



TRI-COUNTY
REGIONAL ENERGY NETWORK
SAN LUIS OBISPO • SANTA BARBARA • VENTURA

Intro to Residential HVAC Design

Russ King – Coded Energy

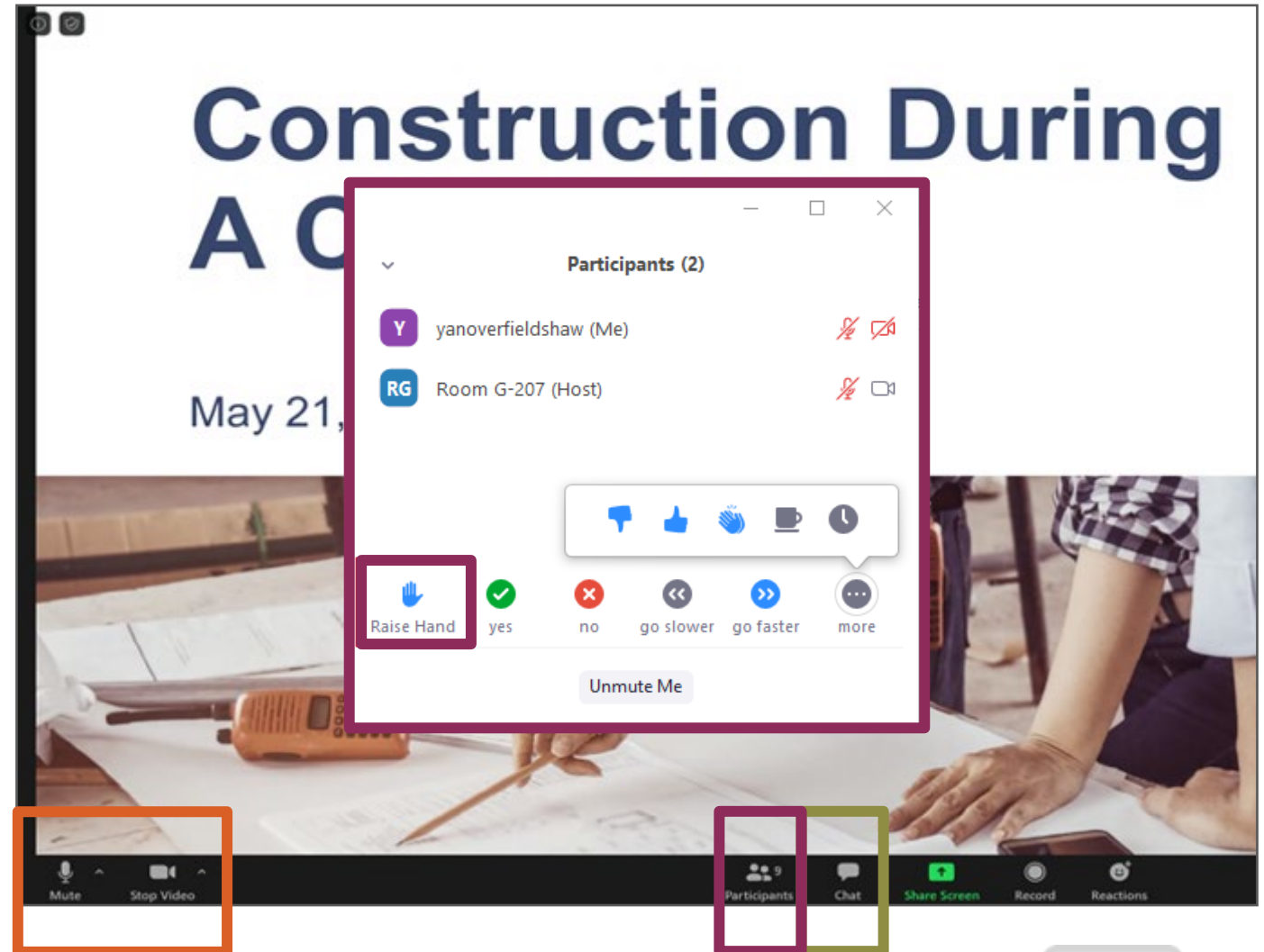
August 20, 2026

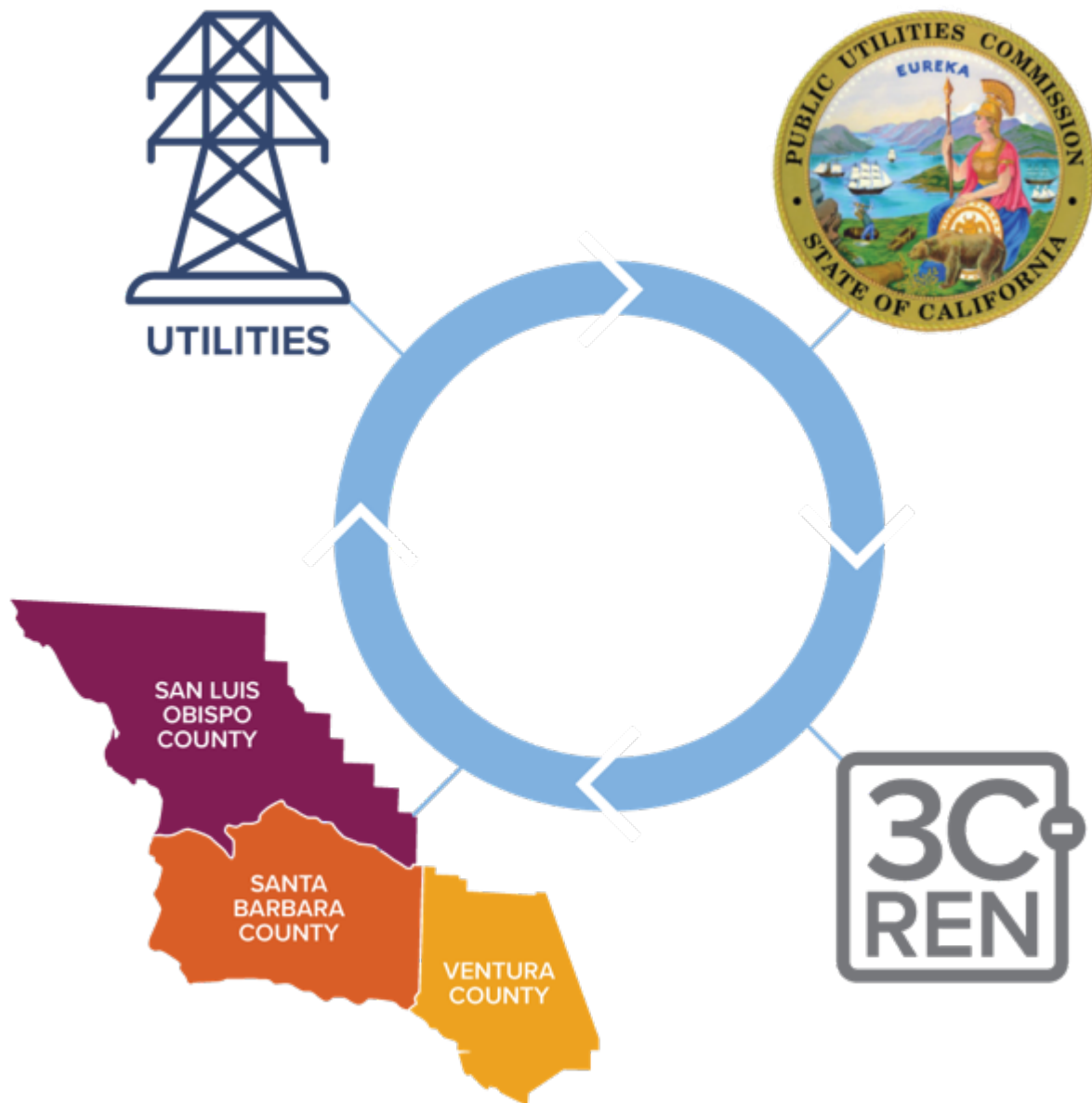


Before We Begin

Here are some quick reminders:

- Call in? Please **share** full name to confirm attendance
- To receive AIA LUs, you **must attend** at least 80% of the training. Attendance will be verified
- Use the "**Chat**" to share questions or comments
- Slides/recording are **shared** after most events and can be found on 3C-REN's on-demand page
- 3C-REN does **not** allow **AI notetakers**, unless used to accommodate a disability





Tri-County Regional Energy Network

3C-REN is a collaboration between the tri-counties

Our programs reduce energy use for a more sustainable, equitable and economically vibrant Central Coast

Our free services are funded via the CPUC, bringing ratepayer dollars back to the region



Our Services

Incentives



HOME ENERGY SAVINGS

3c-ren.org/for-residents
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COMMERCIAL ENERGY SAVINGS

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Contractors can enroll at
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Training



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ENERGY CODE CONNECT

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UNDERSTANDING RESIDENTIAL HVAC DESIGN

PRESENTED BY:

RUSSELL KING, ME
CODED ENERGY, INC.

AGENDA FOR TODAY

1. Introduction
2. The ACCA Manuals
3. Load Calcs in the Code(s)
4. The Basic Steps of HVAC Design
5. Open Discussion, Q&A



INTRODUCTION



I. INTRODUCTION

- Instructor – Russell King, M.E.
- Licensed Mechanical Engineer (3 states)
- CoFounder of Coded Energy, Inc. (Developers of Kwik Model 3D HVAC design software)
- 35+ years experience with residential HVAC design and energy efficiency
- russ@coded.energy
- HVAC Blog: www.russellking.me
- Book: “HVAC 1.0 – Introduction to Residential HVAC Systems”

INTRODUCTION

Capacity vs Load

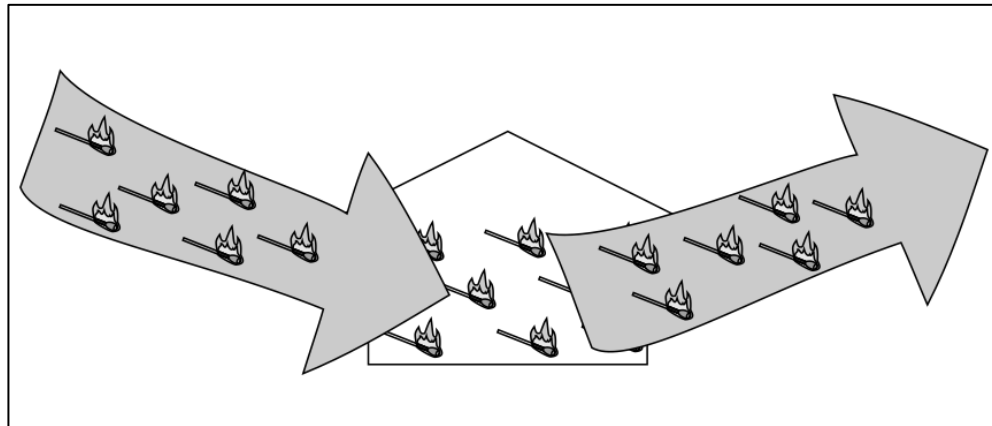
The **capacity** of the heating or cooling equipment is the *output* of the equipment in BTUs per hour. Think of it as the ***supply***.

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***.

INTRODUCTION

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

Not too **big** and not too **small**

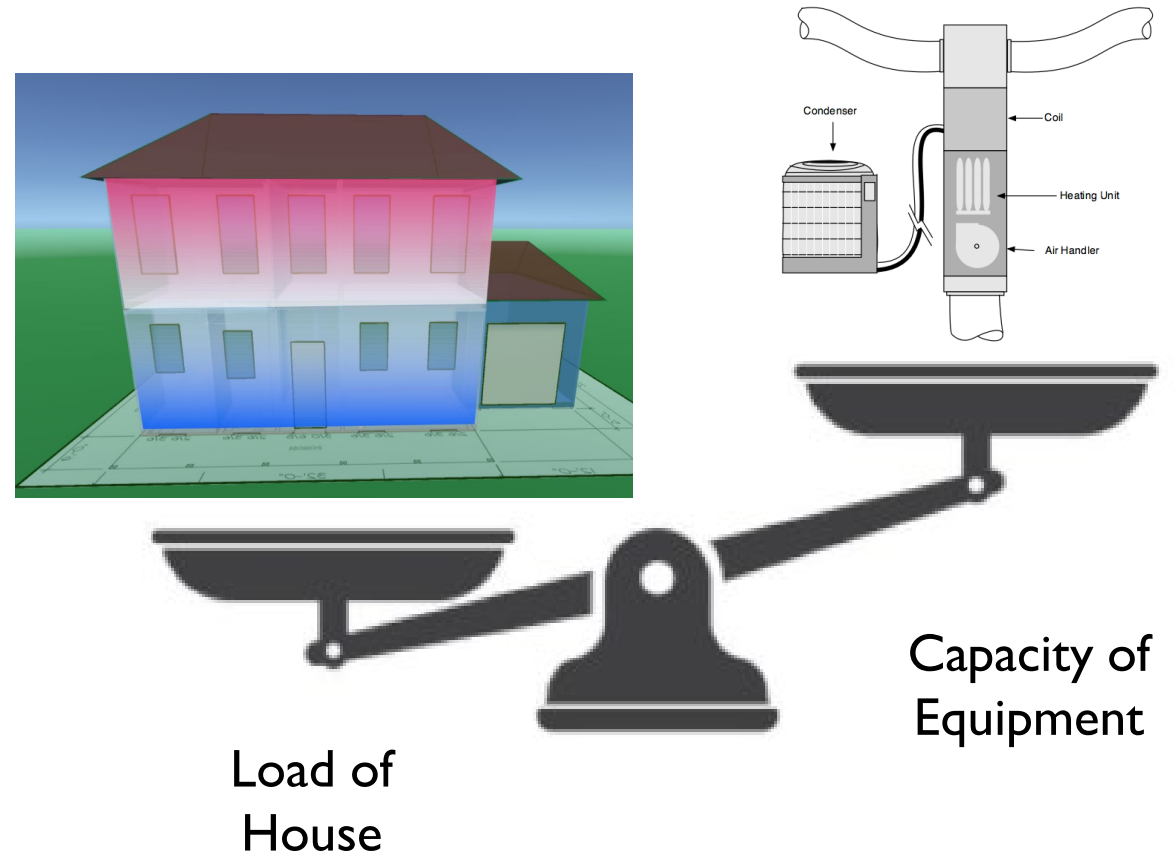


Images from HVAC 1.0 – Introduction to Residential HVAC Systems

INTRODUCTION

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

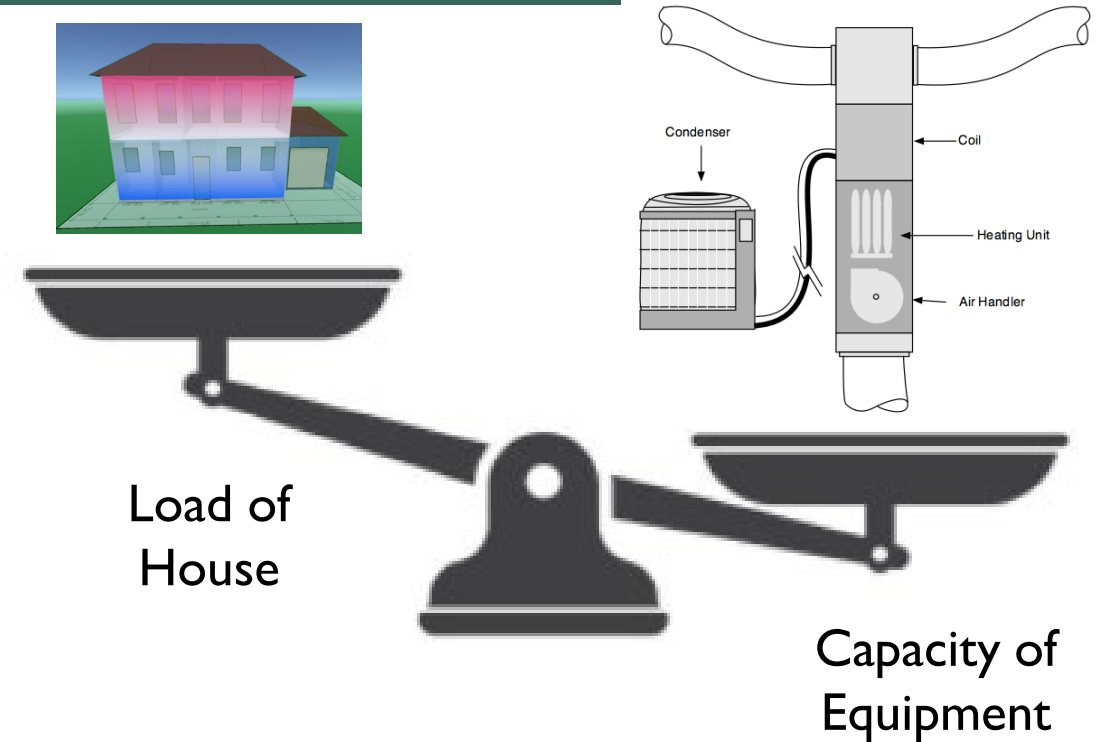
The demand is greater than the supply and the equipment cannot keep up.



INTRODUCTION

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

The supply is much greater than the demand. This can cause other issues.



INTRODUCTION

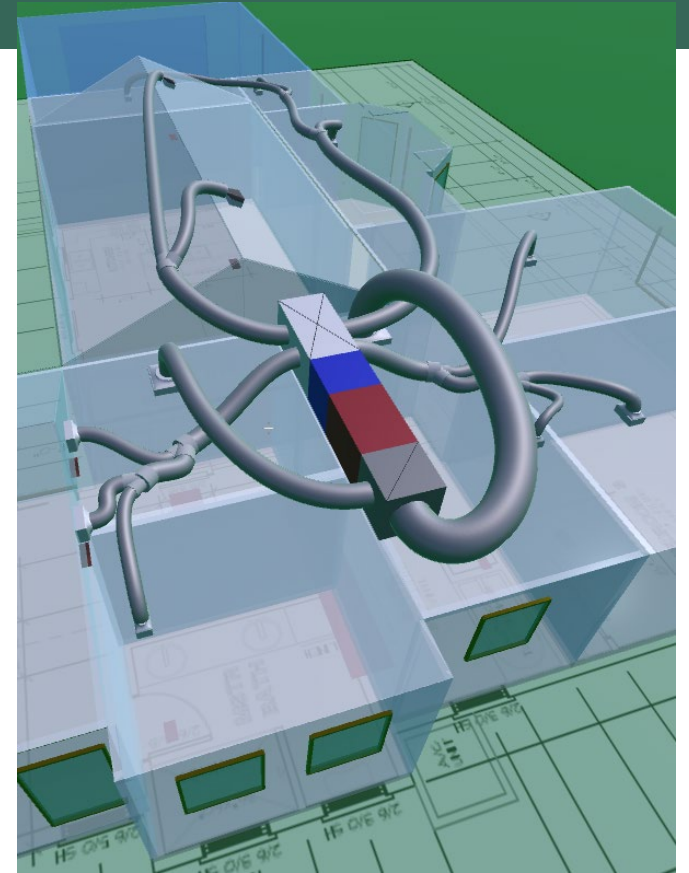
Design conditions are the **code-specified** indoor and outdoor temperatures at which the loads are calculated.

- These are not the very worst temperatures expected each summer or winter

City	Latitude	Elevation (ft)	Longitude	Cooling								Design Wetbulb 0.1%	Design Wetbulb 0.5%	Outdoor Daily Range	Winter Median of Extremes	Heating		HDD*
				0.10%		0.50%		1.00%		2.00%						Design Drybulb (0.2%)	Design Drybulb (0.6%)	
				DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB							
Scotia	40.5	139	124.4	78	61	74	60	73	60	69	58	63	61	19	28	33	35	3954
Scotts Valley	37	400	122	94	68	88	66	86	66	81	64	69	67	28	27	32	35	1097
Seal Beach	33.8	21	118.1	94	69	86	68	84	67	80	65	71	69	15	35	40	42	1519
Seaside	36.6	17	122.9	85	66	79	64	77	64	73	62	67	65	20	30	35	37	
Sebastapol	38.4	102	122.8	99	69	96	68	95	68	92	66	71	69	35	24	27	29	1249
Selma	36.6	305	119.6	104	73	101	71	100	70	97	68	75	73	38	24	30	34	
Sepulveda	34.2	818	118.5	103	71	98	69	96	69	92	67	74	71	32	28	33	36	664

INTRODUCTION

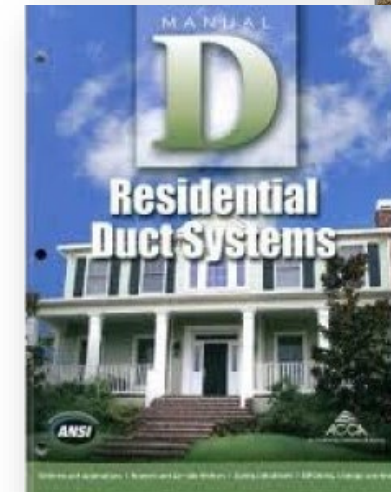
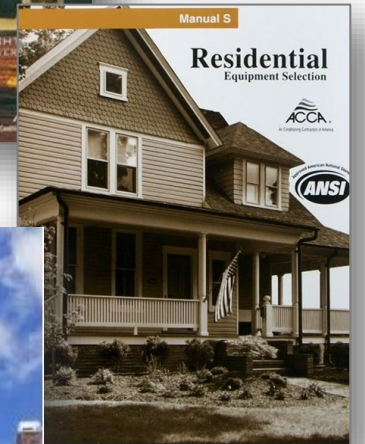
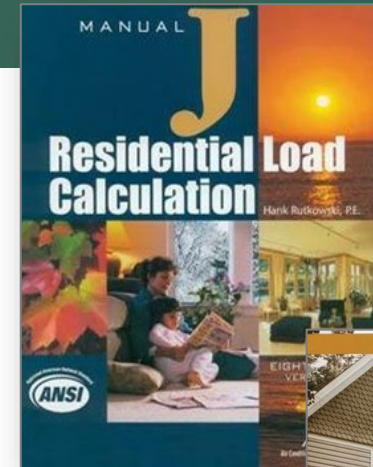
- The system needs to also work at milder conditions
- If we design to really bad conditions, the equipment would be **oversized for most of the season**
- **Oversizing will cause more comfort complaints than undersizing**
- “Short cycling” of equipment can reduce comfort, shorten the life of equipment and increase energy use



Screen snip from Kwik Model with EnergyGauge Loads

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



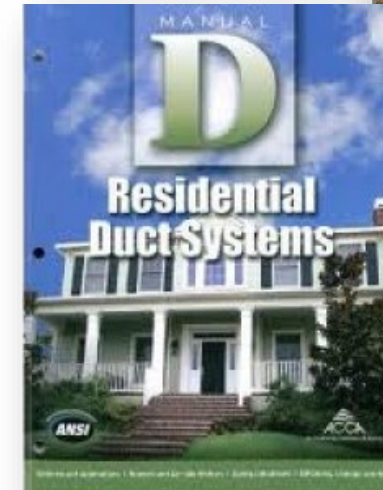
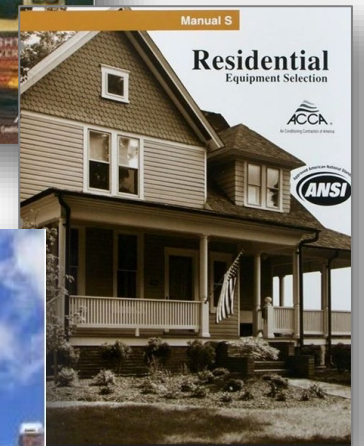
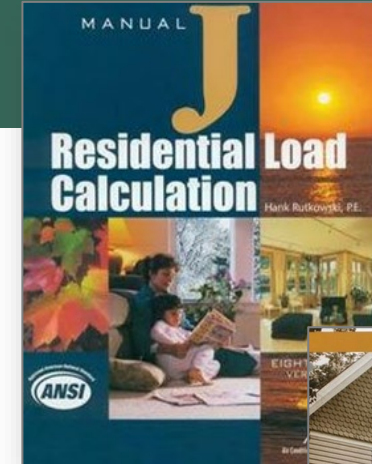
ACCA MANUALS

■ Basic Design Manuals

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

- (All three are referenced in the code)

■ www.acca.org





LOAD CALCS IN THE CODE(S)



LOAD CALCS IN THE CODE(S)

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!



LOAD CALCS IN THE CODE(S)

- **Three** Different California Codes Require Load Calculations and Duct Design for homes (Open any one and search for “ACCA”)

Title 24, Part 4
The Mechanical Code
601.2, 1105.1

Title 24, Part 6
The Energy Code
150.0(h)

Title 24, Part 11
The Green Code
4.507.2

LOAD CALCS IN THE CODE(S)

- 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]
- This has been a code requirement since 2013, possibly longer
- Not well enforced, but HVAC contractors should be doing it anyway (They are not)



THE BASIC STEPS IN THE HVAC DESIGN PROCESS



THE HVAC DESIGN PROCESS – 4 STEPS

■ 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)

THE HVAC DESIGN PROCESS – 4 STEPS

■ The Process

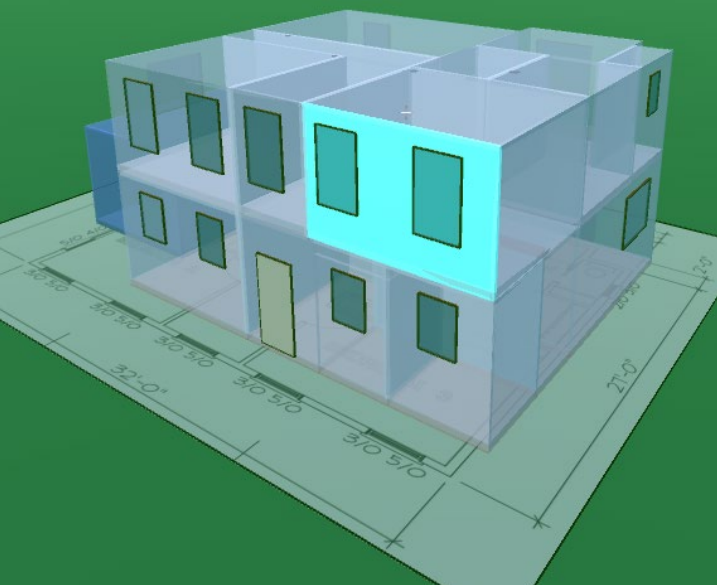
The basic steps in ***designing*** a typical ducted central system for a home are:

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STEP I. COLLECT INFORMATION ABOUT THE HOUSE

- What you really need are *areas* for:
 - ceilings,
 - walls,
 - doors,
 - and floors,
 - Plus, window areas and orientations = N, S, E, W
- These are the surfaces that will conduct heat into and out of the house.

WallNum	Room	Type	Net Area
29	bed3(1)	2x4 R-13	80.5
30	bed3(1)	2x4 R-13	93.5
31	mba(2)	2x4 R-13	76.5
32	toilet(1)	2x4 R-13	25.5
33	toilet(1)	2x4 R-13	53.5

A 3D architectural rendering of a two-story house. The house is shown from an isometric perspective. The walls are light blue, and the roof is dark blue. The house has several windows and doors. One wall on the second floor is highlighted in a bright cyan color. The house is situated on a green lawn. Dimensions are shown on the ground plane: 30'-0" for the overall width, 30'-0" for the depth, and 30'-0" for the width of the highlighted wall. The overall height of the house is 21'-0".

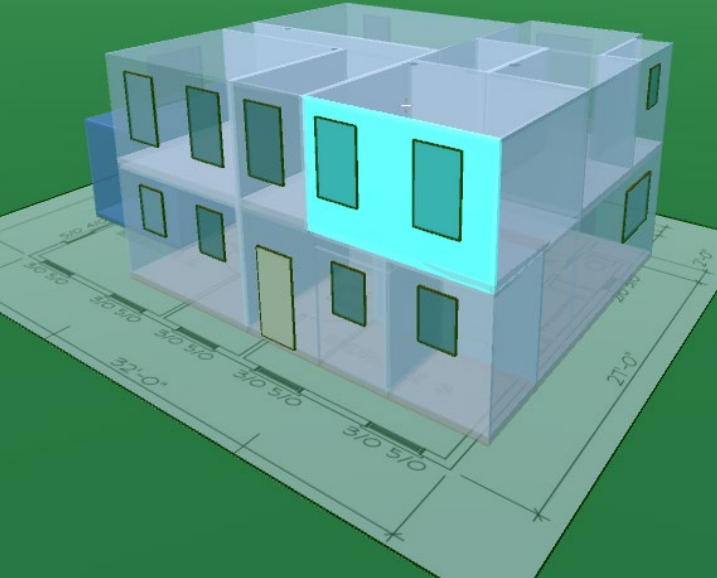
Screen snip from Kwik Model with EnergyGauge Loads

STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Step I. Collect Information About the House

- You will need this on a room-by-room basis if you plan to also size the ducts.
- Keeping track of all these surfaces is challenging.
- This is where design software is most helpful.

WallNum	Room	Type	Net Area
29	bed3(1)	2x4 R-13	80.5
30	bed3(1)	2x4 R-13	93.5
31	mba(2)	2x4 R-13	76.5
32	toilet(1)	2x4 R-13	25.5
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A 3D architectural rendering of a two-story house. The house is shown from an isometric perspective. The walls are light blue, and the windows are dark green. The house is situated on a green lawn. Dimensions are labeled on the ground plane: 30'-0" for the width of the front section, 30'-0" for the width of the side section, 30'-0" for the width of the back section, and 21'-0" for the depth of the house. A wall on the second floor is highlighted in cyan.

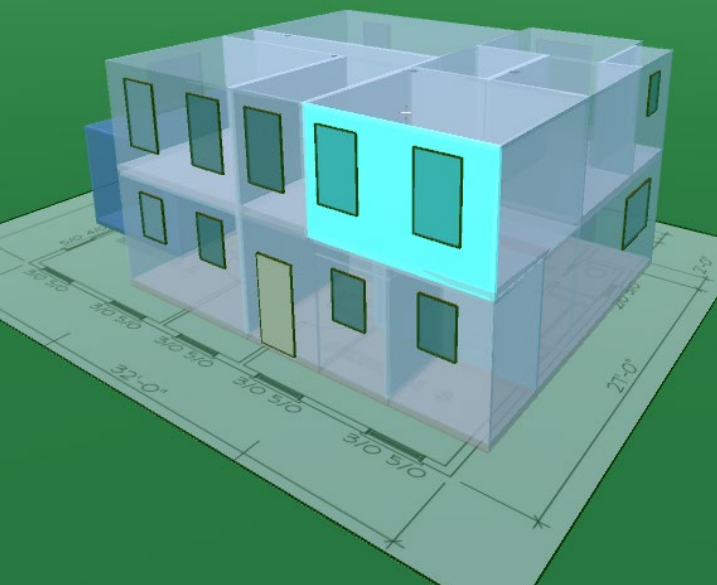
Screen snip from Kwik Model with EnergyGauge Loads

STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Step I. Collect Information About the House

- The goal is to accurately estimate the **conduction, convection and radiation** heat transfer between the inside and outside of the house.
- You need to do it for winter
- And for summer

WallNum	Room	Type	Net Area
29	bed3(1)	2x4 R-13	80.5
30	bed3(1)	2x4 R-13	93.5
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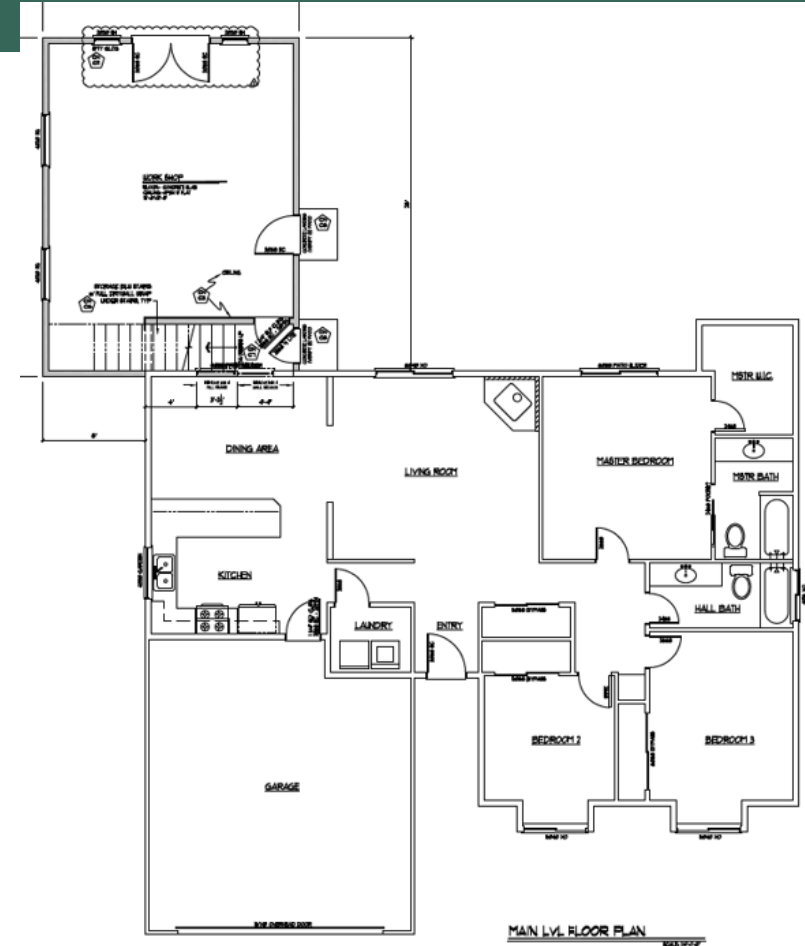


A 3D architectural rendering of a two-story house. The house is shown from an isometric perspective. The walls are light blue, and the roof is dark blue. The house has several windows and doors. One wall on the second floor is highlighted in a bright cyan color. The house is situated on a green lawn. Dimensions are shown on the ground plane: 30'-0" for the overall width, 30'-0" for the depth, and 30'-0" for the width of the highlighted wall. The overall height of the house is 21'-0".

Screen snip from Kwik Model with EnergyGauge Loads

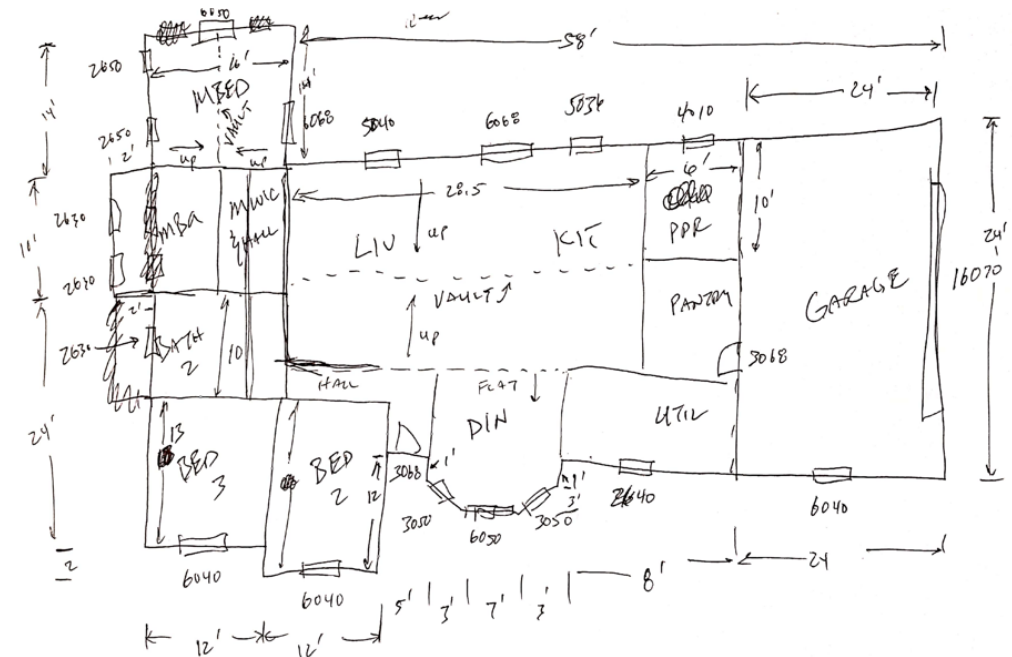
STEP I. COLLECT INFORMATION ABOUT THE HOUSE

- **Step I: Collecting information about the house**
- For new homes, use the architectural plans and Energy Compliance documents



STEP I. COLLECT INFORMATION ABOUT THE HOUSE

- **Step I: Collecting information about the house**
- If you are designing a system for an existing house, you may have to create your own plans by **sketching** a floor plan based on field measurements
- This used to take **hours**

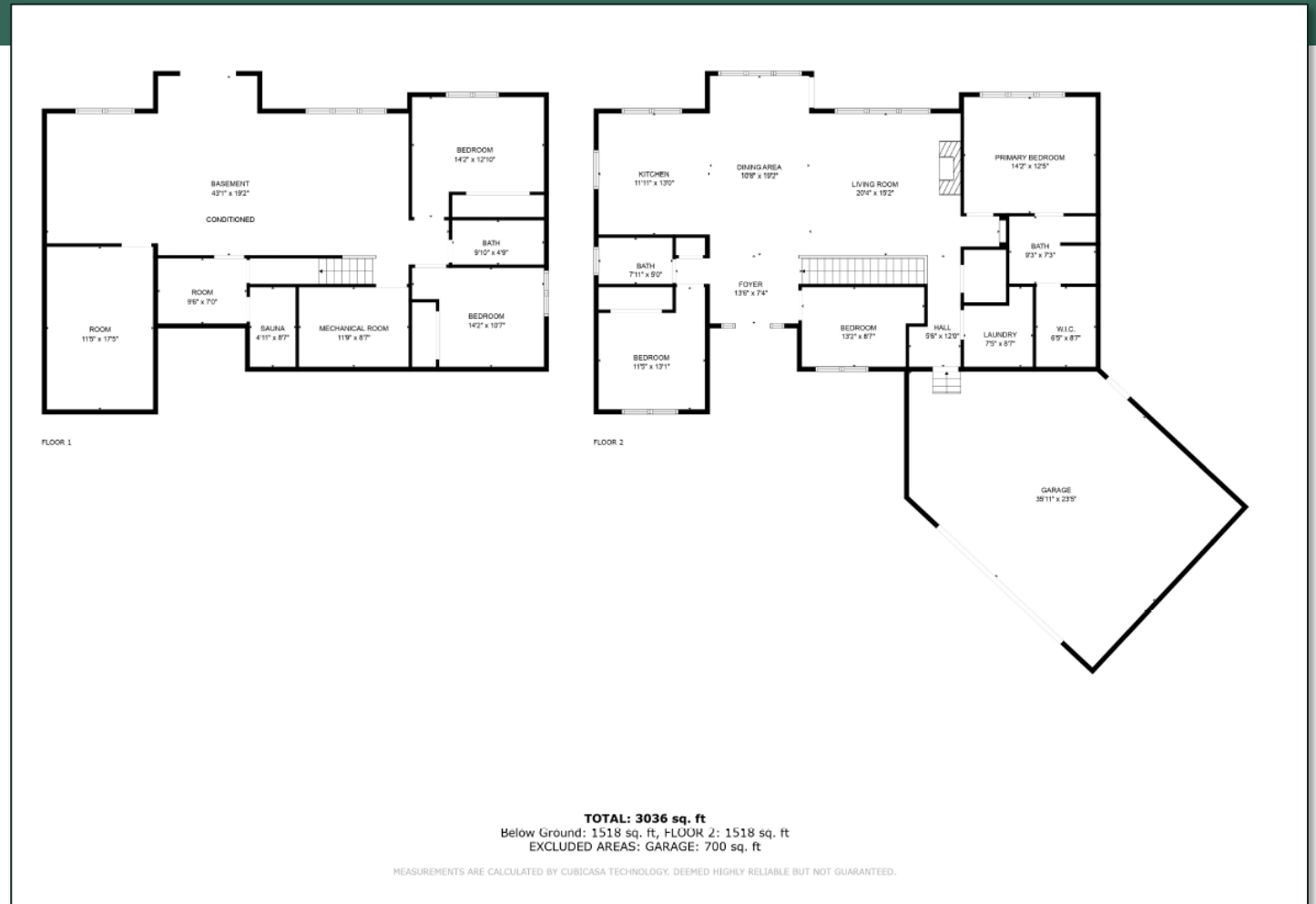


ALL 8' CEILINGS EXCEPT MASTER BED AND LIVING/KITCHEN
WHICH VAULT UP TO AN 11' MIDDLE RIDGE

STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Cubi.Casa

- Free (1 plan)
- Any phone
- Very simple
- Does not capture window sizes or vaulted ceilings
- Takes 1 Day to get file back



STEP I. COLLECT INFORMATION ABOUT THE HOUSE

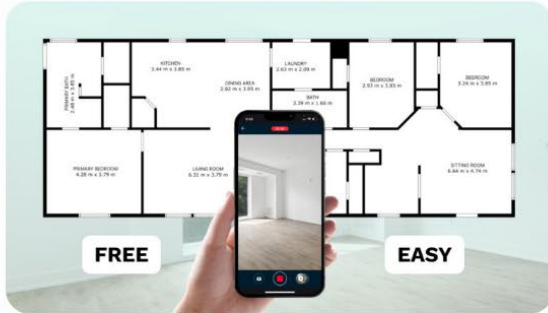
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QUICK & EASY SOLUTION

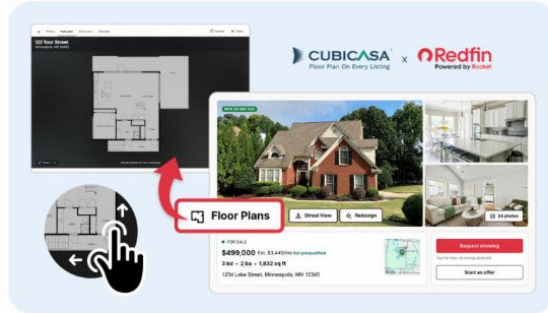
Why use CubiCasa floor plans?



Get **FREE** floor plans with room dimensions from a 5-minute scan

Level up your listings and deliver quality material to your clients with CubiCasa's **FREE** floor plans, only available in the US! Get clear floor plans with black & white elements and room dimensions. All you have to do is sign up and scan a property, it takes about 5 minutes!

Get your **FREE** floor plan



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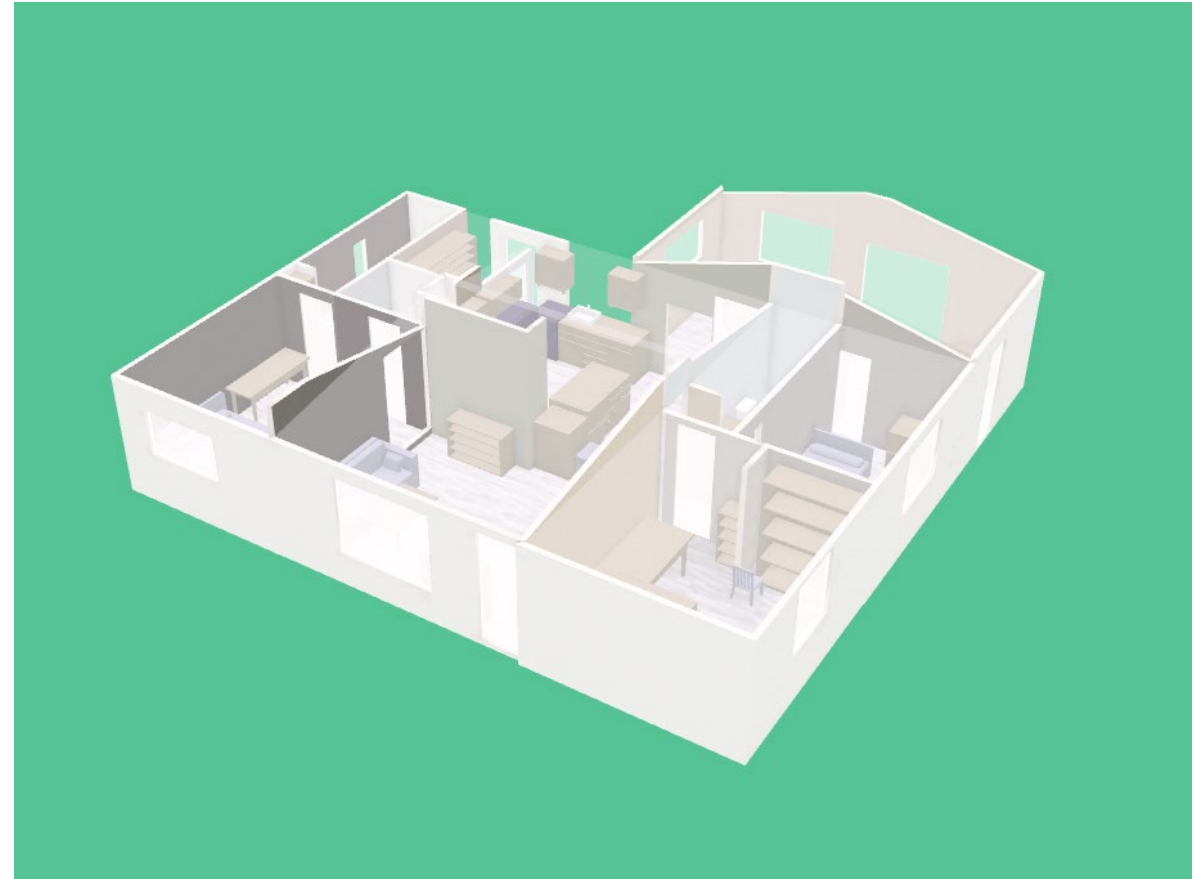


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STEP I. COLLECT INFORMATION ABOUT THE HOUSE

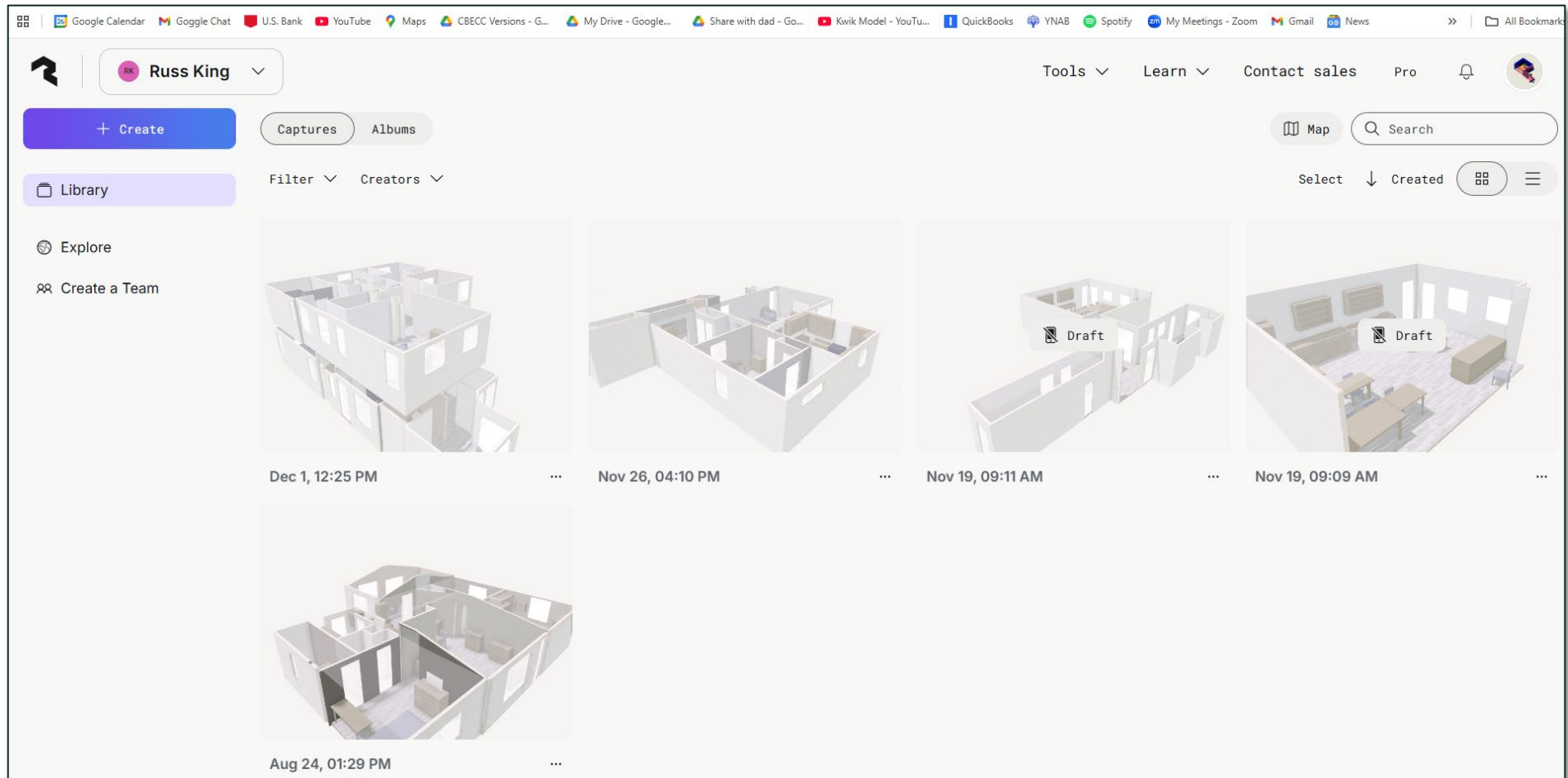
Poly.Cam

- LiDAR
- Requires iPhone or iPad with LiDAR camera
- Free version
- Instant file creation
- Can be imported in load calc software (Kwik Model 3D)
- Some load calc software have built in LiDAR
 - Conduit
 - Amply



STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Poly.com



STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Step I. Collect Information About the House

- You will also need to make engineering estimates about things such as
 - duct leakage and
 - infiltration
- Whatever your assumptions are for these, they need to be **verified** in the field when possible.

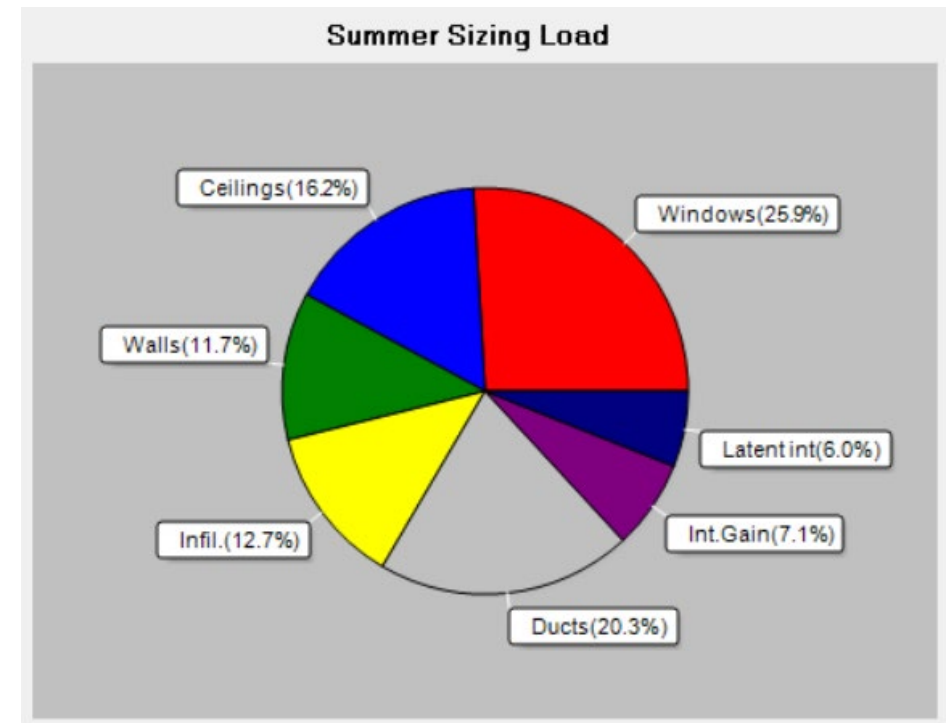
The screenshot displays the 'Leakage Type' and 'Data Entry Method' sections of the Kwik Model software. In the 'Leakage Type' section, 'Proposed Air Leakage' is selected. To its right, 'Duct Air Leakage %' is set to 0% Out and an empty box for % Total. Below this, 'Return Leak Fraction' is set to 0.500. The 'Num. Ducted Returns' field is empty. In the 'Data Entry Method' section, 'Proposed ACH(50)' is selected. To its right, under the 'Infiltration' heading, 'Proposed ACH(50)' is set to 5.

Section	Field	Value
Leakage Type	Default Leakage	☐
	Proposed Qn	☐
	Proposed Leak Free	☐
	Proposed Air Leakage	☒
	Proposed Dist. Eff.	☐
Leakage Parameters	Duct Air Leakage %	0 % Out, [] % Total
	Return Leak Fraction	0.500
General	Num. Ducted Returns	[]
Data Entry Method	Proposed SLA	☐
	Proposed CFM(50)	☐
	Proposed ELA	☐
	Proposed EqLA	☐
	Proposed ACH	☐
	Proposed ACH(50)	☒
Infiltration	Proposed SLA	
	Proposed CFM(50)	
	Proposed ELA	
	Proposed EqLA	
	Proposed ACH	
	Proposed ACH(50)	5

STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Step I. Collect Information About the House

- **Duct leakage** is required to be improved as part of major work being done to an HVAC system.
- For substantially new systems (new equipment and 75% new ducts) the maximum allowed leakage is 5%.
- For altered systems the maximum allowed leakage is 10%.

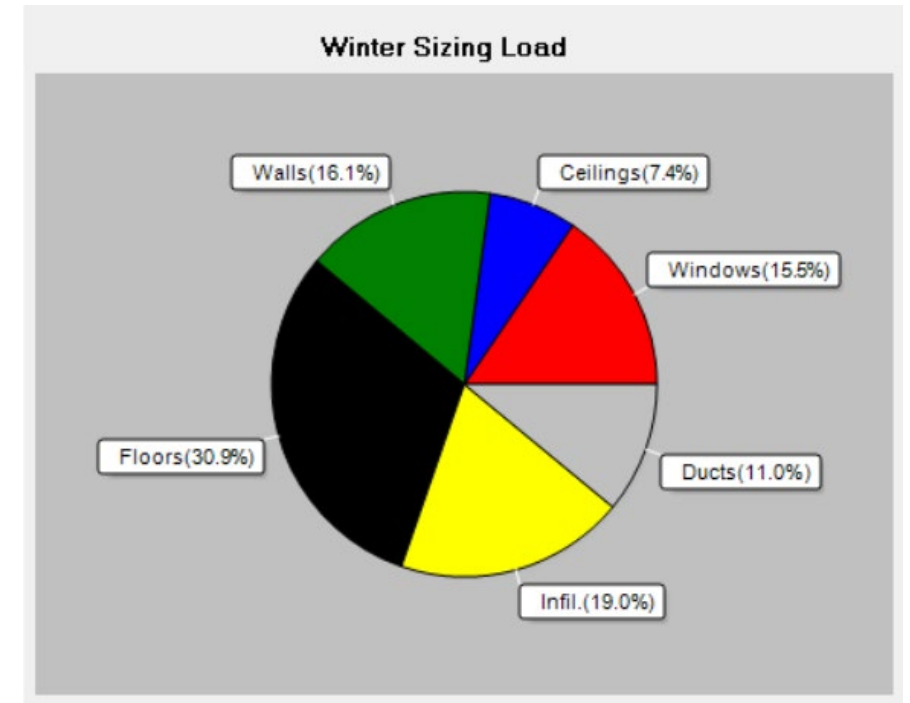


Screen snip from Kwik Model with EnergyGauge Loads

STEP I. COLLECT INFORMATION ABOUT THE HOUSE

Step I. Collect Information About the House

- **Infiltration** can have a dramatic effect on the load calcs.
- For existing houses, it is a good idea to measure it using a blower door prior to doing load calcs.
- If it is very bad (e.g., CFM50 > floor area of the house) it is probably cost effective to seal the house so that you can install smaller equipment.



Screen snip from Kwik Model with EnergyGauge Loads

THE HVAC DESIGN PROCESS – 4 STEPS

■ 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)

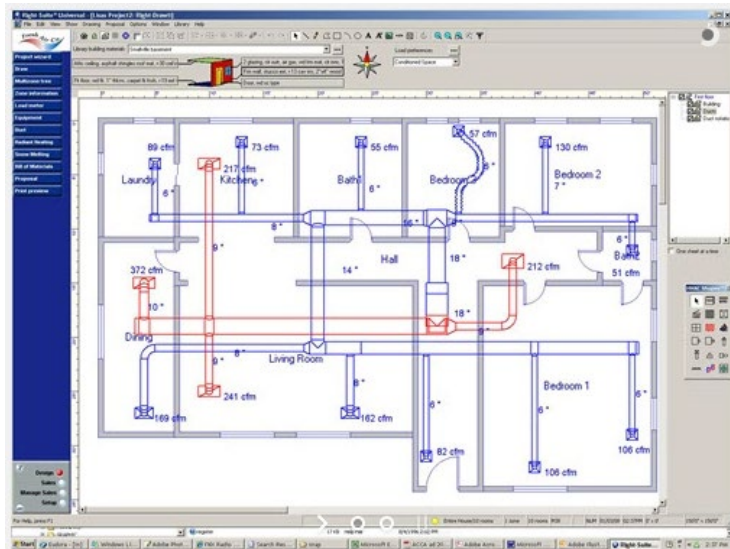
3. **Select** equipment to meet the total loads (ACCA Manual S)

4. **Design** the distribution system (ACCA Manual D)

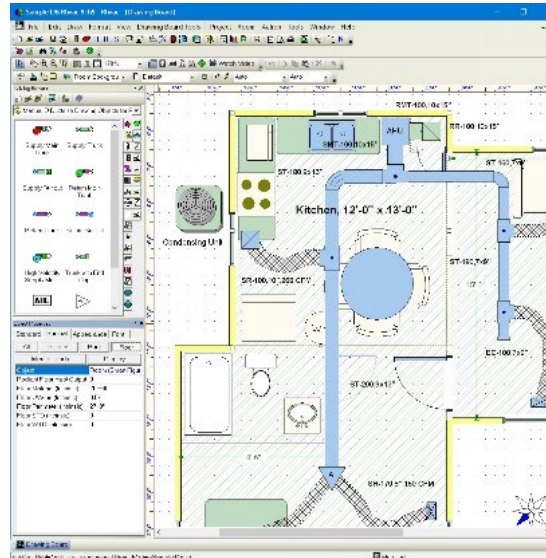
STEP 2. MANUAL J – LOAD CALCULATIONS

Examples of full Manual J/S/D software

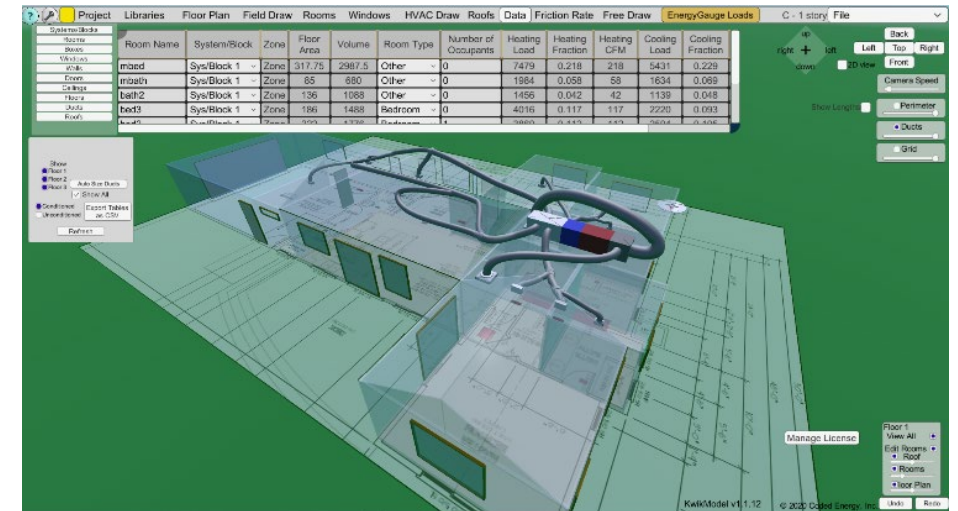
Right-Suite® by
Wrightsoft



RHVAC by
Elite Software



Kwik Model® with
EnergyGauge Loads



STEP 2. MANUAL J – LOAD CALCULATIONS

- There are at least 12 that do **only** Manual J Loads

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](#)



[Elite RHVAC](#)



[Adtek Acculoads](#)



[Florida Solar Energy Center's EnergyGauge](#)



[Carmelsoft HVAC ResLoad-J](#)



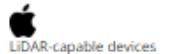
[Avenir MJ8 Editions of HeatCAD and LoopCAD](#)



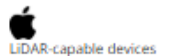
[Cool Calc Manual J](#)



[Conduit Tech](#)



[Amplify Energy](#)



[Zero Homes](#)



Manual J Block Load Compliant

Limited to Block Load Only

[Wrightsoft Right-J Mobile](#)



[CalcuNow MJ8-Calc](#)



STEP 2. MANUAL J – LOAD CALCULATIONS

- There are **two** basic kinds of load calculations.
- One kind is a **whole house** load calculation that lumps the entire house (or zone) into one total value, which can be used to size the **equipment**. (aka “Block” loads)

Location for weather data: Sacramento (Met, CA - Defaults: Latitude(38.7) Altitude(23ft.) Temp Range(H) Humiditydata: Interior RH (50%) Outdoor wet bulb (70F) Humiditydifference(0gr.)					
Winter design temperature(CA Med.)	26	F	Summer design temperature(MJ8 99%)	98	F
Wintersetpoint	68	F*	Summer setpoint	75	F
Winter temperature difference	42	F	Summer temperature difference	23	F
Total heating load calculation	33450	Btuh	Total cooling load calculation	26131	Btuh
Submitted heating capacity	% of calc	Btuh	Submitted cooling capacity	% of calc	Btuh
Total (Electric Heat Pump)	107.6	36000	Sensible (SHR = 0.76)	90.0	22011
Heat Pump + Auxiliary(0.0kW)	107.6	36000	Latent	415.4	6989
			Total (Electric Heat Pump)	111.0	29000

STEP 2. MANUAL J – LOAD CALCULATIONS

- The other kind is a **room-by-room** load calculation, which breaks the house into rooms and calculates a heating and cooling load for each individual room.
- These help you ***distribute*** the heating and cooling correctly.

Room Name	System/Block	Zone	Floor Area	Volume	Room Type	Number of Occupants	Heating Load	Heating Fraction	Heating CFM	Sens Cooling Load	Cooling Fraction	Cooling CFM	Duct Size CFM
mbed	Sys/Block 1 ▾	Zone	317.75	2987.5	Bedroom ▾	0	8439	0.22	220	6047	0.217	261	261
mbath	Sys/Block 1 ▾	Zone	85	680	Other ▾	0	2260	0.059	59	1763	0.063	76	76
bath2	Sys/Block 1 ▾	Zone	136	1088	Other ▾	0	1594	0.042	42	1310	0.047	56	56
bed3	Sys/Block 1 ▾	Zone	186	1488	Bedroom ▾	0	4596	0.12	120	2431	0.087	105	120
bed2	Sys/Block 1 ▾	Zone	222	1776	Bedroom ▾	1	4370	0.114	114	2788	0.1	120	120
liv/kit	Sys/Block 1 ▾	Zone	493	4930	Kitchen ▾	2	6751	0.176	176	6627	0.238	286	286
din	Sys/Block 1 ▾	Zone	184.25	1474	Other ▾	0	4130	0.108	108	3474	0.125	150	150
pdr	Sys/Block 1 ▾	Zone	102	816	Other ▾	0	3746	0.098	98	2273	0.082	98	98
util	Sys/Block 1 ▾	Zone	59.5	476	Other ▾	0	2489	0.065	65	1113	0.04	48	65
Total	---	---	1785.5	15715.5	---	3	38375	1	1000	27825	1	1200	1232

STEP 2. MANUAL J – LOAD CALCULATIONS

- There are load calculations for both heating (winter) and cooling (summer) loads.
- **Winter** = Heat leaving the house
- **Summer** = Heat coming into the house
- Let's look at heating loads calculations first.

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
Wall Load:	5399	Wall Load:	3126
Ceiling Load:	2479	Ceiling Load:	4308
Door Load:	0	Door Load:	0
Floor Load:	10333	Floor Load:	0
Infiltration Load:	6348	Infiltration Load:	2882
Building Subtotal	29757	Internal Gain:	1890
Duct Loss:	3693	Duct Gain:	5347
Mech Ventilation Loss:	0	Sensible Subtotal	24449
TOTAL HEATING LOAD	33450	Mech Vent. Sens. Load:	0
		Blower Sens. Load:	0
		Total Sensible Load	24449
		Infiltration Latent Load:	0
		Mech Vent. Latent Load:	0
		Duct Latent Load:	83
		Internal/Other Latent Load:	1600
		Total Latent Load	1683
		TOTAL COOLING LOAD	26131

Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

- A heating load calculation is a sum of all of the **BTU losses** (convection, conduction and radiation) that occur when it is a certain delta T.

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
Wall Load:	5399	Wall Load:	3126
Ceiling Load:	2479	Ceiling Load:	4308
Door Load:	0	Door Load:	0
Floor Load:	10333	Floor Load:	0
Infiltration Load:	6348	Infiltration Load:	2882
Building Subtotal	29757	Internal Gain:	1890
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		Duct Latent Load:	83
		Internal/Other Latent Load:	1600
		Total Latent Load	1683
		TOTAL COOLING LOAD	26131

Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

- The delta T is determined by two temperatures called the *winter indoor and outdoor design temperatures*.

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
Wall Load:	5399	Wall Load:	3126
Ceiling Load:	2479	Ceiling Load:	4308
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		Total Latent Load	1683
		TOTAL COOLING LOAD	26131

Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

- For heating, assume that these occur at night when there are no solar gains to offset heating load

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
Wall Load:	5399	Wall Load:	3126
Ceiling Load:	2479	Ceiling Load:	4308
Door Load:	0	Door Load:	0
Floor Load:	10333	Floor Load:	0
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		Total Latent Load	1683
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Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

- Cooling loads are similar except that they are more complicated because solar gains are not ignored.
- Solar gains are a big part of the cooling loads.

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
Wall Load:	5399	Wall Load:	3126
Ceiling Load:	2479	Ceiling Load:	4308
Door Load:	0	Door Load:	0
Floor Load:	10333	Floor Load:	0
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Duct Loss:	3693	Duct Gain:	5347
Mech Ventilation Loss:	0	Sensible Subtotal	24449
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		Infiltration Latent Load:	0
		Mech Vent. Latent Load:	0
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		Total Latent Load	1683
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Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

- What makes them so complicated is that solar gains are affected by orientation of windows and by shading from overhangs and interior shading devices such as drapes or blinds.

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
Wall Load:	5399	Wall Load:	3126
Ceiling Load:	2479	Ceiling Load:	4308
Door Load:	0	Door Load:	0
Floor Load:	10333	Floor Load:	0
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Building Subtotal	29757	Internal Gain:	1890
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Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

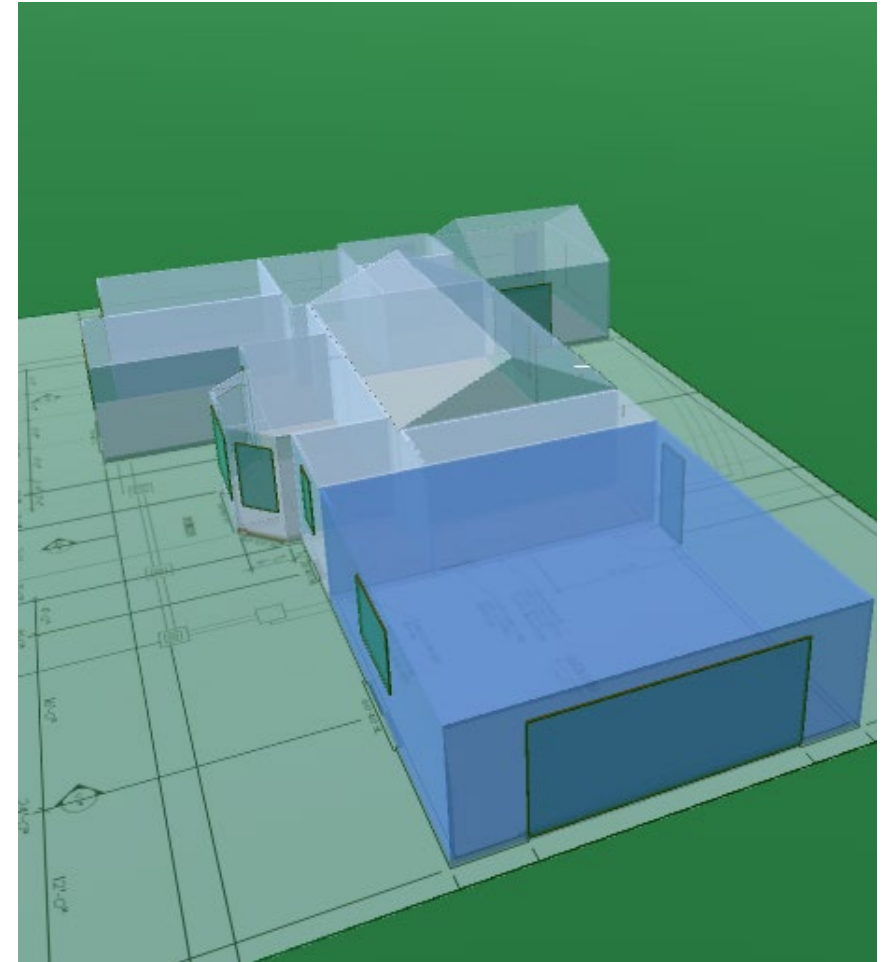
- Cooling loads and the subsequent sizing of equipment is much more precise and involved than heating loads.

Winter Delta Temp. (°F)	42	Summer Delta Temp. (°F)	23
Winter Building Load (Btuh)		Summer Building Load (Btuh)	
Window Load:	5199	Window Load:	6895
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Pie Charts

STEP 2. MANUAL J – LOAD CALCULATIONS

- Depending on the software, you must input all the surface information (geometry), either:
 - By manually typing it in item by item,
 - by re-drawing the floor plan in 2D in the software, or
 - By creating a simple 3D model in the software



Screen snip from Kwik Model with EnergyGauge Loads

STEP 2. MANUAL J – LOAD CALCULATIONS

- The software will use that information to select the correct value from the Manual J tables to determine the heat transfer through each and every surface.
- As you can imagine, this is a lot of information to keep track of, especially for room-by-room loads.

WallNum	Room	Type	Net Area	Direction
1	mbed(3)	2x4 R-13	102	Back
2	mbed(3)	2x4 R-13	68	Right
3	mbed(3)	2x4 R-13	83	Left
4	mbath(1)	2x4 R-13	12	Back
5	mbath(1)	2x4 R-13	16	Front
6	mbath(1)	2x4 R-13	65	Left
7	bath2(1)	2x4 R-13	60.5	Left
8	bed3(1)	2x4 R-13	72	Front
9	bed3(1)	2x4 R-13	124	Left
10	bed2(2)	2x4 R-13	72	Front
11	bed2(2)	2x4 R-13	92	Right
12	bed2(2)	2x4 R-13	16	Left
13	liv/kit(3)	2x4 R-13	154.5	Back
14	din(1)	2x4 R-13	24	Front
15	din(2)	2x4 R-13	8	Right
16	din(2)	2x4 R-13	4	Left
17	din(4)	2x4 R-13	26	Front
18	din(5)	2x4 R-13	18.941	Front Left
19	din(3)	2x4 R-13	18.941	Front Right
20	pdr(1)	2x4 R-13	44	Back
21	pdr(1)	2x4 R-13	119.333	Right
22	util(1)	2x4 R-13	58	Front

Screen snip from Kwik Model with EnergyGauge Loads

THE HVAC DESIGN PROCESS – 4 STEPS

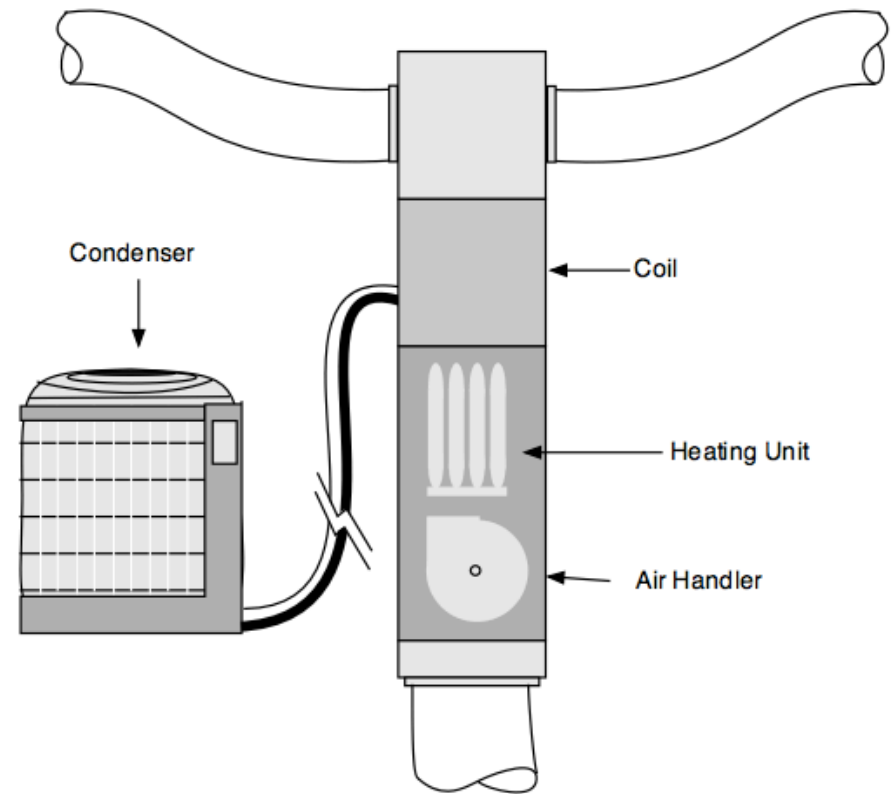
■ The Process

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)

STEP 3 - MANUAL S – EQUIPMENT SELECTION

- Once the room-by-room loads are done, they can be added up to get the **total** heating and cooling loads.
- The next step is to select the equipment.

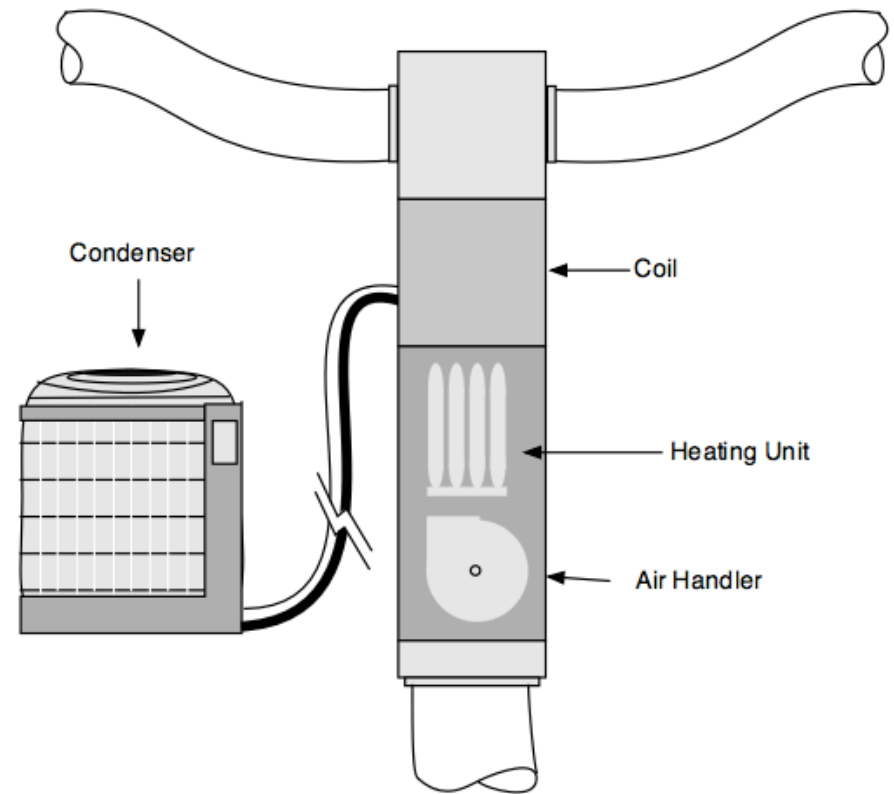


A Typical Split System

STEP 3 - MANUAL S – EQUIPMENT SELECTION

- If it turns out that the total heating or cooling load is too large for a **single** piece of equipment, the house needs to be broken into smaller **zones** and a separate load calculation done on each one.

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



A Typical Split System

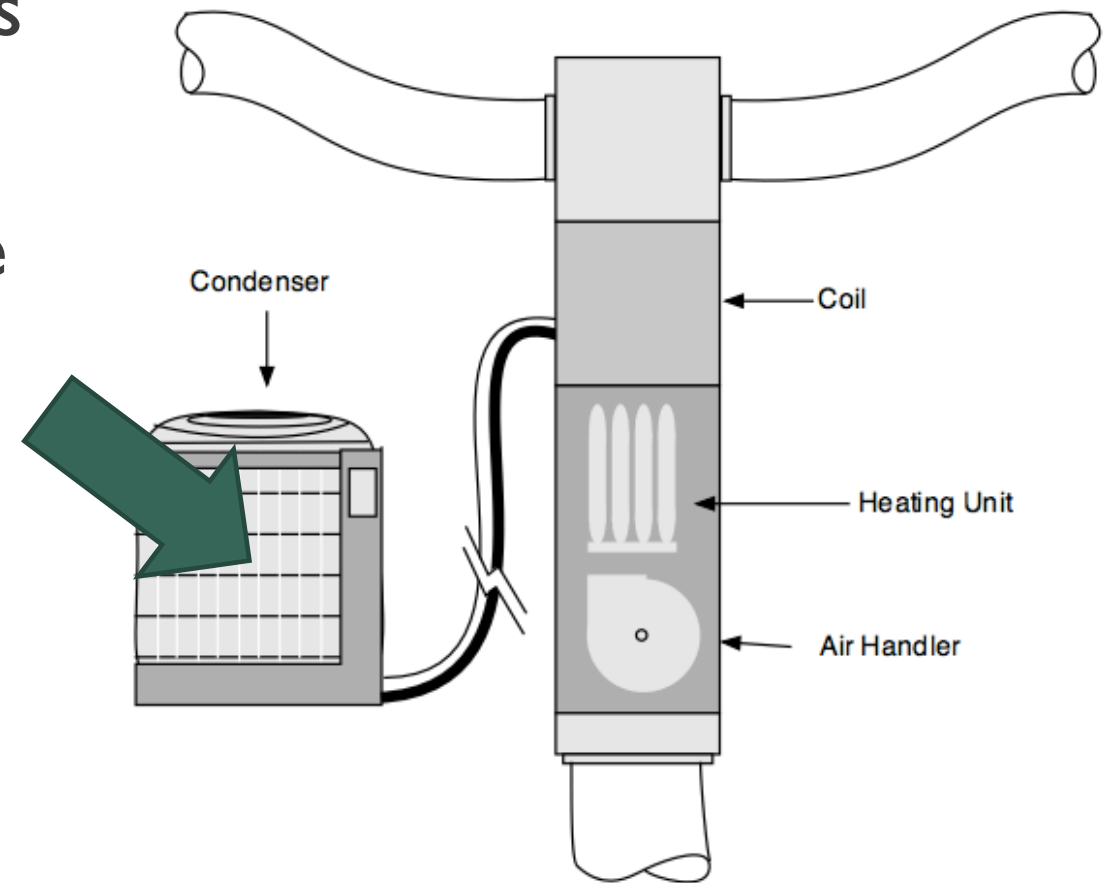
STEP 3 - MANUAL S – EQUIPMENT SELECTION

- Selecting an air conditioner is much more complicated than selecting a gas furnace and is covered in detail by **ACCA Manual S**
- The reason it is more complicated is that many things affect its capacity.

			OUTDOOR AMBIENT TEMPERATURE																
			65°F				75°F				85°F				95°F				
			ENTERING INDOOR WET BULB TEMPERATURE																
			IDB	AIRFLOW	59	63	67	71	59	63	67	71	59	63	67	71	59	63	67
70	525	MBh	17.9	18.1	18.7	-	17.7	18.0	18.5	-	17.3	17.5	18.0	-	16.4	16.7	17.2	-	15.1
		S/T	0.62	0.54	0.40	-	0.62	0.55	0.40	-	0.65	0.57	0.43	-	1.00	0.59	0.45	-	1.00
		ΔT	19	17	14	-	19	17	14	-	19	18	14	-	19	17	14	-	19
		kW	1.06	1.05	1.05	-	1.17	1.17	1.17	-	1.30	1.30	1.30	-	1.45	1.45	1.44	-	1.61
		Amps	4.0	4.0	4.0	-	4.5	4.5	4.5	-	5.1	5.1	5.1	-	5.8	5.8	5.8	-	6.5
		HI PR	244	245	247	-	283	284	286	-	323	325	326	-	367	368	370	-	414
		LO PR	125	126	129	-	132	134	137	-	139	141	144	-	145	146	149	-	150
	610	MBh	18.1	18.4	18.9	-	18.0	18.2	18.8	-	17.5	17.8	18.3	-	16.7	17.0	17.5	-	15.1
		S/T	0.69	0.61	0.47	-	0.69	0.62	0.48	-	0.72	0.64	0.50	-	1.00	0.66	0.52	-	1.00
		ΔT	18	16	13	-	18	16	13	-	18	16	13	-	18	16	13	-	18
		kW	1.06	1.06	1.06	-	1.18	1.18	1.18	-	1.31	1.31	1.31	-	1.45	1.45	1.45	-	1.61
		Amps	4.0	4.0	4.0	-	4.6	4.6	4.6	-	5.2	5.2	5.2	-	5.8	5.8	5.8	-	6.6
		HI PR	247	248	250	-	285	286	288	-	326	327	329	-	369	370	372	-	416
		LO PR	127	128	131	-	134	136	139	-	141	143	146	-	147	148	151	-	152
	675	MBh	18.4	18.6	19.2	-	18.2	18.5	19.0	-	17.8	18.0	18.5	-	16.9	17.2	17.7	-	16.1
		S/T	0.72	0.64	0.50	-	0.73	0.65	0.51	-	0.75	0.67	0.53	-	1.00	0.69	0.55	-	1.00
		ΔT	17	16	12	-	17	15	12	-	17	16	12	-	17	15	12	-	17
		kW	1.07	1.07	1.06	-	1.18	1.18	1.18	-	1.32	1.31	1.31	-	1.46	1.46	1.46	-	1.61
		Amps	4.1	4.1	4.0	-	4.6	4.6	4.6	-	5.2	5.2	5.2	-	5.8	5.8	5.8	-	6.6
		HI PR	248	250	251	-	287	288	290	-	328	329	330	-	371	372	374	-	418
		LO PR	128	130	133	-	136	138	141	-	143	144	147	-	148	150	153	-	154
75	525	MBh	17.9	18.1	18.7	19.5	17.7	18.0	18.5	19.3	17.3	17.5	18.1	18.9	16.5	16.7	17.2	18.1	15.1
		S/T	0.75	0.67	0.53	0.38	0.76	0.68	0.54	0.39	1.00	0.70	0.56	0.42	1.00	0.72	0.58	0.44	1.00
		ΔT	23	21	18	15	23	21	18	15	23	22	18	15	23	21	18	15	23
		kW	1.05	1.05	1.05	1.06	1.17	1.17	1.17	1.18	1.30	1.30	1.30	1.31	1.45	1.45	1.44	1.45	1.61
		Amps	4.0	4.0	4.0	4.0	4.5	4.5	4.5	4.6	5.1	5.1	5.1	5.2	5.8	5.8	5.8	5.8	6.5
		HI PR	245	246	247	252	283	284	286	290	324	325	326	331	367	368	370	374	414
		LO PR	125	126	129	135	132	134	137	142	139	141	144	149	145	146	149	155	150
	610	MBh	18.2	18.4	18.9	19.8	18.0	18.2	18.8	19.6	17.5	17.8	18.3	19.1	16.7	17.0	17.5	18.3	15.1
		S/T	0.82	0.74	0.60	0.46	1.00	0.75	0.61	0.46	1.00	0.78	0.64	0.49	1.00	0.80	0.66	0.51	1.00
		ΔT	22	20	17	13	22	20	17	13	22	20	17	14	22	20	17	13	22
		kW	1.06	1.06	1.06	1.07	1.18	1.18	1.18	1.19	1.31	1.31	1.31	1.32	1.45	1.45	1.45	1.46	1.61
		Amps	4.0	4.0	4.0	4.1	4.6	4.6	4.6	4.6	5.2	5.2	5.2	5.2	5.8	5.8	5.8	5.9	6.6
		HI PR	247	248	250	254	286	287	288	293	326	327	329	333	370	371	372	377	417
		LO PR	127	128	132	137	134	136	139	144	141	143	146	151	147	148	151	157	152
	675	MBh	18.4	18.6	19.2	20.0	18.2	18.5	19.0	19.8	17.8	18.0	18.5	19.4	17.0	17.2	17.7	18.6	16.1
		S/T	0.75	0.67	0.53	0.38	0.76	0.68	0.54	0.39	1.00	0.70	0.56	0.42	1.00	0.72	0.58	0.44	1.00
		ΔT	23	21	18	15	23	21	18	15	23	22	18	15	23	21	18	15	23
		kW	1.05	1.05	1.05	1.06	1.17	1.17	1.17	1.18	1.30	1.30	1.30	1.31	1.45	1.45	1.44	1.45	1.61
		Amps	4.0	4.0	4.0	4.0	4.5	4.5	4.5	4.6	5.1	5.1	5.1	5.2	5.8	5.8	5.8	5.8	6.5
		HI PR	245	246	247	252	283	284	286	290	324	325	326	331	367	368	370	374	414
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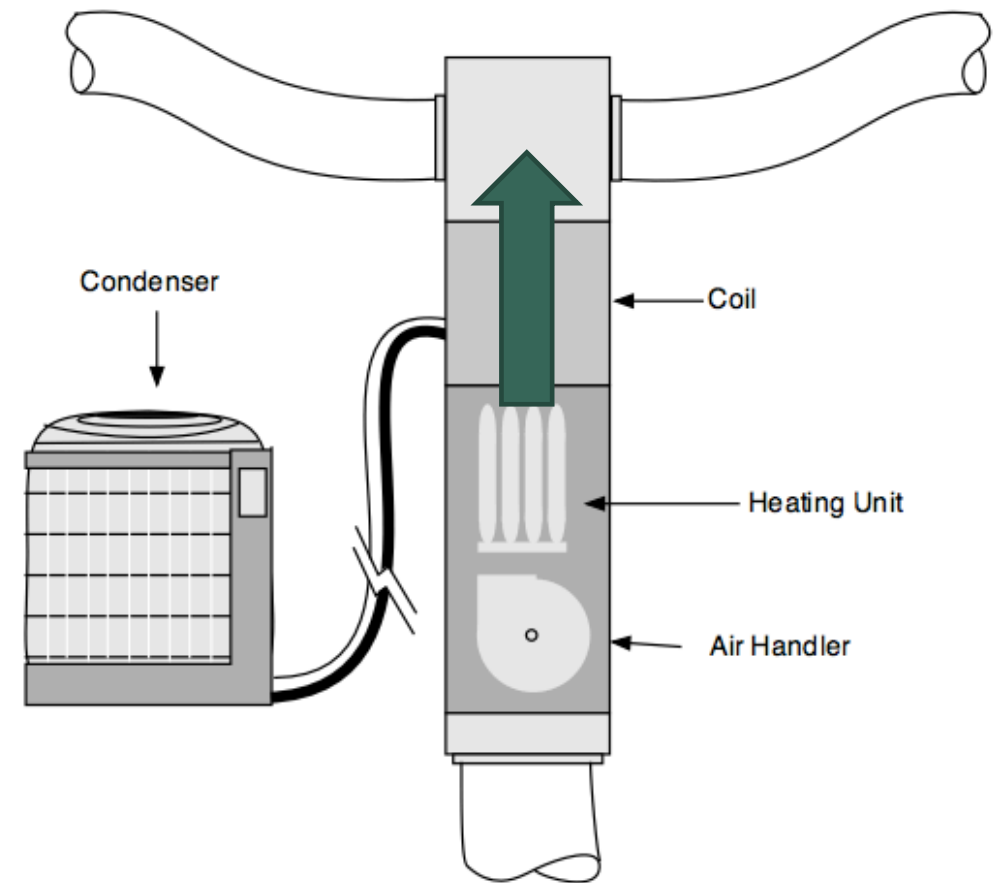
STEP 3 - MANUAL S – EQUIPMENT SELECTION

- An air conditioner's capacity (its ability to cool) is affected by:
 - **The outdoor temperature**
 - The amount of air blowing across the evaporator coil
 - The indoor temperature
 - The indoor humidity



STEP 3 - MANUAL S – EQUIPMENT SELECTION

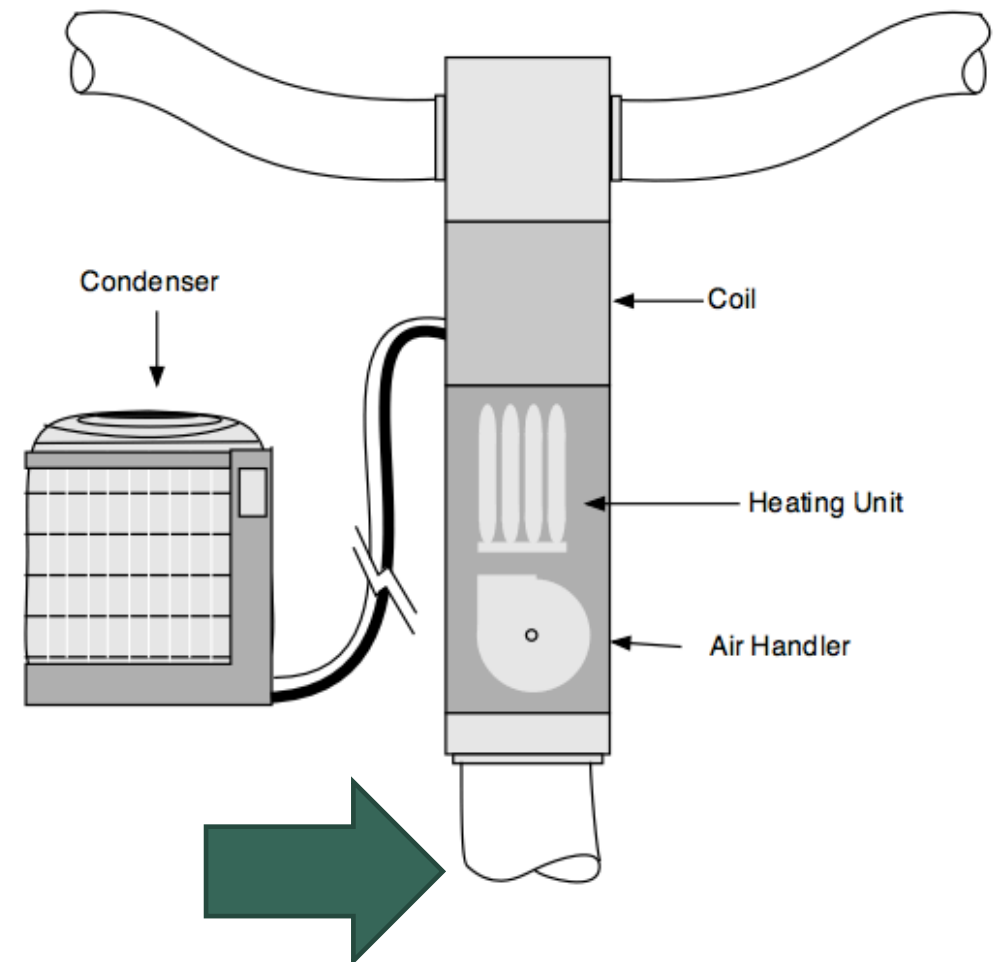
- An air conditioner's capacity (its ability to cool) is affected by:
 - The outdoor temperature
 - **The amount of air blowing across the evaporator coil**
 - The indoor temperature
 - The indoor humidity



STEP 3 - MANUAL S – EQUIPMENT SELECTION

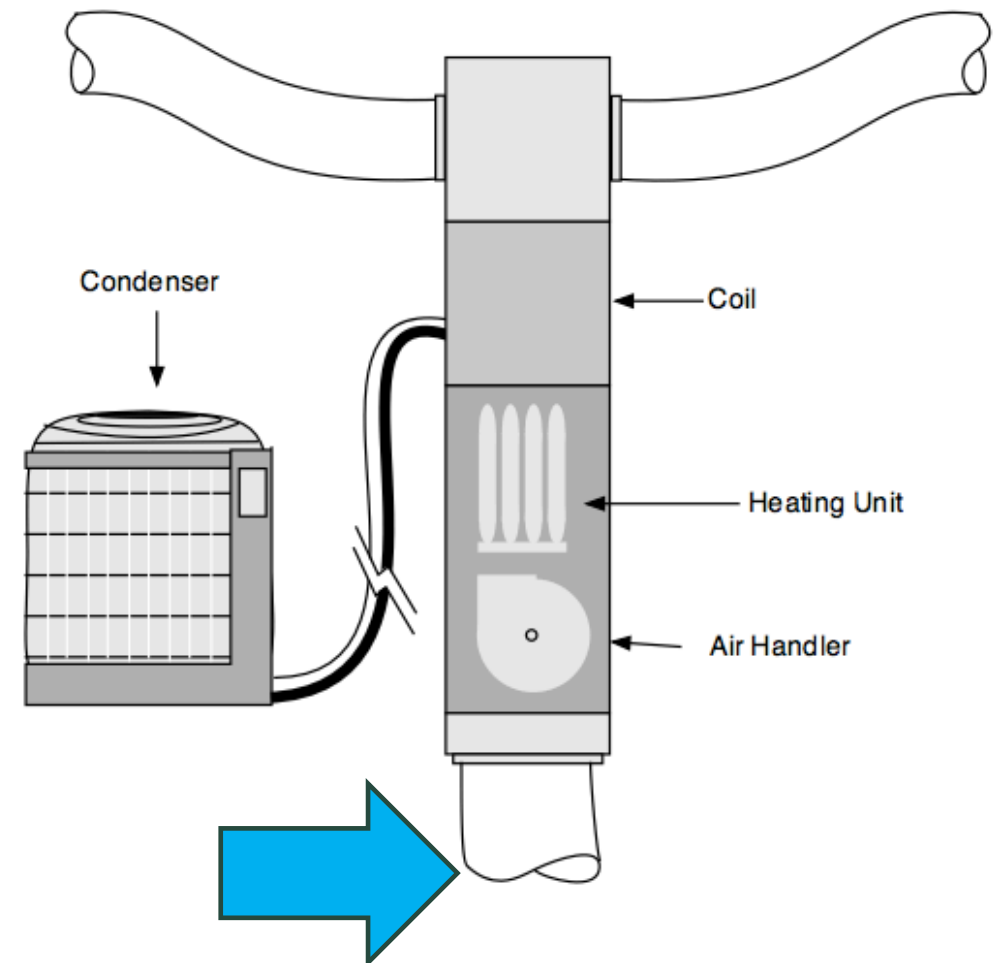
- An air conditioner's capacity (its ability to cool) is affected by:
 - The outdoor temperature
 - The amount of air blowing across the evaporator coil
 - **The indoor temperature**
 - The indoor humidity

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



STEP 3 - MANUAL S – EQUIPMENT SELECTION

- An air conditioner's capacity (its ability to cool) is affected by:
 - The outdoor temperature
 - The amount of air blowing across the evaporator coil
 - The indoor temperature
 - **The indoor humidity**



THE HVAC DESIGN PROCESS – 4 STEPS

■ The Process

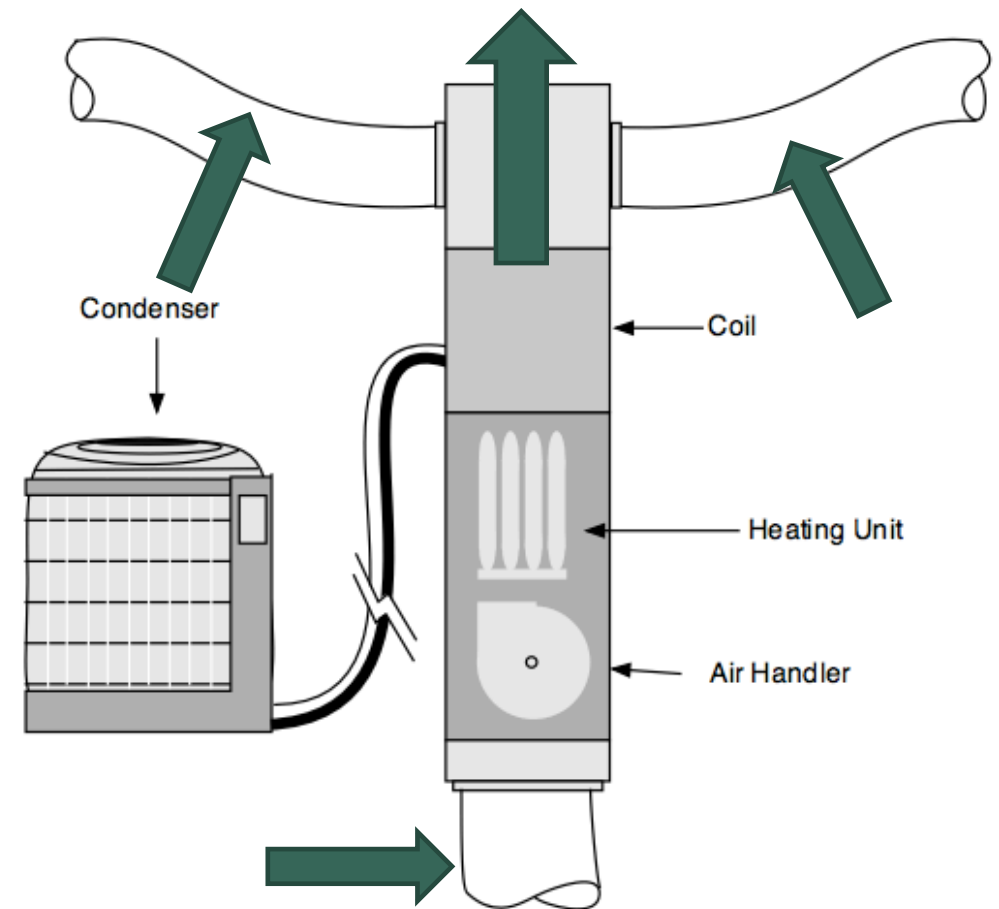
The basic steps in ***designing*** a typical ducted central system for a home are:

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)

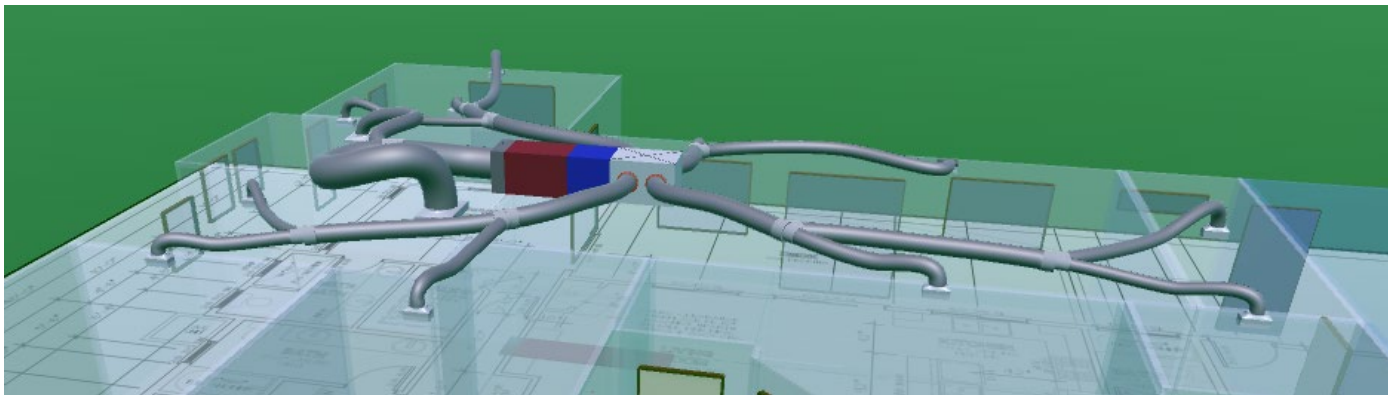
STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

- Airflow is affected by duct sizes.
- This means that duct sizing can have a big impact on cooling capacity.
- **Oversizing** air conditioners and **undersizing** ducts is one of the most common causes of comfort complaints in homes.



STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

- This is one of the most overlooked aspects of HVAC design and one of the biggest sources of comfort problems.
- Sizing the ducts is also one of the easiest parts of the J/S/D process.
- Making the ducts *fit* in the house is where it can get difficult, especially in 2 story homes.



STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

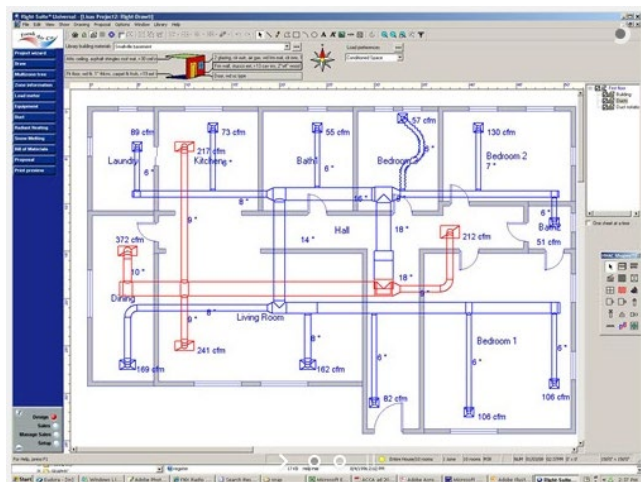
- The process for properly sizing ducts is quite easy as long as you have room-by-room load calculations.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

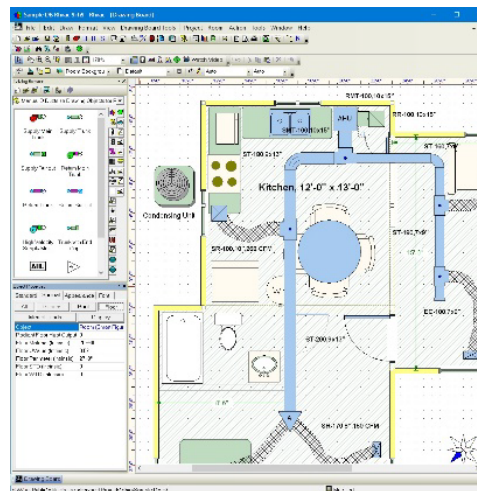
- Room-by-room **cooling loads** will come from the software

Much of the math presented in this example is done automatically by the software, but it is very important to understand the math that the software is doing for you.

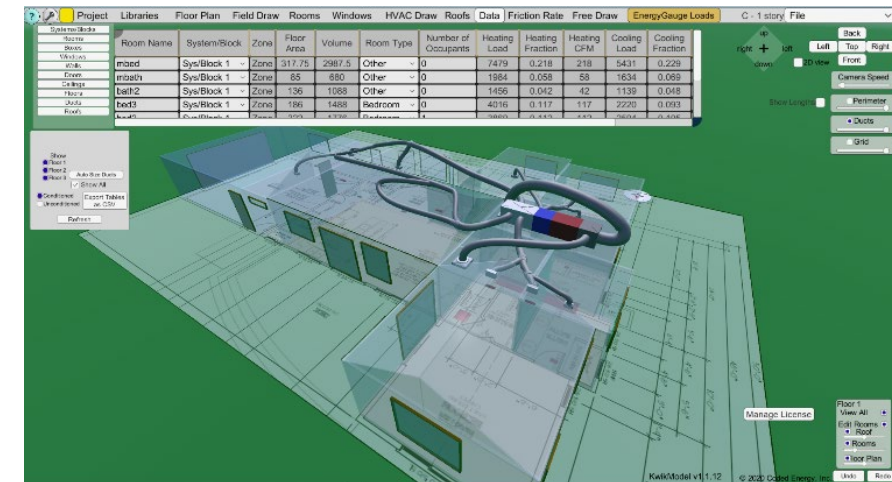
Right-Suite® by
Wrightsoft



RHVAC by
Elite Software



Kwik Model® with
EnergyGauge Loads



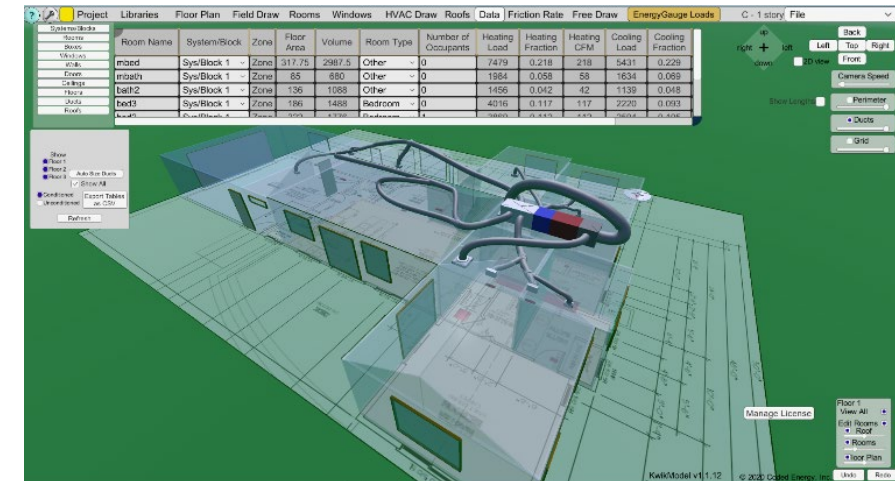
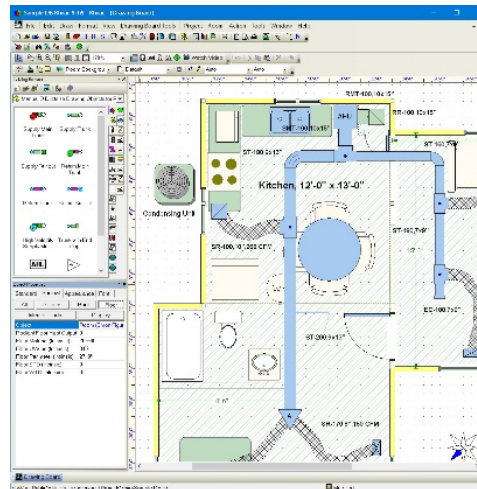
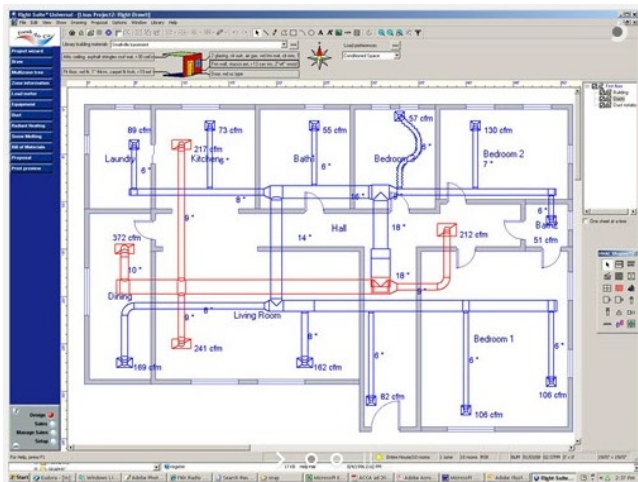
STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

To perform the load calcs, it is recommended that you take a class on how to use a load calculation software.

Right-Suite® by
Wrightsoft

RHVAC by
Elite Software

Kwik Model® with
EnergyGauge Loads



STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

- Example room-by-room cooling loads:

This is an example of what you might see in the software.

Room Name	Floor	System/Block	Zone	Floor Area	Volume	Room Type	Number of Occupants	Heating Load	Heating Fraction	Heating CFM	Sens Cooling Load	Cooling Fraction	Cooling CFM	Duct Size CFM
mbed	1	Sys/Block 1	Zone	317.75	2987.5	Bedroom	0	6632	0.216	183	4411	0.217	217	217
mbath	1	Sys/Block 1	Zone	85	680	Other	0	1745	0.057	48	1310	0.065	64	64
bath2	1	Sys/Block 1	Zone	136	1088	Other	0	1330	0.043	37	948	0.047	47	47
bed3	1	Sys/Block 1	Zone	186	1488	Bedroom	1	3534	0.115	98	1993	0.098	98	98
bed2	1	Sys/Block 1	Zone	222	1776	Bedroom	1	3432	0.112	95	2033	0.1	100	100
liv/kit	1	Sys/Block 1	Zone	493	4930	Kitchen	2	5744	0.187	159	5174	0.255	255	255
din	1	Sys/Block 1	Zone	184.25	1474	Other	0	3497	0.114	97	2620	0.129	129	129
pdr	1	Sys/Block 1	Zone	102	816	Other	0	3002	0.098	83	1032	0.051	51	83
util	1	Sys/Block 1	Zone	59.5	476	Other	0	1848	0.06	51	769	0.038	38	51
Total	---	---	---	1785.5	15715.5	---	4	30762	1	850	20289	1	1000	1045

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

Zooming in ...

This is the total cooling load of just the rooms. It does not include infiltration and other whole house loads.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

Total cooling
airflow based on
selected equipment.
Entered in the
Manual S

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

So, where do these room airflows come from?

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

Room airflow is proportional to room load

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

In other words,
if a room is 10% of
the total load,
it should get 10% of
the air.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

“Cooling Fraction” represents the fraction (percent) of the total load that that room’s load represents.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.165	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	69	0.038	38
Total	20289	1	1000

It's calculated by dividing the room load by the total room load.

$$4411 / 20289 = 0.217$$

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.165	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	69	0.038	38
Total	20289	1	1000

So, in this example the kitchen is 21.7% of the cooling load.

$$4411 / 20289 = 0.217$$

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.165	64
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	69	0.038	38
Total	20289	1	1000

This means that the kitchen needs 21.7% of the air.

$$4411 / 20289 = 0.217$$

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Sens Cooling Load	Cooling Fraction	Cooling CFM
mbed	4411	0.217	217
mbath	1310	0.065	65
bath2	948	0.047	47
bed3	1993	0.098	98
bed2	2033	0.1	100
liv/kit	5174	0.255	255
din	2620	0.129	129
pdr	1032	0.051	51
util	769	0.038	38
Total	20289	1	1000

The total airflow is multiplied by the room's cooling fraction to get the room's cooling cfm.

$$0.217 \times 1000 = 217$$

Don't worry about small roundoff error.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Room Name	Heating CFM	Cooling CFM	Duct Size CFM
mbed	183	217	217
mbath	48	64	64
bath2	37	47	47
bed3	98	98	98
bed2	95	100	100
liv/kit	159	255	255
din	97	129	129
pdr	83	51	83
util	51	38	51
Total	850	1000	1045

To size ducts we need to know airflow, which we now have, and another number, called **“friction rate”**.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Friction Rate (FR)

- FR is a number used to size ducts based on
 - design static pressure,
 - pressure losses and
 - total equivalent lengths.
- Search for “ACCA Manual D Friction Rate Worksheet”

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Friction Rate (FR)

- It's the number used on a duct slide rule (do not confuse it with *external static pressure* that is used to determine the airflow of the air handler)
- The units of FR are *inches of water column per 100 feet*.
- The equation for FR is:

(next slide)

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Friction Rate (FR)=

$(\text{available static pressure}) \times 100 / (\text{total equivalent length})$

$\text{available static pressure} = \text{TESP} - \text{Component Pressure Losses}^*$

*miscellaneous things that are in line to airflow to all runs

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

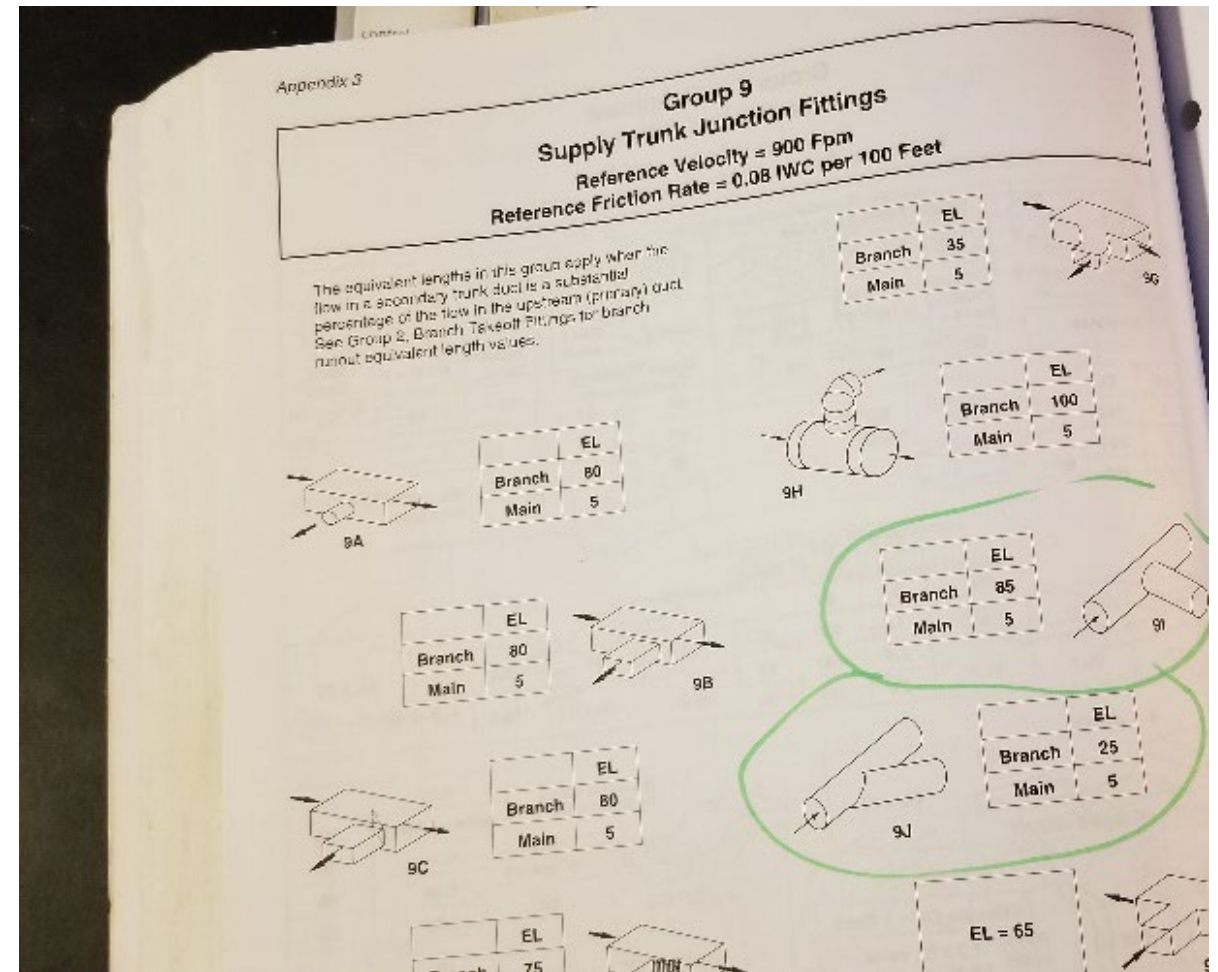
Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil		Used with furnaces. Not needed for HP fan coil units with internal coils.
Electric resistance heating coil		Aux heat for HP. Manufacturer provides this for various CFMs
Hot water coil		Hydronic systems
Heat exchanger		Other systems. Not common.
Low efficiency filter		Make sure you pick a filter that meets this.
High or mid-efficiency filter		Same. Make sure you pick a filter that meets this.
Electronic filter		Add on
Humidifier		Very cold climates
Supply outlet		All systems
Return grille		All systems
Balancing damper		If needed
UV lights or other component		Add on
Total component losses (CPL)		IWC

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Equivalent Lengths

- Manual D accounts for resistance created by various fittings in the duct system, by equating them to the resistance of a certain length of straight duct hence the name “equivalent length”.



STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Friction Rate (FR)

- FR represents how much static pressure can be “used up” as the air passes through the ducts.
- Lower friction rate = bigger ducts.
- FR is lower for longer runs than for shorter runs.
- 0.09 to 0.11 are common FRs for simple systems like this example.
- For a detailed explanation of Friction Rate, visit the blog www.russellking.me and search for “friction rate”.

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

- This table is based on a duct slide rule using a friction rate of 0.1
- We can use this table to size flex ducts, **but only when the friction rate is 0.1.**
- Choose the size of duct that provides the next largest airflow to what you need.
- For example, if you need 89 cfm, you will choose a 7" duct because a 6" duct will only give you 80 cfm.

Duct Diameter	Air Flow CFM
4"	20
5"	50
6"	80
7"	120
8"	170
9"	230
10"	300
12"	500
14"	740
16"	1050
18"	1400
20"	1875

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

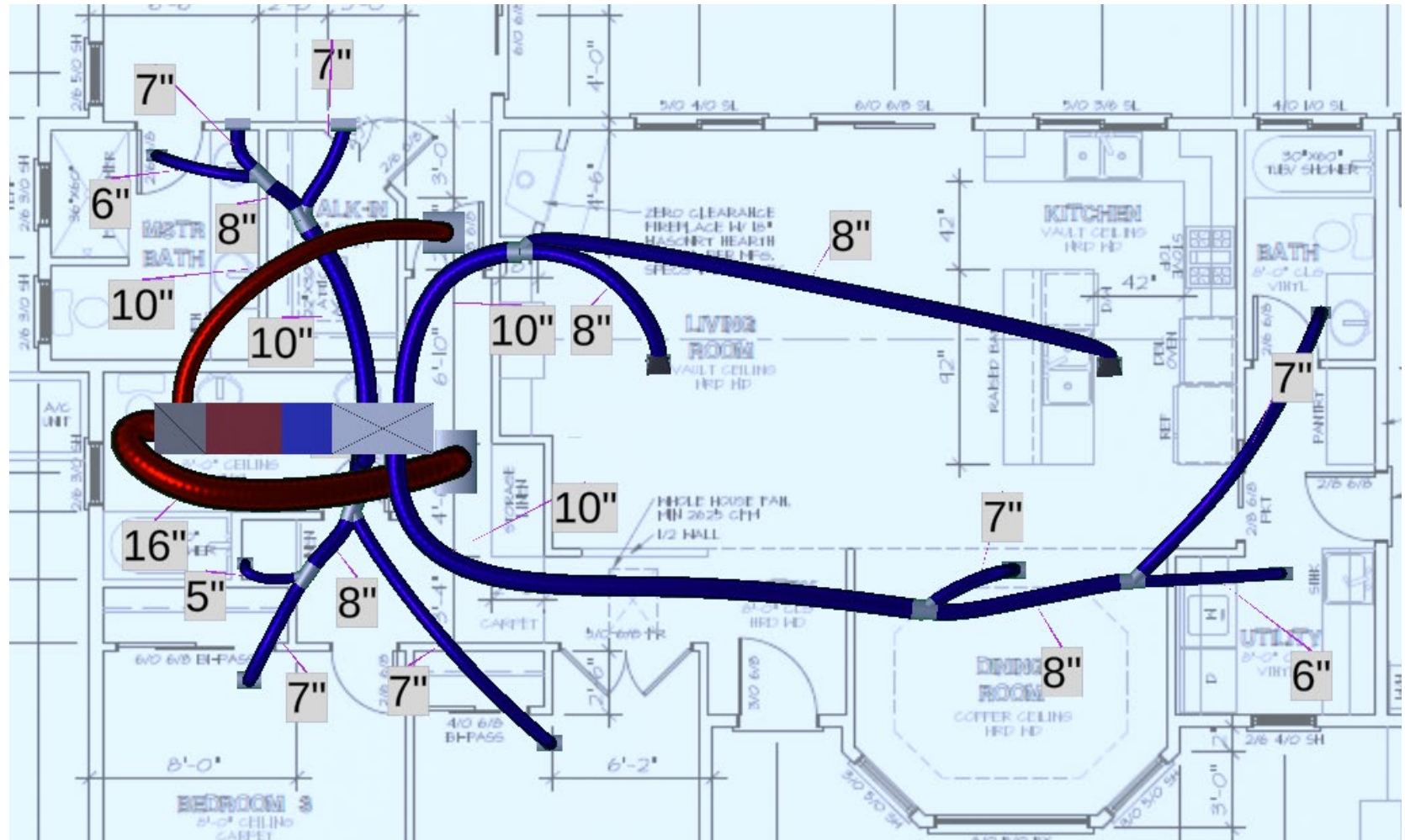
This table summarizes the entire duct system for this example.

SB Number (Does not match EG)	Room Served	AirFlow CFM	Friction Rate	Diameter Inches	Length Feet	Velocity FPM	Register Size (in)	Trunk #	Return #	Type
SB 01.1	mbed	109	0.11	7	2	407	12 x 8	ST2	RB2(mbed(4))	Vinyl Flex
SB 01.2	mbed	109	0.09	7	3	407	12 x 8	ST1	RB2(mbed(4))	Vinyl Flex
SB 02.1	mbath	64	0.09	6	4	328	10 x 6	ST2	RB2(mbed(4))	Vinyl Flex
SB 03.1	bath2	47	0.09	5	3	342	8 x 6	ST4	RB1(bath2(1))	Vinyl Flex
SB 04.1	bed3	98	0.1	7	5	367	12 x 8	ST4	RB1(bath2(1))	Vinyl Flex
SB 05.1	bed2	100	0.09	7	13	375	12 x 8	ST3	RB1(bath2(1))	Vinyl Flex
SB 06.1	liv/kit	128	0.07	8	7	365	12 x 8	ST7	RB1(bath2(1))	Vinyl Flex
SB 06.2	liv/kit	128	0.06	8	24	365	12 x 8	ST7	RB1(bath2(1))	Vinyl Flex
SB 07.1	din	129	0.08	8	4	370	12 x 8	ST5	RB1(bath2(1))	Vinyl Flex
SB 08.1	pdr	83	0.07	7	14	310	10 x 6	ST6	RB1(bath2(1))	Vinyl Flex
SB 09.1	util	51	0.09	5	6	375	12 x 6	ST6	RB1(bath2(1))	Vinyl Flex
ST Number	---	AirFlow CFM	Friction Rate	Diameter Inches	Length Feet	Velocity FPM	---	Trunk #	---	Type
ST1	---	282	0.09	10	6	517	---	handler	---	Vinyl Flex
ST2	---	173	0.09	8	1	496	---	ST1	---	Vinyl Flex
ST3	---	245	0.09	10	4	449	---	handler	---	Vinyl Flex
ST4	---	145	0.09	8	2	415	---	ST3	---	Vinyl Flex
ST5	---	263	0.07	10	24	482	---	handler	---	Vinyl Flex
ST6	---	134	0.07	8	7	384	---	ST5	---	Vinyl Flex
ST7	---	255	0.06	12	6	325	---	handler	---	Vinyl Flex
RB Number	Location	AirFlow CFM	Friction Rate	Diameter Inches	Length Feet	Velocity FPM	Grille Size (inches)	Trunk #	---	Type
RB1	bath2	763	0.06	16	20	547	30 x 20	handler	---	Vinyl Flex
RB2	mbed	282	0.09	10	14	517	20 x 20	handler	---	Vinyl Flex
RT Number	---	AirFlow CFM	Friction Rate	Diameter Inches	Length Feet	Velocity FPM	---	Trunk #	---	Type

STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

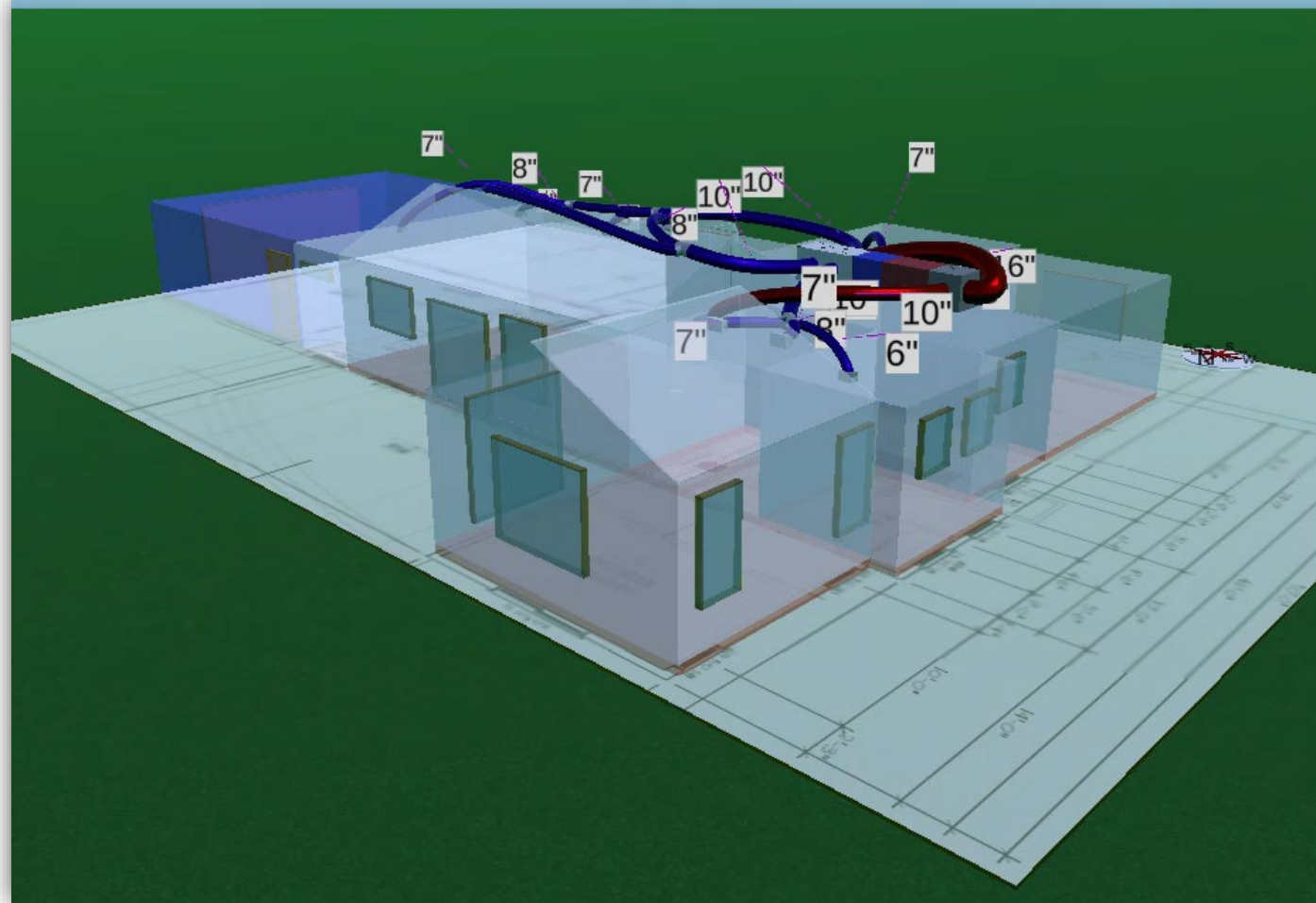
This is what a final design would look like.

It should show duct sizes and approximate routing.



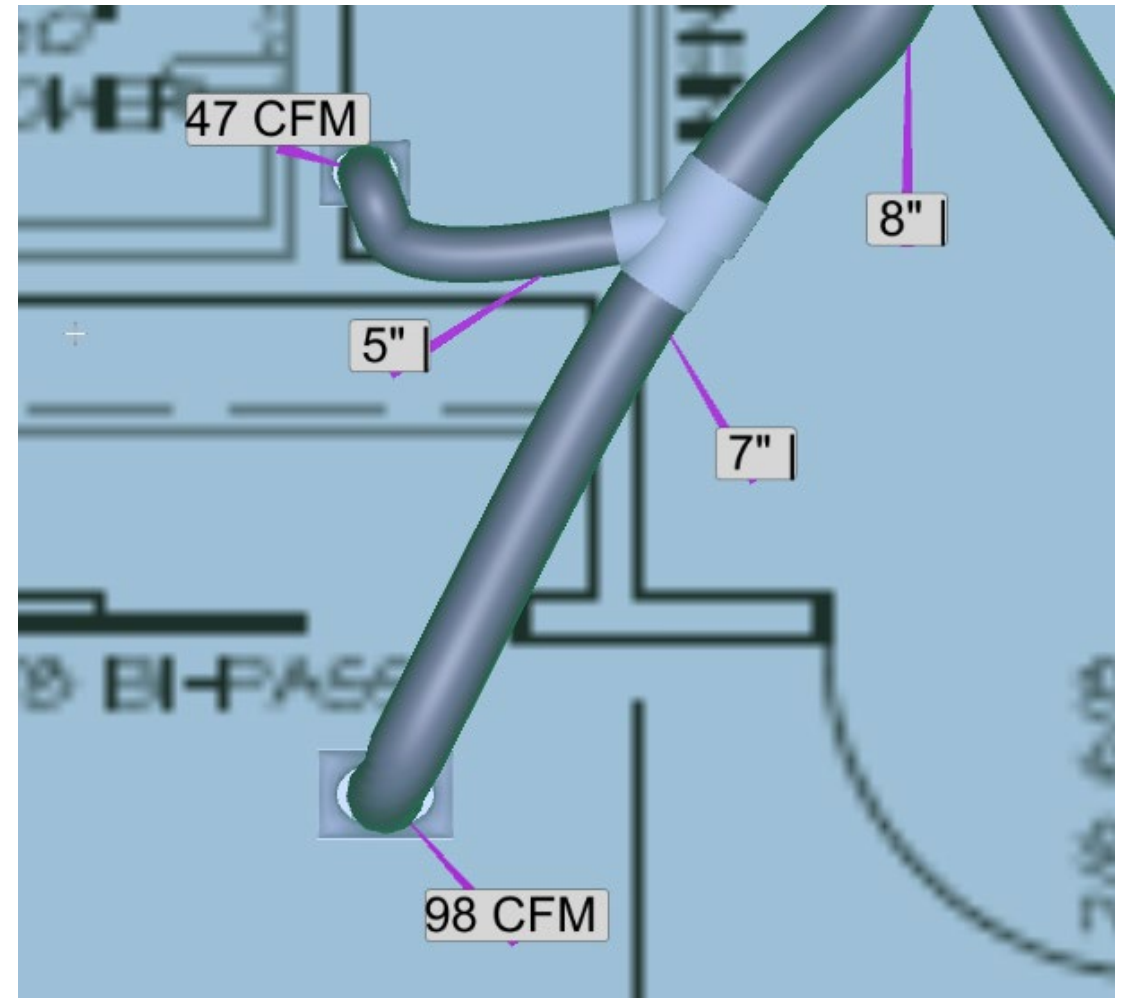
STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

Better yet, show it in 3D!



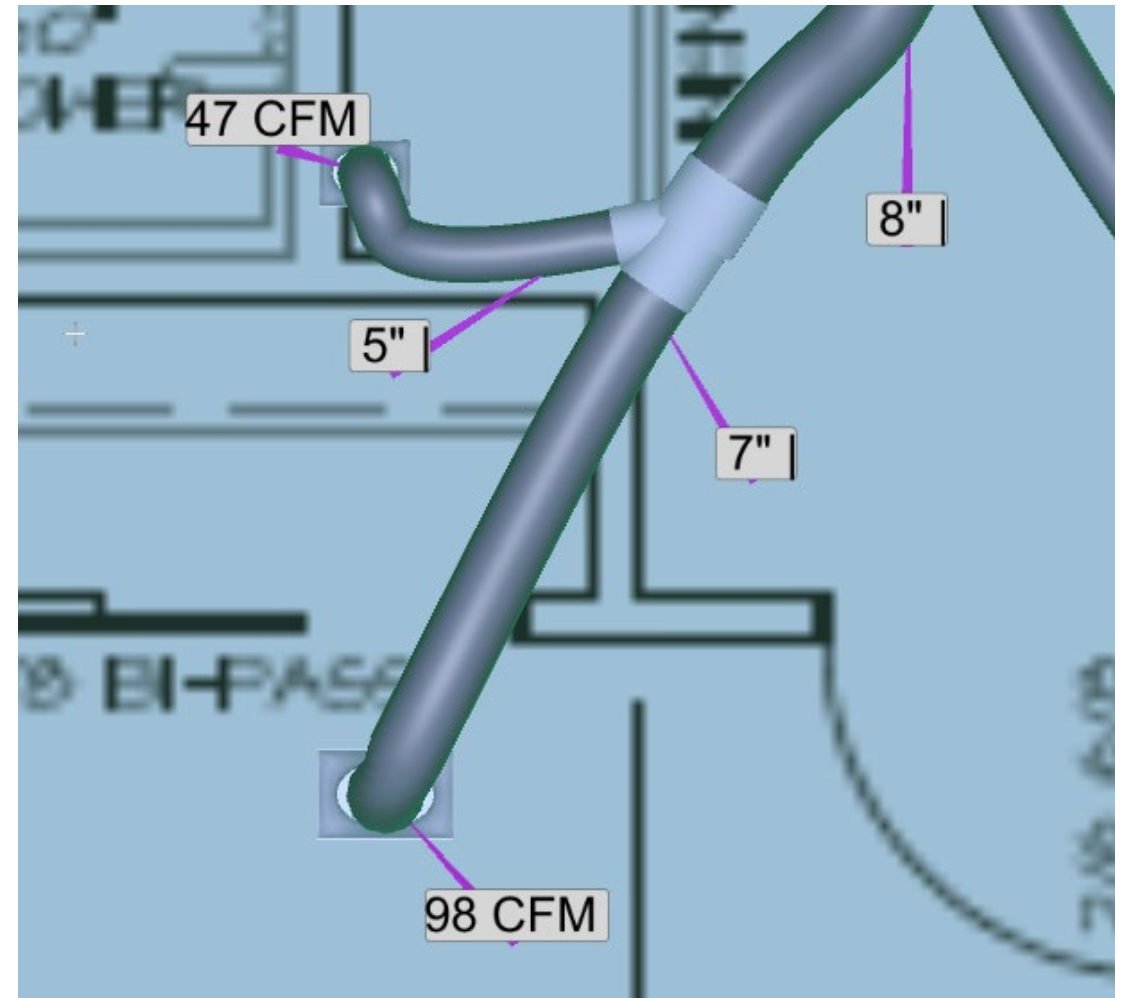
STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

- It is a good idea to show the target airflows next to each register so that they can be verified after the system is installed.



STEP 4. DESIGN THE DISTRIBUTION SYSTEM – MANUAL D

- When possible, compare installed airflows and static pressure to design targets.
- This feedback from the field is critical, especially if you are just learning to design systems.



WRAP UP

- Where things can go wrong.
 - Incomplete information or bad assumptions about the house.
 - House not built the way you were told.
 - Equipment undersized.
 - Equipment oversized.
 - Low total system airflow
 - Target room flows incorrect – poor balance
 - Supply register types and locations
 - Thermostat location
 - Occupant behavior/expectations

WRAP UP

- How to avoid these problems.
 - Become proficient and confident with the software.
 - Practice, practice, practice.
 - Double check your work.
 - Join user's groups. Share your designs with others. Ask for feedback and comments.
 - Test your designs after they are installed. Airflow, static pressure and duct leakage. (required in CA for new systems)
 - Educate homeowners on proper system operation.
 - When in doubt, err toward smaller equipment and larger ducts.



END OF PRESENTATION

OPEN DISCUSSION TIME

Questions about Title 24?

3C-REN offers a *free* Code Coach Service



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Call:
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Energy Code Coaches are local experts who can help answer your Title 24 Part 6 or Part 11 questions.

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