We will be starting soon!

Thanks for joining us

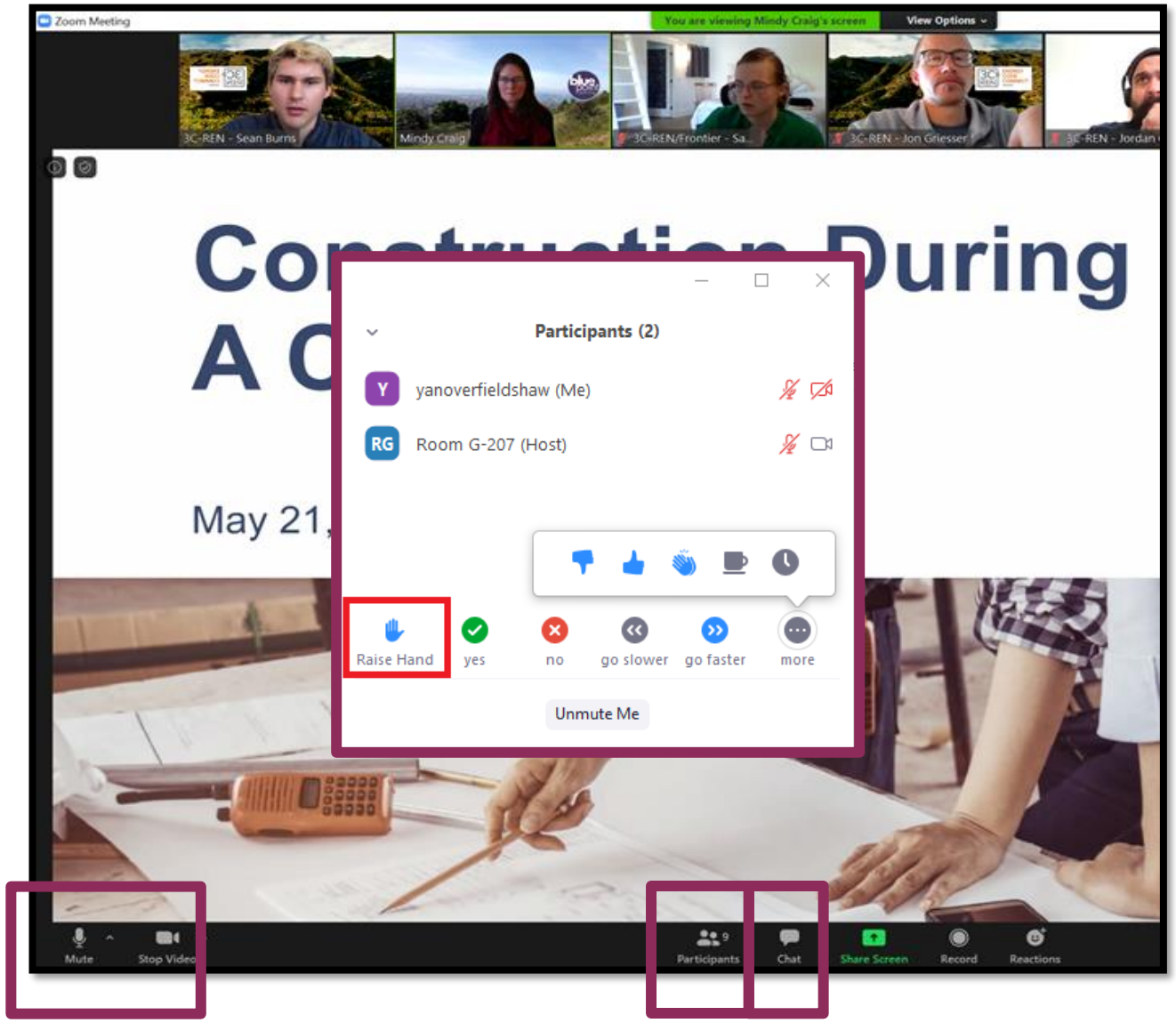
Residential Load Calculation and Duct Design for Building Departments

Russ King – Coded Energy Inc.

February 27, 2024

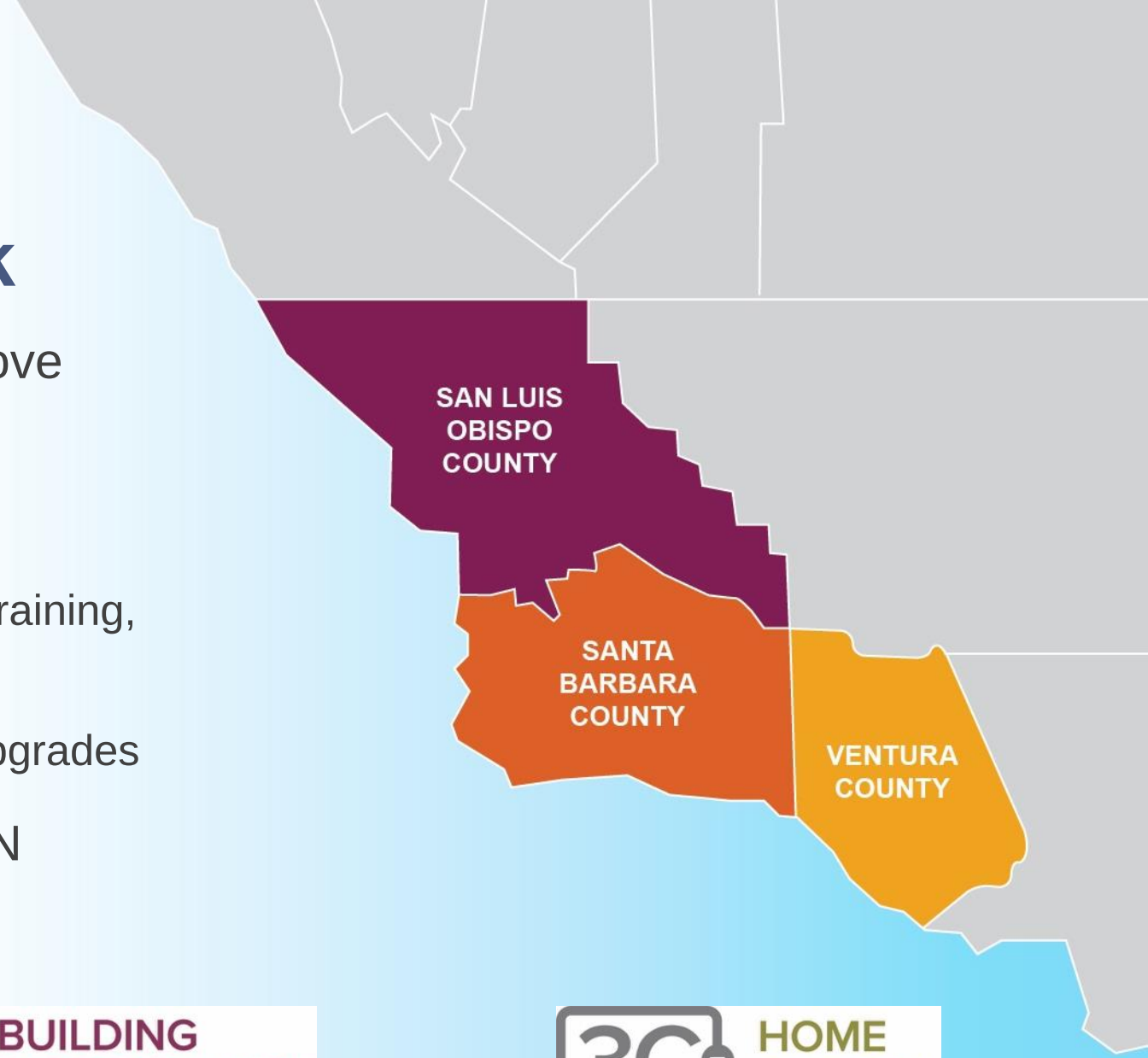
Zoom Orientation

- Please be sure your full name is displayed
- Please mute upon joining
- Use "Chat“ box to share questions or comments
- Under "Participant" select "Raise Hand" to share a question or comment verbally
- The session may be recorded and posted to 3C-REN's on-demand page. Feel free to ask questions via the chat and keep video off if you want to remain anonymous in the recording.



3C-REN: Tri-County Regional Energy Network

- Three counties working together to improve energy efficiency in the region
- Services for –
  - **Building Professionals:** industry events, training, and energy code compliance support
  - **Households:** free and discounted home upgrades
- Funded by ratepayer dollars that 3C-REN returns to the region



3C REN ENERGY CODE CONNECT

3C REN BUILDING PERFORMANCE TRAINING

3C REN HOME ENERGY SAVINGS

3C REN ENERGY CODE CONNECT

- Serves all building professionals
- Three services –
  - **Energy Code Coach**
  - **Training and Support**
  - **Regional Forums**
- Makes the Energy Code easy to follow

Energy Code Coach:
3c-ren.org/codes
805.781.1201

Event Registration:
3c-ren.org/events

BUILDING PERFORMANCE TRAINING

- Serves current and prospective building professionals
- Expert instruction:
  - **Technical skills**
  - **Soft skills**
- Helps workers to thrive in an evolving industry

Event Registration:
3c-ren.org/events

3C-REN HOME ENERGY SAVINGS

Multifamily (5+ units)

- No cost technical assistance
- Rebates up to $750/apartment plus additional rebates for specialty measures like heat pumps

Single Family (up to 4 units)

- Sign up to participate!
- Get paid for the metered energy savings of your customers

Enrollment:
3C-REN.org/contractor-participation

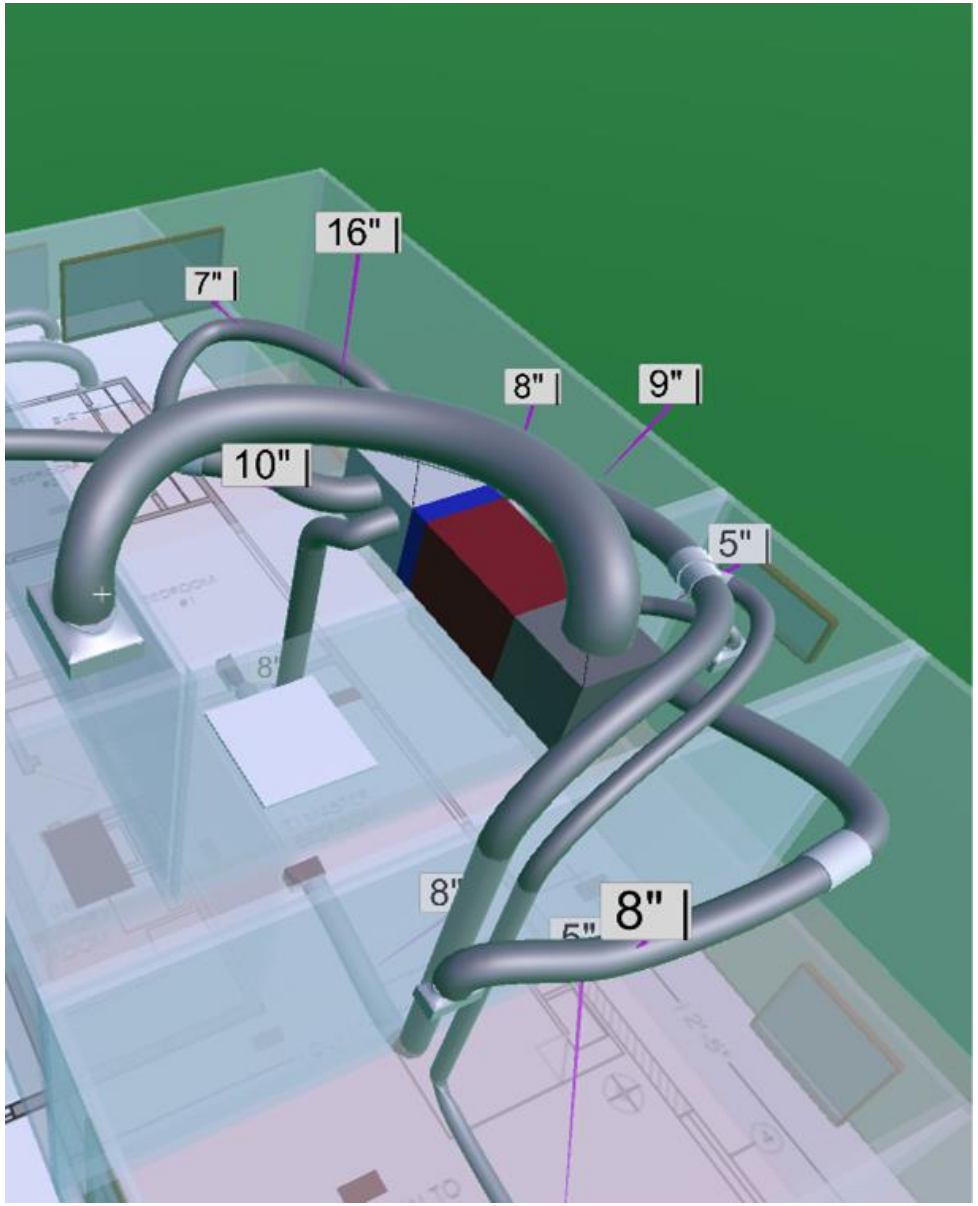
Local Governments Empowering Our Communities

2022 California Energy Standards: Residential HVAC Load Calcs and Duct Design for Building Departments

BayREN Codes & Standards

www.BayREN.org

Introduction



Today's Learning Objectives

- Review the overall compliance process including **prescriptive and performance approaches**.
- Understand how **HVAC fits into the overall compliance** of homes.
- Understand **the code requirements** for residential load calculations and duct designs.
- Understand **how to plan check and field inspect** load calcs and duct designs.
- Be familiar with the **best practices** for energy code compliance.

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Agenda

- Energy Code Compliance Process
- Basic HVAC Compliance Issues
- Energy Code Requirements for Residential HVAC Load Calcs and Duct Designs
- Energy Code Compliance Documents
- Plan Check and Field Inspection Checklist
- Best Practices for Energy Code Enforcement
- Q&A, Additional Resources

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Handouts

- You were emailed the following handouts before the training:
  - Compliance Process Flow Diagram
  - Plan Check and Field Inspection Checklist for Residential HVAC Load Calcs and Duct Design

- You will receive copies of slides and ICC Certification approx. 1 week from today – **Need to complete the evaluation at the end to receive credit**

The Energy Code Compliance Process

Energy Code Compliance Options

Mandatory Measures: Minimum requirements that must **always** be met

Prescriptive Path

- Usually a "prescribed" list of measures by CZ
- No design flexibility
- Common for alterations, changeouts, and smaller additions.

Pick One

Performance Path

- The energy performance of the "prescriptive package" is the target, but tradeoffs are allowed.
- Based on an energy simulation using State-approved software (CBECC, Energy Pro, etc.)
- Very common for new construction and larger additions.
- Rare for alterations, changeouts, etc.

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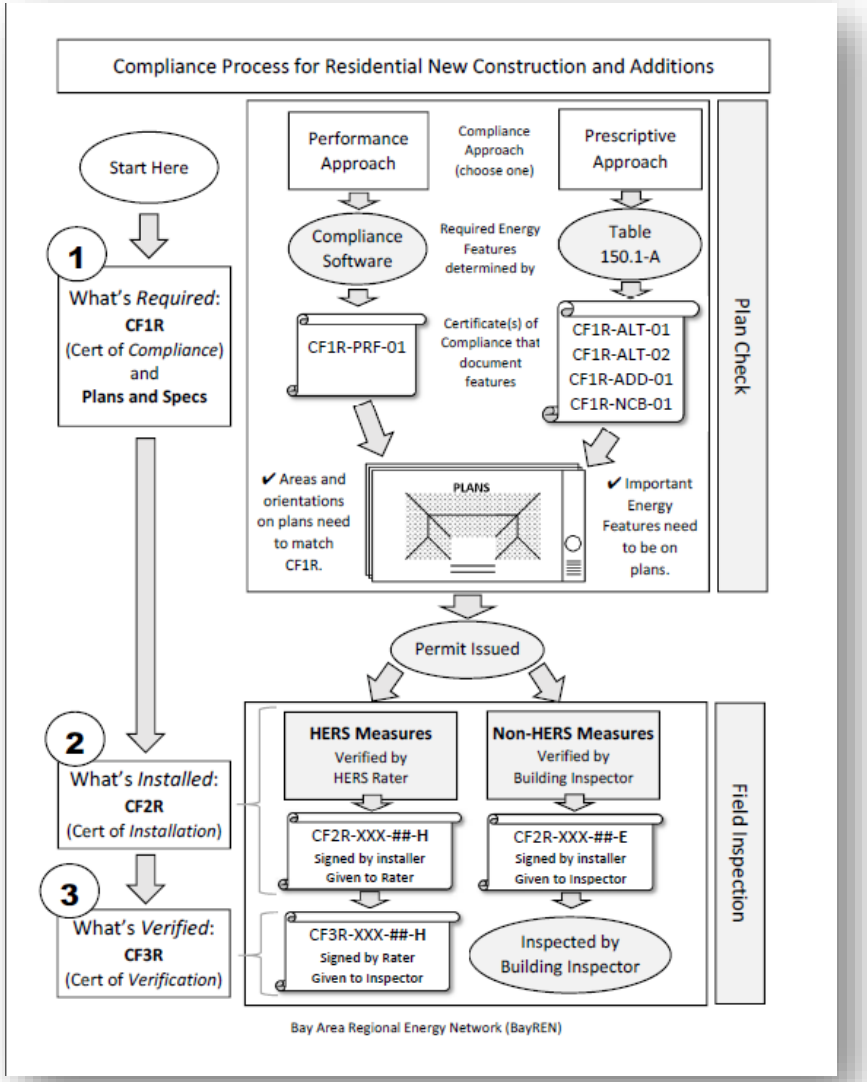
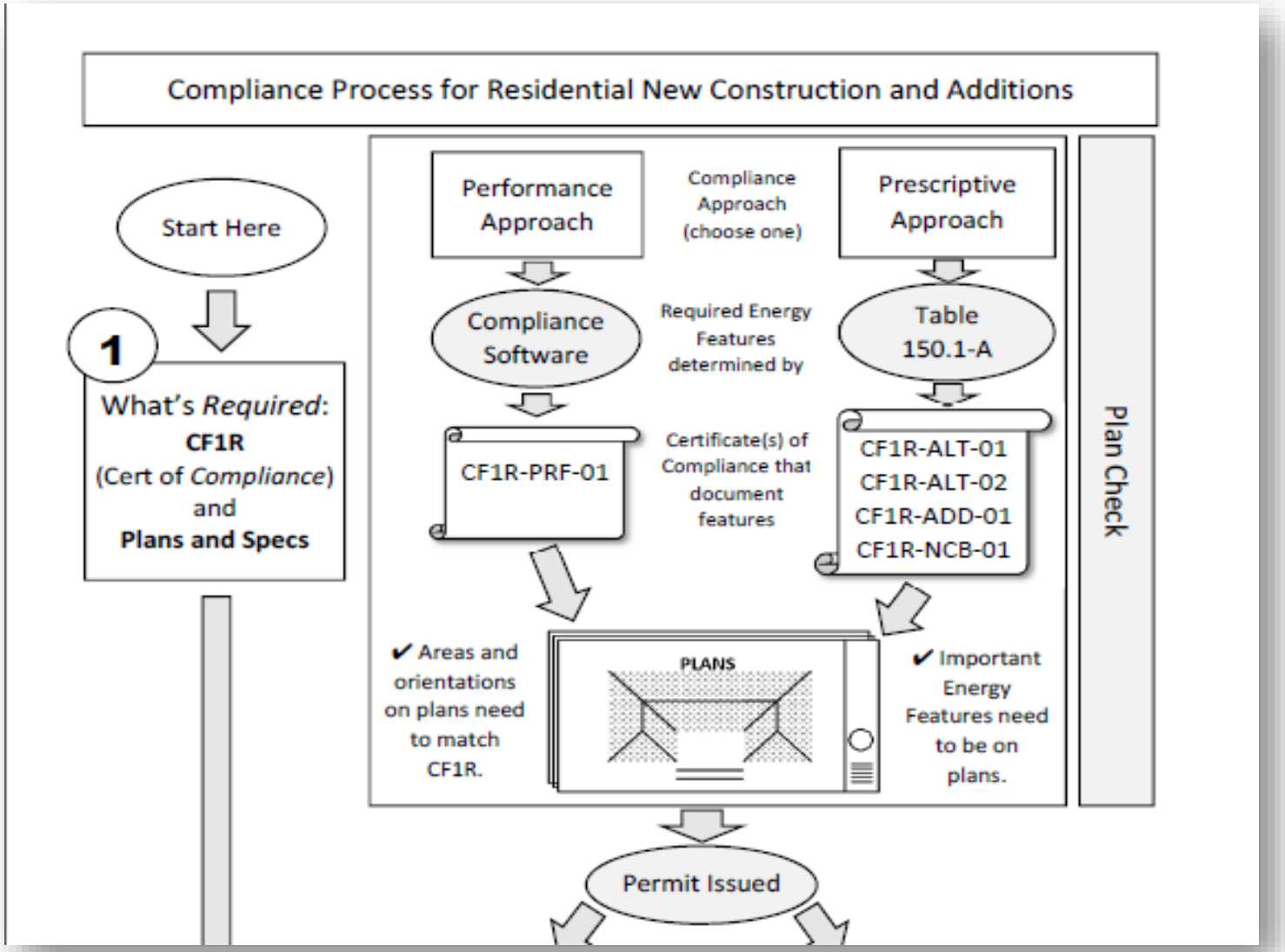
Compliance Process Flow Diagram

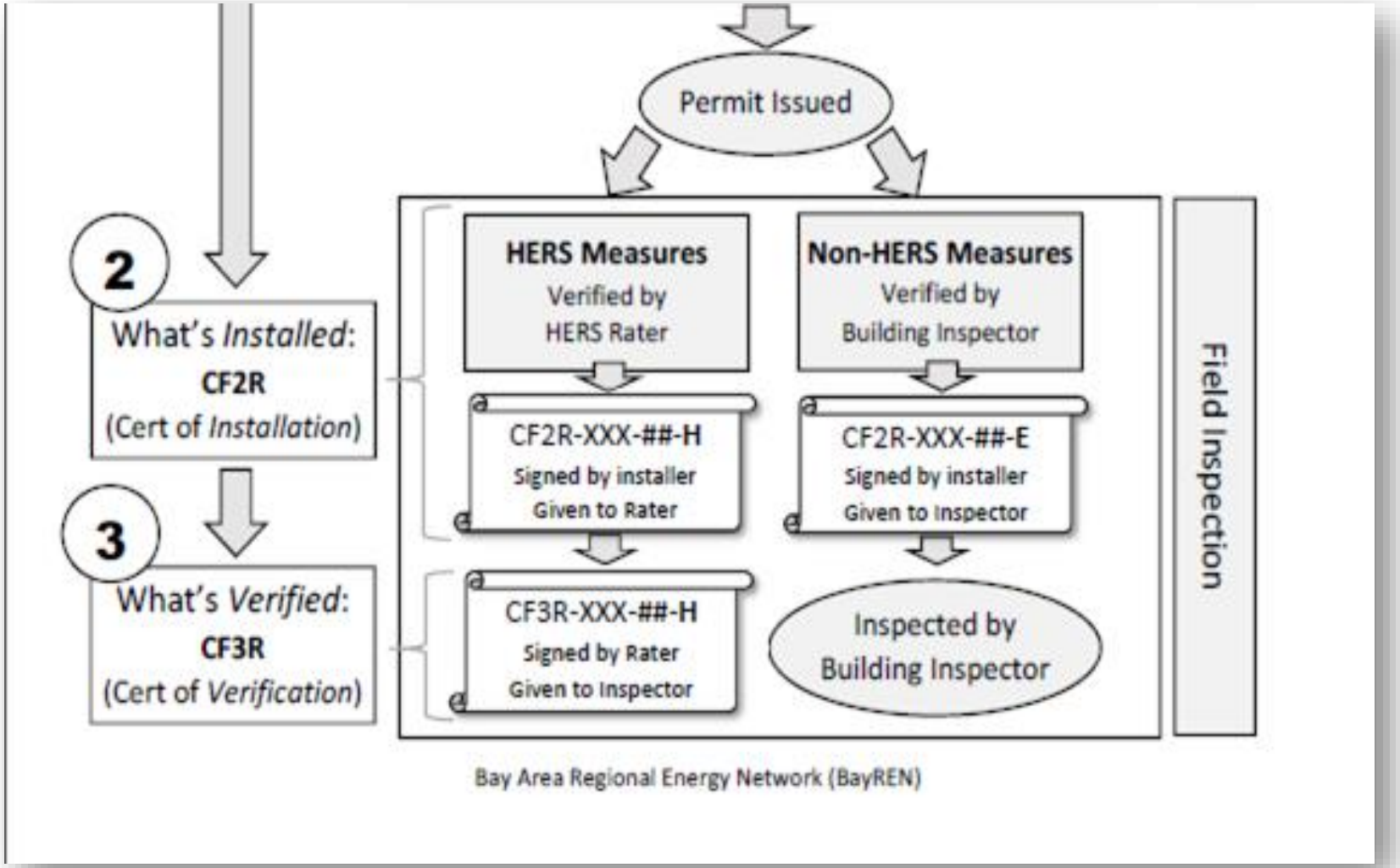
Refer to full-size copy provided with your handouts.



Compliance Process Flow Diagram



Compliance Process Flow Diagram

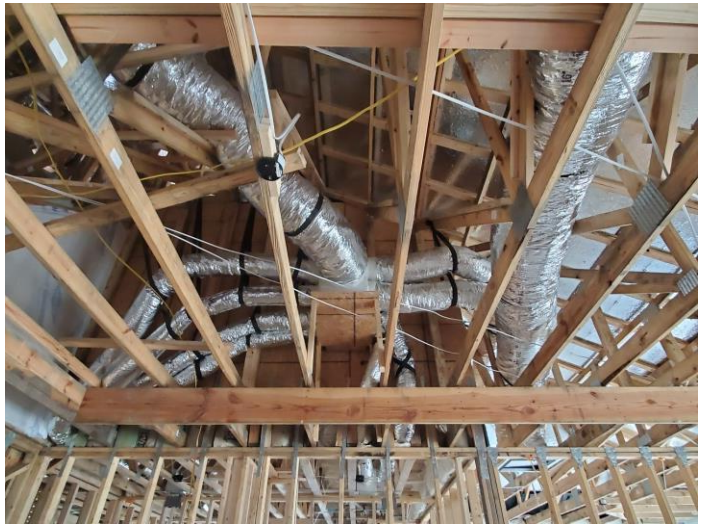


Basic HVAC Compliance Issues

HVAC and the Energy Code

Heating, Ventilation and Air Conditioning

- HVAC covers a wide range of topics when talking about energy use.
- We will focus on heating and cooling energy use here.
- Ventilation (mechanical ventilation for purposes of indoor air quality) is a mandatory measure and well regulated.
- It's important to realize that how much energy a heating and cooling system uses depends on:
  - Its **efficiency,**
  - Its **size,** and
  - How much it **runs.**



See Chapter 4 of the **Residential Compliance Manual** (click here) for more information.

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HVAC and the Energy Code

Efficiency of Equipment

- The Energy Code regulates:
  - Equipment **efficiencies** (SEER, EER, HSPF, AFUE, etc.)
  - System **performance** (airflow, fan watt draw, refrigerant charge)
  - **Distribution efficiency** (duct R-value, duct location, duct leakage)
- Efficiency of HVAC equipment, *regardless of the type*, is well regulated and relatively well enforced.
- Most of these are HERS verified measures.

HVAC and the Energy Code

Size of Equipment (Capacity)

- Equipment capacity depends on
  - the **climate** and
  - the efficiency of the **building envelope**.
- The Energy Code *assumes* that equipment is properly sized according to the loads.
- This is not always the case, which is why enforcement of this part of the code is so important.
- Even the most efficient equipment will waste energy and not maintain comfort if it is not properly sized to the home's loads.

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HVAC and the Energy Code

Size vs. Load vs. System Efficiency

- Many contractors do not do accurate load calculations and then oversize equipment to be “safe”.
- Many people mistakenly believe that oversized equipment will use less energy because it runs less and will maintain better comfort.
- The opposite is true: **Oversized equipment wastes energy and is more prone to comfort problems.**
- Oversized equipment negates all the efforts of enforcing equipment efficiency and building shell measures.

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Energy Code Requirements for Residential HVAC Load Calcs and Duct Design

Why It's Important

Health and Safety

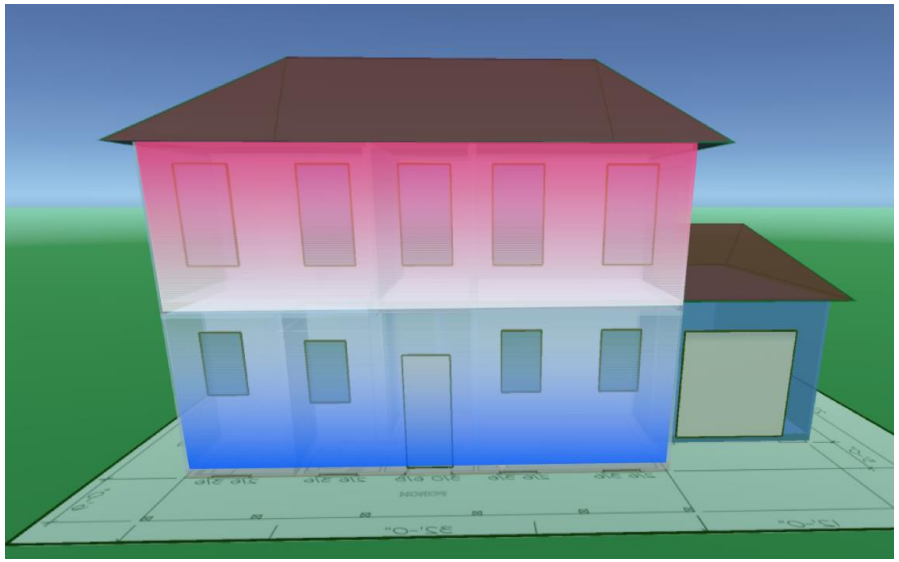
- Adequate heating/cooling during extreme temperatures (CA Mechanical Code)

Energy Efficiency

- Oversized equipment will run at sub-optimal performance
- Undersized ducts reduces airflow, which reduces efficiency **and** capacity.

Comfort

- This is something that homeowners are most likely to complain about.



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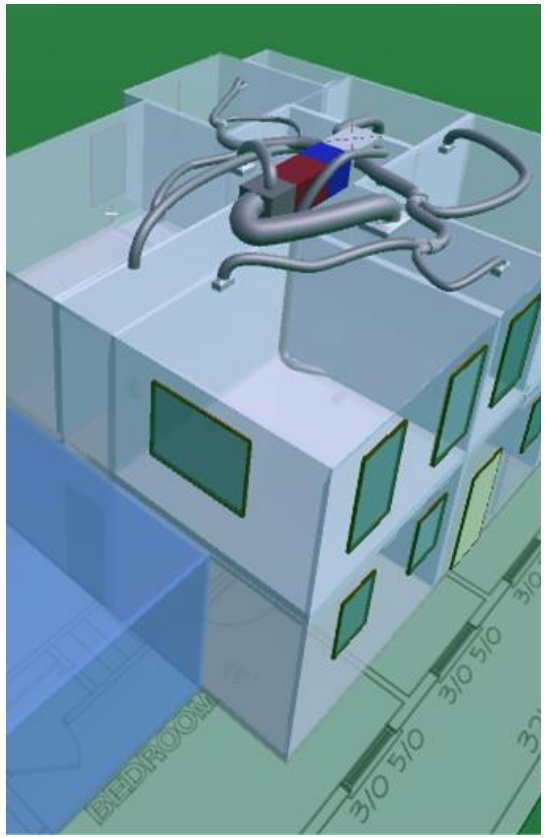
Why It's Important

Equipment Sizing

Load Calculations are critical to properly sized heating and cooling equipment

- ***Undersizing*** may cause the house not to heat or cool well on extreme days.
- ***Oversizing*** can cause excess stratification, uneven temperature distribution. Plus, higher energy use and shortened equipment life.



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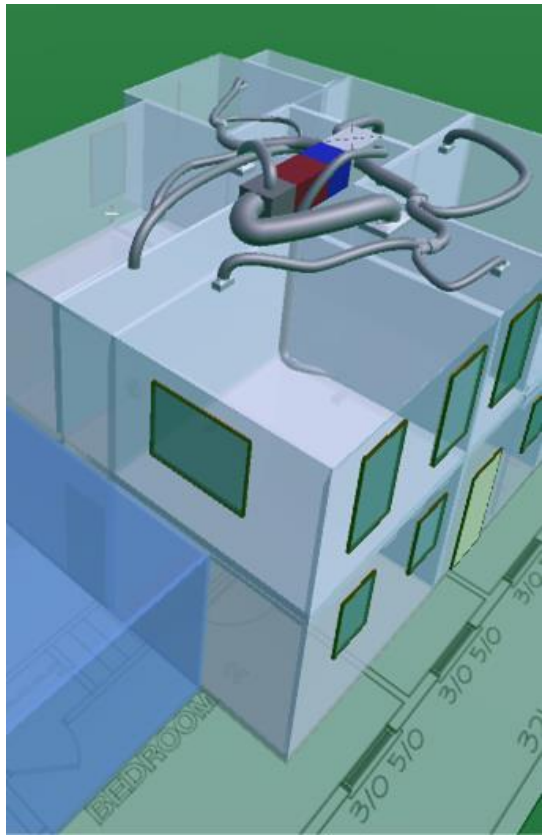
Why It's Important

Equipment Sizing

- ***Undersized Equipment*** will work ***fine*** on milder days (which is most of the time).
- ***Oversized Equipment*** will perform ***worse*** on milder days (which is most of the time).
- ***Oversized Equipment*** will cause **more** comfort complaints than undersized equipment.
- Some of the oversizing problems can be mitigated by variable capacity equipment **if sized correctly.**



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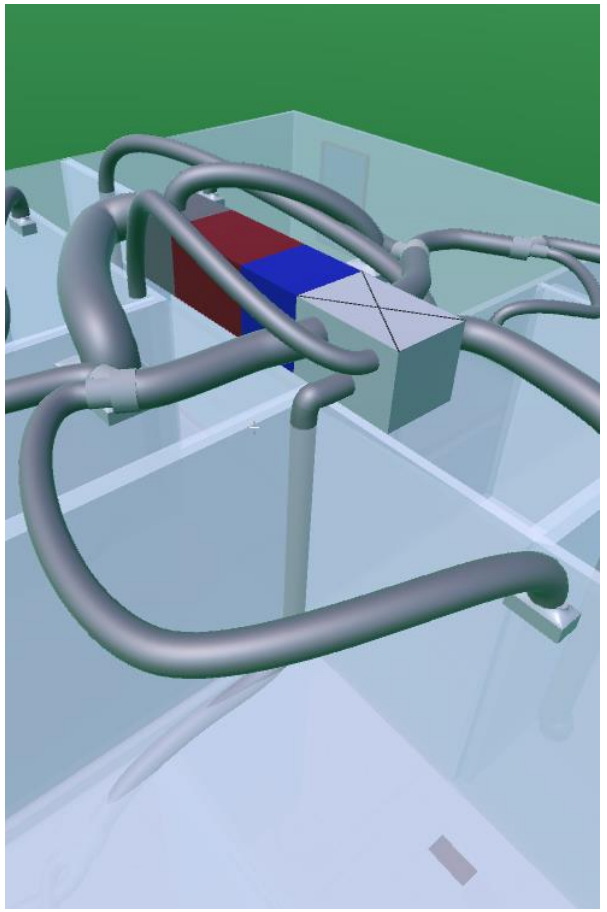
Why It's Important

Duct sizing

- Target room airflows need to be determined from **room-by-room loads** – you need to know what the load of a room is relative to other rooms.
- General undersizing of **all ducts**, especially return ducts, will reduce total system fan flow, which will reduce **capacity and efficiency** of system.



Energy Code: Load Calcs and Duct Design

Load Calcs and Duct Design are rarely done correctly

- Historically, the most common method of equipment sizing was **rules of thumb** and **trial and error**.
- This almost always leads to oversized equipment (and undersized ducts).
- “500 sq ft per Ton” is NOT A LOAD CALCULATION!

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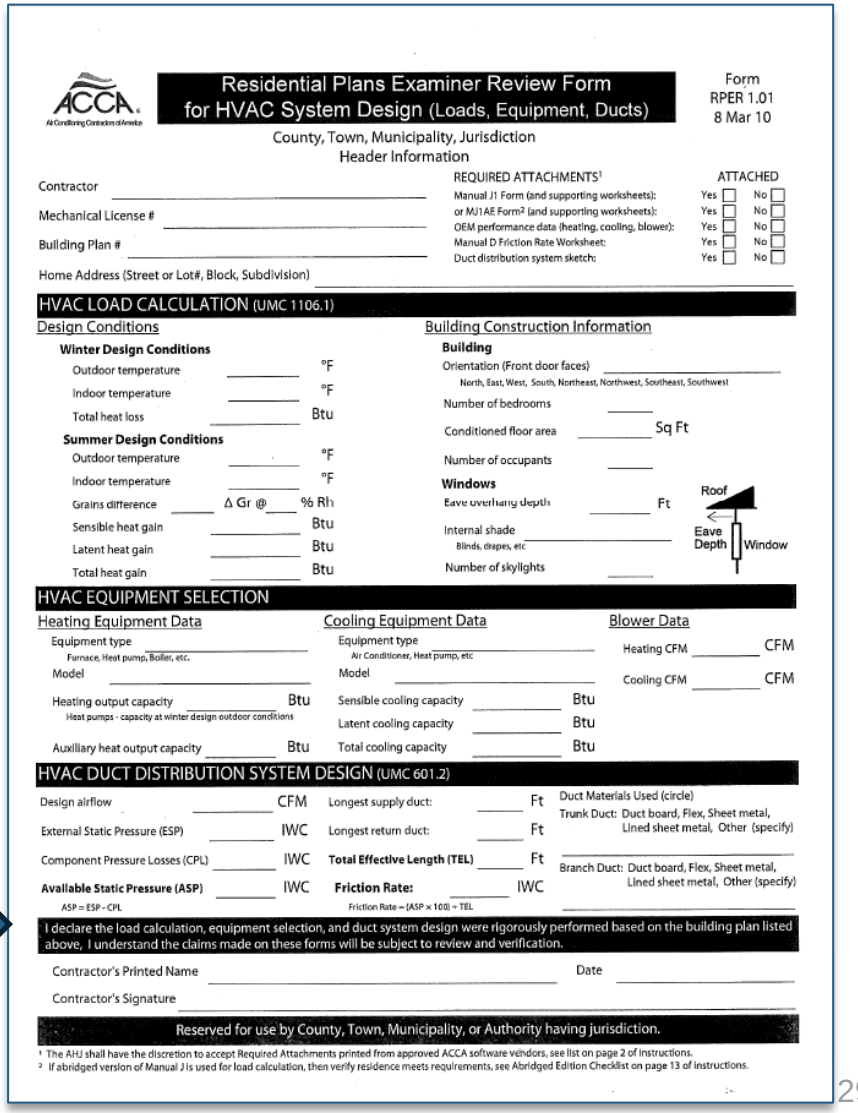
Energy Code: Load Calcs and Duct Design

- The California Mechanical Code 601.2 **<u>requires</u>** ACCA Manual D (or equal) to size residential ducts.
- Manual D specifically requires Manual J and Manual S.
- This requires full design calculations on all new systems whether installed in new homes or existing homes.
- See Review form in Appendix A



ACCA Air Conditioning Contractors of America

Residential Plans Examiner Review Form for HVAC System Design (Loads, Equipment, Ducts)

Form RPER 1.01 8 Mar 10

County, Town, Municipality, Jurisdiction Header Information

Contractor

Mechanical License #

Building Plan #

Home Address (Street or Lot#, Block, Subdivision)

REQUIRED ATTACHMENTS[1] — ATTACHED

- Manual J1 Form (and supporting worksheets): Yes ☐ No ☐
- or MJ1AE Form[2] (and supporting worksheets): Yes ☐ No ☐
- OEM performance data (heating, cooling, blower): Yes ☐ No ☐
- Manual D Friction Rate Worksheet: Yes ☐ No ☐
- Duct distribution system sketch: Yes ☐ No ☐

HVAC LOAD CALCULATION (UMC 1106.1)

Design Conditions

Winter Design Conditions

- Outdoor temperature ____ °F
- Indoor temperature ____ °F
- Total heat loss ____ Btu

Summer Design Conditions

- Outdoor temperature ____ °F
- Indoor temperature ____ °F
- Grains difference ____ Δ Gr @ ____ % Rh
- Sensible heat gain ____ Btu
- Latent heat gain ____ Btu
- Total heat gain ____ Btu

Building Construction Information

Building

- Orientation (Front door faces) (North, East, West, South, Northeast, Northwest, Southeast, Southwest)
- Number of bedrooms
- Conditioned floor area ____ Sq Ft
- Number of occupants

Windows

- Eave overhang depth ____ Ft
- Internal shade (Blinds, drapes, etc)
- Number of skylights

Roof, Eave Depth, Window

HVAC EQUIPMENT SELECTION

Heating Equipment Data

- Equipment type (Furnace, Heat pump, Boiler, etc.)
- Model
- Heating output capacity ____ Btu (Heat pumps - capacity at winter design outdoor conditions)
- Auxiliary heat output capacity ____ Btu

Cooling Equipment Data

- Equipment type (Air Conditioner, Heat pump, etc)
- Model
- Sensible cooling capacity ____ Btu
- Latent cooling capacity ____ Btu
- Total cooling capacity ____ Btu

Blower Data

- Heating CFM ____ CFM
- Cooling CFM ____ CFM

HVAC DUCT DISTRIBUTION SYSTEM DESIGN (UMC 601.2)

- Design airflow ____ CFM
- External Static Pressure (ESP) ____ IWC
- Component Pressure Losses (CPL) ____ IWC
- **Available Static Pressure (ASP)** ____ IWC (ASP = ESP - CPL)
- Longest supply duct: ____ Ft
- Longest return duct: ____ Ft
- **Total Effective Length (TEL)** ____ Ft
- **Friction Rate:** ____ IWC (Friction Rate = (ASP x 100) ÷ TEL)

Duct Materials Used (circle)

Trunk Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify)

Branch Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify)

I declare the load calculation, equipment selection, and duct system design were rigorously performed based on the building plan listed above. I understand the claims made on these forms will be subject to review and verification.

Contractor's Printed Name ____ Date ____

Contractor's Signature ____

Reserved for use by County, Town, Municipality, or Authority having jurisdiction.

[1] The AHJ shall have the discretion to accept Required Attachments printed from approved ACCA software vendors, see list on page 2 of instructions.

[2] If abridged version of Manual J is used for load calculation, then verify residence meets requirements, see Abridged Edition Checklist on page 13 of instructions.

Energy Code: Load Calcs and Duct Design

- The California Energy Code **requires** ACCA Manual J (or equal) for all ***new*** residential HVAC systems, whether in a new house or an existing house. [Section 150.0(h)1, Mandatory Measures]
- The California Green Building Standards Code (CalGreen) requires ACCA Manuals J/S/D (section 4.507.2)
- This has been a code requirement since 2013.
- HVAC contractors should be doing it anyway! But they are not.

SECTION 4.507
ENVIRONMENTAL COMFORT

4.507.1 Reserved.

4.507.2 Heating and air-conditioning system design. Heating and air-conditioning systems shall be sized, designed and have their equipment selected using the following methods:

1. The heat loss and heat gain is established according to ANSI/ACCA 2 Manual J—2016 (*Residential Load Calculation*), ASHRAE handbooks or other equivalent design software or methods.
2. Duct systems are sized according to ANSI/ACCA 1 Manual D—2016 (*Residential Duct Systems*), ASHRAE handbooks or other equivalent design software or methods.
3. Select heating and cooling equipment according to ANSI/ACCA 3 Manual S—2014 (*Residential Equip-*

Energy Code: Load Calcs and Duct Design

150.0(h) **Space-Conditioning Equipment.**

1. **Building Cooling and Heating Loads.** Building heating and cooling loads shall be determined using a method based on any one of the following:

- A. The ASHRAE Handbook, Equipment Volume, Applications Volume, and Fundamentals Volume; or
- B. The SMACNA Residential Comfort System Installation Standards Manual; or
- C. The ACCA Manual J.

The cooling and heating loads are two of the criteria that shall be used for equipment sizing and selection.

NOTE: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC. The furnace output capacity and other specifications are published in the Commission's directory of certified equipment or other directories approved by the Commission.

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Energy Code: Load Calcs and Duct Design

150.0(h) **Space-Conditioning Equipment.**

2. **Design conditions**. For the purpose of sizing the space-conditioning (HVAC) system, the indoor design temperatures shall be 68°F for heating and 75°F for cooling. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE Climatic Data for Region X. The outdoor design temperatures for heating shall be no lower than the Heating Winter Median of Extremes values. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

Joint Appendix JA2

2019 Joint Appendices

				Cooling												Heating		
				0.10%		0.50%		1.00%		2.00%								
City	Latitude	Elevation (ft)	Longitude	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	Design Wetbulb 0.1%	Design Wetbulb 0.5%	Outdoor Daily Range	Winter Median of Extremes	Design Drybulb (0.2%)	Design Drybulb (0.6%)	HDD*
Lomita	33.8	56	119	95	69	87	68	85	68	81	66	71	69	18	33	38	40	
Lompoc	34.9	95	120.5	84	63	77	62	76	62	72	60	65	63	18	26	31	34	2888
Long Beach	33.7	34	118.2	97	70	88	68	86	67	82	65	65	63	18	35	31	34	
Long Beach AP	33.8	25	118.2	99	71	90	69	88	68	84	66	73	71	21	33	38	41	1606
Loomis	38.8	408	121.2	107	71	103	70	102	70	98	69	74	72	39	21	27	30	
Los Alamitos NAS	33.8	30	118.1	98	71	89	69	87	69	83	68	73	71	23	32	37	39	1740
Los Altos	37.3	163	122	96	68	88	65	86	64	80	62	70	68	26	28	33	35	
Los Altos Hills	37.3	183	122.1	93	67	85	64	83	64	77	63	68	66	25	28	33	35	1103

Energy Code: Load Calcs and Duct Design

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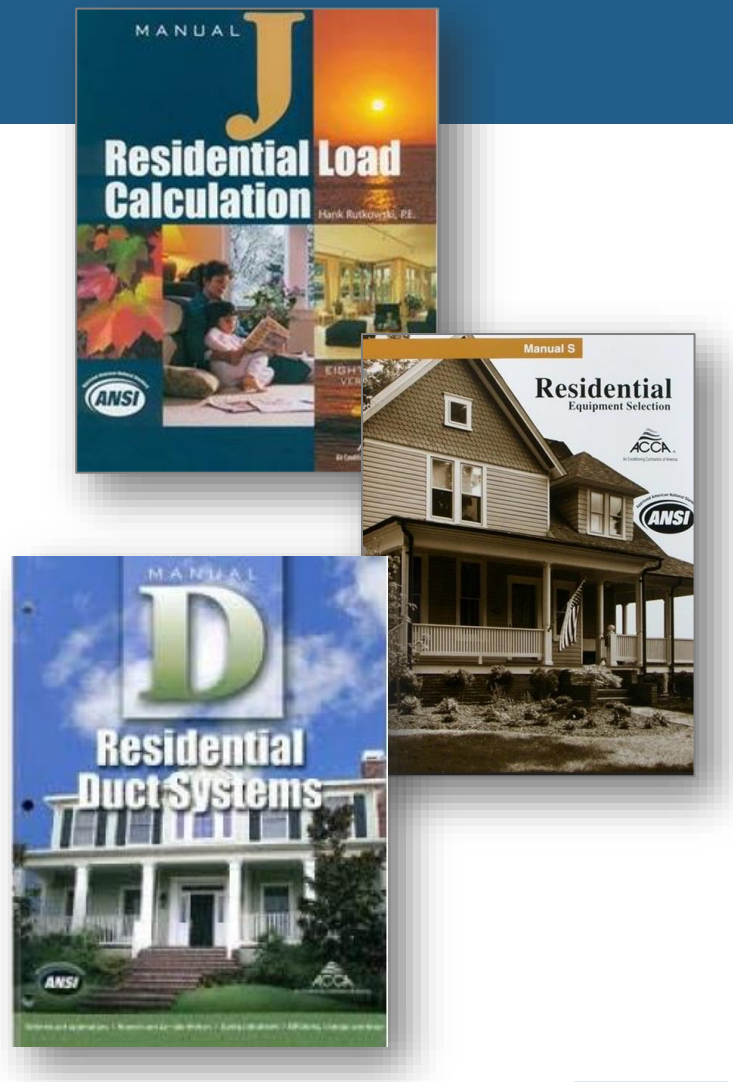
ACCA Manuals

About ***ACCA Manuals J/S/D***

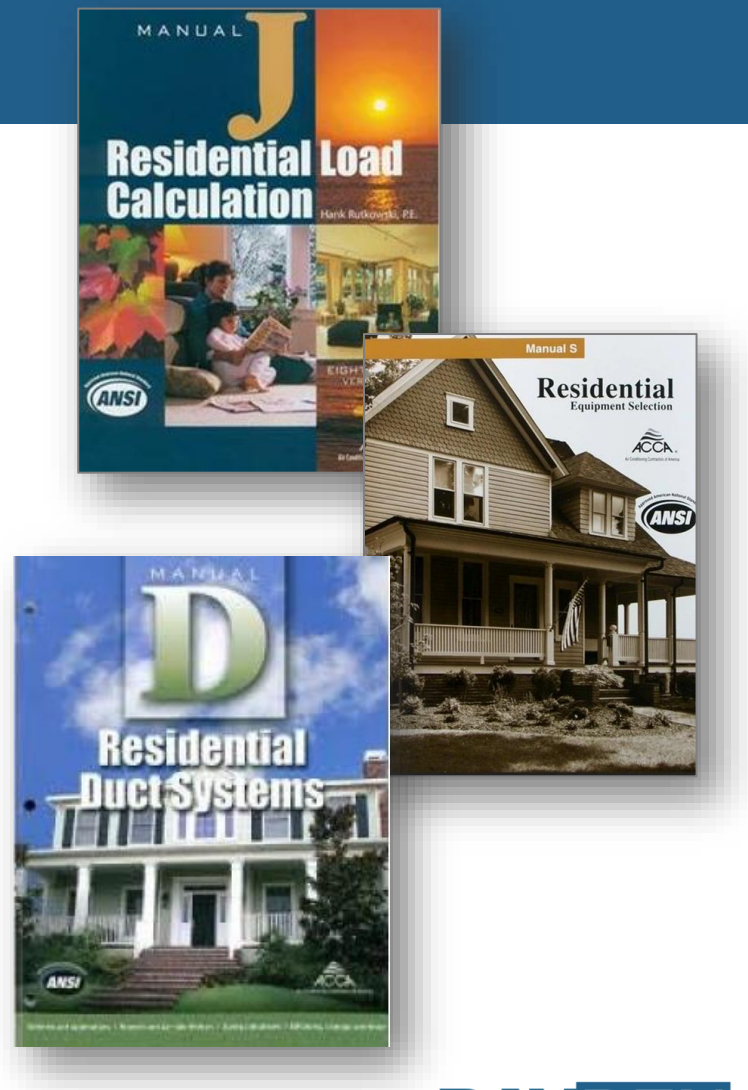
- ACCA is **Air Conditioning Contractors of America**, the largest HVAC trade association in the United States.
- They write and publish ANSI approved manuals on residential and nonresidential HVAC design
- Widely recognized as the industry standard for residential HVAC design (though not the only recognized standard).
- Adopted into most codes.



ACCA Manuals

Basic Design Manuals

- Manual J – Residential Load Calculations
- Manual S – Equipment Selection
- Manual D – Duct Design



www.acca.org

Approved Software

Powered by ACCA Manual J - Full Residential Load Calculation

(Supports Block Load™, Room-by-Room Load™, Zone-by-Zone™ and Adequate Exposure Diversity™ or AED™ Calculations)

Wrightsoft Right-J8	Windows
Elite RHVAC	Windows
Adtek Acculoads	Windows
Florida Solar Energy Center's EnergyGauge	Windows
Carmelsoft HVAC ResLoad-J	iPad
Avenir MJ8 Editions of HeatCAD and LoopCAD	Windows
Cool Calc Manual J	Browser

Screenshot from:

https://www.acca.org/standards/approved-software

Look for this logo on software reports

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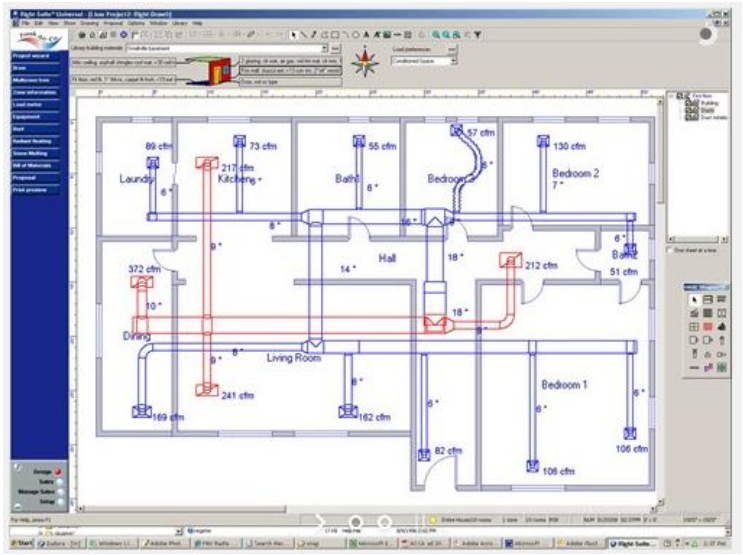
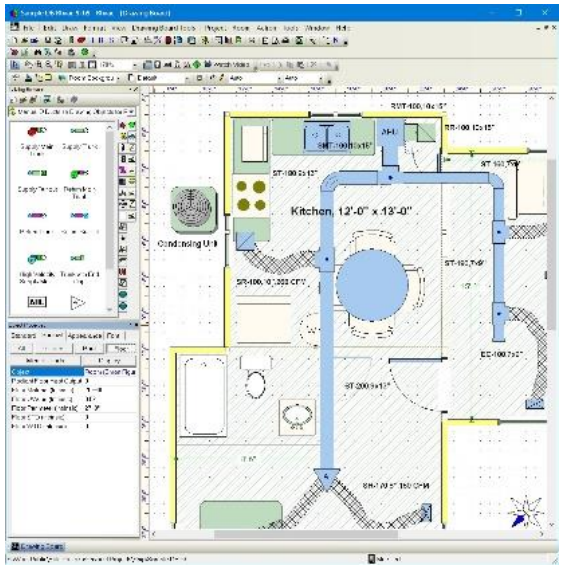
Approved Software

Examples of full Manual J/S/D software

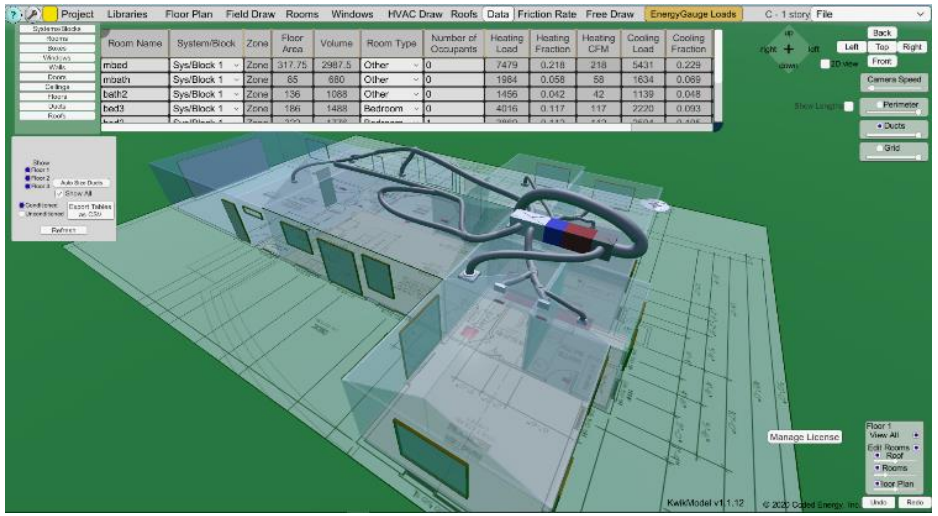
Right-Suite® by Wrightsoft



RHVAC by Elite Software



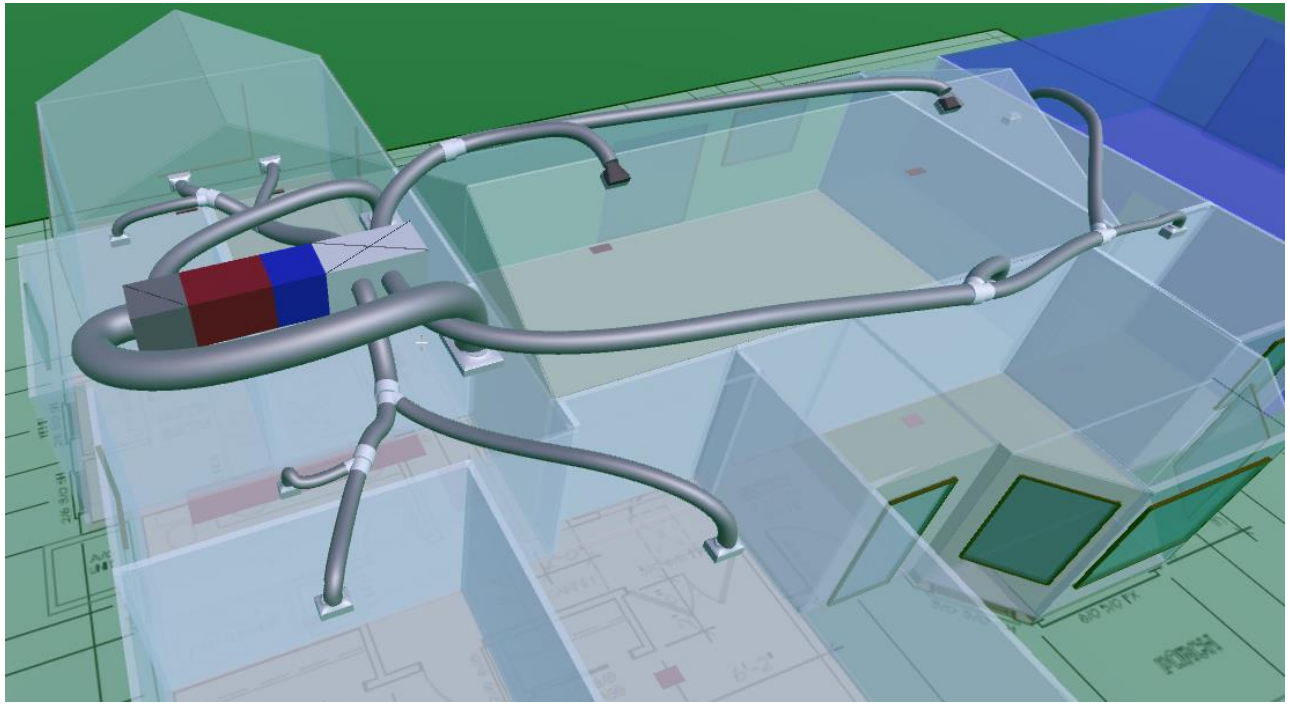
Kwik Model® with *EnergyGauge Loads*



Residential HVAC Design Basics

HVAC Design Basics

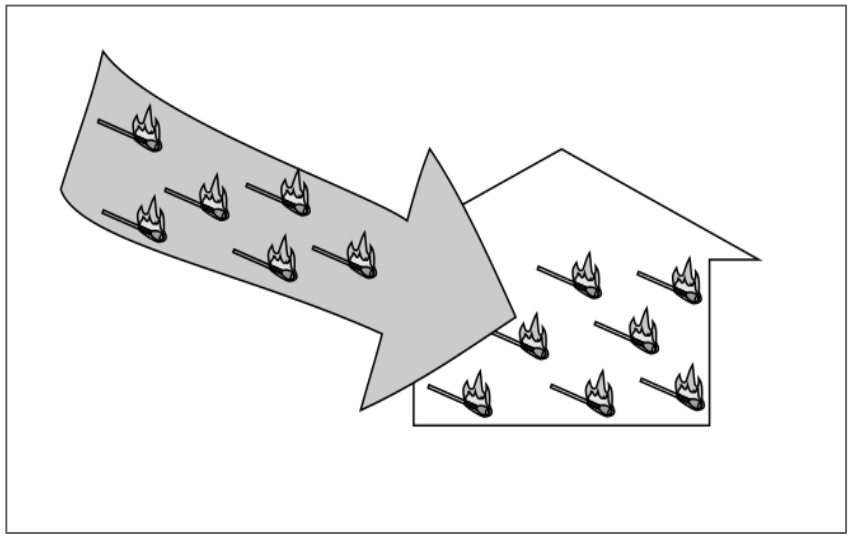
- Definitions
- The Basic Steps
- Special Topic: Heat Pumps
- Example Project

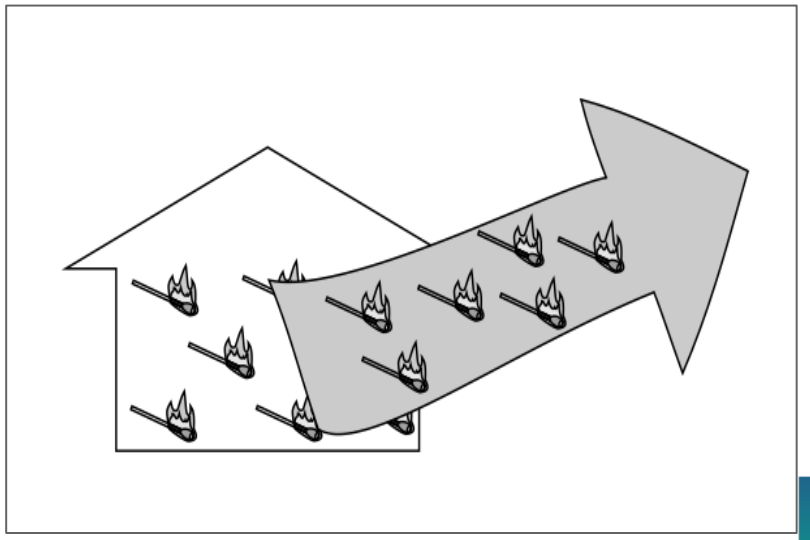


Residential HVAC Design Basics

To maintain a **constant temperature** in a house the rate of heat coming in must **equal** the rate of heat going out.

1 Btu = 1 kitchen match





Images from *HVAC 1.0 – Introduction to Residential HVAC Systems*

Residential HVAC Design Basics

Definitions

The **capacity** of the heating or cooling equipment is the *output* of the equipment in BTUs per hour. Think of it as the ***supply***.

The **load** of the house is what the house *needs* in BTUs per hour to maintain a constant temperature at design conditions. Think of it as the ***demand***.

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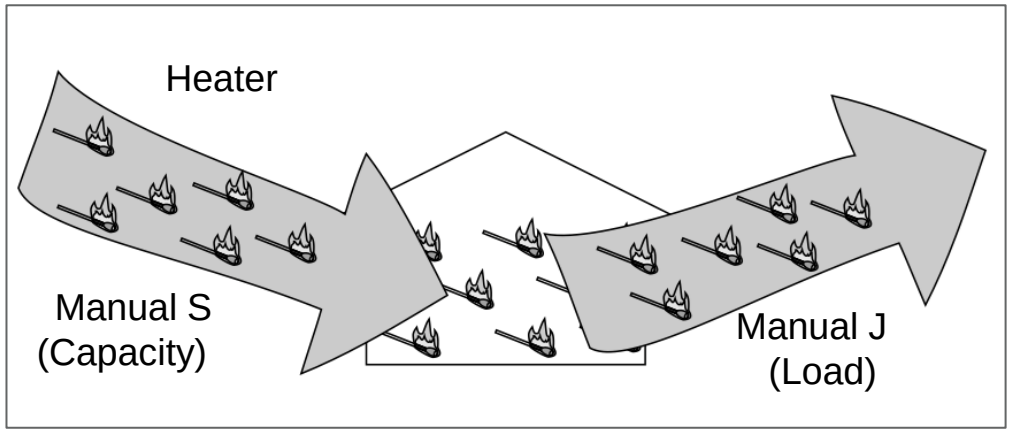
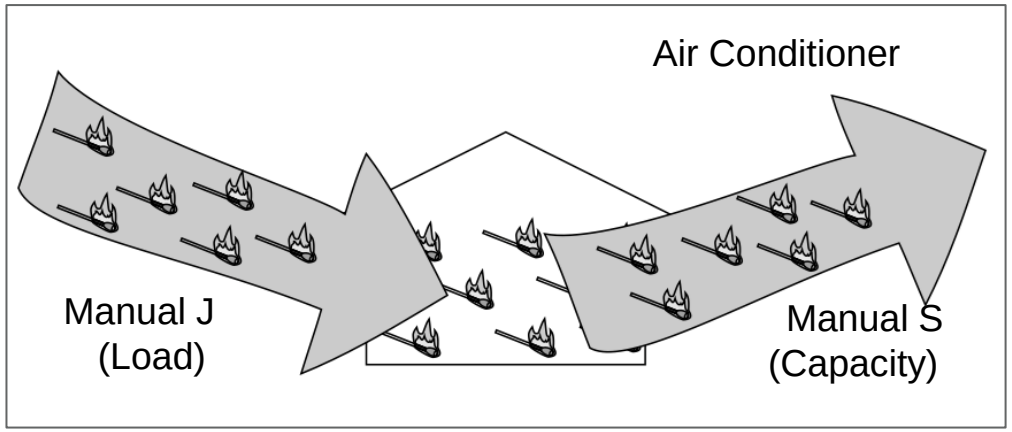
Residential HVAC Design Basics

Good equipment sizing is the ability to match the equipment's supply to the house's demand.

Winter (Heating)



Summer (Cooling)



Images from *HVAC 1.0 – Introduction to Residential HVAC Systems*

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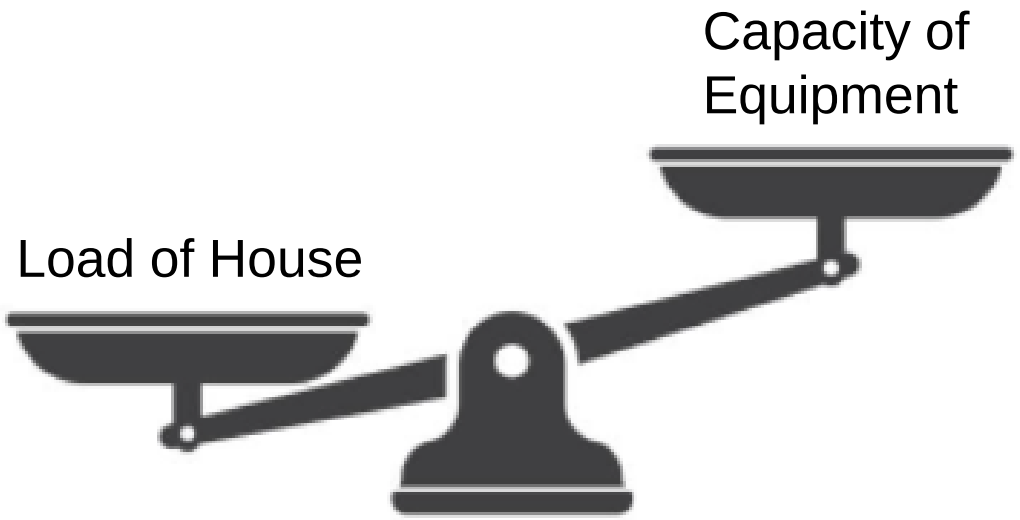
Residential HVAC Design Basics

Definitions

Undersizing is defined as when the *capacity* of the equipment is less than the *load* of the house at design conditions.

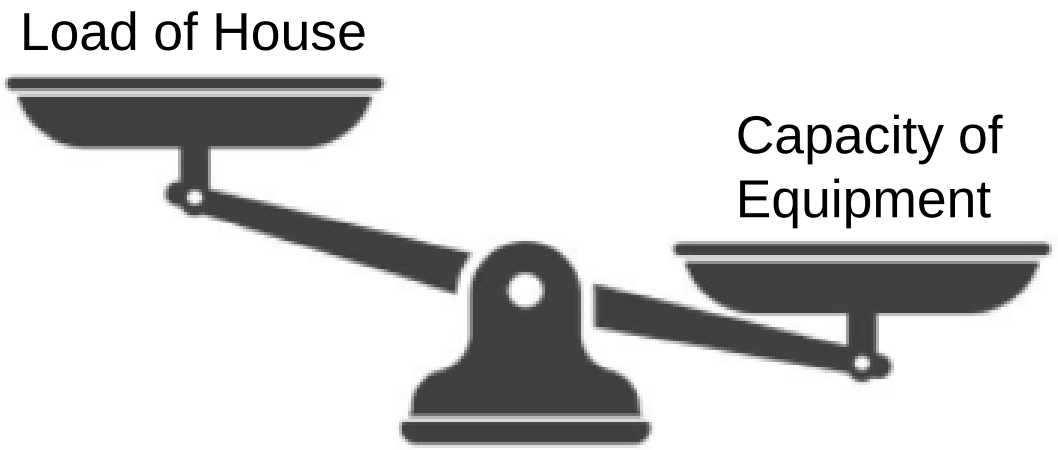


Residential HVAC Design Basics

Definitions

Oversizing is defined as when the *capacity* of the equipment is substantially higher than the *load* of the house at design conditions.

Manual S sets some guidelines for maximum oversizing and undersizing of equipment.



Residential HVAC Design Basics

Definitions

Design conditions are the specified indoor and outdoor temperatures at which the loads are calculated.

- These are not the *very worst* temperatures expected each summer or winter.
- It would not be wise to design to such temperatures because these rarely occur.
- The system needs to also work at milder conditions.
- If we design to really bad conditions, the equipment would be oversized for most of the season.

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Residential HVAC Design Basics

Design Conditions

- The difference between the indoor design temperature and the outdoor design temperature is referred to as the “Delta T”.
- There is a delta T for the summer and a delta T for the winter.

Overview of HVAC Design Process

The Process

The basic steps in ***designing*** a typical ducted central system for a home are:

1. **Collect** information about the house (plans)
2. **Perform** *room-by-room* load calculations (ACCA Manual J)
3. **Select** equipment to meet the total loads (ACCA Manual S)
4. **Design** the distribution system (ACCA Manual D)

- This can be time consuming and expensive.
- Many contractors simply don't know how to do it.
- Most utilities offer free training.

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Special Topic: Heat Pump HVAC Systems

What is a Heat Pump?

- Heat pumps are electric heaters.
- Rather than using electricity to **create** heat like electric resistance heaters, they use a compressor and refrigerant to condense and **move** heat.
- **It takes MUCH less energy to move heat than to create it.**
- This is what makes heat pumps super efficient and cost effective – even compared to gas.

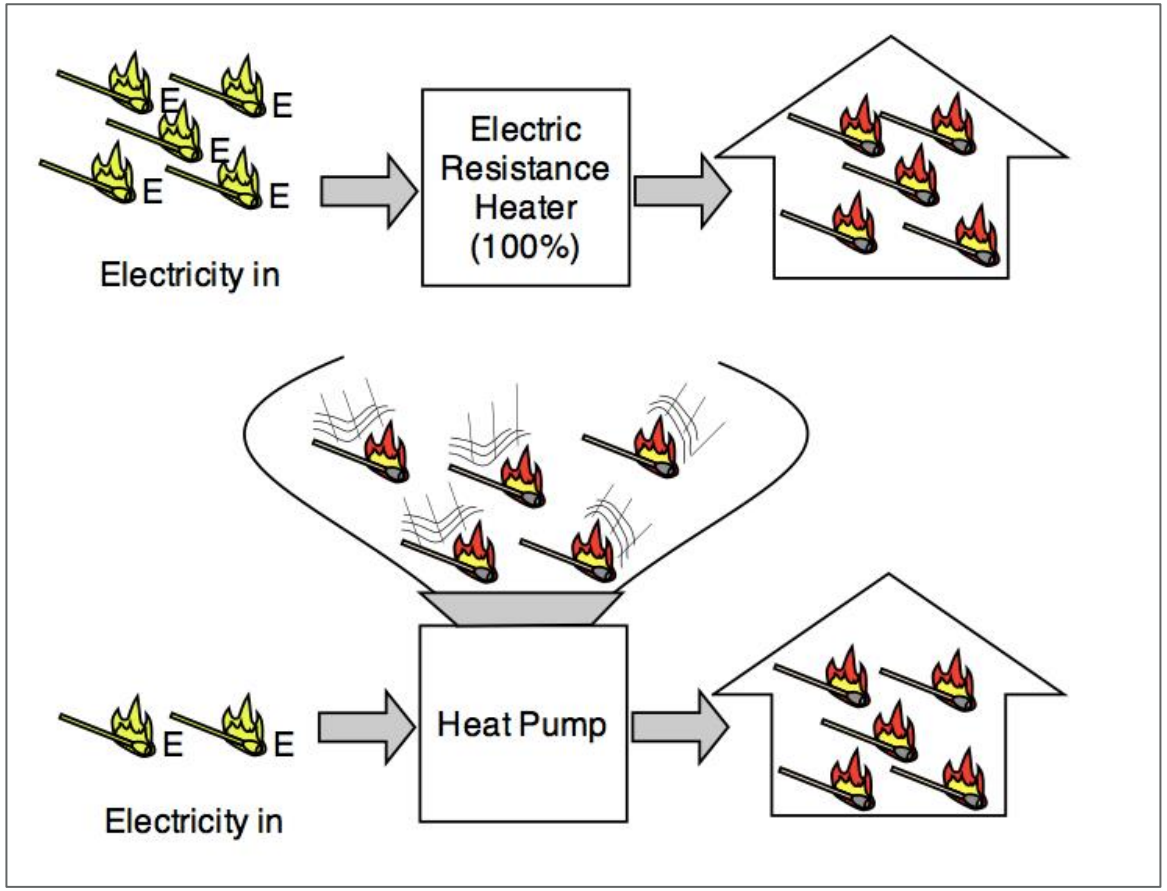

Image from *HVAC 1.0 – Introduction to Residential HVAC Systems*

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Special Topic: Heat Pump HVAC Systems

- Improved controls and electric motor technology has greatly improved the efficiency and performance of heat pumps.
- Heat pump technology has been used in other countries for much longer than in the US.
- Even so, heat pumps are particularly susceptible to bad design issues: oversizing, undersizing, airflow issues

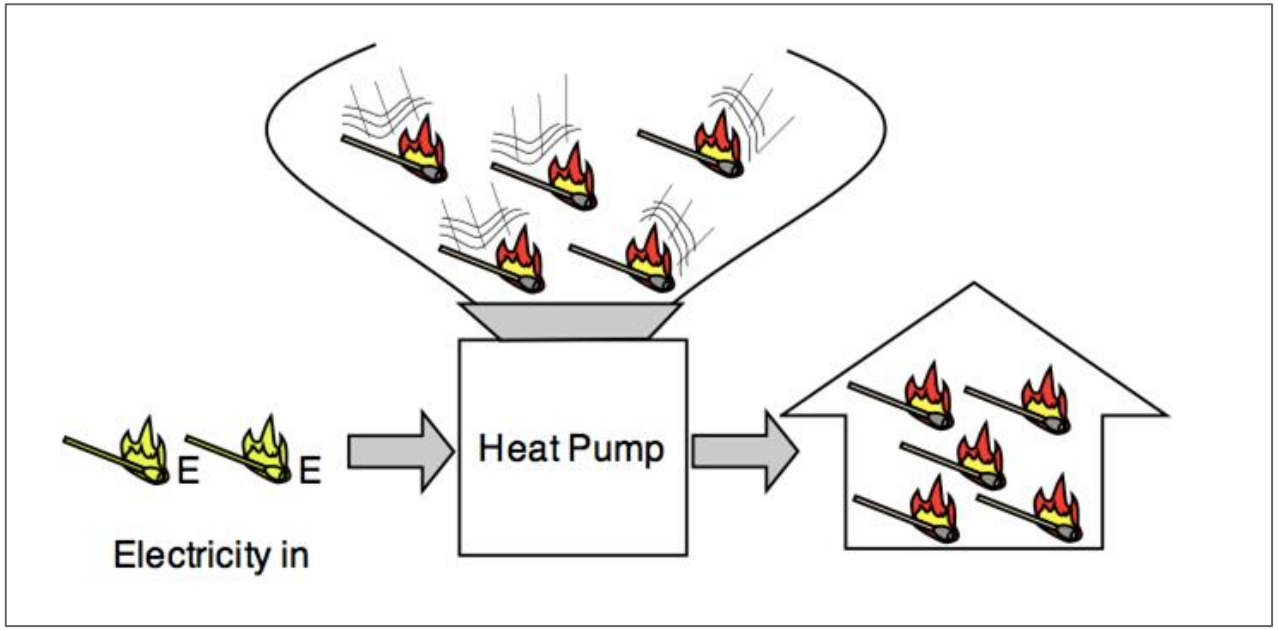
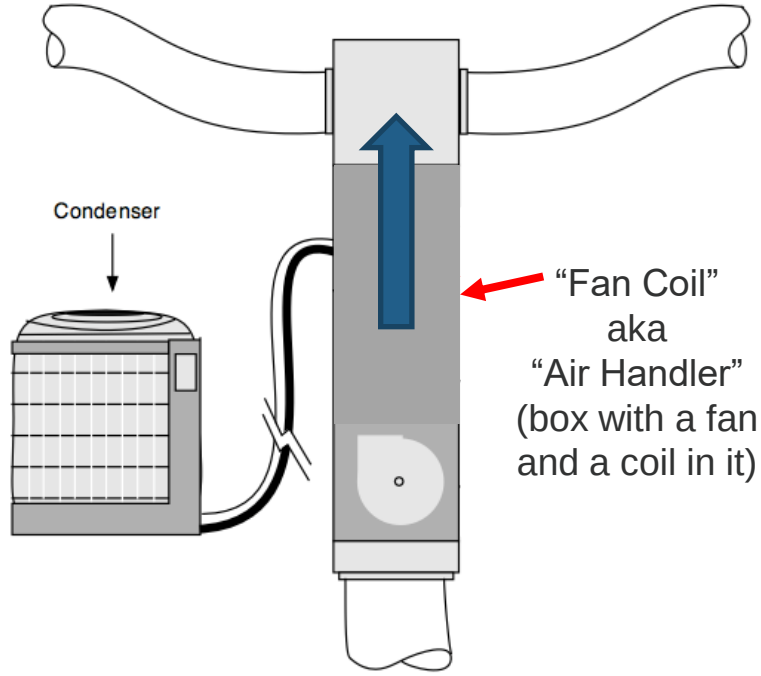


Image from *HVAC 1.0 – Introduction to Residential HVAC Systems*

Special Topic: Heat Pump HVAC Systems

Heat pumps come in a variety of configurations:

- Typical split (ducted) systems have been around for years and resemble standard gas furnace central systems.
- They have a “Fan coil unit” instead of a gas furnace and evaporator coil.
- No gas lines, no flue vents, no combustion air needed.
- MUCH safer than gas furnaces.



A Typical Split System Heat Pump

Image from *HVAC 1.0 – Introduction to Residential HVAC Systems*

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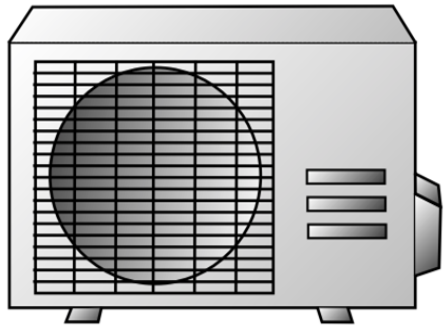
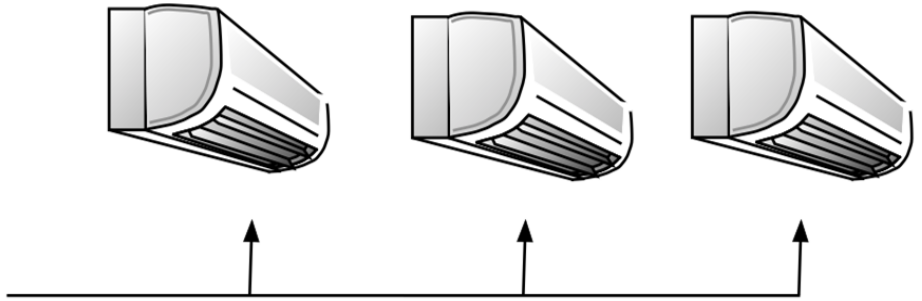
Special Topic: Heat Pump HVAC Systems

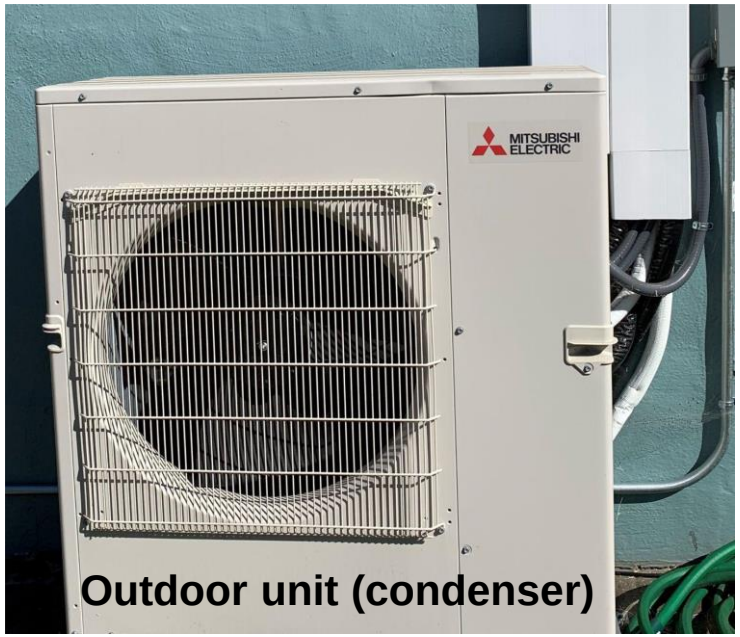
Ductless “Mini-Splits” –
Single head or multi-head



Outdoor Unit (Condenser)



Ductless Indoor Units (Heads)



Outdoor unit (condenser)

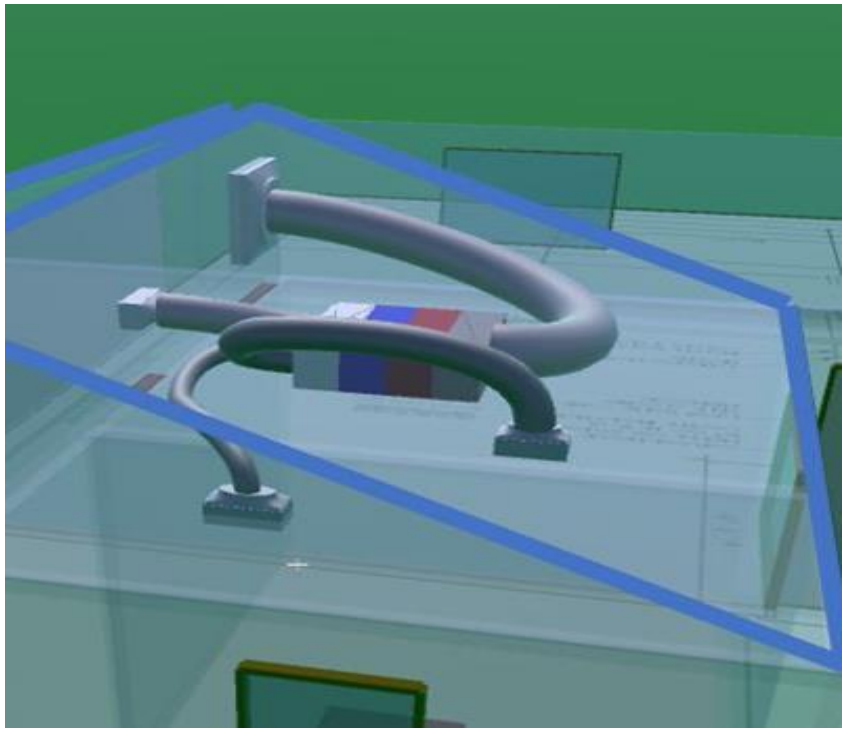
Wall Cassette (ductless)

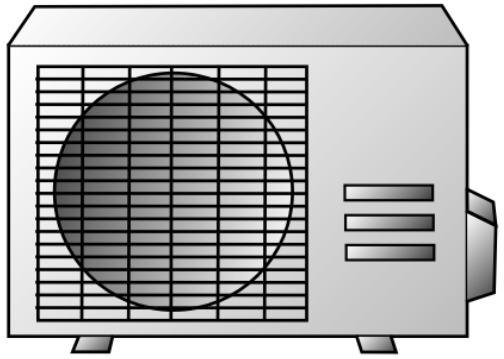
Ceiling Cassette (ductless)

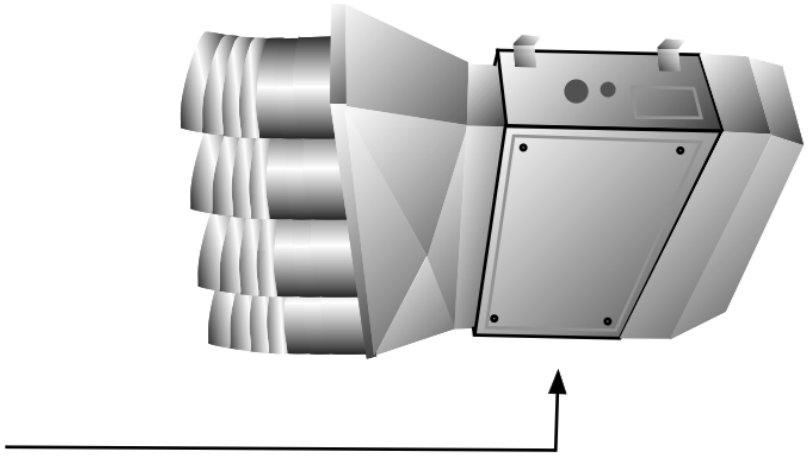
Special Topic: Heat Pump HVAC Systems

Ducted “Mini-Splits” –

Single head or multi-head







Outdoor Unit (Condenser)

Ducted Indoor Unit

Ducted and ductless heads can be mixed on multi-head condensers.

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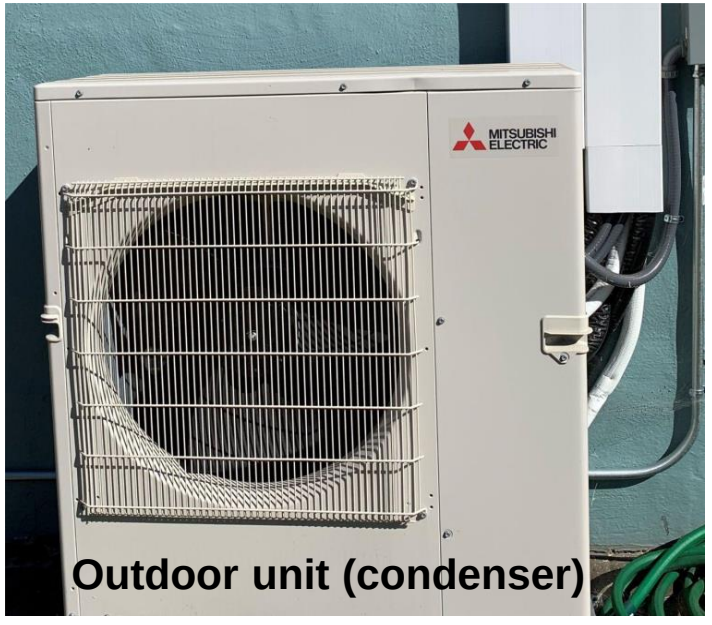
Special Topic: Heat Pump HVAC Systems

Enforcement:

- ✓ Make sure that the **type** of heat pump that was required on the CF1R matches what is installed.
- ✓ Make sure **load and duct design** calculations are submitted and checked.
- ✓ Note if a special new construction credit called **Variable Capacity Heat Pump (VCHP) Credit** is taken. This triggers extra HERS tests.
- ✓ Make sure all **CF2R-MCH and CF3R-MCH** forms get registered (green dot in HERS registry)

Wall Cassette (ductless)



Outdoor unit (condenser)

Energy Code Compliance Documents

Forms Needed to Verify Good HVAC Design

Prescriptive Approach – Existing homes and smaller additions

- CF1Rs:
  - CF1R-ALT-02 – HVAC Alterations to Existing Homes
  - CF1R-ADD-01– Prescriptive Additions (covers everything but HVAC)
- CF2Rs:
  - **CF2R-MCH-01-E – Make/Model, Type and Efficiencies (all projects)**
  - CF2R-MCH-20-H – Duct Leakage testing (most ducted systems)
  - CF2R-MCH-22-H – Fan Efficacy (all new ducted systems, or MCH-28)
  - CF2R-MCH-23-H – Airflow (all new ducted systems, or MCH-28)
  - CF2R-MCH-25-H – Refrigerant Charge Verification (all AC systems in CZs 2, 8-15)
  - CF2R-MCH-28-H – Return Duct Sizing (alternative to MCH-22 and MCH-23)
- CF3Rs: Same as all the "-H" CF2Rs, above

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Forms Needed to Verify Good HVAC Design

Performance Approach – New homes and larger additions

- CF1R-PRF-01 (All Performance Projects)
- CF2Rs: all required CF2Rs will be specifically called out on CF1R-PRF-01
  - **CF2R-MCH-01-E – Make/Model, Type and Efficiencies**
  - CF2R-MCH-20-H – Duct Leakage testing
  - CF2R-MCH-21-H – Duct Location Verification
  - CF2R-MCH-22-H – Fan Efficacy
  - CF2R-MCH-23-H – Airflow
  - CF2R-MCH-25-H – Refrigerant Charge Verification
  - CF2R-MCH-26-H – Rated Equipment Verification and heat pump heating capacities
  - CF2R-MCH-28-H – Return Duct Sizing
  - CF2R-MCH-29-H – Duct Surface Area Reduction, Special Duct Credits
- CF3Rs: same as all the "-H" CF2Rs, above

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Other Documents

Other documents (See “Load Calc and Duct Design Checklist”)

- Plans
  - Can be schematic (Not the same as a full “mechanical plan”)
  - Need to show duct sizes and layout clearly.
  - Should show reasonable representation of rooms and floor plan
- Calculations
  - Confirm approved method. Look for “Powered by ACCA J” logo on software.
  - Energy Pro compliance software does an ASHRAE based load.
  - Loads Summary page(s)
  - Detailed room-by-room loads
- Equipment Specifications
  - Make/model
  - AHRI Test Capacities
  - Design capacities

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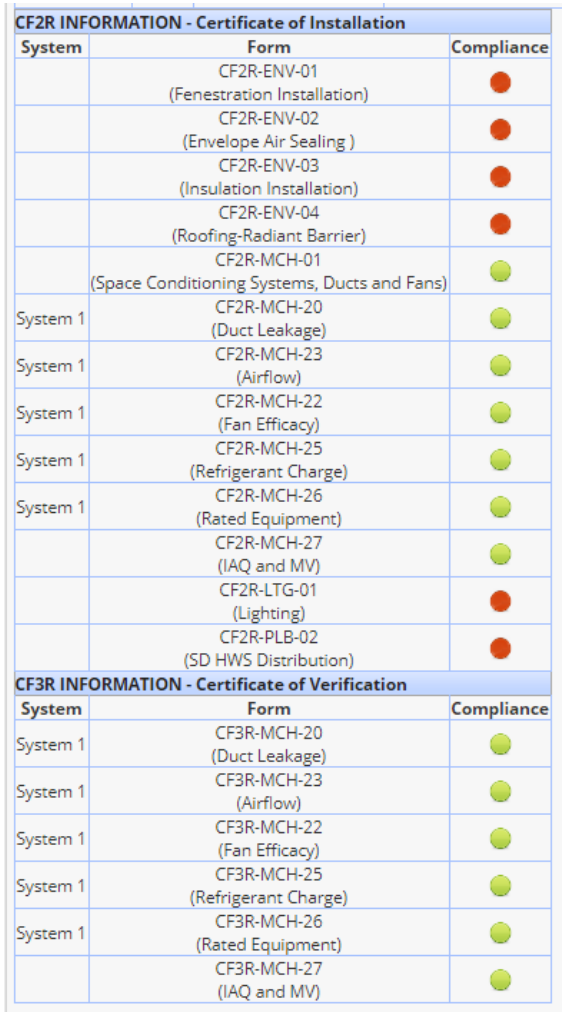
Use HERS Registry to Track Forms

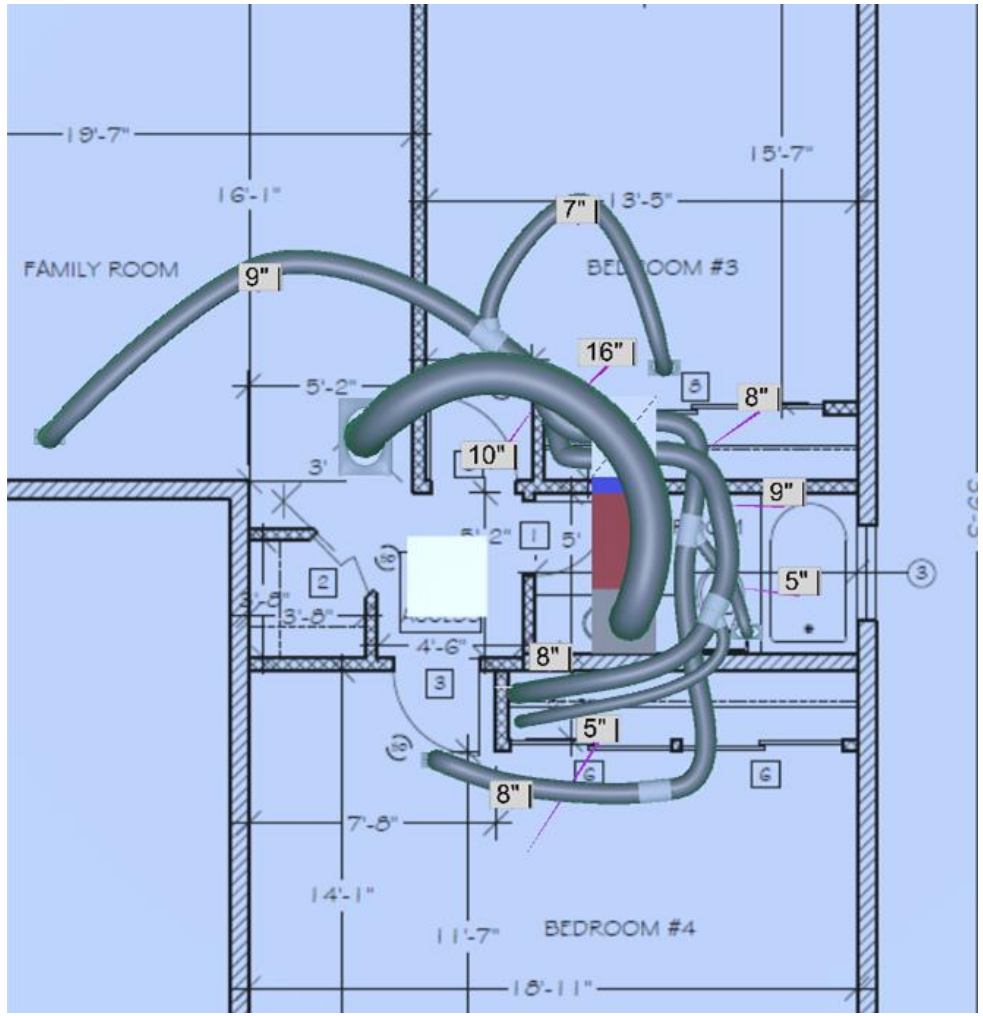
- Login to the HERS provider registry to check the status of any project *that requires HERS Verification*.
- Projects are *searchable* by registration number, address, or permit number.
- ***Use the Project Status Report***
- BayREN has a class specifically on how to get the most out of a HERS registry.



CF2R INFORMATION - Certificate of Installation		
System	Form	Compliance
	CF2R-ENV-01 (Fenestration Installation)	
	CF2R-ENV-02 (Envelope Air Sealing)	
	CF2R-ENV-03 (Insulation Installation)	
	CF2R-ENV-04 (Roofing-Radiant Barrier)	
	CF2R-MCH-01 (Space Conditioning Systems, Ducts and Fans)	
System 1	CF2R-MCH-20 (Duct Leakage)	
System 1	CF2R-MCH-23 (Airflow)	
System 1	CF2R-MCH-22 (Fan Efficacy)	
System 1	CF2R-MCH-25 (Refrigerant Charge)	
System 1	CF2R-MCH-26 (Rated Equipment)	
	CF2R-MCH-27 (IAQ and MV)	
	CF2R-LTG-01 (Lighting)	
	CF2R-PLB-02 (SD HWS Distribution)	
CF3R INFORMATION - Certificate of Verification		
System	**Form**	**Compliance**
System 1	CF3R-MCH-20 (Duct Leakage)	
System 1	CF3R-MCH-23 (Airflow)	
System 1	CF3R-MCH-22 (Fan Efficacy)	
System 1	CF3R-MCH-25 (Refrigerant Charge)	
System 1	CF3R-MCH-26 (Rated Equipment)	
	CF3R-MCH-27 (IAQ and MV)	

Image from CalCERTS Registry

Plan Check and Field Inspection Checklist



Checklist

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Load Calc and Duct Design Checklist for Building Departments

Code References:

Title 24, Part 6, **Section 150.0(h)1** (load calculations per Manual J)
Title 24, Part 11, **Section 4.507.2** (Manuals J/S/D)

Plan Check:

- ☐ Duct layout/Plans Provided– Can be schematic, unless required otherwise. Should reasonably show duct layout, duct sizes and target airflow at each register.
- ☐ Room-by-room Load Calculations - Manual J
  - Room-by-room loads – (Not block loads)
    - ☐ Summary (e.g., Short J Summary) – Showing design temps and room by room loads for heating and cooling.
    - ☐ Detail – Shows all surface areas and associated loads for each room
  - Indoor design temps (Set by Title 24):
    - ☐ Heating: 68 degF
    - ☐ Cooling: 75 degF
  - Outdoor design temps (from Reference Appendix JA2):
    - ☐ Heating: Winter Median of Extremes: _____
    - ☐ Cooling:
      - 1% Dry Bulb: _____ (don't allow arbitrarily raising due to "microclimates" without prior approval)
      - 1% Mean coincident Wet Bulb:_____ (rarely an issue in dry climates)
  - Building Features- for new homes and additions, should match CF1R
    - ☐ Conditioned floor area:_____
    - ☐ Window areas, U-factor, SHGC, orientations
    - ☐ Infiltration, new construction 5 ACH50 or less. Existing homes watch for excessively high values (>10 ACH50)
    - ☐ Walls, floors, ceilings – R-values
    - ☐ Duct R-value, location and leakage
- ☐ Equipment Selection - Manual S (Should match CF2R-MCH-01 after install)
  - Manual S report, if available: Make/Model
  - AHRI Certificates for actual equipment combination: efficiencies
  - Design capacities
    - ☐ Cooling: outdoor temperature, CFM, indoor WB ~60-65 degF
    - ☐ Heating: gas furnace use output, heat pump ask for balance point diagram (17 degF and 47 degF)
  - Allowed Oversizing/Undersizing Met? See Manual S Report for allowed percentages.

Field Inspection:

- ☐ Installed building features should match CF-1R
- ☐ Installed equipment should match CF-1R and Manual S reports
- ☐ Installed ducts should reasonably match duct design layout.

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Residential HVAC Design ***Detailed*** Plan Check Checklist

(This Optional Checklist provides more detail and is Based on ANSI/RESNET/ACCA 310 HVAC Design Report)

Item	Checked	Value/Notes
1. Design Basis & Architectural Scope	✓	
1.1 Design description (optional):		
1.2 Designer company:		
1.3 Software name and version used to complete design:		
1.4 Architectural plan name or address of the property:		
1.5 Architectural options accounted for in the design (master plans)		
1.6 Other architectural options that the design can be used with		
2. Dwelling-Unit Mechanical Ventilation System Design		
2.1 Unique name or ID for each system:		
2.2 Vent. equipment manufacturer:		
2.3 Specified system type:		
2.4 Specified control location:		
2.5 Ventilation zone name(s) served by system:		
2.6 Ventilation zone name:		
2.7 Design basis:		
2.8 Floor area (sq. ft.) and # bedrooms in vent. zone:		
2.9 Ventilation design airflow rate (CFM):		
2.10 Vent. runtime per cycle & cycle time (mins):		
2.11 Time-averaged mechanical vent. rate (CFM):		
3. Heat Gain & Heat Loss Loads		
3.1 Design basis for the loads:		
3.3 Indoor design temperatures used in loads (°F): Heating Season:		
3.4 Outdoor design temperatures used in loads (°F):		
3.5 Outdoor design temperature location & data source:		
3.6 Name of heated or cooled zone:		
3.7 Occupants & total occup. internal gains (Btuh):		
3.8 Total non-occupant internal gains (Btuh):		
3.9 Conditioned floor area (sq. ft.):		
3.10 Window area (sq. ft.):		
3.11 Predominant window SHGC:		
3.12 Predominant insulation nominal R-value:		
3.13 Infiltration rate (Qualitative or ACH50):		
3.14 Time-averaged mechanical vent. rate (CFM):		
3.15 Heat gain (kBtuh):		
3.16 Maximum - Minimum total heat gain (kBtuh):		
3.17 Total heat loss (kBtuh):		
4. Heating & Cooling Equipment Selection		
4.1 Unique name or ID for each system:		
4.2 Zone that system serves (See Item 3.6):		
4.3 Equipment type:		
Cooling Equipment		
4.4 Evaporator / fan coil mfr. & model #:		
4.5 Condenser mfr. & model #:		
4.6 AHRI ref. #, or check box for alt. OEM doc.:		
4.7 If AC / HP, rated cooling efficiency:		
4.8 If HP, rated heating efficiency:		
4.9 If HP, ratio of max. to min. rated capacity: Not available		
4.10 If AC / HP, blower fan motor & speed type:		
4.11 If AC / HP, compressor speed type:		
4.12 If AC / HP, meter device type:		
4.13 If TXV or EEV, OEM subcooling target (°F):		
4.14 Filter performance metric and rating:		
Heating Equipment		
4.15 Unique name or ID for each system:		
4.16 Zone that system serves (See Item 3.6):		
4.17 Equipment type: N/A		
4.18 Equipment manufacturer & model #:		
4.19 AHRI ref. #, or check box for alt. OEM doc		
4.20 If furnace or boiler, rated heating efficiency:		
4.21 If furnace, blower fan motor & speed type:		
4.22 If furnace or boiler, heating capacity type:		
4.23 If furnace or boiler, venting type:		
4.24 Filter performance metric and rating:		
5. Duct Design		
5.1 Unique name or ID for each system: 1		
5.2 Zone that system serves (See Item 3.6): Sys Block 1		
Design Values for Cooling and Heating Mode		
5.3 Design blower fan airflow (CFM):		
5.4 Design blower fan speed setting:		
5.5 Design external static pressure (IWC):		

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Checklist

Load Calc and Duct Design Checklist for Building Departments

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  - ☐ Duct R-value, location and leakage

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Checklist

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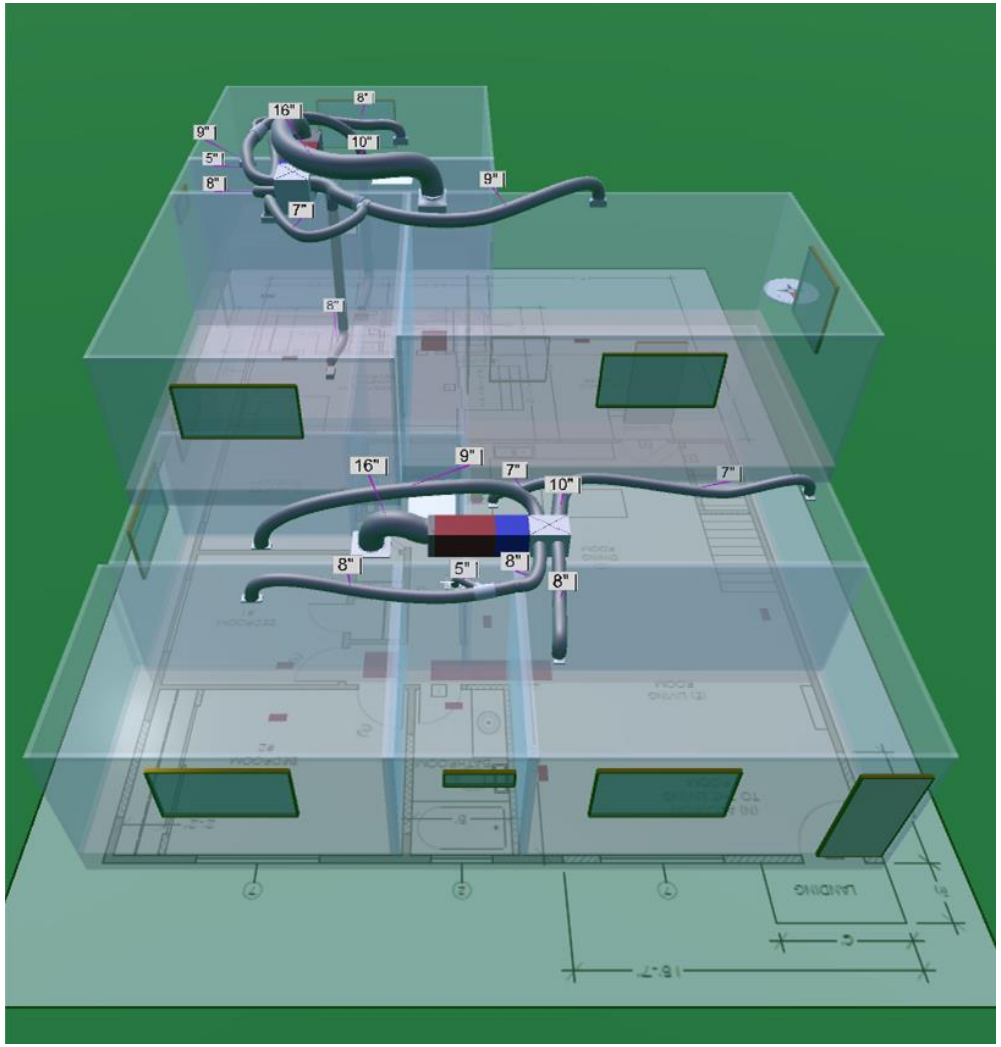
Best Practices for Energy Code Enforcement



Best Practices

- Make sure all required forms get registered by using the Project Status Report in the HERS Registries.
- Require and check load calculations and duct sizing for all new systems and system upgrades.
- Make sure assumptions used in Manual J and Manual S reports are consistent with energy code requirements.
- Make sure assumptions used in Manual J and Manual S reports are consistent with what is installed in the field.

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Final Word

- Most contractors who have learned how to do good design appreciate the benefits of it, they just need a more level playing field where their competition is also doing them.
- Homeowners benefit the most from good design by have a comfortable house that is also cheaper to operate.
- If homeowners knew how important good design is, they would insist on it.
- Enforcement and education are critical to improving a major flaw in the HVAC industry.

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Polls and Resources

Closing

- Continuing Education Units Available
  - Contact itzel.torres@ventura.org for AIA and ICC LUs
- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - February 29 – **3C-REN Single Family Program 2024 Updates**
  - February 29 - **DIY-Energy Savings Toolkit Workshop**
  - March 5 -**ADU Planning and Best Practice**
  - March 5 – **Recovery Ventilators: Energy Savings and Compliance Credit in the 2022 Energy Code**
  - March 6 – **Real Estate Professionals Community Mentoring Sessions**
  - March 7 –**High Performance Buildings & Careers – Class 1: High Performance Fundamentals Series**

Visit www.3c-ren.org/events for our full catalog of trainings.

Questions about Title 24?

Energy Code Coaches are local experts who can help answer your Title 24 questions. Coaches have decades of experience in green building and energy efficiency improvements. They can provide citations and offer advice for your project to help your plans and forms earn approval the first time.

Online:
3c-ren.org/codes

Call:
805.781.1201

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Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org

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