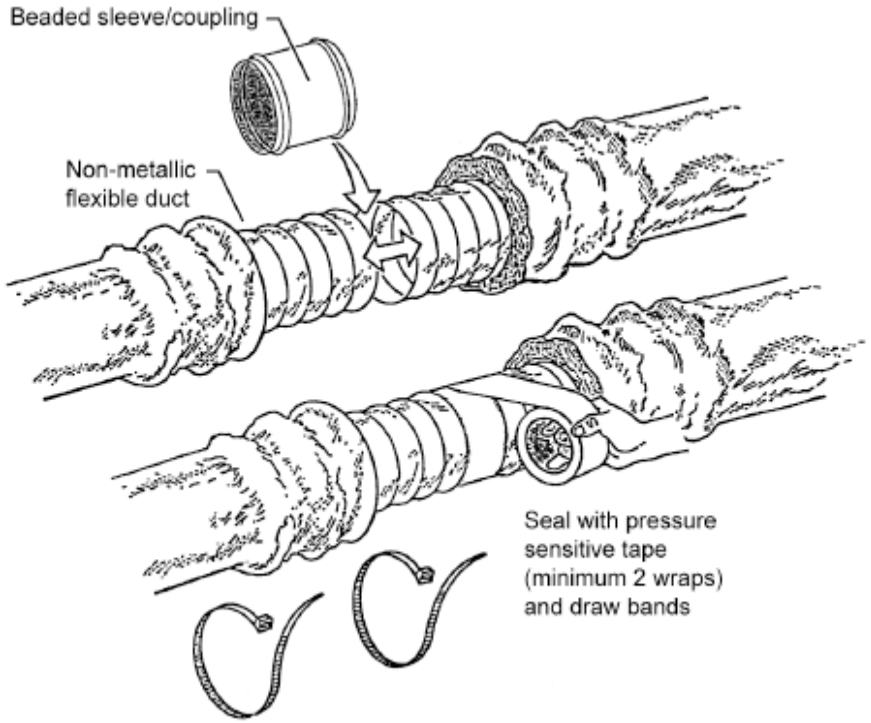
Code Quiz:

1. **If the ducts are located in a mezzanine, what insulation level is required?**
   a) R-8
   b) R4.2
   c) None



§120.4 - Requirements for Ducts and Plenums

- **Duct and Plenum Materials**
  - The energy code requires UL and ASTM material performance testing for the following:
    - Factory fabricated ducts
    - Field fabricated ducts
    - Tapes
    - Mastics and Mesh
    - Aerosol sealants
    - Draw bands
    - Insulation R-values
  - See §120.4 for test requirements



§120.4 - Requirements for Ducts and Plenums

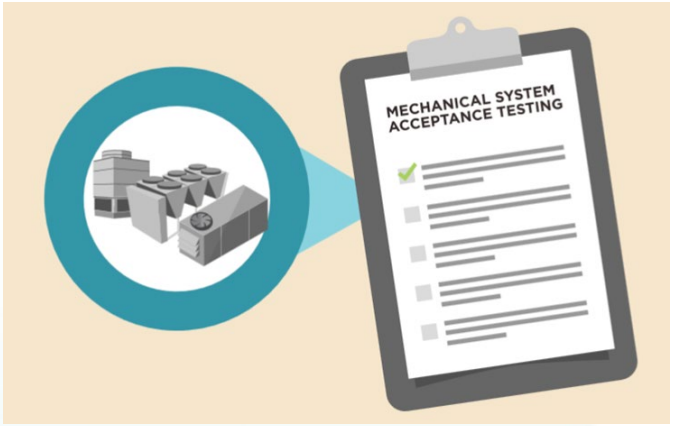
- **Protection of Insulation**
  - Insulation must be protected from sunlight, moisture, equipment maintenance, and wind
  - Insulation exposed to weather must be protected by aluminum, sheet metal, painted canvas, or plastic cover
  - Cellular foam insulation must be protected as above or painted with a coating that is water retardant and provides shielding from solar radiation

▪ Sunlight ▪ Wind ▪ Moisture ▪ Equip. Maint.

§120.4 - Requirements for Ducts and Plenums

- **Takeaways**
  - R-8 insulation in unconditioned spaces and outside
  - Insulation not required inside conditioned space
  - R-4.2 everywhere else
  - Duct and sealing materials must be UL or ASTM tested as applicable
  - Insulation must be protected from the elements

§120.5 – Required Nonresidential Mechanical System Acceptance



§120.5 – Required Mechanical System Acceptance

- Acceptance testing is required for HVAC, indoor/outdoor lighting, site-built fenestration, and covered processes
- Applicable mechanical acceptance tests must be specified on the NRCC-MCH form at permit
- Field technician must report results of acceptance testing on respective NRCA-MCH form at final inspection
- Test procedures are located in Reference Nonresidential Appendix NA7
- Field technicians performing testing for HVAC will need to be a CMATT when thresholds are satisfied
  - For a list of required Acceptance Tests, see §120.5

§120.8 – Nonresidential Building Commissioning

Source: https://thecodecoach.blogspot.com/2016/06/the-5-documents-commissioning-requires.html

§120.8 – Nonresidential Building Commissioning

- **Newly constructed nonresidential buildings and spaces 10,000 ft^2 or more must comply with all sections in §120.8**
  - (b) Owner's or owner representative's project requirements
  - (c) Basis of design
  - (d) Design phase design review
  - (e) Commissioning measures shown in the construction documents
  - (f) Commissioning plan
  - (g) Functional performance testing
  - (h) Documentation and training
  - (i) Commissioning report

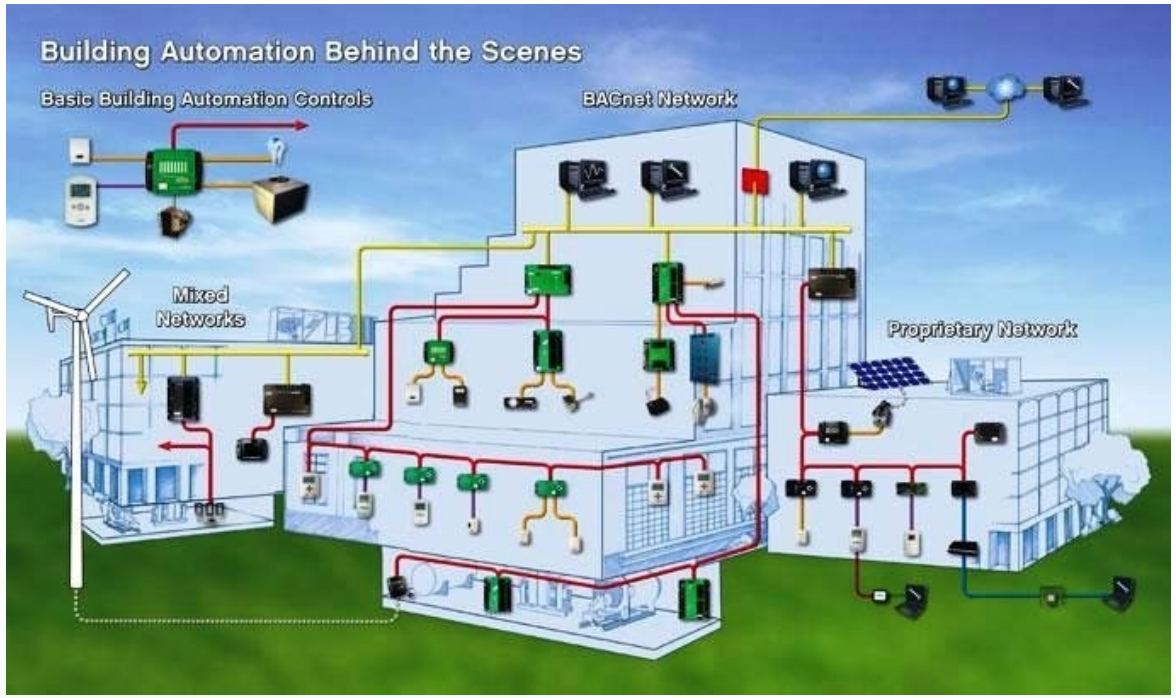
§120.8 – Nonresidential Building Commissioning

- **Buildings <u>less than 10,000 ft²</u> must comply with only the following sections:**
  - (d) Design Phase Design Review
  - (e) Commissioning Measures Shown in the Construction Documents

- **Commissioning requirements also apply to nonresidential spaces within mixed occupancy hotel/motel and high-rise residential buildings based on the square footage of the nonresidential spaces**

§120.8 – Nonresidential Building Commissioning

- **(b) Owner's or Owner Representative's Project Requirements (OPR)**
  - Document showing owners energy efficiency expectations, ventilation requirements, occupancy schedule, equipment expectations…etc.
- **(c) Basis of Design (BOD)**
  - A written explanation of how the system designs meet the OPR
    - HVAC systems and controls
    - Lighting systems and controls
    - Water heating systems and controls
    - Envelope features



Source: https://tops-stars.com/schematic/building-management-system-schematic-diagram/

§120.8 – Nonresidential Building Commissioning

- **(d) Design Phase Design Review**
  - Design Review Kickoff
    - Discuss the project scope, schedule, documentation and coordination of team activities and responsibilities
  - Construction Documents Design Review
    - Reviewer verifies the construction documents meet the design requirements as shown in the NRCC-CXR dynamic compliance form
  - Reviews must be conducted and signed off by licensed professionals as described in §10-103 and summarized as follows:
    - **< 10,000 ft²**: the building design engineer, architect, or contractor
    - **10,000 ft² to 50,000 ft²**: an in-house engineer or architect not associated with the project, or a third party design engineer, architect, or contractor
    - **> 50,000 ft²** : a third party design engineer, architect, or contractor
    - Buildings > **10,000 ft²** with complex mechanical systems: a third party engineer, architect, or contractor

§120.8 – Nonresidential Building Commissioning

- **(e) Commissioning measures shown in the construction documents**
  - Complete descriptions of requirements necessary for commissioning must be included with the construction documents (plans and specifications)
- **(f) Commissioning Plan**
  - The Plan is developed during the design phase, and documents how the project will be commissioned
  - Includes general project information, commissioning goals, systems to be commissioned, and plans for testing systems and components
- **(g) Functional performance testing**
  - Functional performance tests will demonstrate installation and operation of systems per the acceptance test requirements in Sections 120.5

§120.8 – Nonresidential Building Commissioning

- **(h) Documentation and Training**
  - **Systems Manual**. A manual of the operational aspects delivered to the building owner and facilities operator
  - **Systems Operations Training**. Maintenance staff training for each equipment type system must be documented in the commissioning report
- **(i) Commissioning Report**
  - A complete report of the commissioning process activities must be provided to the owner
  - The report documents the commissioning process and test results.
  - The report should include confirmation that commissioned systems meet the conditions of the OPR, BOD, and Contract Documents

Code Quiz:

1. **When is commissioning required?**
   a) Nonresidential buildings and spaces greater than 10,000 ft^2
   b) Nonresidential buildings and spaces less than 10,000 ft^2
   c) Both a) and b)

2. **Who can conduct a design review for a building > 50,000 ft^2?**
   a) A third party engineer, architect, or contractor
   b) In-house engineer or architect not associated with the project
   c) Both a) and b)

Code Quiz:

1. **Which commissioning measures are mandatory for a new, 9,999 sf motel building? Choose all that apply.**
   a) Owner's or owner representative's project requirements
   b) Basis of design
   c) Design phase design review
   d) Commissioning measures shown in the construction documents
   e) Commissioning plan
   f) Functional performance testing
   g) Documentation and training
   h) Commissioning report
   i) None.

Code Quiz:

1. **Which commissioning measures are mandatory for a new, 9,999 sf nonresidential building? Choose all that apply.**
   a) Owner's or owner representative's project requirements
   b) Basis of design
   c) Design phase design review
   d) Commissioning measures shown in the construction documents
   e) Commissioning plan
   f) Functional performance testing
   g) Documentation and training
   h) Commissioning report

§120.8 – Nonresidential Building Commissioning

- **Takeaways**
  - Design Review and Commissioning Measures are required for all new nonresidential buildings or spaces regardless of size
  - OPR, BOD, Commissioning Plan, Systems Manual, Training and Commissioning Report are also required for nonresidential buildings and spaces > 10,000 ft^2
  - Nonresidential spaces of Hotel/Motel and High-rise Residential buildings also require commissioning
  - Commissioning compliance documents must be signed by a licensed engineer, architect or contractor
  - Building size and equipment type (simple or complex) determines who can or must sign off

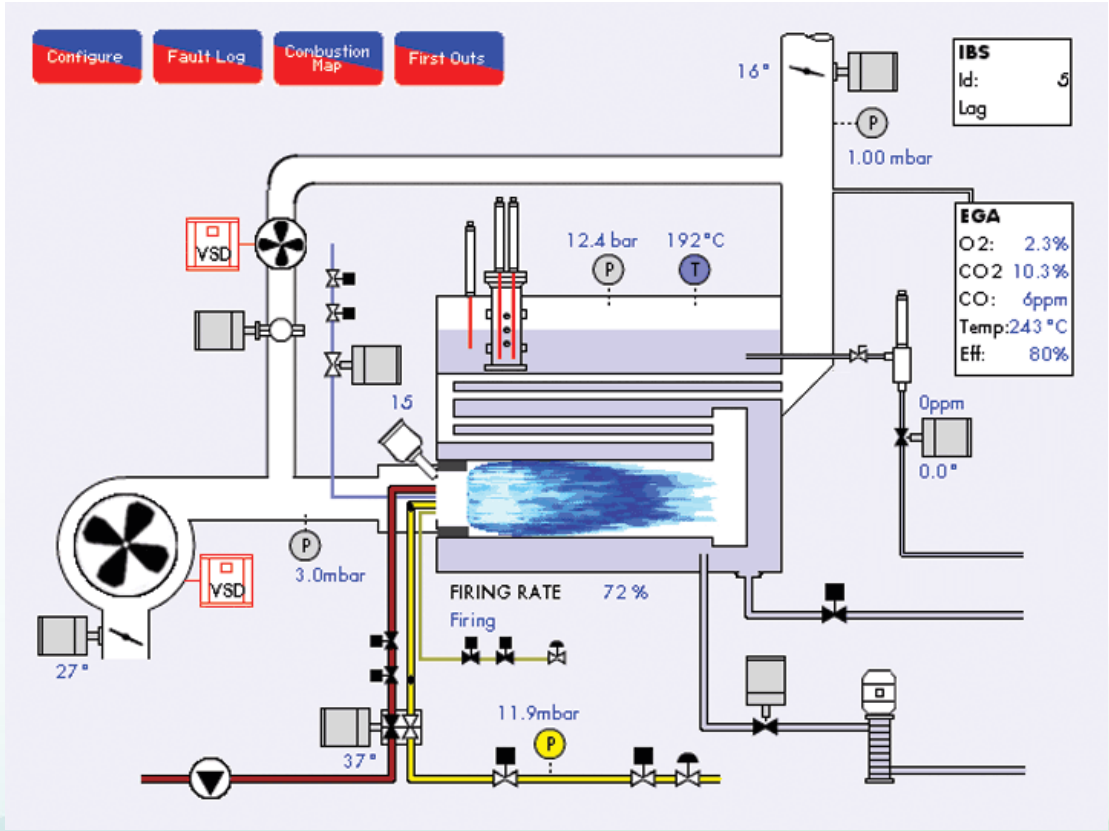
§120.9 – Requirements for Commercial Boilers

Source: http://byworthboilers.dnsupdate.co.uk/boilers-by-sector/boilers-for-laundries/

§120.9 – Requirements for Commercial Boilers

What is a "Commercial Boiler"??

- **Standards §100.1 Definitions:**
  - Commercial Boiler: A type of boiler with a capacity (rated maximum input) of 300,000 Btus per hour (Btu/h) or more and serving a space heating or water heating load in a commercial building



Source: https://www.autoflame.com/mk8_mini/

§120.9 – Requirements for Commercial Boilers

- **Mandatory Requirements for Commercial Boilers**
  - Combustion air positive shut-off is required on all newly installed boilers as follows:
    - All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure
    - Two or more boilers served by one stack with a total combined input of 2.5 MMBtu/h (2,500,000 Btu/h)
  - Combustion air fans motors 10 horsepower or larger must have **one** of the following:
    - Variable speed drive motor; or
    - Controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume

§120.9 – Requirements for Commercial Boilers

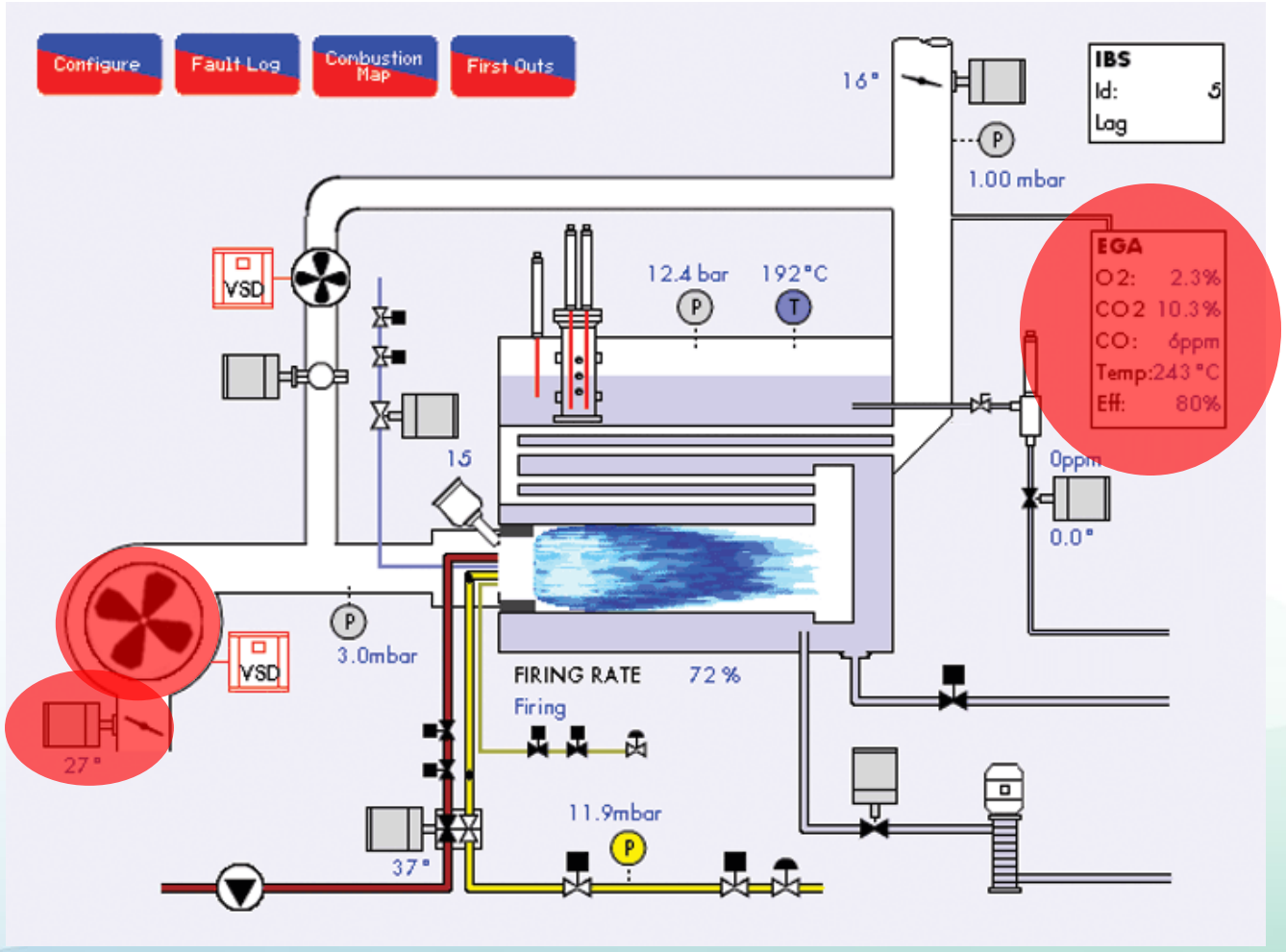
- **Mandatory Requirements for Commercial Boilers**
  - Boilers 5 MMBtu/h (5,000,000 Btu/h) input and greater must control **excess (stack-gas) oxygen** concentrations
    - Must be less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent
    - Combustion air volume must be controlled with respect to firing rate or flue gas oxygen concentration
    - Use of a common gas and combustion air control linkage or jack shaft is prohibited

❖EXCEPTION:

✓ Boilers with steady state full-load thermal efficiency 85 percent or higher are exempt from stack gas requirements

Code Quiz:

1. **Identify the three devices with T24 requirements on this 6 MMBtu/h boiler with a 15 hp combustion air fan.**

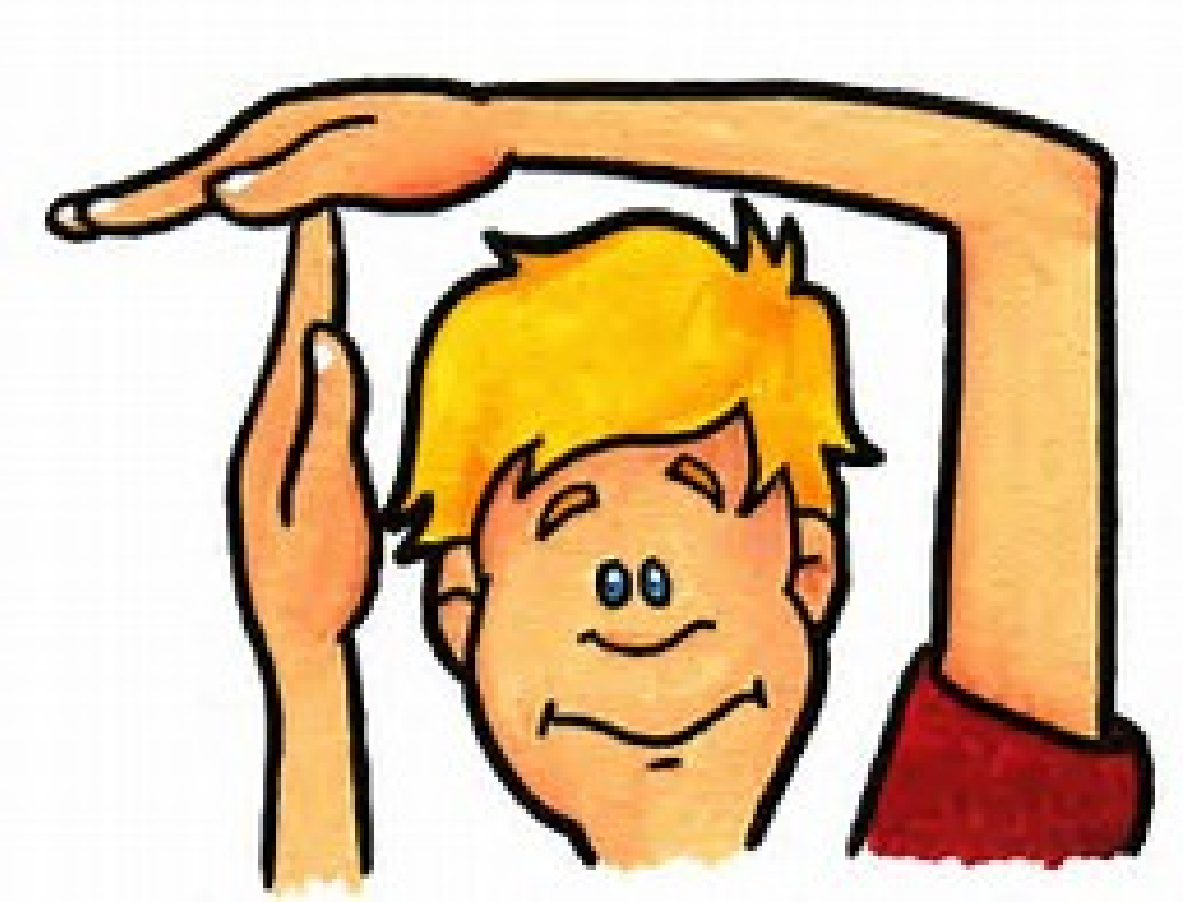


Source: https://www.autoflame.com/mk8_mini/

§120.9 – Requirements for Commercial Boilers

- **Takeaways**
  - Combustion air positive shut-off requirements
  - Combustion air fan motors 10 horsepower or larger must be variable speed or have controls to reduce airflow and power
  - Limits on excess oxygen levels in the exhaust gas
  - These requirements are all mandatory

Time for a Break?



Subchapter 5
Nonresidential, High-Rise Residential, and Hotel/Motel Occupancies—Performance and Prescriptive Compliance Approaches for Achieving Energy Efficiency
(§140.0 -§140.9)

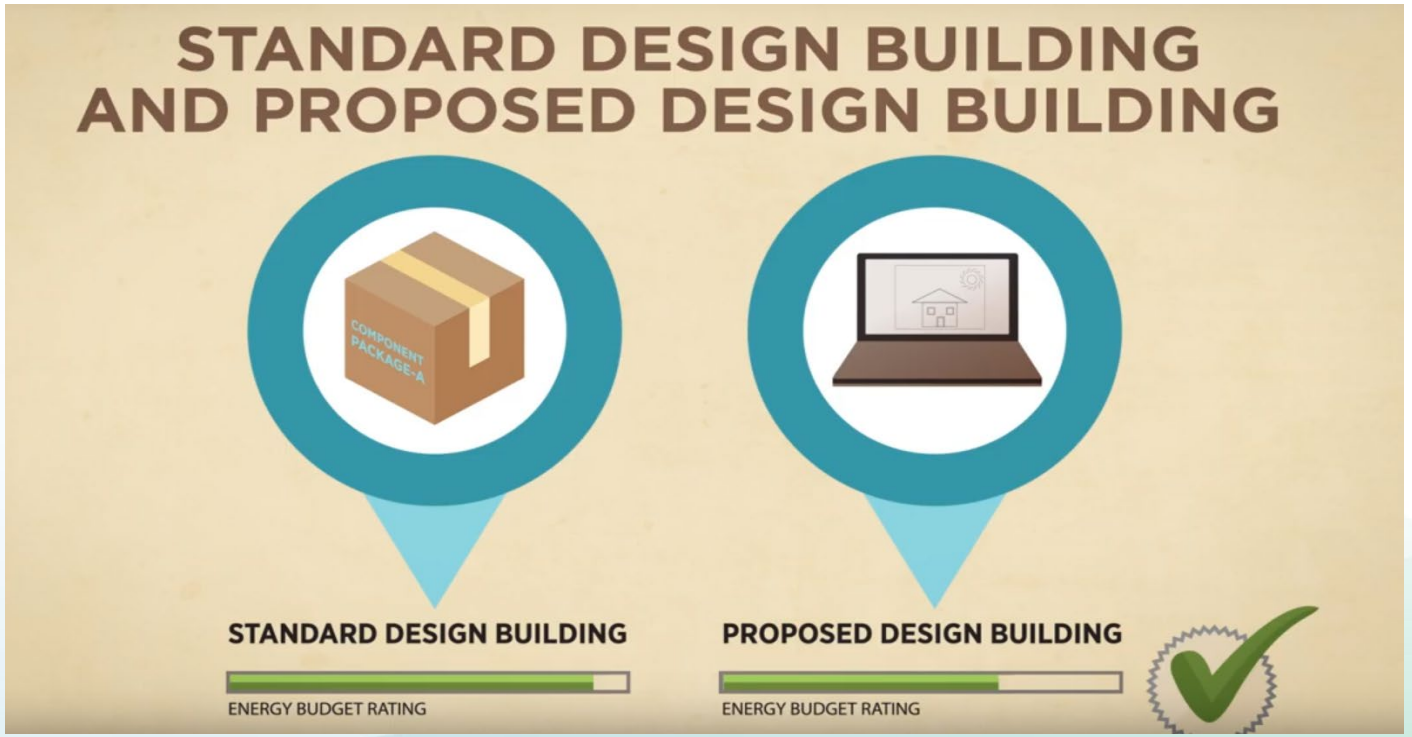
§140. Series: Performance and Prescriptive Compliance

- §140.1 - Performance Approach: Energy Budget
- §140.2 - Prescriptive Approach
- §140.4 - Prescriptive Requirements for Space Conditioning Systems

§140.1 – Performance Approach: Energy Budgets

§140.1 – Performance Approach: Energy Budgets

- A building complies with the performance approach if the energy budget calculated for the Proposed Design Building is no greater than the energy budget calculated for the Standard Design Building



§140.1 – Performance Approach: Energy Budgets

- **Energy Budget for the <u>Proposed Design</u> Building.**
  - The energy budget for a Proposed Design is calculated from the sum of the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, service water heating and covered process loads
- **Energy Budget for the <u>Standard Design</u> Building.**
  - The energy budget for the Standard Design Building is determined by applying the mandatory and prescriptive measures and calculating the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, service water heating, and covered process loads
- **Calculation of <u>Energy Budget</u>.**
  - The TDV energy for both the Standard Design Building and the Proposed Design Building are computed by Compliance Software certified for this use by the Commission. The processes for Compliance Software approval by the Commission are documented in the **ACM Approval Manual**

§140.4 – Prescriptive Requirements for Space Conditioning Systems

§140.4 – Prescriptive Requirements for HVAC

- **§140.4 covers the following prescriptive topics:**
  - Sizing and Equipment Selection
  - Calculations
  - Power Consumption of Fans
  - Space-conditioning Zone Controls
  - Economizers
  - Supply Air Temperature Reset Controls
  - Electric Resistance Heating
  - Heat Rejection Systems
  - Minimum Chiller Efficiency
  - Limitation of Air-Cooled Chillers
  - Hydronic System Measures
  - Air Distribution System Duct Leakage Sealing
  - Fan Control
  - Mechanical System Shut-off
  - Exhaust System Transfer Air

§140.4 – Prescriptive Requirements for HVAC

- **(a) Sizing and Equipment Selection**
  - Heating and cooling equipment must be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building

❖ EXCEPTIONS:

- ✓ Where it can be demonstrated to the satisfaction of the enforcing agency that oversizing will not increase building TDV energy use
- ✓ Standby equipment with controls that allow the standby equipment to operate only when the primary equipment is not operating
- ✓ Multiple units of the same equipment type, such as multiple chillers and boilers, having combined capacities exceeding the design load, if they have controls that sequence or otherwise optimally control the operation of each unit based on load

§140.4 – Prescriptive Requirements for HVAC

- **(b) Calculations**
  - Heating and cooling **design loads** must be determined in accordance with the ASHRAE Handbook, Fundamentals Volume, or as specified in a method approved by the Commission
  - Other calculation methods such as ACCA, SMACNA, etc., are acceptable because they are based on ASHRAE
  - **Indoor** design conditions must be determined in accordance with ASHRAE Standard 55 or ASHRAE Handbook, Fundamentals Volume
  - **Outdoor** design conditions must be selected from Reference Joint Appendix JA2, which is based on climate data from ASHRAE
  - Healthcare facility loads must be determined by the method and conditions described in the California Mechanical Code

§140.4 – Prescriptive Requirements for HVAC

- **(b) Calculations – cont**

  - Load calculations should include the following:
    - Outdoor air ventilation
    - Envelope thermal conductance and air leakage
    - Solar heat gain
    - Shading such as overhangs
    - People loads based on occupant density
    - Process loads
    - Lighting loads
    - Any anticipated miscellaneous loads
  - Internal heat gains can be ignored for heating calcs

§140.4 – Prescriptive Requirements for HVAC

- **(b) Calculations – cont.**
  - **Safety factor**. Design loads may be increased by up to 10 percent to account for unexpected loads or changes in space usage.
  - **Other loads**.
    - Loads such as warm-up or cool-down should be based on the heat capacity of the building and contents, the degree of setback, and desired recovery time
    - They may be assumed to be up to 30 percent for heating and 10 percent for cooling on top of the 10 percent safety actor.

Total Safety Factor

Cooling: 1.1 x 1.1 = 1.21 ➡ 21%

Heating: 1.1 x 1.3 = 1.43 ➡ 43%

§140.4 – Prescriptive Requirements for HVAC

- **(c) Fan Systems**
  - Fan power limits for fan systems with a total nameplate horsepower of 5 hp or more
    - 2 options for determining allowable fan power are calculated from the equations in Table 140.4-A with data from Table 140.4-B (on next slide).
      - Option 1: allowable system motor nameplate hp calculation
      - Option 2: allowable fan system bhp calculation

§140.4 – Prescriptive Requirements for HVAC

TABLE 140.4 - A Fan Power Limitation

	Limit	Constant Volume	Variable Volume
Option 1: Fan system motor nameplate hp	Allowable motor nameplate hp	hp ≤ cfm_s × 0.0011	hp ≤ cfm_s × 0.0015
Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ cfm_s × 0.00094 + A	bhp ≤ cfm_s × 0.0013 + A

[1] cfm_s = maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute
hp = maximum combined motor nameplate horsepower for all fans in the system
bhp = maximum combined fan-brake horsepower for all fans in the system
A = sum of (PD × cfm_D/4131)
PD = each applicable pressure drop adjustment from Table 140.4 – B, in inches of water
cfm_D = the design airflow through each applicable device from Table 140.4 – B, in cubic feet per minute

TABLE 140.4-B – Fan Power Limitation Pressure Drop Adjustment

Device	Adjustment Credits
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.5 in. of water
Return and/or exhaust airflow control devices	0.5 in. of water
Exhaust filters, scrubbers, or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2 × clean filter pressure drop at fan system design condition
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition
Biosafety cabinet	Pressure drop of device at fan system design condition
Energy recovery device, other than coil runaround loop	For each airstream [(2.2 × Energy Recovery Effectiveness) – 0.5] in. of water
Coil runaround loop	0.6 in. of water for each airstream
Exhaust systems serving fume hoods	0.35 in. of water

§140.4 – Prescriptive Requirements for HVAC

- **(c) Fan Systems – cont.**
  - Variable air volume (VAV) systems.
    - Static pressure sensors location requirements for optimal operation
    - Static pressure setpoint reset based on the zone requiring the most pressure for DDC systems

Source: By PictorialEvidence - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=15795962

§140.4 – Prescriptive Requirements for HVAC

- **(c) Fan Systems – cont.**
  - Fractional HVAC fan motors have individual efficiency requirements
    - HVAC motors for fans that are < 1 hp and ≥ 1/12 hp must be electronically commutated motors (ECM) or have a minimum motor efficiency of 70 percent
    - These motors must also be capable of speed adjustment

❖EXCEPTIONS:

- ✓ Motors in fan-coils and terminal units that operate only when providing heating to the space served
- ✓ Motors in space conditioning equipment certified under Section 110.1 or 110.2

§140.4 – Prescriptive Requirements for HVAC

- **(m) Fan Control**
  - Each **cooling system** listed in TABLE 140.4-G must vary the indoor fan airflow as a function of load
  - These systems must have least 2 speed fan control

TABLE 140.4-G FAN CONTROL SYSTEMS

Cooling System Type	Fan Motor Size	Cooling Capacity
DX Cooling	any	≥ 65,000 Btu/hr
Chilled Water and Evaporative	≥ 1/4 HP	any

Code Quiz:

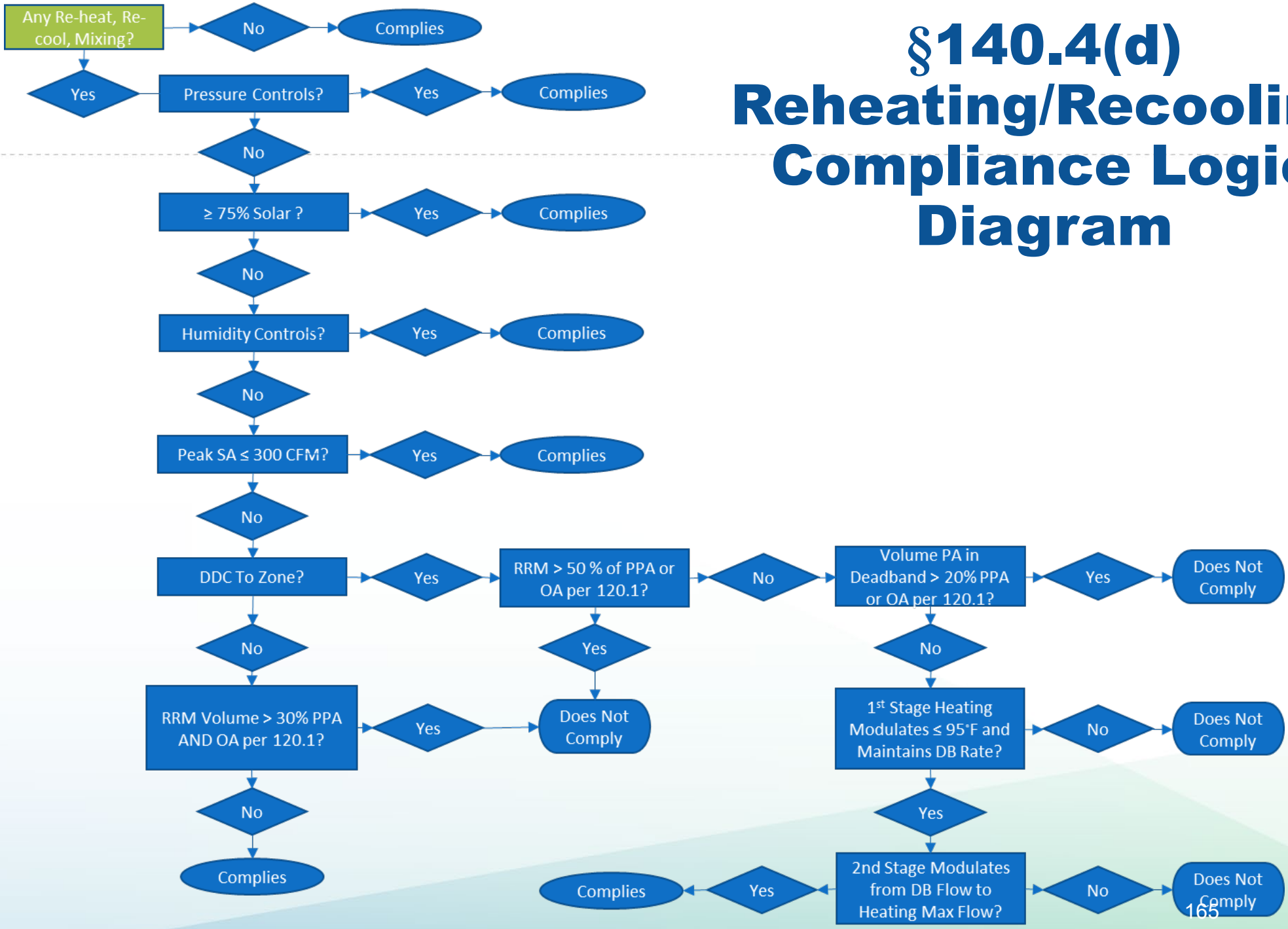
1. **Load calculations are based on which of the following?**
   a) ACCA
   b) ASHRAE
   c) SMACNA
   d) All of the above
2. **What is the fan system total nameplate horsepower that triggers horsepower limitations?**
   a) 5
   b) 10
   c) 25
   d) Any hp
3. **Which system(s) require(s) a 2 speed motor?**
   a) DX system ≥ 65,000 Btu/hr
   b) Chilled water system ≥ ¼ hp
   c) Evaporative ≥ ¼ hp
   d) a) and b)
   e) a), b), and c)

§140.4 – Prescriptive Requirements for HVAC

- **(d) Space-conditioning Zone Controls**
  - Each zone must have controls preventing **reheating, recooling, or simultaneous heating and cooling** to the same zone
  - There are allowances for systems with and without DDC for how much volume of primary air that can be reheated, re-cooled, or mixed air supply

❖ EXCEPTIONS:
- ✓ Zones with special pressurization relationships or cross-contamination control needs
- ✓ Zones with systems in which at least 75 percent of the energy for reheating, or warm air in mixing systems, is from a site-recovered or site solar energy source
- ✓ Zones where specific humidity levels are required
- ✓ Zones with a peak supply-air quantity of 300 cfm or less
- ✓ Healthcare facilities

§140.4(d) Reheating/Recooling Compliance Logic Diagram



§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers**
  - Cooling air handlers over 54,000 Btu/hr or chilled water systems without a fan and with capacities listed in Table 140.4-C must have either:
    - A modulating air economizer capable of supplying 100 percent of the design supply cooling air as outside-air; or
    - A water economizer providing 100 percent of the cooling load at outside air temperatures of 50°F dry-bulb and 45°F wet-bulb and below

TABLE 140.4-C CHILLED WATER SYSTEM COOLING CAPACITY

Climate Zones	Total Building Chilled Water System Capacity, Minus Capacity of the Cooling units with Air Economizers	
	Building Water-Cooled Chilled Water System	Air-Cooled Chilled Water Systems or District Chilled Water Systems
15	≥ 960,000 Btu/h (280 kW)	≥ 1,250,000 Btu/h (365 kW)
1-14	≥ 720,000 Btu/h (210 kW)	≥ 940,000 Btu/h (275 kW)
16	≥ 1,320,000 Btu/h (385 kW)	≥ 1,720,000 Btu/h (505 kW)

§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers – cont.**
  - If an air economizer is installed to meet the prescriptive requirement, it must have controls that:
    - Prevent an increase in the building heating energy use during normal operation

      ❖EXCEPTION:
      - ✓ Systems that provide 75 percent of the annual energy used for mechanical heating from site-recovered energy or a site-solar energy source may increase building energy use.

    - Must provide partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load

§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers – cont.**
  - Air economizers must be a type listed in TABLE 140.4-E with **high limit shut off** shown

TABLE 140.4-E AIR ECONOMIZER HIGH LIMIT SHUT OFF CONTROL REQUIREMENTS

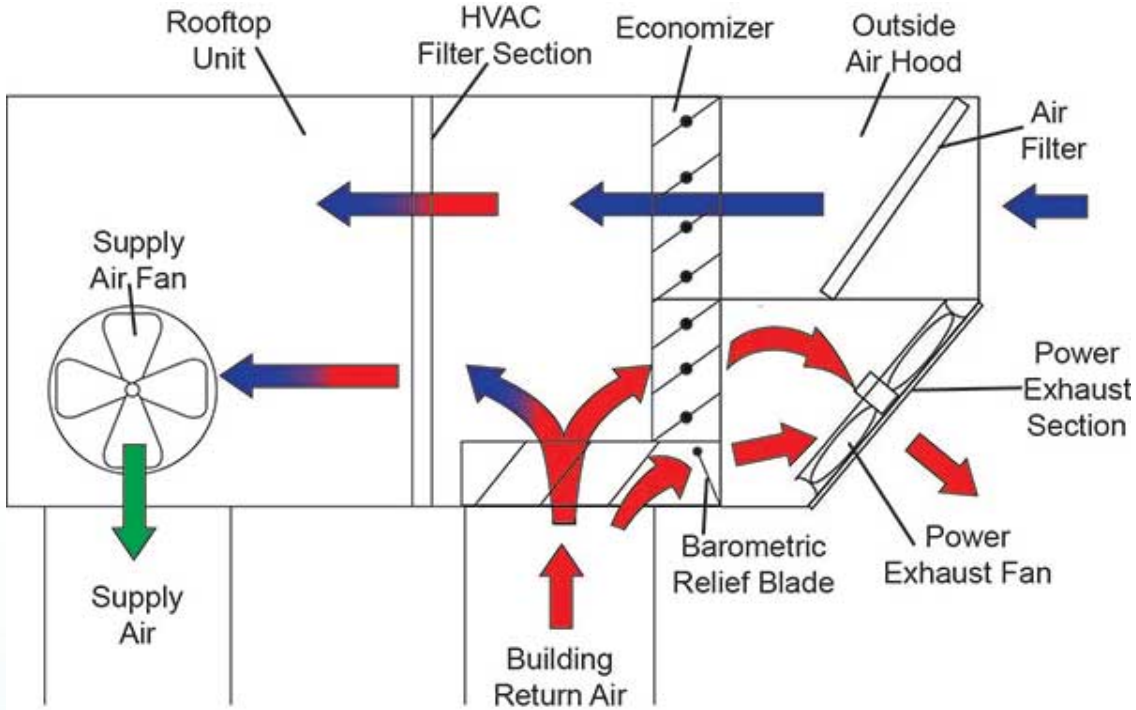
Device Type[a]	Climate Zones	Required High Limit (Economizer Off When):	
		Equation[b]	Description
Fixed Dry Bulb	1, 3, 5, 11-16	T_{OA} > 75°F	Outdoor air temperature exceeds 75°F
	2, 4, 10	T_{OA} > 73°F	Outdoor air temperature exceeds 73°F
	6, 8, 9	T_{OA} > 71°F	Outdoor air temperature exceeds 71°F
	7	TOA > 69°F	Outdoor air temperature exceeds 69°F
Differential Dry Bulb	1, 3, 5, 11-16	T_{OA} > T_{RA}°F	Outdoor air temperature exceeds return air temperature
	2, 4, 10	T_{OA} > T_{RA}-2°F	Outdoor air temperature exceeds return air temperature minus 2°F
	6, 8, 9	T_{OA} > T_{RA}-4°F	Outdoor air temperature exceeds return air temperature minus 4°F
	7	T_{OA} > T_{RA}-6°F	Outdoor air temperature exceeds return air temperature minus 6°F
Fixed Enthalpy[c] + Fixed Drybulb	All	h_{OA} > 28 Btu/lb[c] or T_{OA} > 75°F	Outdoor air enthalpy exceeds 28 Btu/lb of dry air[c] or Outdoor air temperature exceeds 75°F

§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers – cont.**
  - Air economizer air damper requirements:
    - **Warranty:** 5-year Manufacturer warranty of economizer assembly
    - **Damper reliability testing:** Suppliers must certify that dampers and actuators operate at rated system airflow and pressure for 60,000 cycles
    - **Damper leakage:** Outdoor and return dampers must be tested to leak ≤ 10 cfm/sf at 1.0 in. w.g., and **certified to the Commission** per Section 110.0
    - **Adjustable setpoint:** If the high-limit control is fixed dry-bulb or fixed enthalpy + fixed dry-bulb then the control must have an adjustable setpoint
    - **Relief air system**. Relief air systems must allow 100 percent outside air without over-pressurizing the building
    - **Sensors must be calibrated**

§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers – cont.**
  - Acceptance tested per §120.5(a)4 or certified to the Commission by the manufacturer
  - Space conditioning systems controls:
    - **Capacity controls** interlocked with economizer allowing 100 percent open and does not start closing until the leaving air is less than 45°F
    - Direct Expansion **(DX) units** > 65,000 Btu/hr controlling cooling **based on the occupied space temperature** must have a **minimum of 2 stages** of mechanical cooling.



Source: MicroMetl.com

§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers – cont.**
  - Space conditioning systems controls – cont.:
    - All other DX units must comply with the following:
      - Have controls that do not false load the mechanical cooling system by limiting or disabling the economizer or by any other means except at the lowest stage of mechanical cooling capacity
      - Comply with the requirements in TABLE 140.4-F

TABLE 140.4-F DIRECT EXPANSION (DX) UNIT REQUIREMENTS FOR COOLING STAGES AND COMPRESSOR DISPLACEMENT

Cooling Capacity	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement
≥ 65,000 Btu/h and < 240,000 Btu/h	3 stages	≤ 35% full load
≥ 240,000 Btu/h	4 stages	≤ 25% full load

§140.4 – Prescriptive Requirements for HVAC

- **(e) Economizers – cont.**
  - Water economizer requirements:
    - Water economizers must have one of the following:
      - Precooling coils and water-to-water heat exchangers must have a waterside pressure drop of < 15 feet of water; or
      - Secondary loop that prevents the coil or heat exchanger from contributing to pressure drop when the system is in non-economizer cooling mode.
    - Must be integrated to allow partial cooling
    - Taylor Engineering Design Guide located at http://www.taylor-engineering.com/articles

Code Quiz:

1. **When is an economizer mandatory?**
   a) On systems with cooling capacity over 54,000 Btu/hr.
   b) On all VAV systems
   c) Both a) and b)
   d) Not mandatory

2. **When is an economizer required prescriptively?**
   a) On systems with cooling capacity over 54,000 Btu/hr
   b) On all VAV systems
   c) Both a) and b)

3. **Economizer damper leakage must be certified to the Commission**
   a) True
   b) False

§140.4 – Prescriptive Requirements for HVAC

- **(f) Supply Air Temperature (SAT) Reset Controls**
  - Space-conditioning systems **supplying multiple zones** must include controls that **automatically reset supply-air temperatures**
  - **SAT** must be reset by the following:
    - In response to representative building loads or to outdoor air temperature.
    - At least 25 percent of the difference between the design supply-air temperature and the design room air temperature

❖ EXCEPTIONS:
- ✓ There are some exceptions for certain zonal controls and process humidification requirements
- ✓ Healthcare facilities

§140.4 – Prescriptive Requirements for HVAC

- **(g) Electric Resistance Heating**
  - Electric resistance heating systems cannot be used for space heating

❖ EXCEPTIONS:
✓ There are exceptions related to solar power, heat pumps, percentage of total building design output, maximum wattage, and building features.

Source: https://en.wikipedia.org/wiki/Joule_heating#/media/File:Toaster-quartz_element.JPG

§140.4 – Prescriptive Requirements for HVAC

- **(h) Heat Rejection Systems**
  - Cooling system **heat rejection equipment** such as **condensers**, and **cooling towers**
  - Fan Speed Control
    - Fan motor 7.5 hp (5.6 kW) or larger must be able to operate at 2/3 of full speed or less
    - Fans must be able to change speed in order to control condenser temperature or pressure

Source: https://commons.wikimedia.org/wiki/File:Evaporative_Cooling_Tower.jpg

❖ EXCEPTIONS:
✓ Of course, there are exceptions to Fan Speed Control. See §140.4(h)1.

§140.4 – Prescriptive Requirements for HVAC

- **(h) Heat Rejection Systems – cont.**
  - Tower Flow Turndown
    - **Open cooling towers** with multiple condenser water pumps must be designed so that all cells can be run in parallel with the larger of:
      - The flow that is produced by the smallest pump; **or**
      - 50 percent of the design flow for the cell
  - Limitations on **cooling tower centrifugal fans**
    - Open cooling towers with a combined rated capacity of 900 gpm and greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor wetbulb temperature, must use propeller fans and cannot use centrifugal fans

❖ EXCEPTIONS:
✓ There are exceptions to the Limitation on Centrifugal Fan Cooling Towers. See §140.4(h)4

§140.4 – Prescriptive Requirements for HVAC

- **(h) Heat Rejection Systems – cont.**
  - Cooling tower efficiency requirement:
    - Axial fan, open-circuit cooling towers with capacity of 900 gpm or greater, must have an efficiency ≥ 60 gpm/hp

❖ There are exceptions for the following:
- ✓ Replacement of existing cooling towers inside an existing building or on an existing roof.
- ✓ Cooling towers serving buildings in Climate Zone 1 or 16.

§140.4 – Prescriptive Requirements for HVAC

- **(h) Heat Rejection Systems – cont.**
  - Multiple Cell Heat Rejection Equipment
    - Multiple cell heat rejection equipment with variable speed fan drives must:
      - Operate the maximum number of fans allowed by the manufacturer
      - Control all operating fans to the same speed
      - Minimum fan speed is based on the manufacture's specifications
      - Staging of fans is allowed once the fans are at their minimum operating speed

Source: https://www.theseverngroup.com/what-are-chiller-systems/

§140.4 – Prescriptive Requirements for HVAC

- **(i) Minimum Chiller Efficiency**
  - Chillers must meet or exceed Path B from Table 110.2-D

TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS [a,b]

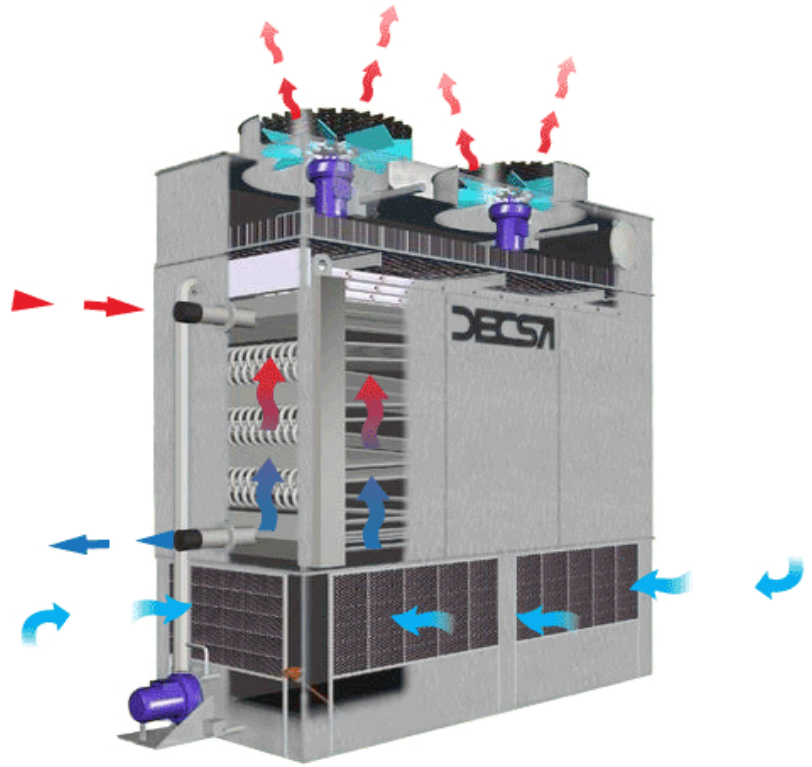
Equipment Type	Size Category	Path A Efficiency [a,b]	Path B Efficiency [a,b]	Test Procedure [c]
Air Cooled, With Condenser Electrically Operated	< 150 Tons	≥ 10.100 EER ≥ 13.700 IPLV	≥ 9.700 EER ≥15.800 IPLV	AHRI 550/590
	≥ 150 Tons	≥ 10.100 EER ≥ 14.000 IPLV	≥ 9.700 EER ≥16.100 IPLV	
Air Cooled, Without Condenser Electrically Operated	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements.		
Water Cooled, Electrically Operated, Reciprocating	All Capacities	Reciprocating units must comply with the water-cooled positive displacement efficiency requirements.		AHRI 550/590

❖ EXCEPTIONS:
- ✓ There are exceptions related to electrical service size, chillers with heat recovery systems, thermal energy storage and the number of chillers.

§140.4 – Prescriptive Requirements for HVAC

- **(j) Limitation of Air-Cooled Chillers**
  - Chilled water plants cannot have more than 300 tons of capacity provided by air-cooled chillers

❖ EXCEPTIONS:
✓ There are exceptions related to poor water quality, thermal energy storage and certified high efficient air cooled chillers.

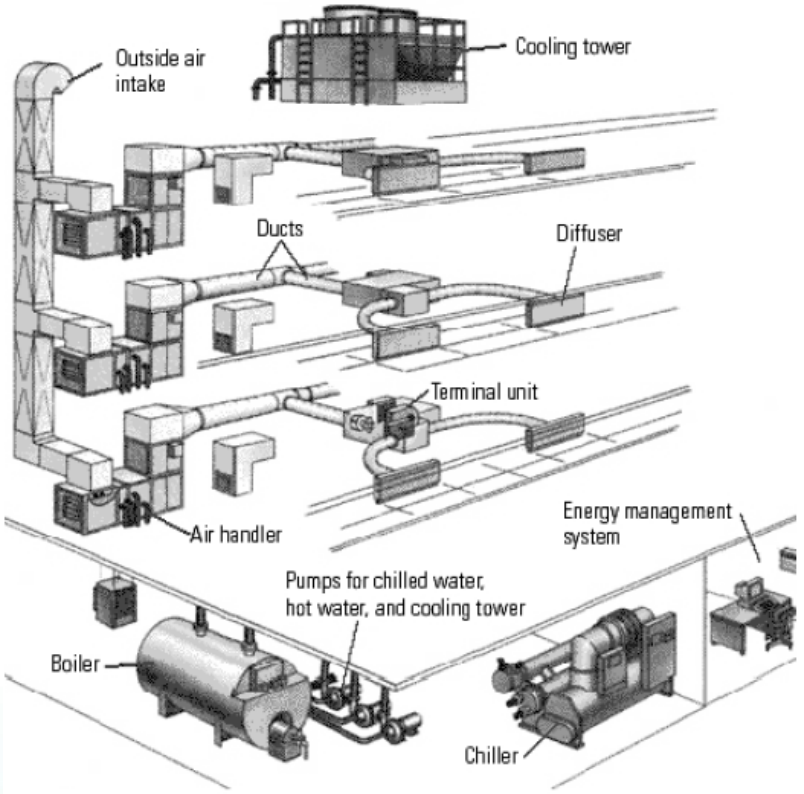


Source: https://coolingtowertech.weebly.com/blog/how-evaporative-cooling-towers-works-explained-by-industry-leaders

§140.4 – Prescriptive Requirements for HVAC

- **(k) Hydronic System Measures**
  - HVAC chilled and hot water must have **variable fluid flow** and be **capable of reducing pump flow rates** to no more than the larger of:
    - 50 percent or less of the design flow rate; **or**
    - The minimum flow required by the equipment manufacturer

❖ EXCEPTION:
✓ Systems that include no more than three control valves or have total pump power less than 1.5 hp



Source: http://energy-models.com/hvac-centrifugal-chillers

§140.4 – Prescriptive Requirements for HVAC

- **(k) Hydronic System Measures – cont.**
  - Chiller Isolation
    - System with **parallel chillers** must have provisions to **automatically shut off flow** to chillers not in use while still **maintaining flow** through operating chiller(s)
    - Chillers that are piped **in series** are considered to be one chiller
  - Boiler Isolation
    - Hot water plants with **more than one** boiler must automatically shut off flow through boilers not in use while maintaining flow through other operating boiler(s)

→ Acceptance testing is required for both of these

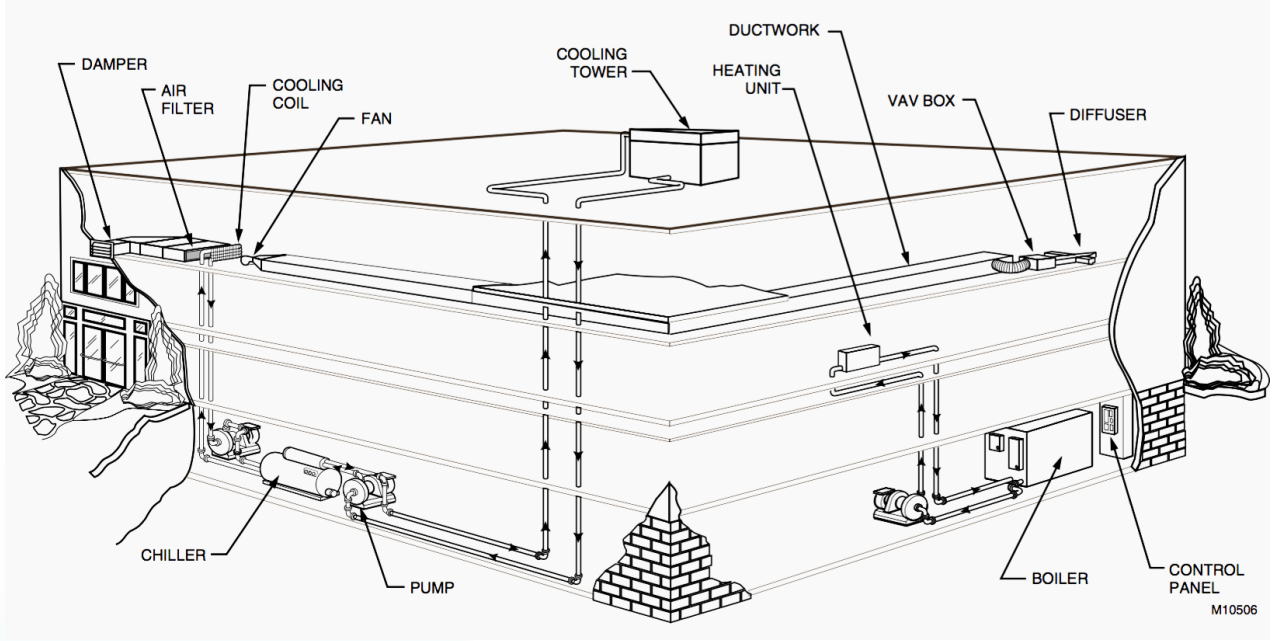
§140.4 – Prescriptive Requirements for HVAC

- **(k) Hydronic System Measures – cont.**
  - Chilled and Hot Water Temperature Reset Controls
    - Systems with a design capacity exceeding 500,000 Btu/hr supplying chilled or heated water must have controls that **automatically reset supply water** temperatures as a function of building loads or outside air temperature
  - Water-Cooled Air Conditioner and Hydronic Heat Pump Systems
    - Systems with total pump system power exceeding 5 hp must have **variable flow controls**
    - Air conditioners and heat pumps must automatically shut off water flow when the compressor is off

→ Acceptance testing is required for these also

§140.4 – Prescriptive Requirements for HVAC

- **(k) Hydronic System Measures – cont.**
  - Variable Flow Controls
    - Individual pumps serving variable flow systems and having a motor horsepower exceeding 5 hp must have motors with 30% power at 50% flow
    - Pressure Sensor Location and Setpoint depends on DDC to the coil or not



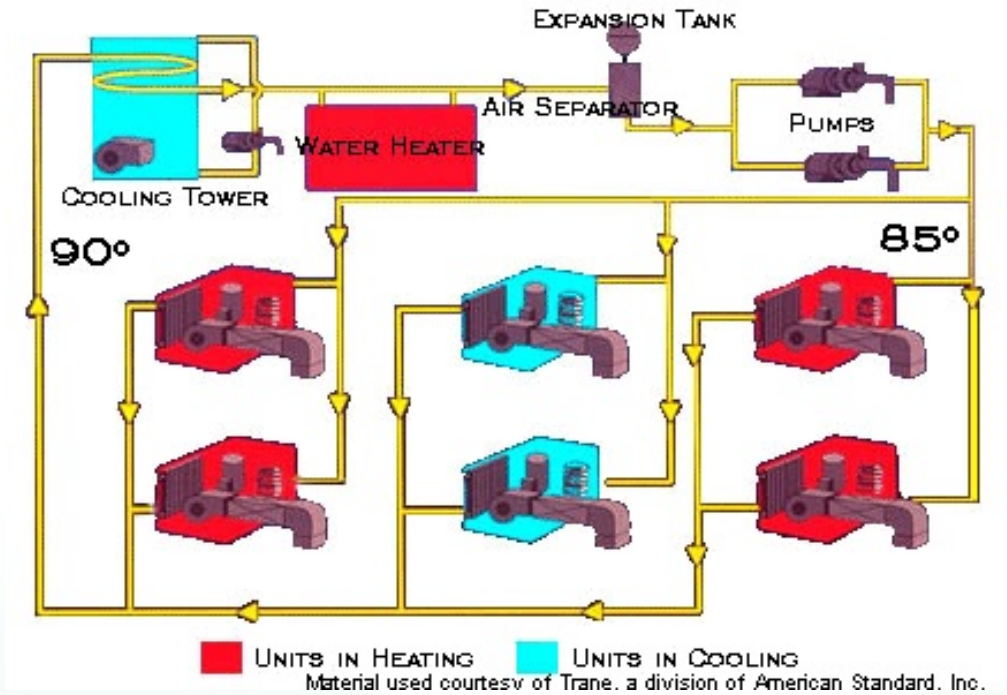
Source: https://electrical-engineering-portal.com/download-center/books-and-guides/automation-control/automatic-control-commercial-buildings

❖ EXCEPTIONS:
✓ There are exceptions to Variable Flow Controls. See §140.4(k)6

§140.4 – Prescriptive Requirements for HVAC

- **(k) Hydronic System Measures – cont.**
  - Hydronic Heat Pump (WLHP) Controls
    - WLHPs with central heat rejection and heat addition must allow for a water supply temperature **dead band** of **at least 20°F** between initiation of heat rejection and heat addition

❖ EXCEPTIONS:
✓ Systems with a temperature optimization controller.



Source: https://c03.apogee.net/mvc/home/hes/land/el?spc=cel&id=18995&utilityname=northwestern

§140.4 – Prescriptive Requirements for HVAC

- **(l) Air Distribution System Duct Leakage Sealing**
  - Duct systems must be sealed to a leakage rate ≤ 6 percent of the nominal air handler airflow rate as **verified by a HERS rater** in accordance with Nonresidential Reference Appendices NA1 and NA2 **if all the following are met**:
    - The space is served by a constant volume, single zone system
    - The space conditioning system serves less than 5,000 square feet
    - Has more than 25 percent of the duct surface area in unconditioned space

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

§140.4 – Prescriptive Requirements for HVAC

- **(n) Mechanical System Shut-off**
  - Any space with operable openings to outdoors must have interlock controls
  - When open for more than 5 minutes:
    - Disable or reset the setpoint to 55°F for mechanical heating, **and**
    - Disable or reset the setpoint to 90°F for mechanical cooling

❖ EXCEPTIONS:
✓ They are not required on openings with automatic closing devices or in spaces without thermostatic control

Source: https://www.americanwindowproducts.com/the-uv-protection-new-windows-provide-and-how-it-protects-home-assets/

§140.4 – Prescriptive Requirements for HVAC

- **(o) Exhaust System Transfer Air**
  - Conditioned supply air delivered to a space with mechanical exhaust cannot exceed the greater of:
    - The supply flow required to meet the space heating or cooling load; or
    - The required ventilation rate; or
    - The mechanical exhaust flow minus the available transfer air

Source: https://blog.cashins.com/blog-0/bid/117266/How-Much-Is-That-Exhaust-Ventilation-Fan-Costing-You

§140.4 – Prescriptive Requirements for HVAC

- **Takeaways**
  - Heating and Cooling loads must be calculated based on ASHRAE
  - A safety factor increase is allowed
  - Fan horsepower limitations based on maximum design system airflow
  - Zonal controls required to prevent reheat, recooling and mixing
  - Air economizers are required on air handlers over 54,000 Btu/hr
  - Water economizers are required on chilled water systems ≥ 720,000 Btu/hr (210 kW) without a fan
  - Economizers have acceptance testing and certification requirements
  - Multi-zone systems are required to have SAT reset controls
  - Heat rejection systems have requirements for fan and pump controls and motor efficiencies

§140.4 – Prescriptive Requirements for HVAC

- **Takeaways – cont.**
  - Chiller efficiencies must meet path B in Table 110.2-D
  - Limitation of no more than 300 tons of air cooled chiller capacity
  - Hydronic systems have requirements for isolation, variable flow control, and fluid temperature reset
  - Single zone systems less than 5,000 sf may need HERS duct testing
  - DX, chilled water and evaporative cooling systems have fan motor control requirements
  - Mechanical shut-off devices are required for operable openings in spaces with thermostatic controls
  - These are prescriptive requirements and can be traded off when using the performance approach

Subchapter 6
Nonresidential, High-Rise Residential, Hotel/Motel Occupancies – Additions, Alterations, and Repairs
(§141.0 -§141.1)

§141.0(a) – Additions

§141.0(a) – Additions

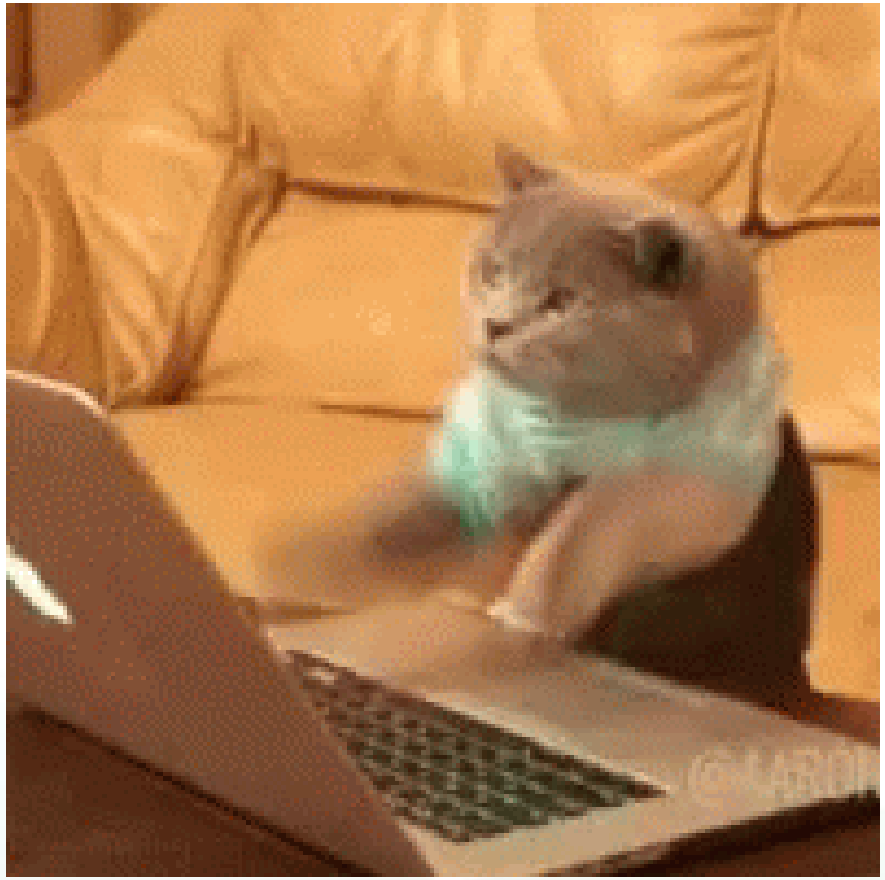
- **Prescriptive approach**
  - Newly installed space-conditioning systems installed in an addition must meet the applicable prescriptive requirements of §140.4 and all applicable mandatory requirements as discussed in previous sections

Addition Definition:

Any change to a building that increases conditioned floor area and conditioned volume.

§141.0(a) – Additions

- **Performance approach**
  - All applicable mandatory measures must be achieved or exceeded
  - Either the **addition alone can comply or t**he **existing plus addition** or the **existing plus addition plus alteration** approach can be taken



Source: https://www.reddit.com/r/CatGifs/comments/48sql9/hacker_cat_at_it_again_taking_over_the_webs/

§141.0(a) – Additions

- **Exceptions for additions that apply to both prescriptive and performance approaches:**

❖ EXCEPTIONS:
- ✓ When expanding existing systems, existing systems and equipment need not comply with current requirements except for duct sealing
- ✓ Duct Sealing. When ducts are extended from an existing duct system, the existing and extended ducts must have ≤ 15% leakage or pass a smoke test
- ✓ There are exceptions allowing expansion of existing systems with electric heat when adding VAV boxes to the addition. See Exception 2 to Section 141.0(a)

§141.0(b) – Alterations

Source: https://barrettandsons.net/hvac-careers/

§141.0(b)2 Alterations: Prescriptive Approach

- **New or Replacement Space-Conditioning Systems or Components**
  - New Systems or Components **except** ducts must meet the requirements of section §140.4 applicable to the systems or components being altered

❖ EXCEPTIONS:
- ✓ Replacements of electric resistance heaters with equivalent or smaller heaters for high rise residential units or when natural gas is not available.
- ✓ Mechanical System Shutoff Devices in §140.4(n) (interlock devices) are not required for new or replacement space conditioning systems.
- ✓ Economizer FDD is not required for space conditioning system alterations.

  - Additional fan power limitations credits can be taken per Table 141.0-D

Table 141.0-D Fan Power Limitation Pressure Drop Adjustment

Device	**Adjustment Credits**
Particulate Filtration Credit: MERV 9 through 12	0.5 in. of water
Particulate Filtration Credit: MERV 13 through 15	0.9 in. of water

§141.0(b)2 Alterations: Prescriptive Approach

- **Altered Duct Systems**
  - New or replacement ducts must meet mandatory requirements for Ducts and Plenums in §120.4
  - If the space conditioning system meets the criteria of §140.4(l), the duct system must be tested by a HERS rater:
    - **Entirely new or replacement** duct system directly connected to the air handler must have leakage ≤ 6 percent when tested per NA2.1.4.2.1

NOTE: Entirely new or replacement duct systems means at least 75 percent new duct material. Up to 25 percent may consist of reused parts from the building's existing duct system, including registers, grilles, boots, air handlers, coils, plenums, and ducts, if the reused parts are accessible for sealing

§141.0(b)2 Alterations: Prescriptive Approach

- **Altered Duct Systems – cont.**
  - HERS testing – cont.:
    - When ducts are extended from an existing duct system, the existing and extended ducts must have leakage ≤ 15% or be smoke tested and accessible leaks sealed

❖ EXCEPTION:
✓ Existing ducts constructed, insulated or sealed with asbestos

Source: https://www.rosco.com/spectrum/

§141.0(b)2 Alterations: Prescriptive Approach

- **Altered Space-Conditioning Systems**
  - When replacing the air handler, outdoor condensing unit of a split system air conditioner or heat pump, or cooling or heating coil:
    - An Occupant Controlled Smart Thermostat (OCST) that complies with Reference Joint Appendix JA5 must be installed; **and**
    - If the system meets the criteria of §140.4(l)1, 2 and 3, the connected duct system shall be sealed and tested as discussed previously

❖ EXCEPTION:
- ✓ Buildings altered so that the duct system no longer meets the criteria of Section 140.4(l)1
- ✓ Ducts documented to have been previously tested by a HERS Rater
- ✓ Existing duct systems constructed, insulated or sealed with asbestos

§141.0(b)3 Alterations: Performance Approach

- **Performance Approach**
  - All applicable mandatory measures for the new equipment must be met
  - For altered components, the standard design is based on either the existing conditions or the prescriptive requirements, which ever has higher efficiency
  - For components not being altered, the standard design is based on the existing conditions
  - The proposed design must be based on the actual values of the altered components

§141.0(b) Alterations

- **Exceptions to Alterations**

❖ EXCEPTIONS:
- ✓ When HVAC systems are altered, the existing systems and equipment need not comply with the current requirements
- ✓ When existing systems or components are moved in a building, the existing systems or components need not comply with the current requirements
- ✓ There are exceptions allowing expansion of existing systems with electric heat when adding VAV boxes to the addition. See Exception 3 to §141.0(b)
- ✓ Economizer fault detection diagnostics (FDD) per §120.2(i) is not required for alterations

§141.0(c) – Repairs

- A repair is the reconstruction or renewal for the purpose of maintenance of a component, system, or equipment of an existing building
- Replacement of any component, system, or equipment for which there are requirements in the Standards is considered an alteration and not a repair
- Repairs do not have requirements under Part 6 except they shall not increase the preexisting energy consumption of the repaired component, system, or equipment

Code Quiz:

1. **Is economizer FDD per §120.2(i) required on an altered system?**
   a) No
   b) Yes because it is a mandatory measure
   c) Only when an economizer is added or replaced
   d) b and c

2. **A thermostat per §110.12 is required for alterations to a duct system?**
   a) True
   b) False

Code Quiz:

1. **What are the triggers for duct testing requirements?**
   a) Constant volume single zone
   b) System serves less than 5,000 sf
   c) More than 25% of ducts in unconditioned space
   d) All of the above

2. **What is the maximum allowed leakage rate for a complete replacement duct system?**
   a) ≤ 6%
   b) ≤ 15%

§141.0 – Additions, Alterations and Repairs

- **Takeaways**
  - All mandatory measure apply to new and altered components
  - §140.4 is the bases for the performance approach standard model
  - §140.4 requirements must be met or exceeded for the altered components when complying prescriptively unless stated otherwise in this section
  - Unaltered systems and equipment are not required to meet current code
  - Duct testing is required on existing ducts if ducts are extended and the requirements of §140.4(l) are met
  - Altered systems, other than ducts, require a §110.12 (JA5) Thermostat
  - ❖ Always check the exceptions

QUESTIONS…

About Additions, Alterations or Repairs?

Enforcement

Enforcement – Prescriptive Compliance

- **Permit and Plans Review:**
  - NRCC-MCH-E Certificate of Compliance:
    - Verify Table **A. GENERAL INFORMATION** is correct

STATE OF CALIFORNIA

Mechanical Systems

NRCC-MCH-E (Created 6/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE			NRCC-MCH-E
This document is used to demonstrate compliance for mechanical systems that are within the scope of the permit application and are demonstrating compliance using the prescriptive path outlined in §140.4, or §141.0(b)2 for alterations.			
Project Name:	Mechanical	Report Page:	Page 1 of 14
Project Address:	123 Compliance Street	Date Prepared:	2020-04-27

A. GENERAL INFORMATION

01	Project Location (city)	Sacramento	04	Total Conditioned Floor Area	30,000
02	Climate Zone	12	05	Total Unconditioned Floor Area	0
03	Occupancy Types Within Project:		06	# of Stories (Habitable Above Grade)	3

☑ Office (B)	☐ Retail (M)	☐ Non-refrigerated Warehouse (S)
☐ Hotel/ Motel Guest Rooms (R-1)	☐ School (F)	☐ Healthcare Facility (H)
☐ High-Rise Residential (R-2/R-3)	☐ Relocatable Class Bldg (E)	☐ Other (Write In):

[1] *FOOTNOTES: Climate zone can be determined on the California Energy Commission's website at http://www.energy.ca.gov/maps/renewable/building_climate_zones.html*

Enforcement – Prescriptive Compliance

- **Permit and Plans Review:**
  - NRCC-MCH-E Certificate of Compliance:
    - Verify Table **B. PROJECT SCOPE** on form matches scope of work on plans

B. PROJECT SCOPE		
Table Instructions: Include any mechanical systems that are within the scope of the permit application and are demonstrating compliance using the prescriptive path outlined in §140.4, or §141.0(b)2 for alterations.		
My project consists of (check all that apply)		
01	02	03
Air System(s)	Wet System Components	Dry System Components
☑ Heating Air System	☑ Water Economizer	☑ Air Economizer
☑ Cooling Air System	☑ Pumps	☑ Electric Resistance Heat
Mechanical Controls	☑ Hydronic System Piping	☑ Fan Systems
☑ Mechanical Controls	☑ Cooling Towers	☑ Ductwork
	☑ Chillers	☑ Ventilation
	☑ Boilers	☑ Zonal Systems/ Terminal Boxes

Enforcement – Prescriptive Compliance

- **Permit and Plans Review:**
  - NRCC-MCH-E Certificate of Compliance:
    - Verify Table **C. COMPLIANCE RESULTS** shows **COMPLIES**

C. COMPLIANCE RESULTS

Table Instructions: If any cell on this table says "DOES NOT COMPLY" or "COMPLIES with Exceptional Conditions" refer to Table D. for guidance.

01		02		03		04		05		06		07		08	09
System Summary §110.1, §110.2, §140.4	AND	Pumps §140.4(k)	AND	Fans/ Economizers §140.4(c), §140.4(e)	AND	System Controls §110.2, §120.2, §140.4(f)	AND	Ventilation §120.1	AND	Terminal Box Controls §140.4(d)	AND	Distribution §120.3, §140.4(l)	AND	Cooling Towers §110.2(e)2	**Compliance Results**
(See Table F)		(See Table G)		(See Table H)		(See Table I)		(See Table J)		(See Table K)		(See Table L)		(See Table M)	
No	AND	Yes	AND	Yes	AND	Yes	AND	Yes	AND	Yes	AND	Yes	AND	Yes	**DOES NOT COMPLY**
												Mandatory Measures Compliance (See Table Q for Details)			**COMPLIES**

CA Building Energy Efficiency Standards - 2019 Nonresidential Compliance: http://www.energy.ca.gov/title24/2019standards/ June 2020

Enforcement – Prescriptive Compliance

- **Permit and Plans Review:**
  - NRCC-MCH-E Certificate of Compliance:
    - Table **D. EXCPTIONAL CONDITIONS** and Table **E. ADDITIONAL REMARKS** are information tables to assist the AHJ at permit and plan check

D. EXCEPTIONAL CONDITIONS
This table is auto-filled with uneditable comments because of selections made or data entered in tables throughout the form.
Please review Table F for compliance: all fields which are not grey must be completed; design or rated efficiency must be greater than or equal to the minimum efficiency required.

E. ADDITIONAL REMARKS
This table includes remarks made by the permit applicant to the Authority Having Jurisdiction.

Enforcement – Prescriptive Compliance

- **Permit and Plans Review – cont.:**
  - NRCC-MCH-E Certificate of Compliance:
    - Verify mechanical plans match the equipment Tables F- M.

F. HVAC SYSTEM SUMMARY (DRY & WET SYSTEMS)

Table Instructions: Complete the following equipment schedules to show compliance with mandatory requirements found in §110.1 and §110.2(a) and prescriptive requirements found in §140.4(a), §140.4(b) and §140.4(k) or §141.0(b)2 for alterations.

Dry System Equipment Sizing (includes air conditioners, condensers, heat pumps, VRF, furnaces and unit heaters)

01	02	03	04	05	06	07	08	09	10	11
				Equipment Sizing per Mechanical Schedule (Btu/h) §140.4 (a&b)						
				Heating Output[2,3]			Cooling Output[2,3]		Load Calculations[3,4]	
Name or Item Tag	Equipment Category per Tables 110.2	Equipment Type per Tables 110.2 & Title 20	Smallest Size Available[1] §140.4(a)	Sensible Per Design (kBtu/h)	Rated (kBtu/h)	Supp. Heating Output (kBtu/h)	Sensible Per Design (kBtu/h)	Rated (kBtu/h)	Total Heating Load (kBtu/h)	Total Sensible Cooling Load (kBtu/h)
AC	Unitary AC/ Condensers	AC, air cooled, split (3 phase)	Yes	0	0	0	75,000	75,000	0	74,000
Furnace	Furnace/ Unit heater	Warm-air duct furnace, gas-fired	Yes	180,000	180,000	0	0	0	175,000	0

Reset | Add Row | Remove Last

[1] *FOOTNOTES: Equipment shall be the smallest size, within the available options of the desired equipment line, necessary to meet the design heating and cooling loads of the building per §140.4(a). Healthcare facilities are excepted.*

[2] *It is common practice to show rated output capacity on the equipment schedule. Sensible cooling output comes from specification sheet tables.*

[3] *If equipment is heating only, leave cooling output and load blank. If equipment is cooling only, leave heating output and load blank.*

[4] *Authority Having Jurisdiction may ask for load calculations used for compliance per §140.4(b).*

Table Continued

Enforcement – Prescriptive Compliance

- **Permit and Plans Review – cont.:**
  - NRCC-CXR-E Commissioning Document:
    - Verify Table **A. GENERAL INFORMATION** matches plans (area, HVAC)

STATE OF CALIFORNIA

Nonresidential Building Commissioning

NRCC-CXR-E (Created 12/19) — CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF COMPLIANCE			NRCC-CXR-E
This document is used to demonstrate compliance with mandatory commissioning requirements in §120.8 for nonresidential buildings and hotel/motel or high-rise residential buildings with nonresidential spaces. This document does not demonstrate compliance with commissioning requirements within Title 24, Part 11, which need to be documented separately if they apply.			
Project Name:	Mechanical	Report Page:	Page 1 of 7
Project Address:	123 Compliance Street	Date Prepared:	2020-04-27

A. GENERAL INFORMATION					
01	Project Location (city)	Sacramento	04	Building Size (ft²)	30,000
02	Occupancy Type	Nonresidential	05	Nonresidential Conditioned Floor Area (ft²)	10,000 - 49,999 ft²
03	Project Type	Newly constructed	06	HVAC System Type	All other HVAC system types (indicates "complex")

Enforcement – Prescriptive Compliance

- **Permit and Plans Review – cont.:**
  - NRCC-CXR-E Commissioning Document:
    - Table **B. PROJECT SCOPE** will populate automatically based on nonresidential area

B. PROJECT SCOPE			
Table Instructions: Based on project information provided in Table A, Table B indicates which commissioning related requirements apply per §120.8. Table B is not editable by the user.			
Commissioning Requirements per §120.8			
01	Table F: Design Review Kickoff	§120.8(d)1 and §120.8(d)2	The design review kickoff meeting establishes who will play the role of the design reviewer, the project schedule and identify owner's requirements. This meeting should be conducted during schematic design.
02	Table G: Owner's Project Requirements (OPR)	§120.8(b)	The owner's project requirements establish the owner's goals, requirements, and expections for everything related to energy consumption and operation. This should be completed during schematic design.
03	Table H: Basis of Design (BOD)	§120.8(c)	The basis of design documents the design elements such as calculations and product selections that meet the owner's project requirements and applicable regulatory requirements. This should be completed during schematic design.
04	Table I: Design Review	§120.8(d) and §120.8(e)	The design reviewer(s) reviews the construction documents for clarity, completeness, and adherence to the owner's goals. Commissioning measures must be included in the construction documents to faciliate the design review and commissioning process. For projects with ≥ 10,000 ft² of nonresidential conditioned floor area, or with complex mechanical systems, the design review is for adherence with the Owner's Project Requirements (OPR) and Basis of Design (BOD). This should be conducted during design.
05	Table J: Commissioning Plan	§120.8(f)	The commissioning plan is developed by the commissioning provider with input from the designer and defines the scope of commissioning the project. This should be drafted during design and completed during early construction.
06	Table K: Functional Performance Testing	§120.8(g)	Functional performance testing is conducted on building systems to demonstrate correct installation and operation.
07	Table L: Documentation and Training	§120.8(h)	Documentation of the operational aspects of the building shall be completed within the Systems Manual and delivered to the building owner or representative and facilities operator.
08	Table M: Commissioning Report	§120.8(i)	A complete report of commissioning process activities undertaken through the design, construction and reporting recommendations for post-construction phases of the building project shall be completed and provided to the owner or representative.

Enforcement – Prescriptive Compliance

- **Permit and Plans Review – cont.:**
  - NRCC-CXR-E Commissioning Document:
    - Verify Table **C. COMPLIANCE RESULTS** shows **COMPLIES**.

C. COMPLIANCE RESULTS								
Table Instructions: Table C will indicate if the project data input into the compliance document is compliant with commissioning requirements per §120.8. This table is not editable by the user. If this table says "DOES NOT COMPLY" or "COMPLIES with Exceptional Conditions" refer to Table D. for guidance.								
01	02	03	04	05	06	07	08	09
Design Review Kickoff	Owner's Project Requirements	Basis of Design	Design Review	Commissioning Plan	Functional Performance Testing	Documentation and Training	Commissioning Report	Compliance Results
Table F	Table G	Table H	Table I	Table J	Table K	Table L	Table M	
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	COMPLIES
10	Design Reviewer(s) for the project include:			Licensed Third Party Reviewer				COMPLIES

Enforcement – Prescriptive Compliance

- **Permit and Plans Review – cont.:**
  - NRCC-CXR-E Commissioning Document:
    - Table **D. EXCPTIONAL CONDITIONS** and Table **E. ADDITIONAL REMARKS** are information tables to assist the AHJ at permit and plan check

D. EXCEPTIONAL CONDITIONS
This table is auto-filled with uneditable comments because of selections made or data entered in tables throughout the form.
Table G. indicates that the Owner's Project Requirements (OPR) document is attached to the permit application. Table H. indicates that the Basis of Design (BOD) document is attached to the permit application. Table I. indicates that a Design Review document is attached to the permit application. Table J. indicates that a draft commissioning plan is attached to the permit application.

E. ADDITIONAL REMARKS
This table includes remarks made by the permit applicant to the Authority Having Jurisdiction.

Enforcement – Prescriptive Compliance

- **Field Inspection:**
  - NRCI-MCH-01 Certificate of Installation:
    - Verify NRCI table **A. GENERAL INFORMATION** matches plans and NRCC-MCH-E information

STATE OF CALIFORNIA
MECHANICAL
CEC-NRCI-MCH-01-E (Revised 01/20) CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF INSTALLATION		NRCI-MCH-01-E
Mechanical		(Page 1 of 2)
Project Name: Mechanical	Enforcement Agency: City of Sacramento	Permit Number: 123456
Project Address: 123 Compliance Street	City: Sacramento	Zip Code: 95814

A. GENERAL INFORMATION			
DATE OF BUILDING PERMIT:			
BUILDING TYPE	☒ Nonresidential	☐ High-Rise Residential	☐ Hotel/Motel
PHASE OF CONSTRUCTION	☒ New Construction	☐ Addition	☐ Alteration
If more than one person has responsibility for building construction, each person shall prepare and sign an Installation Certificate document applicable to the portion of construction for which they are responsible; alternatively, the person with chief responsibility for construction shall prepare and sign the Installation Certificate document(s) for the entire construction.			

Enforcement – Prescriptive Compliance

- **Field Inspection:**
  - NRCI-MCH-01 Certificate of Installation:
    - Verify NRCI installed equipment matches plans and NRCC-MCH-E Tables F – M

B. SCOPE OF RESPONSIBILITY	
Date of approval by the enforcement agency of the Certificate of Compliance that provides the specifications for this Installation Certificate.	Date: 4/1/2020

In the table below identify all applicable construction documents that specify the features, materials, components, manufactured devices, or system performance diagnostic results required for the scope of responsibility for this Installation Certificate.

Document Title or Description	Applicable Sheets or Pages, Tables, Schedules, etc.	Date Approved By the Enforcement Agency
Cooling System #1	Mechanical Equipment Schedule on plans page 4	
Cooling System #2	Mechanical Equipment Schedule on plans page 4	
Heating System #1	Mechanical Equipment Schedule on plans page 5	
Electric Resistance Heating	Mechanical Equipment Schedule on plans page 5	

Enforcement – Prescriptive Compliance

- **Field Inspection – cont.:**
  - NRCC-MCH-E Certificate of Compliance:
    - Check Pass or Fail in Table **N. DECLARATION OF REQUIRED CERTIFICATES OF INSTALLATION** to verify NRCI-MCH-01 completion

N. DECLARATION OF REQUIRED CERTIFICATES OF INSTALLATION				
Table Instructions: Selections have been made based on information provided in previous tables of this document. If any selection needs to be changed, please explain why in Table E. Additional Remarks. These documents must be provided to the building inspector during construction and can be found online at https://www.energy.ca.gov/title24/2019standards/2019_compliance_documents/Nonresidential_Documents/NRCI/				
YES	NO	Form/Title	Field Inspector	
			Pass	Fail
●		NRCI-MCH-01-E - Must be submitted for all buildings.	☐	☐

Note: If performance method is used, the NRCI and NRCA documents are still required.

Enforcement – Prescriptive Compliance

- **Field Inspection – cont.:**
  - NRCC-MCH-E Certificate of Compliance:
    - Review Tables O and P to verify all acceptance and verification testing is complete. There should be an NRCA and NRCV form for each required test

O. DECLARATION OF REQUIRED CERTIFICATES OF ACCEPTANCE

Table Instructions: Selections have been made based on information provided in previous tables of this document. If any selection needs to be changed, please explain why in Table E. Additional Remarks. These documents must be provided to the building inspector during construction and can be found online at https://www.energy.ca.gov/title24/2019standards/2019_compliance_documents/Nonresidential_Documents/NRCA/

YES	NO	Form/Title	Field Inspector	
			Pass	Fail
●	○	NRCA-MCH-02-A Outdoor Air must be submitted for all newly installed HVAC units. *Note: MCH02-A can be performed in conjunction with MCH-07-A Supply Fan VFD Acceptance (if applicable) since testing activities overlap.*	☐	☐
○	●	NRCA-MCH-03-A Constant Volume Single Zone HVAC NOTE: This form does not automatically move to "Yes". If Constant Volume Single Zone HVAC Systems are included in the scope, permit applicant should move this form to "Yes".	☐	☐
○	●	NRCA-MCH-04-A Air Distribution Duct Leakage	☐	☐
●	○	NRCA-MCH-05-A Air Economizer Controls	☐	☐
●	○	NRCA-MCH-06-A Demand Control Ventilation Systems Acceptance must be submitted for all systems required to employ demand controlled ventilation (refer to §120.1(c)3) can vary outside ventilation flow rates based on maintaining interior carbon dioxide (CO_2) concentration setpoints.	☐	☐
○	●	NRCA-MCH-07-A Supply Fan Variable Flow Controls	☐	☐
●	○	NRCA-MCH-08-A Valve Leakage Test	☐	☐

Note: If performance method is used, the NRCI and NRCA documents are still required.

Enforcement – Prescriptive Compliance

- **Field Inspection – cont.:**
  - Verify the following are documented and completed at final inspection as required by the NRCC-CXR-E Commissioning Document:
    - Owner's or owner representative's project requirements (OPR)
    - Basis of design (BOD)
    - Commissioning plan
    - Functional performance testing (NRCA Documents and any additional testing required by the OPR)
    - Documentation and training
    - Commissioning report

Enforcement – Performance Compliance

- **Permit and Plans Review:**
  - NRCC-PRF-01-E has similar setup to NRCC-MCH-E
    - Table A for General project information
    - Table B for scope
    - Table C for compliance results
    - Tables K1 - K9 are similar to Tables F – M in NRCC-MCH-E for equipment and efficiencies
  - Verify equipment type, efficiencies, controls, zones, and areas match plans
  - NRCC-CXR-E Form is not generated by the software but must still be submitted

Note: Calculations performed by the software are most likely correct if the data was entered correctly and completely.

Enforcement – Prescriptive Compliance

- **Field Inspection:**
  - NRCI-MCH-01 is required with performance as with prescriptive compliance
    - Verify NRCI equipment matches plans and NRCC-PRF-01-E Tables K1 - K9
  - NRCC-PRF-01-E has similar setup to NRCC-MCH-E
    - Table A for General project information
    - Table B for scope
    - Table C for compliance results
    - Tables K1 - K9 are similar to Tables F – M in NRCC-MCH-E for equipment and efficiencies
    - Table P is similar to Table O in NRCC-MCH-E listing required acceptance tests
    - Table Q is similar to Table P in NRCC-MCH-E listing required HERS tests
  - Commissioning verification is the same as prescriptive compliance. Review NRCC-CXR-E Form and verify all commissioning documents are complete and on site.

Note: Calculations performed by the software are most likely correct if the data was entered correctly and completely.

Enforcement

- **How do I know what measures are required?**

Energy Code Ace Trigger Sheet

2019 ENERGY CODE

Ace Resources | Title 24, Part 6 Triggers

Nonresidential

Small Commercial HVAC – Alterations

Packaged Units — Single-zone, Direct Expansion (DX) — Split Systems

	Mandatory Requirements									Prescriptive Requirements						
Change This *(and nothing else)*	Tstat[B] §§110.2(c), 110.12(a), 120.2 (a), (b), (c) & (e)	Supply & Exhaust Dampers (ventilation provided by HVAC) §120.2(f)	Min. Cooling Efficiency §110.2(a)	Min. Heating Efficiency §110.2(a)	Ventil-ation Calcs[J] §120.1	Demand Control Ventil-ation[D, J] §§120.1(c) 3 & 4	Duct Insulation §120.4	Demand Shed Controls[E] §§110.2(c), 110.12(a), 110.12(b), 120.2(b), (h)	Occupant Sensor Ventilation Control[J] §120.1(d)5	Cooling Load Calcs §140.4(b)	Heating Load Calcs §140.4(b)	Equipment Sizing (per load calcs) §140.4(a)	Fan Power[F] §140.4(c)	Econo-mizer[G] §140.4(e)	Duct Seal & Test[H, J] §140.4(l)	Fan Control §140.4(m)
Whole Pkg Unit or Split System NO ALTERED DUCTS	YES	YES	YES	YES	YES	YES	no	YES	YES	YES	YES	YES	YES	YES	YES	YES[I]
Cooling Coil of Packaged System	YES	no	YES	no	no	no	no	YES	no	no	no	no	no	no	YES	no
Split System Outdoor Condensing Unit	YES	no	YES	YES[C]	no	no	no	YES	no	no	no	no	no	no	YES	no
Split System, Air Handler, or Cooling or Heating Coil	YES	no	YES	YES[C]	no	no	no	YES	no	no	no	no	YES	YES	YES	no
Ductwork[A]	no	no	no	no	no	no	YES	no	no	no	no	no	no	no	YES	no
New or Replacement Ducts and Whole Pkg Unit or Split System	YES	YES	YES	YES	YES[K]	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES[I]

NOTE: For Nonresidential HVAC systems, a change in blower motor, compressor or condenser coil is considered a repair and does not trigger the Energy Code. However, repairs must not increase the pre-existing energy consumption of the repaired component, system or equipment.

Enforcement

- **How do I know what acceptance tests are required?**

Acceptance Tests: Packaged Units — Single-zone, Constant Air Volume (CAV) — and Split Systems

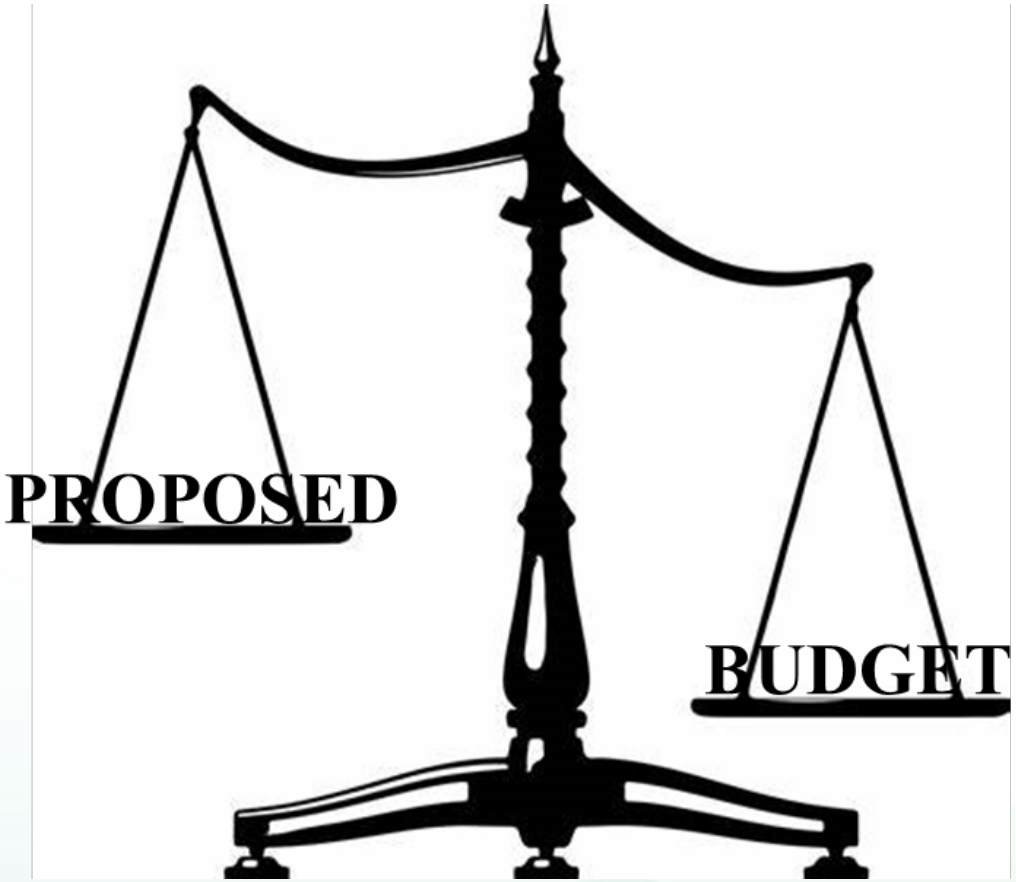
Change This *(and nothing else)*	Form NRCA-MCH-02-A: Ventilation Systems Adequate OSA (when ventilation provided by HVAC)	Form NRCA-MCH-03-A: Constant-volume, Single-zone Unitary A/C and HP Temperature Scheduling & Controls for DX units Proper system temperature scheduling & controls for DX units	Form NRCA-MCH-04a-H Form NRCA-MCH-04b-A: Air Distribution Systems[C] Duct leakage rate	Form NRCA-MCH-05-A: Air Economizer Controls Proper operation of economizer controls	Form NRCA-MCH-06-A: Demand Control Ventilation Proper operation of DCV controls	Form NRCA-MCH-11-A: Demand Shed Controls Demand response[E]	Form 2019-NRCA-MCH-19-A: Occupancy Sensor Controls Proper operation of occupancy sensors
Whole Package Unit	**YES**	**YES**	**YES**	**YES**[B]	**YES**[D]	**YES**	**YES**
Air Handler, or Cooling or Heating Coil, or Outdoor Condensing Unit	no	**YES**	**YES**	no	no	**YES**	no
Entire Split System	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
Ductwork[A]	no	no	**YES**	no	no	no	no
New or Replacement Ducts and Whole Pkg Unit or Split System	**YES**[B]	**YES**	**YES**	**YES**[B]	**YES**[D]	**YES**	**YES**

NOTE: For Nonresidential HVAC systems, a change in blower motor, compressor or condenser coil is considered a repair and does not trigger the Energy Code. However, repairs must not increase the pre-existing energy consumption of the repaired component, system or equipment.

RESOURCES

Compliance Software

- **Used to demonstrate compliance with the Energy Standards when using the Performance Approach**
- **All approved software is available**
- **More information at:** https://www.energy.ca.gov/title24/2019standards/2019_computer_prog_list.html



HERS Providers

- **CHEERS and CalCERTS are both certified to be HERS providers for the 2019 Energy Code**

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

Acceptance Test Technician Certification Providers (ATTCP)

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

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

Blueprint

- Email Newsletter
- Published quarterly
- Clarifications on frequently asked questions

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.

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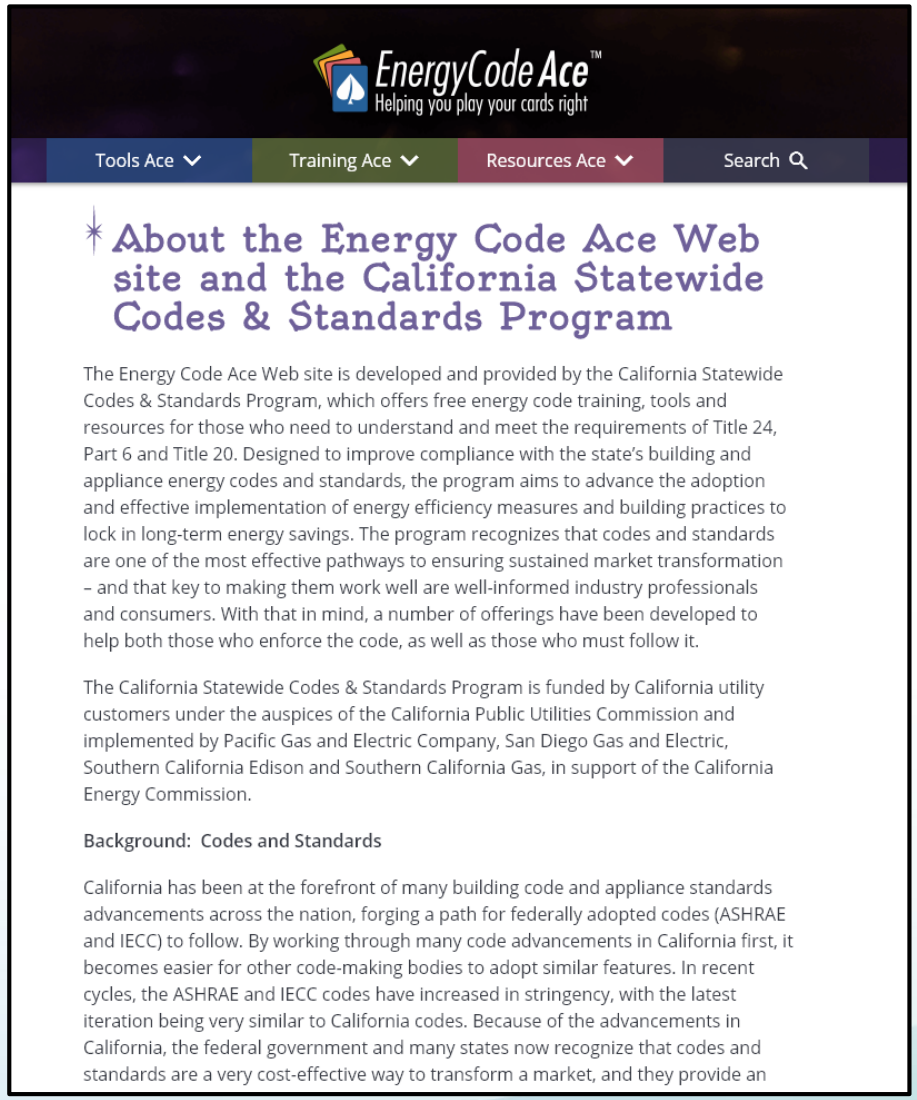
Online Resources Center (ORC)

Visit the ORC at: 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**

Visit Energy Code Ace at:
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 Lists

- **Main conduit for communicating with stakeholders**
- **Sign up at:**
  - http://www.energy.ca.gov/listservers/
- **Subscribe to the following Efficiency Lists:**
  - Building Standards
  - 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