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

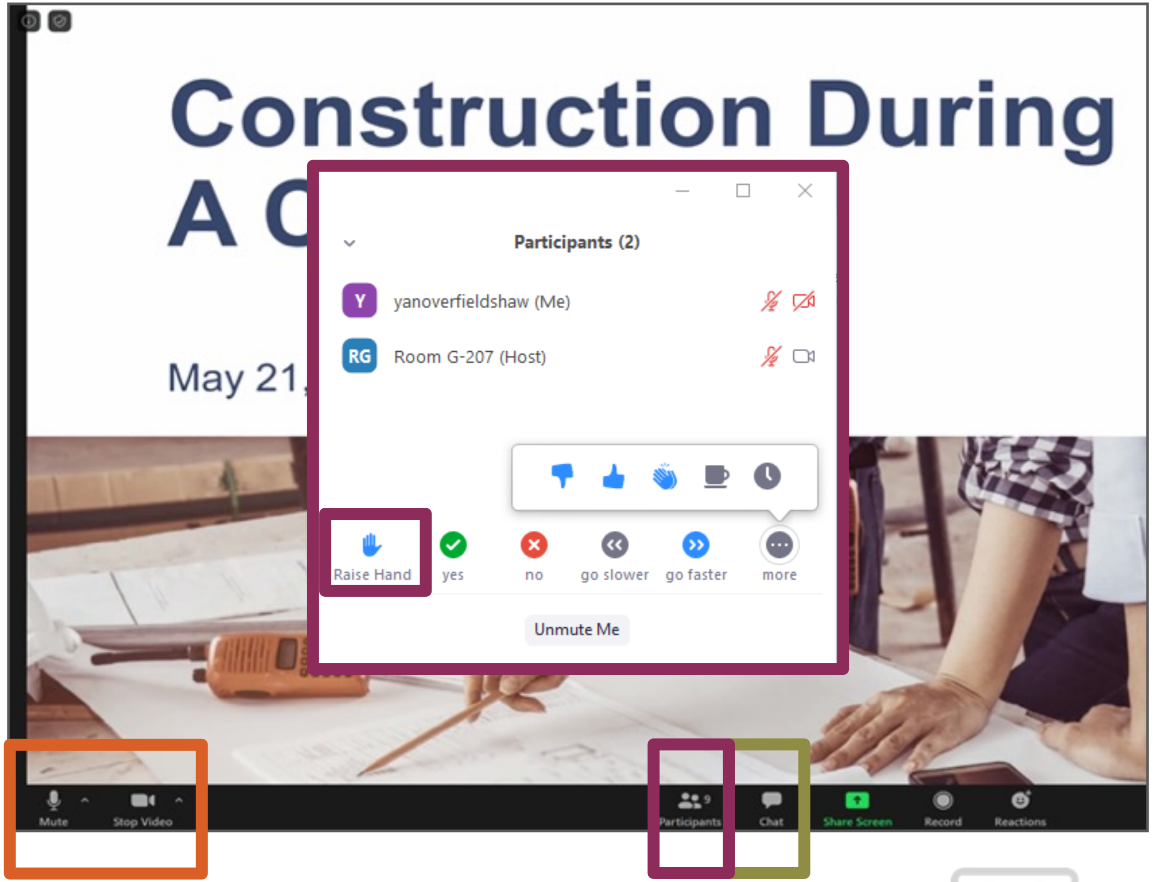
Load Calculation Site Survey Essentials

Judy Rachel
Home Performance Professional

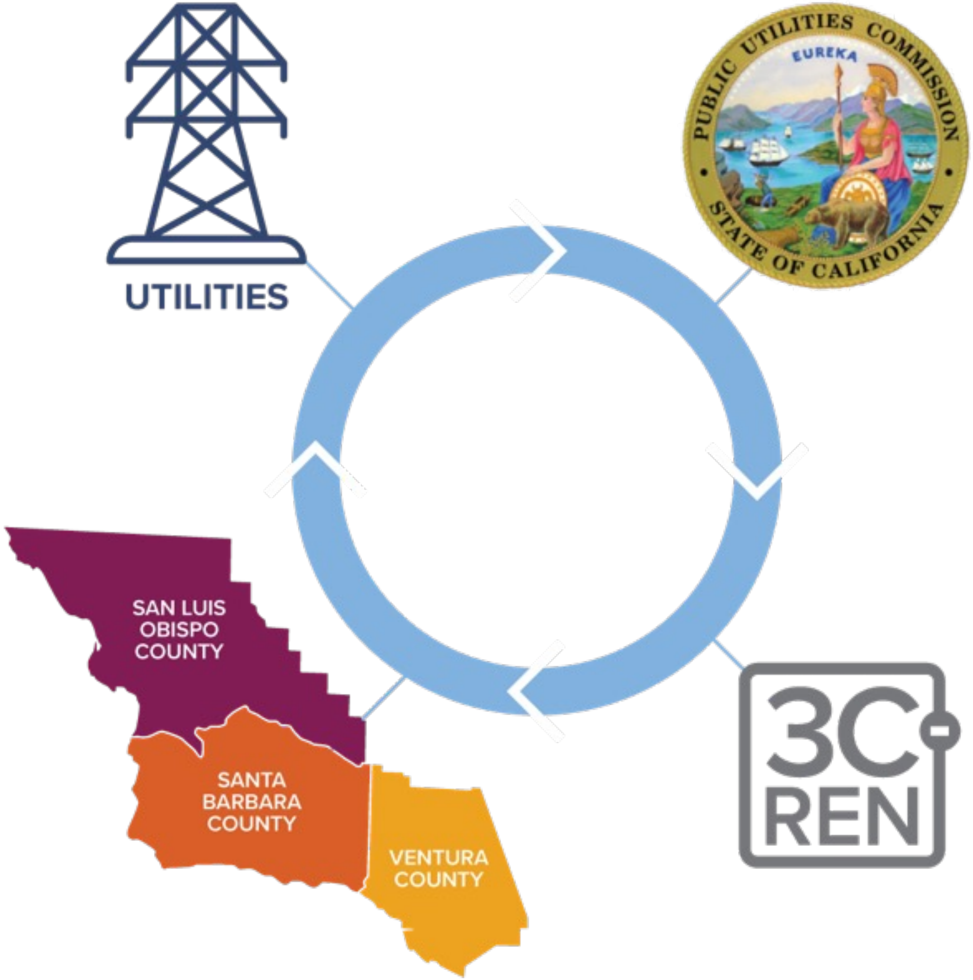
April 22, 2025

Zoom Orientation

- Add an **introduction** in the chat.
  Be sure **full name** is displayed.
- Did you call in? Please **share** first and last name with us.
- Please **mute** upon joining
- Use the "**Chat**" to share questions or comments
- Under "**Participant**" select "**Raise Hand**" to share a question or comment verbally
- Session may be **recorded** and posted to 3C-REN's on-demand page
- Slides/recording are **shared** after most events



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
3c-ren.org/multifamily

COMMERCIAL ENERGY SAVINGS

3c-ren.org/commercial

Contractors can enroll at
3c-ren.org/contractors

Training

BUILDING PERFORMANCE TRAINING

3c-ren.org/events
3c-ren.org/building

ENERGY CODE CONNECT

3c-ren.org/code

View past trainings at
3c-ren.org/on-demand

Technical Assistance

AGRICULTURE ENERGY SOLUTIONS

3c-ren.org/agriculture

ENERGY ASSURANCE SERVICES

3c-ren.org/assurance

3C REN

3C-REN Achievements

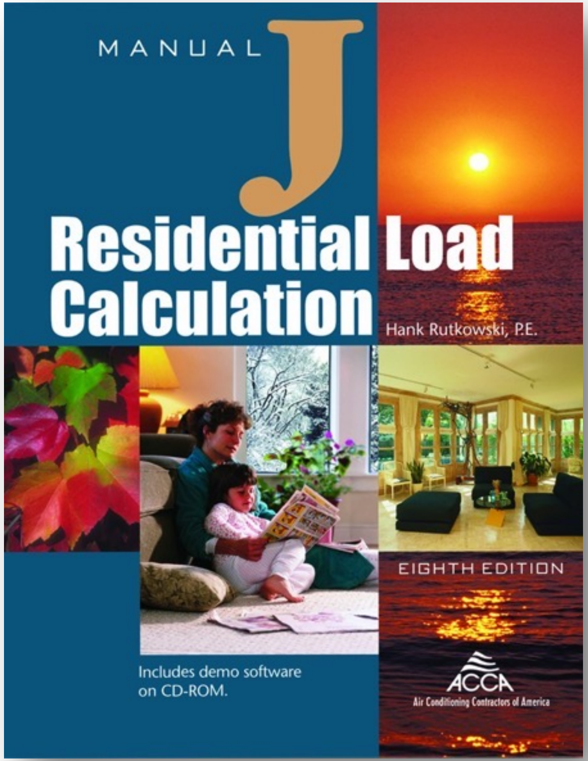
4,000+
Individuals Attended Training

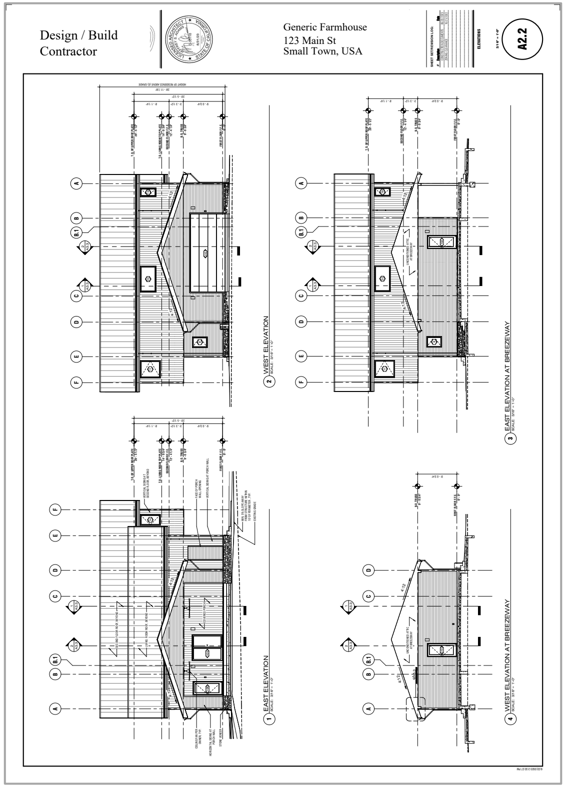
1,374
Energy-Saving Projects Completed

334
Title 24/CalGreen Questions Answered

$155M
Secured for investment in the tri-county region through 2028

Data from 2019-2023 for three programs

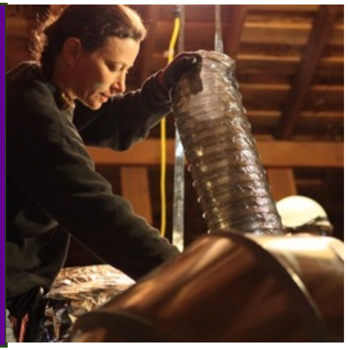




LOAD CALCULATION SITE SURVEY ESSENTIALS

APRIL 22, 2025

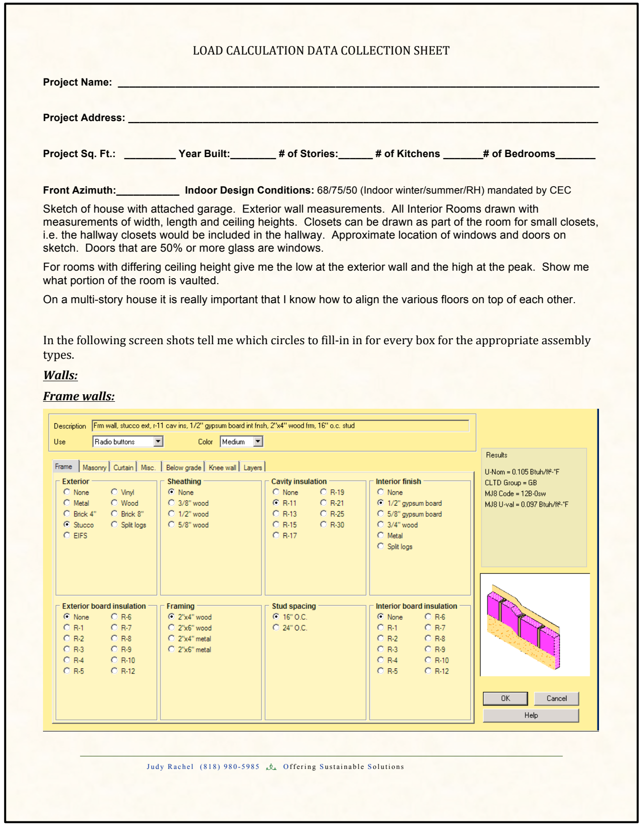
PRESENTER – JUDY RACHEL



1. Home Performance Technician
2. Contractor Field Mentor
3. Perform load calculations and HVAC system design
4. Field Research/Building Performance Testing
5. Diagnostic testing of existing HVAC systems
6. Trainer for Home/High Performance Homes, ACCA load calculations, Healthy Homes, use of diagnostic test equipment, combustion safety, etc.

TODAY'S TAKEAWAYS

1. What a load calculation is.
2. Why the site survey data collection procedure is the only way to produce an accurate load calculation
3. What information needs to be obtained during the site survey in order to create a load calculation
4. Explore some of the challenges in collecting accurate site survey data



LOAD CALCULATION DATA COLLECTION SHEET

Project Name: ______________________________

Project Address: ______________________________

Project Sq. Ft.: ________ **Year Built:**_______ **# of Stories:**_____ **# of Kitchens** ______**# of Bedrooms**______

Front Azimuth:__________ **Indoor Design Conditions:** 68/75/50 (Indoor winter/summer/RH) mandated by CEC

Sketch of house with attached garage. Exterior wall measurements. All Interior Rooms drawn with measurements of width, length and ceiling heights. Closets can be drawn as part of the room for small closets, i.e. the hallway closets would be included in the hallway. Approximate location of windows and doors on sketch. Doors that are 50% or more glass are windows.

For rooms with differing ceiling height give me the low at the exterior wall and the high at the peak. Show me what portion of the room is vaulted.

On a multi-story house it is really important that I know how to align the various floors on top of each other.

In the following screen shots tell me which circles to fill-in in for every box for the appropriate assembly types.

Walls:

Frame walls:

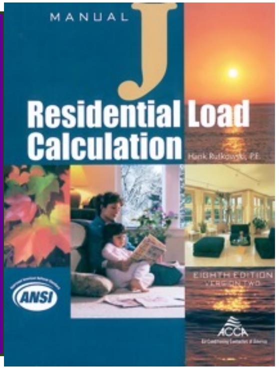
Judy Rachel (818) 980-5985 Offering Sustainable Solutions

WHAT IS A LOAD CALCULATION?

LOAD CALCULATION - DEFINITION

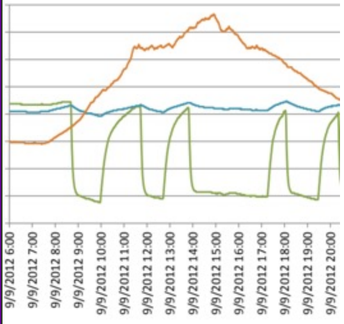
The measure of energy the heating and / or cooling system needs to add or remove from a space to provide the desired level of comfort.

LOAD CALCULATION PROCEDURES



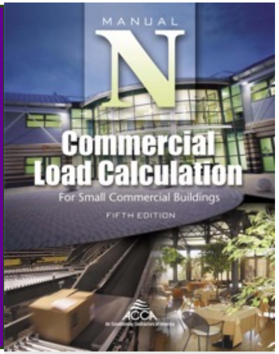
Manual J Residential Load Calculation

Manual J 8th Edition is the national ANSI-recognized standard for producing HVAC equipment sizing loads for single-family detached homes, small multi-unit structures, condominiums, town houses, and manufactured homes.



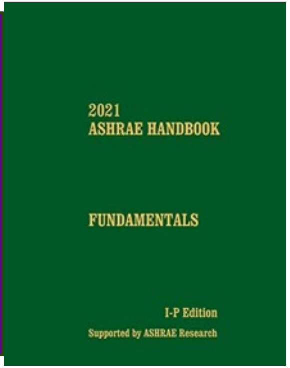
Measured Performance Load Calculation Method

Uses live measurements in the building to calculate the heating and cooling Btu/h needed to provide the desired indoor temperature at determined design conditions.



Manual N Commercial Load Calculation

Manual N details the load calculation procedure in the commercial construction industry.



ASHRAE HANDBOOK FUNDAMENTALS

To provide the engineer, the architect and contractor alike, with a useful and reliable reference data book relating to the art of heating and ventilating. A wide range of data within the scope of the field is presented and every effort has been made to present the material in a practical and useful manner.

GOAL OF THE LOAD CALCULATION

Provides the information necessary to select appropriately sized space conditioning equipment.

4-2. Heating capacity

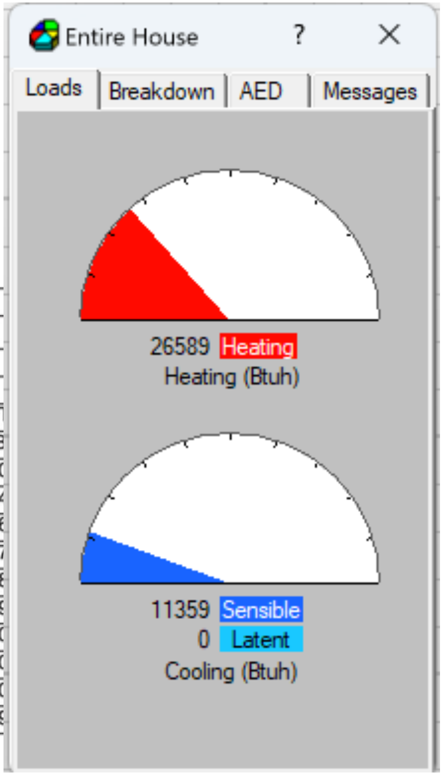
NOTE: Values mentioned in the table are calculated based on the maximum capacity.

■ **Model: AMUG24LMAS**

AFR	CFM	800

			Indoor temperature								
		°FDB	60		65		70		72		
Outdoor temperature	°FDB	°FWB	TC	IP	TC	IP	TC	IP	TC	IP	T
			kBtu/h	kW	kBtu/h	kW	kBtu/h	kW	kBtu/h	kW	kB
	-5	-7	21.24	3.84	20.64	3.90	20.50	3.49	20.08	4.01	20
	5	3	24.03	3.29	22.91	3.37	23.00	3.47	23.38	3.51	24
	14	12	25.97	3.31	24.64	3.40	24.93	3.40	25.46	3.56	26
	17	15	26.69	3.25	25.34	3.34	25.60	3.38	26.13	3.50	27
	23	19	28.07	3.18	26.76	3.26	26.86	3.33	27.31	3.40	28
	32	28	30.13	3.14	29.06	3.19	28.80	3.26	28.81	3.29	29
	41	37	32.20	3.16	31.51	3.18	30.73	3.20	30.09	3.21	30
	47	43	33.59	3.21	32.81	3.20	32.00	3.15	31.20	3.18	30
	50	47	34.42	3.28	34.22	3.25	32.82	3.16	31.37	3.20	30
	59	50	34.72	3.39	35.05	3.30	33.09	3.04	30.85	3.15	29

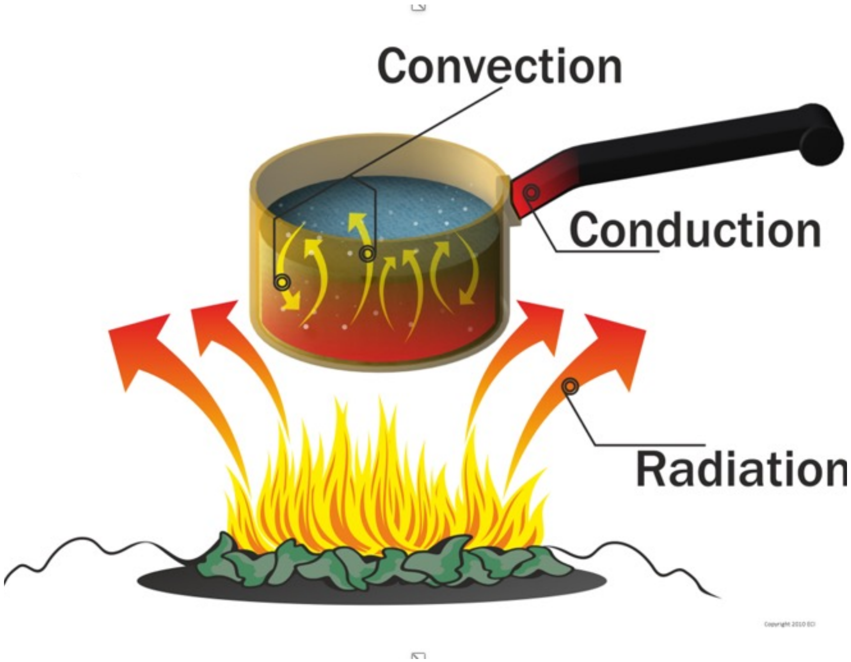
29.23 @34F OAT / 70F IDT



HEAT IS A FORM OF ENERGY

Heat is transferred whenever there is a temperature difference between two materials or spaces.

METHODS OF HEAT TRANSFER

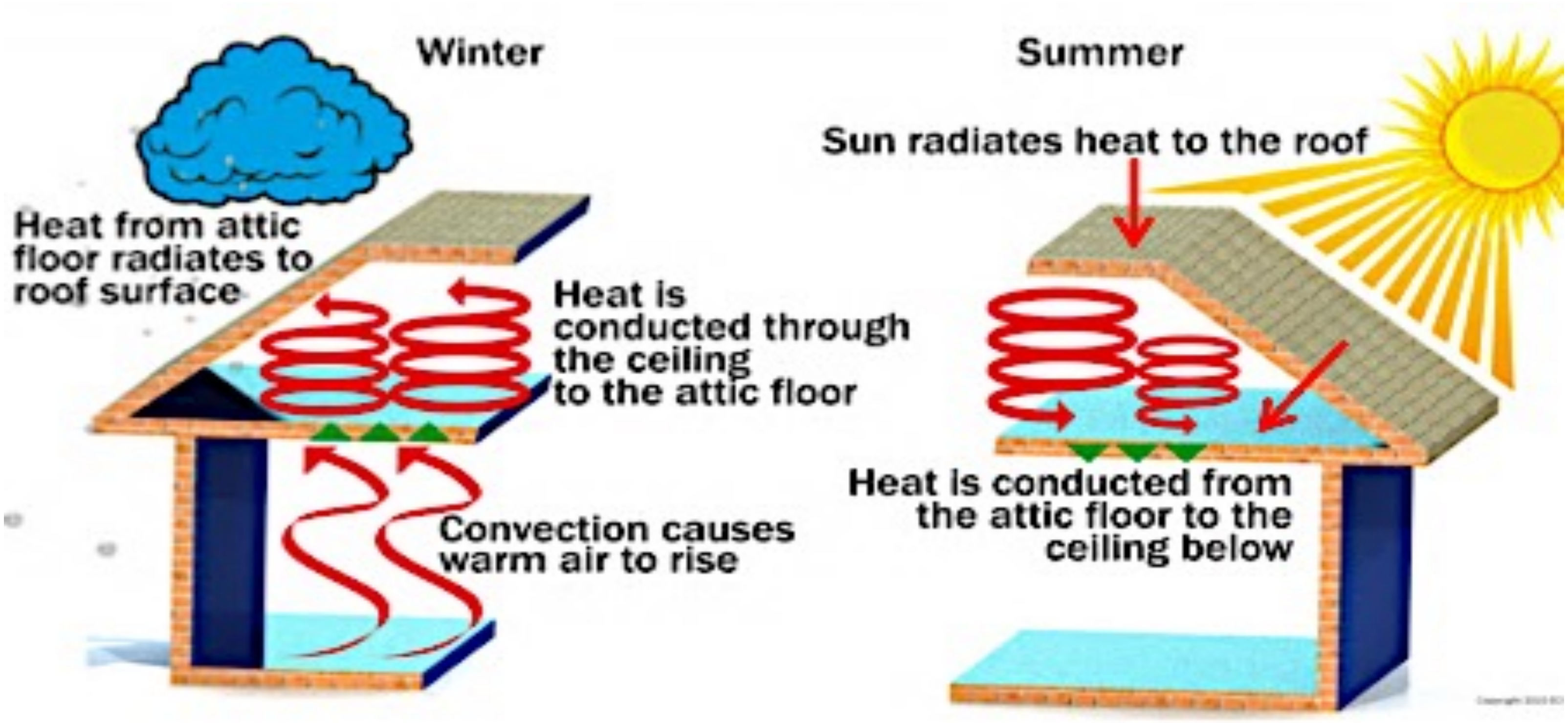


Conduction – the movement of heat through a solid object. The objects must have physical contact

Convection – heat transferred by a moving fluid like air or water

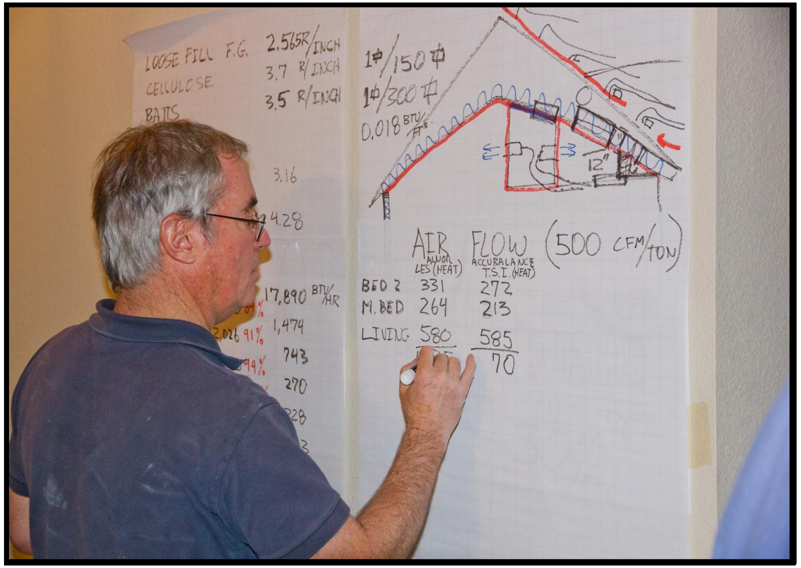
Radiation – the transfer of heat, as a wavelength, through space

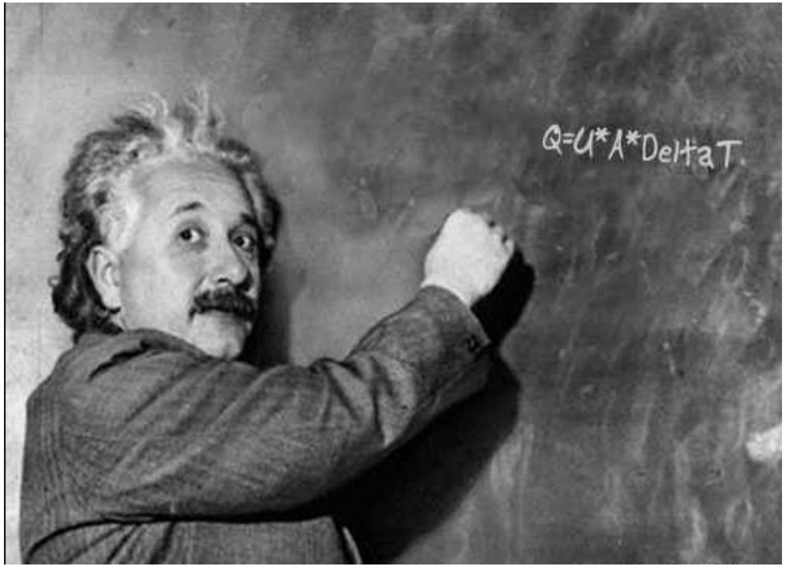
HEAT TRANSFER IN BUILDINGS



HEAT TRANSFER IS COMPLICATED

The load calculation procedure is a gross simplification of the physics and mathematics necessary to determine the amount of energy needed in a space to provide comfort.

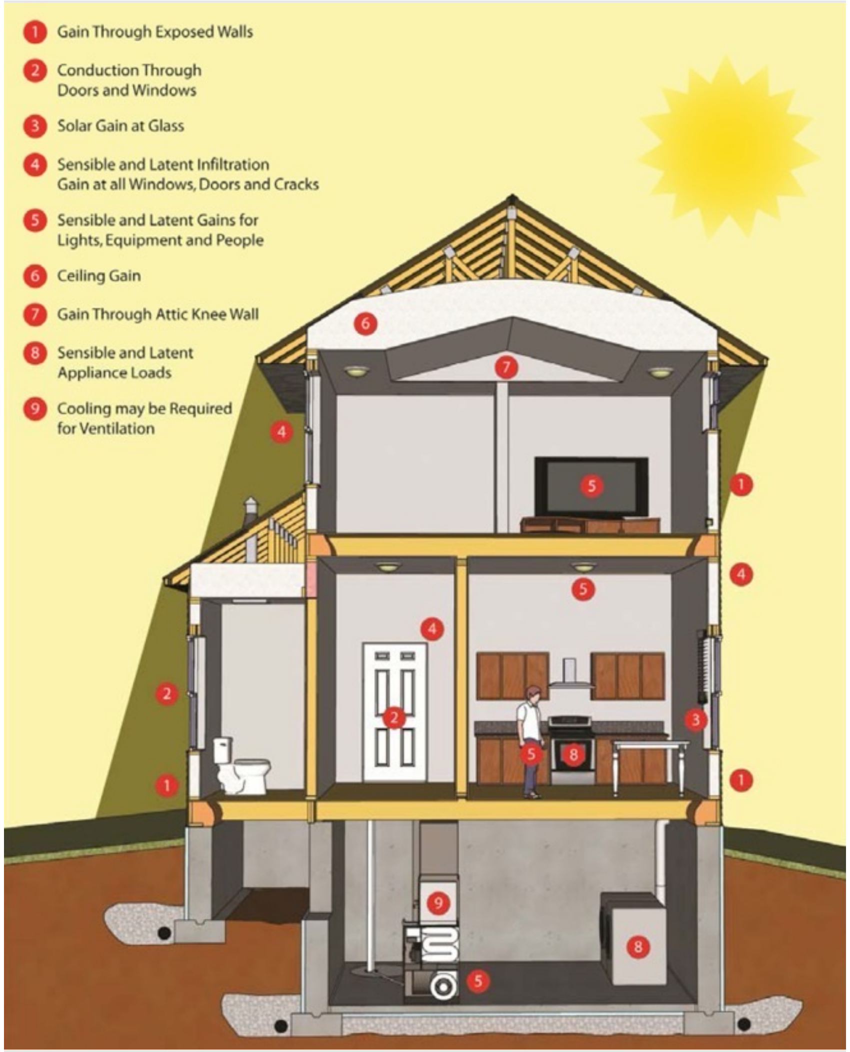


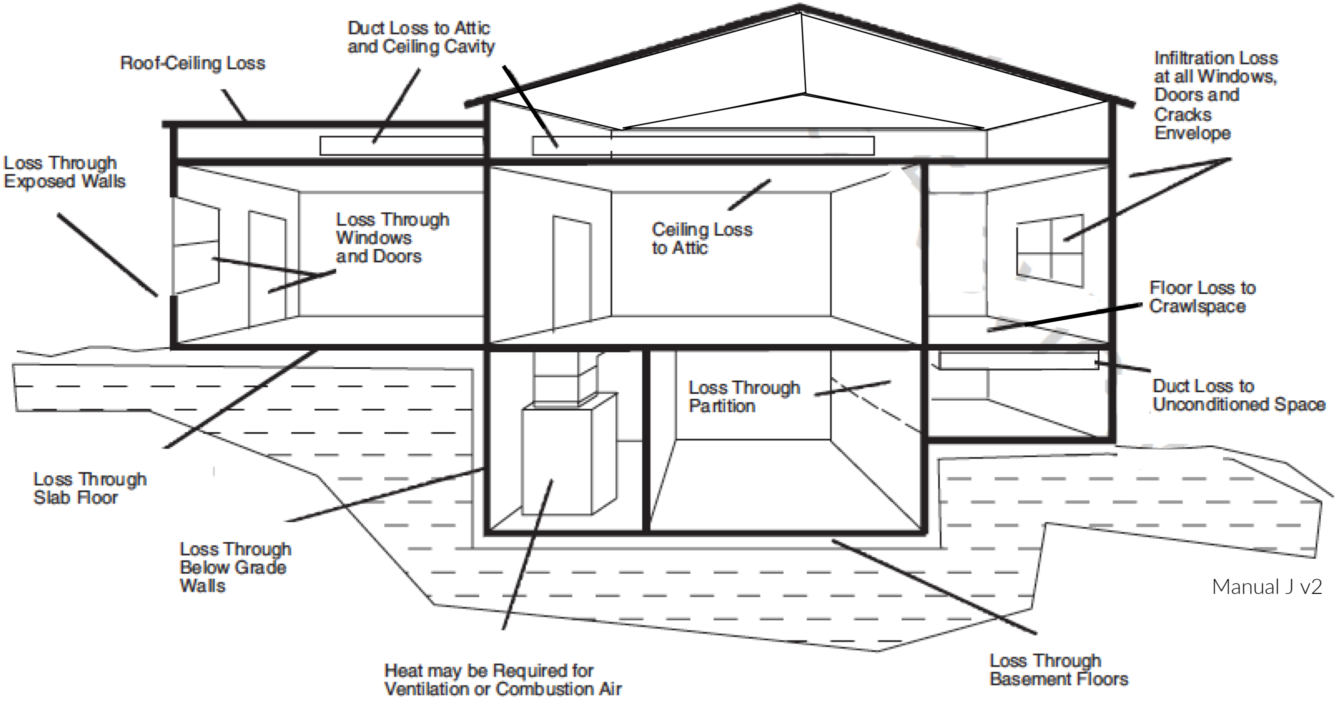


TYPES OF HEATING AND COOLING LOADS

Each dwelling has a unique set of enclosure loads determined by:

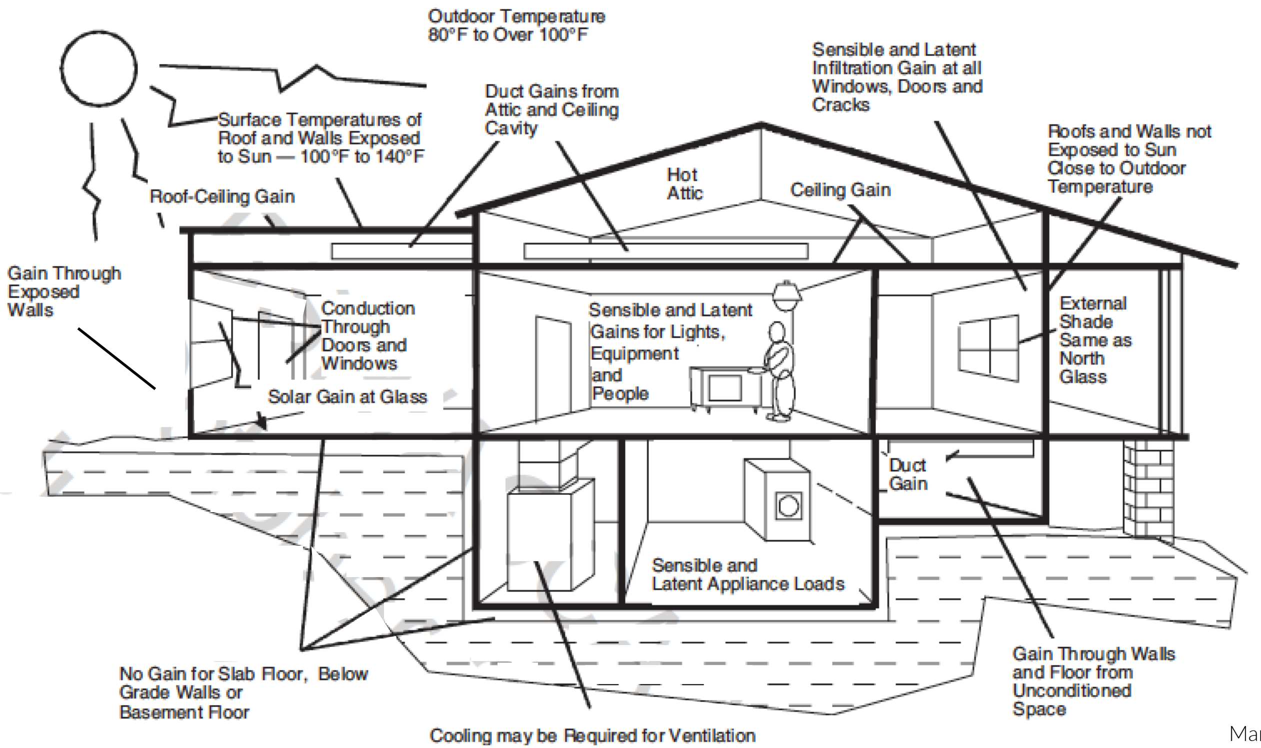
1) Local weather
2) Architectural features of the dwelling
3) Materials and techniques used to build the structure,
4) Type of appliances
5) Number of full-time occupants





TYPES OF HEATING LOADS

The envelope load is the sum of the component loads, which may include a ceiling load, a wall load, a fenestration (window, glass door or skylight) load, a door (wood or metal) load, a floor load and an infiltration load.



Manual J v2

TYPES OF COOLING LOADS

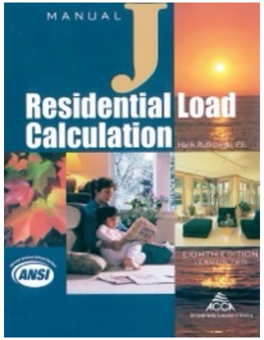
For cooling, an internal (occupant and appliance) load is added to the envelope loads.

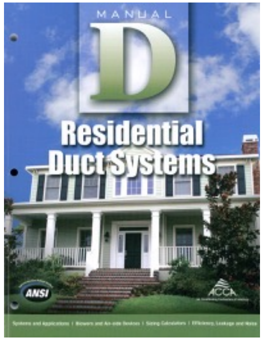
WHY ARE ACCURATE LOAD CALCULATIONS IMPORTANT?

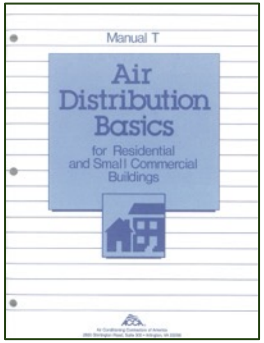
The foundation of the space conditioning system design procedure.

HVAC DESIGN PROCESS

The load calculation is the **first step** of the iterative HVAC design procedure.







The values determined by the heating and cooling load calculation process drive the equipment selection process towards correctly sized equipment.

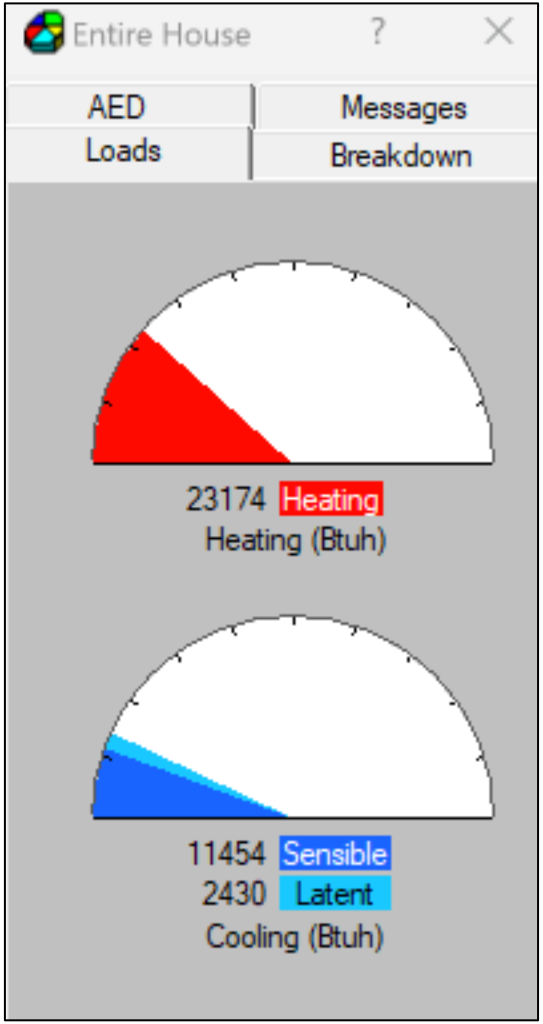
Building America U.S. Department of Energy CONCLUDES:

Accurate load calculations have a direct impact on

- Operating Energy Efficiency
- Occupant Comfort
- Indoor Air Quality
- Building Durability

BENEFITS

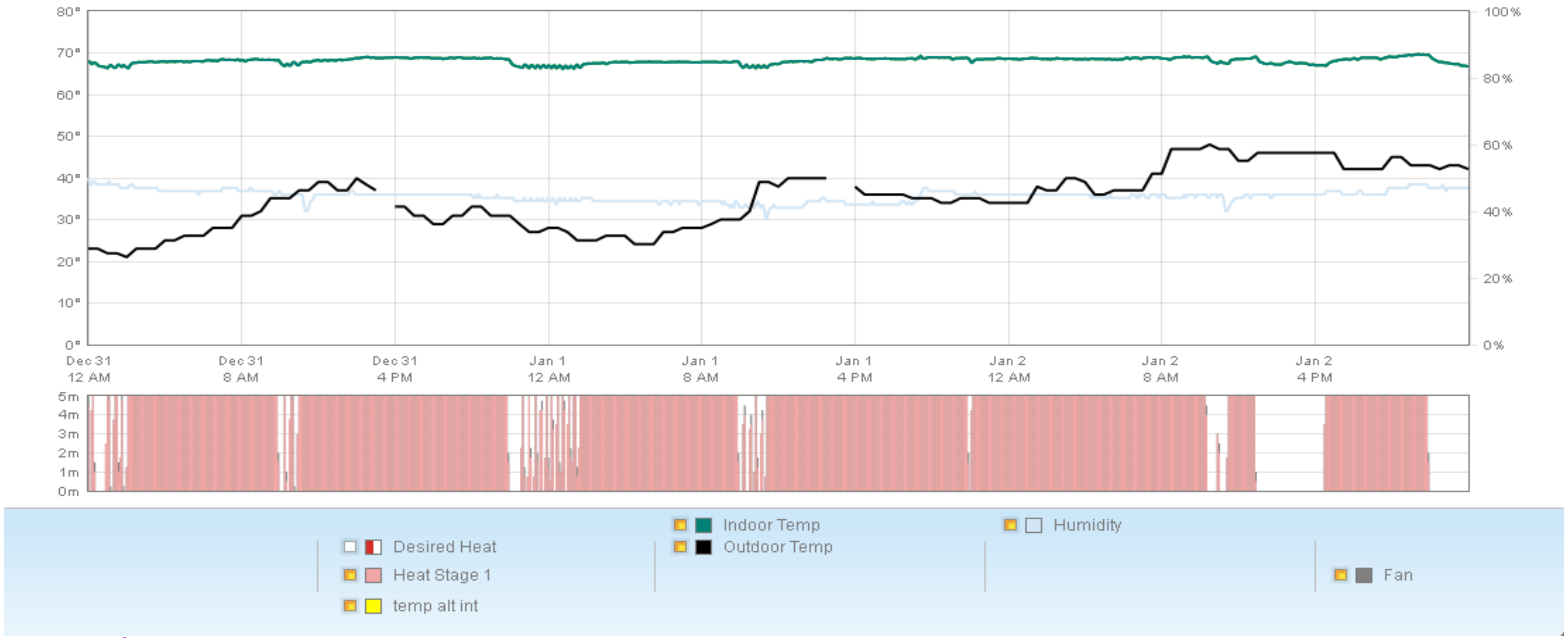
Provide design values for sensible & latent equipment capacity.



RIGHT-SIZING HVAC EQUIPMENT

Right-sizing is selecting HVAC equipment and designing the air distribution system to meet the accurate predicted heating and cooling loads of the house.

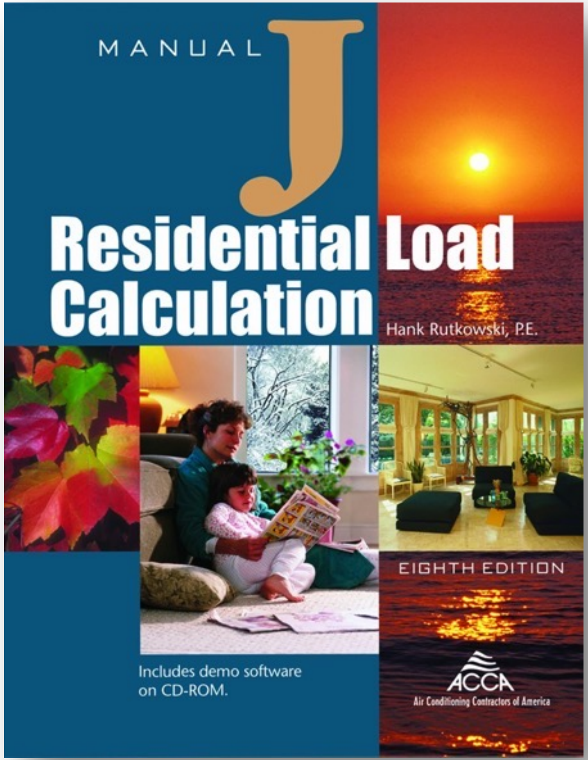
RIGHT-SIZING HVAC EQUIPMENT



Reduced operating cost

Improve reliability (minimize short cycling)

BENEFITS OF A DETAILED AND ACCURATE LOAD CALCULATION

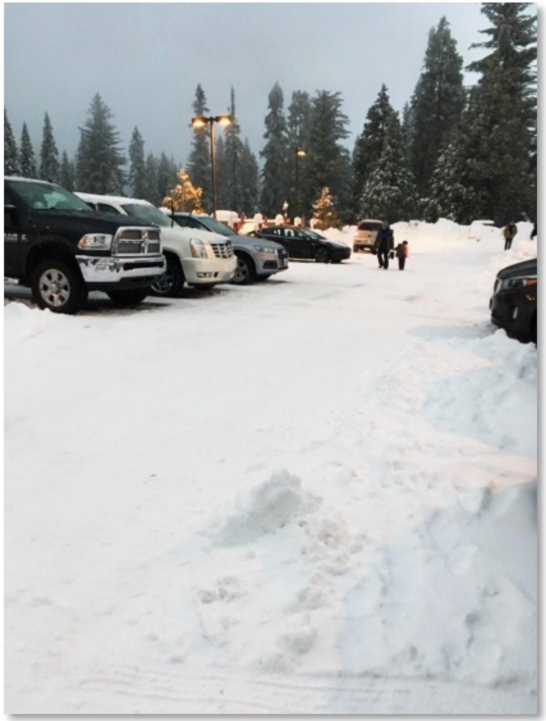


Using the smallest defensible load approach to equipment sizing optimizes system performance and maximizes customer satisfaction.

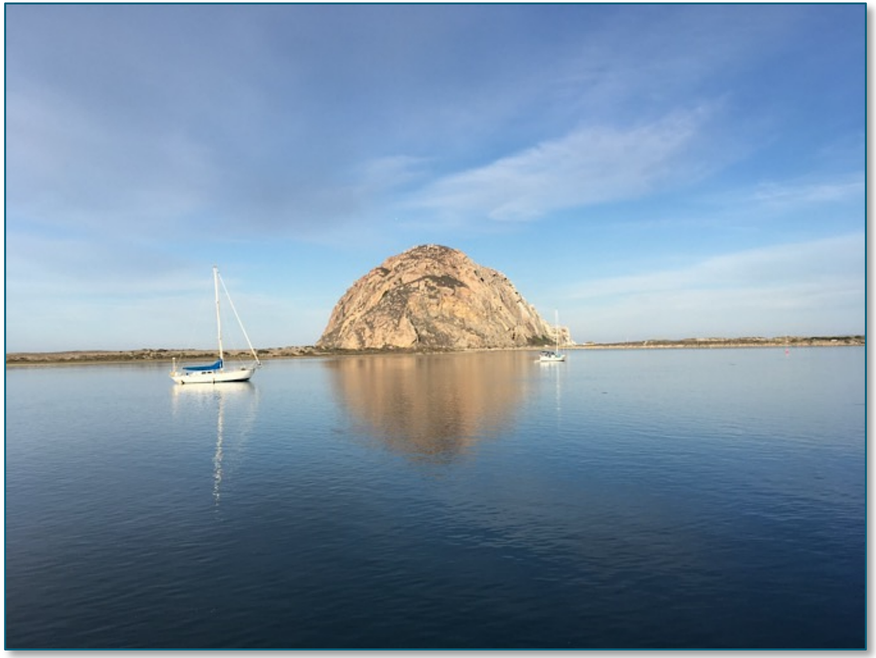
Manual J v2 pg xiv

BENEFITS

Provide specified comfort & humidity control at **design conditions.**



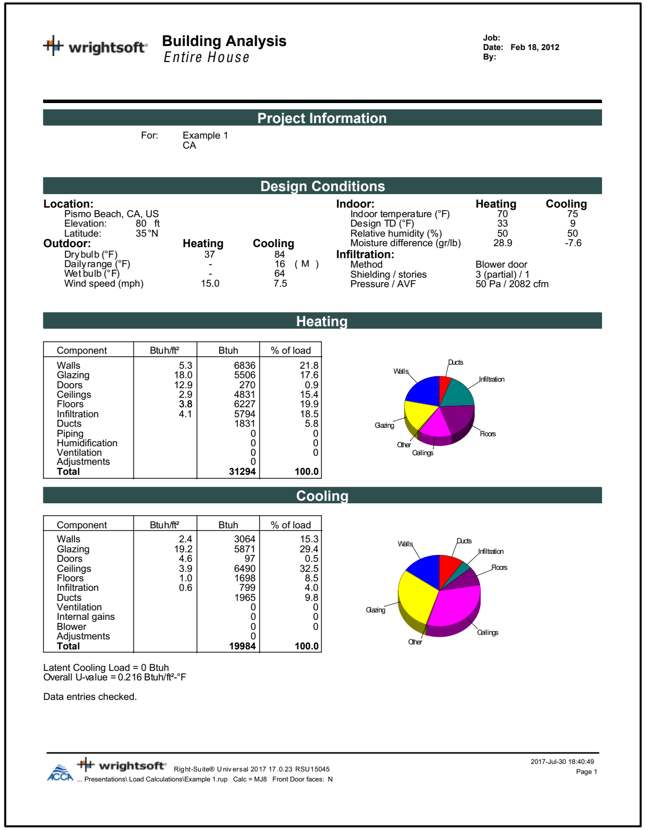
Provide acceptable comfort & humidity control at **part-load conditions.**



BENEFITS

Reduce the possibility of indoor mold and mildew.

BENEFITS



Building Analysis
Entire House

Job:
Date: Feb 18, 2012
By:

Project Information

For: Example 1
CA

Design Conditions

Location:
Pismo Beach, CA, US
Elevation: 80 ft
Latitude: 35°N

Outdoor:	**Heating**	**Cooling**
Dry bulb (°F)	37	84
Daily range (°F)	-	16 (M)
Wet bulb (°F)	-	64
Wind speed (mph)	15.0	7.5

Indoor:	**Heating**	**Cooling**
Indoor temperature (°F)	70	75
Design TD (°F)	33	9
Relative humidity (%)	50	50
Moisture difference (gr/lb)	28.9	-7.6

Infiltration:
Method: Blower door
Shielding / stories: 3 (partial) / 1
Pressure / AVF: 50 Pa / 2082 cfm

Heating

Component	Btuh/ft²	Btuh	% of load
Walls	5.3	6836	21.8
Glazing	18.0	5506	17.6
Doors	12.9	270	0.9
Ceilings	2.9	4831	15.4
Floors	3.8	6227	19.9
Infiltration	4.1	5794	18.5
Ducts		1831	5.8
Piping		0	0
Humidification		0	0
Ventilation		0	0
Adjustments		0	
Total		**31294**	**100.0**

Cooling

Component	Btuh/ft²	Btuh	% of load
Walls	2.4	3064	15.3
Glazing	19.2	5871	29.4
Doors	4.6	97	0.5
Ceilings	3.9	6490	32.5
Floors	1.0	1698	8.5
Infiltration	0.6	799	4.0
Ducts		1965	9.8
Ventilation		0	0
Internal gains		0	0
Blower		0	0
Adjustments		0	
Total		**19984**	**100.0**

Latent Cooling Load = 0 Btuh
Overall U-value = 0.216 Btuh/ft²-°F

Data entries checked.

wrightsoft Right-Suite® Universal 2017 17.0.23 RSU15045
... Presentations\ Load Calculations\Example 1.rup Calc = MJ8 Front Door faces: N
2017-Jul-30 18:40:49
Page 1

Demonstrate "due diligence" in a court of law.

CONSEQUENCES OF NOT MAKING A DETAILED AND ACCURATE LOAD ESTIMATE

Errors (accidental, or an effort to manipulate output) in the load estimate filter through the entire design and cause the installation to miss the mark.

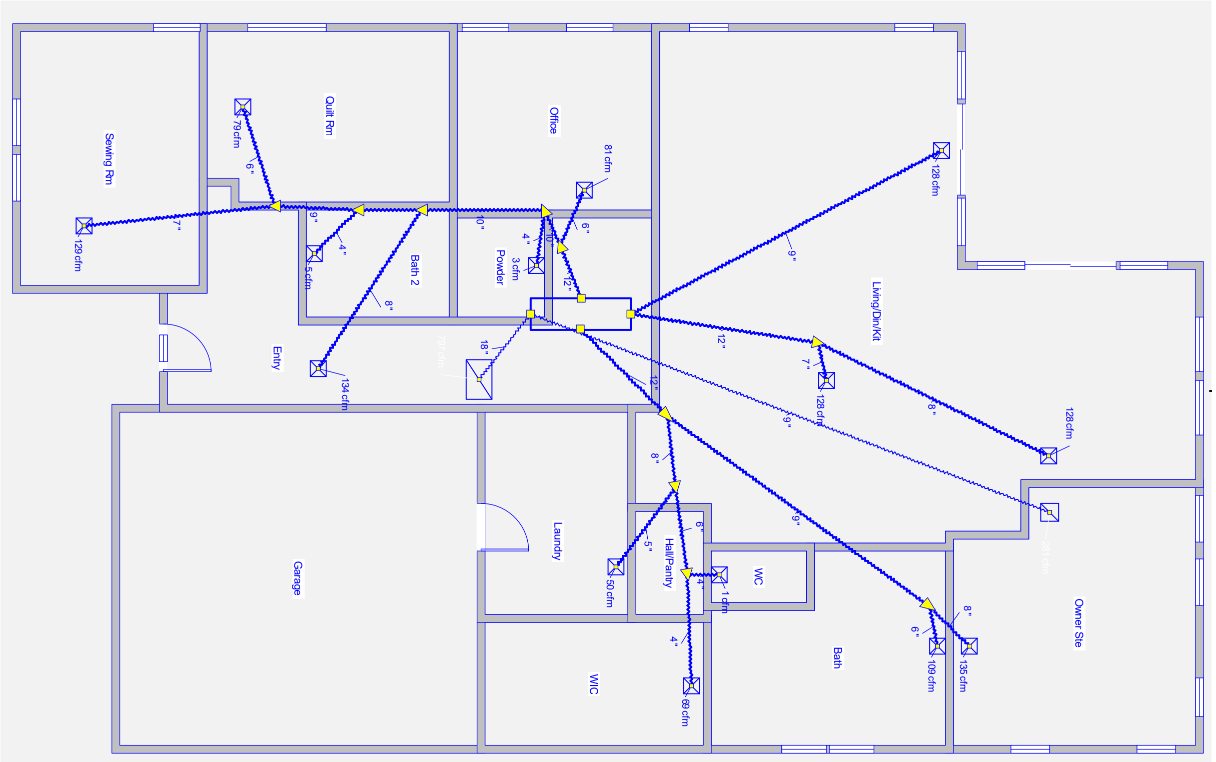
Manual J v2 pg xv

EQUIPMENT OVERSIZING

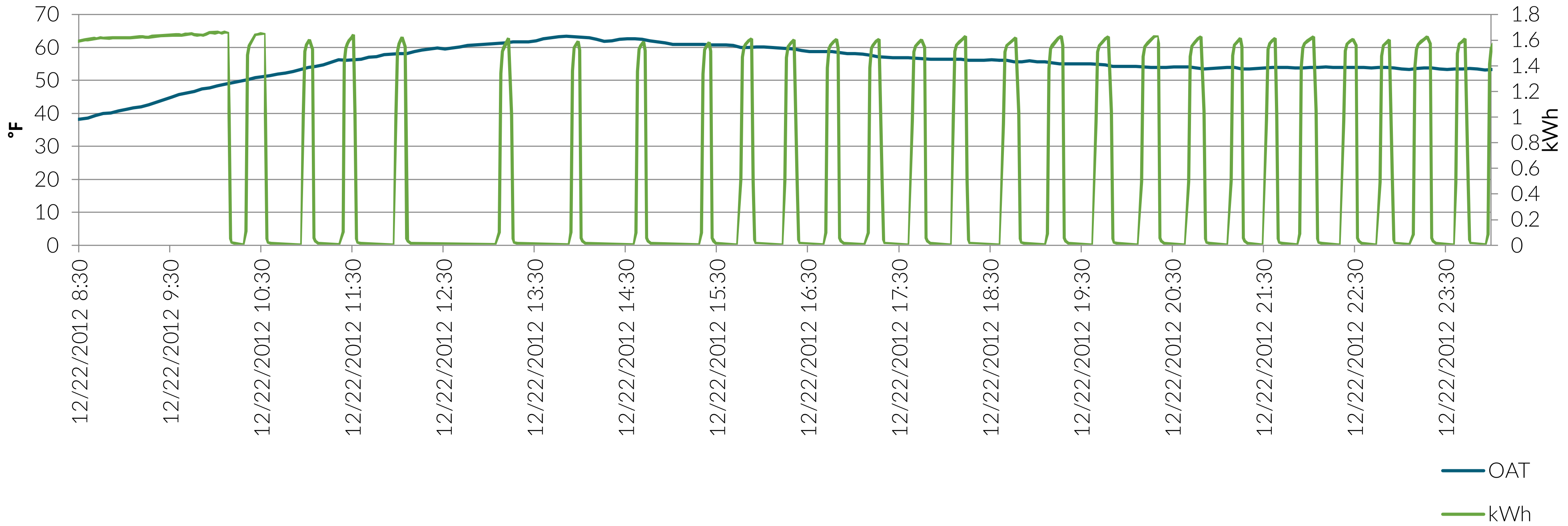
Translates to:

- Larger equipment
- Reduced system efficiency
- Increases the installed cost and operating cost
- Imposes unnecessary loads on utility grids

EQUIPMENT OVERSIZING



Duct sizes and numbers of runs must also be increased to account for the significantly increased system airflow



CONSEQUENCES -OVERSIZING

Short cycling of HAC which affects comfort, system efficiency, operating cost and reduces equipment life.

CONSEQUENCES

Discomfort

- Cause discomfort during design-day weather.
- Produce marginal or unacceptable comfort at part-load conditions.
- Reduce the equipment's ability to control indoor humidity.

INDOOR MOLD GROWTH

In the cooling season in humid climates, cold clammy conditions can occur due to reduced dehumidification caused by the short cycling of the equipment.

Excess humidity in the conditioned air delivered to a space may lead to mold growth within the house.

Strategy Guideline: Accurate Heating and Cooling Load Calculations
https://www.nrel.gov/docs/fy11osti/51603.pdf

CONSEQUENCES

Less defensible in a court of law

SITE SURVEY ESSENTIALS

PURPOSE OF THE SITE SURVEY

To gather detailed data about the structure's site plan, floor plan, foundation plan, and fenestration plan.

To gather construction details pertaining to structural panels, fenestration, equipment cabinet and duct run locations, duct system insulation and sealing, engineered ventilation requirements, and use of heat recovery equipment for engineered ventilation.

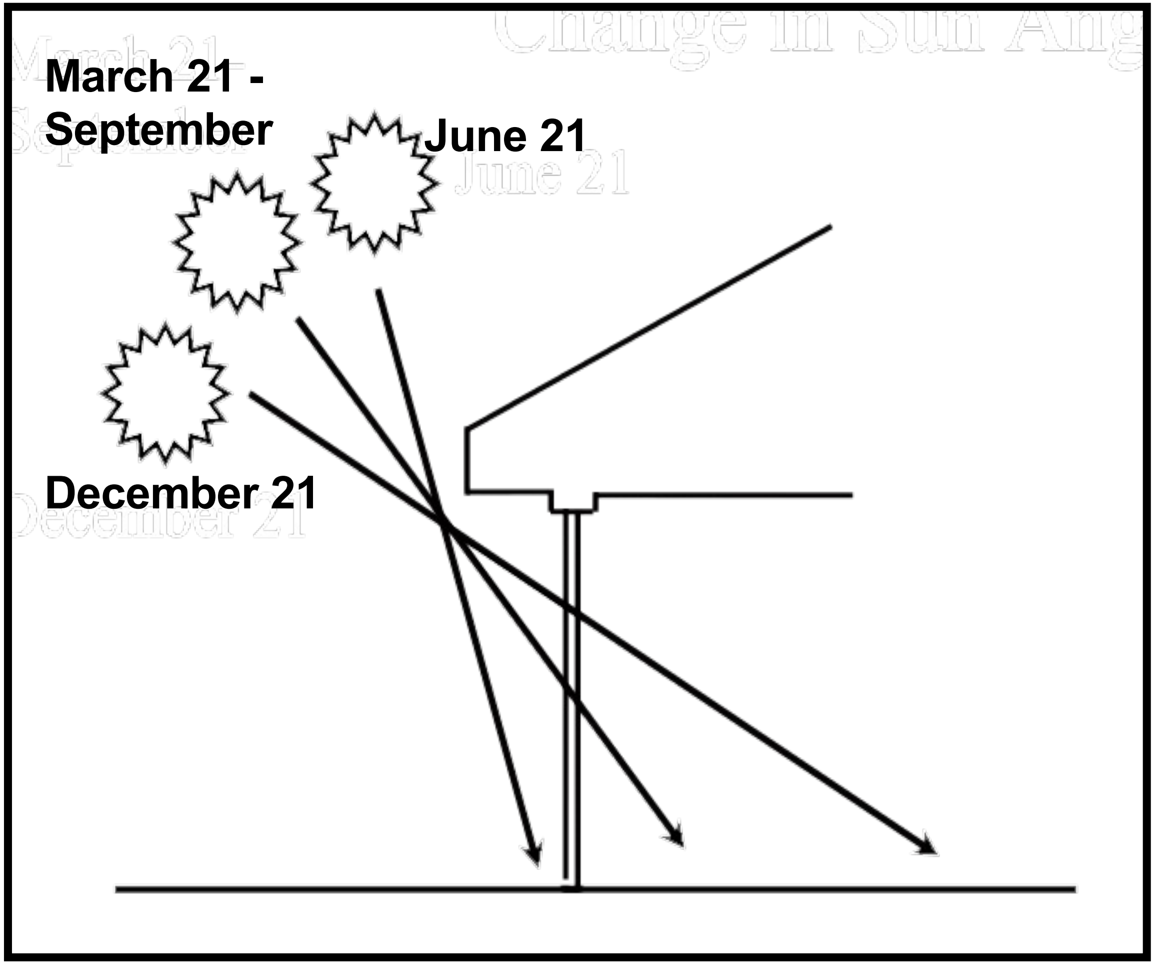
THE SITE SURVEY PROVIDES THE INPUT DATA FOR THE LOAD CALCULATION PROCEDURE

The accuracy of the load estimating procedure is only as good as the input, and the input is only as good as the survey.

Manual J v2.5 pg 23

LOCATION

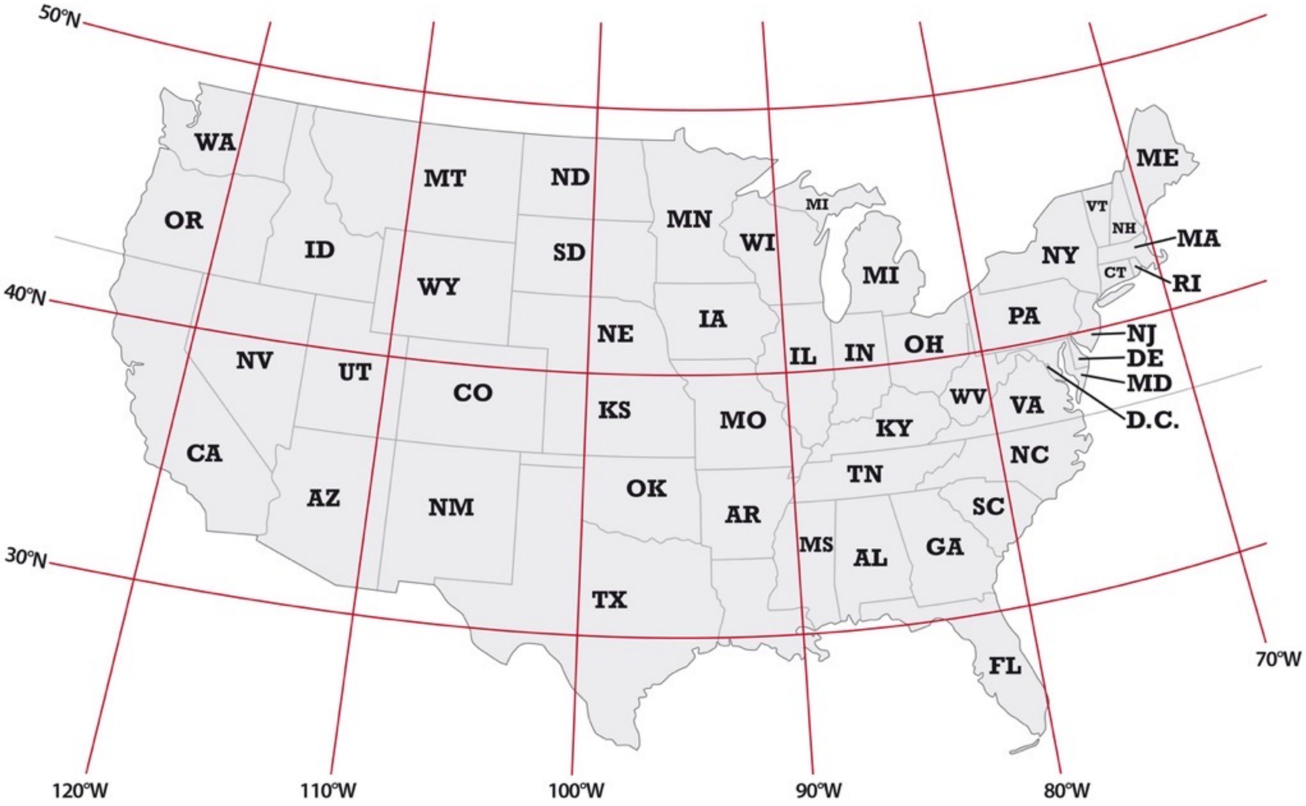
Latitude has an effect on solar gain through glazing systems



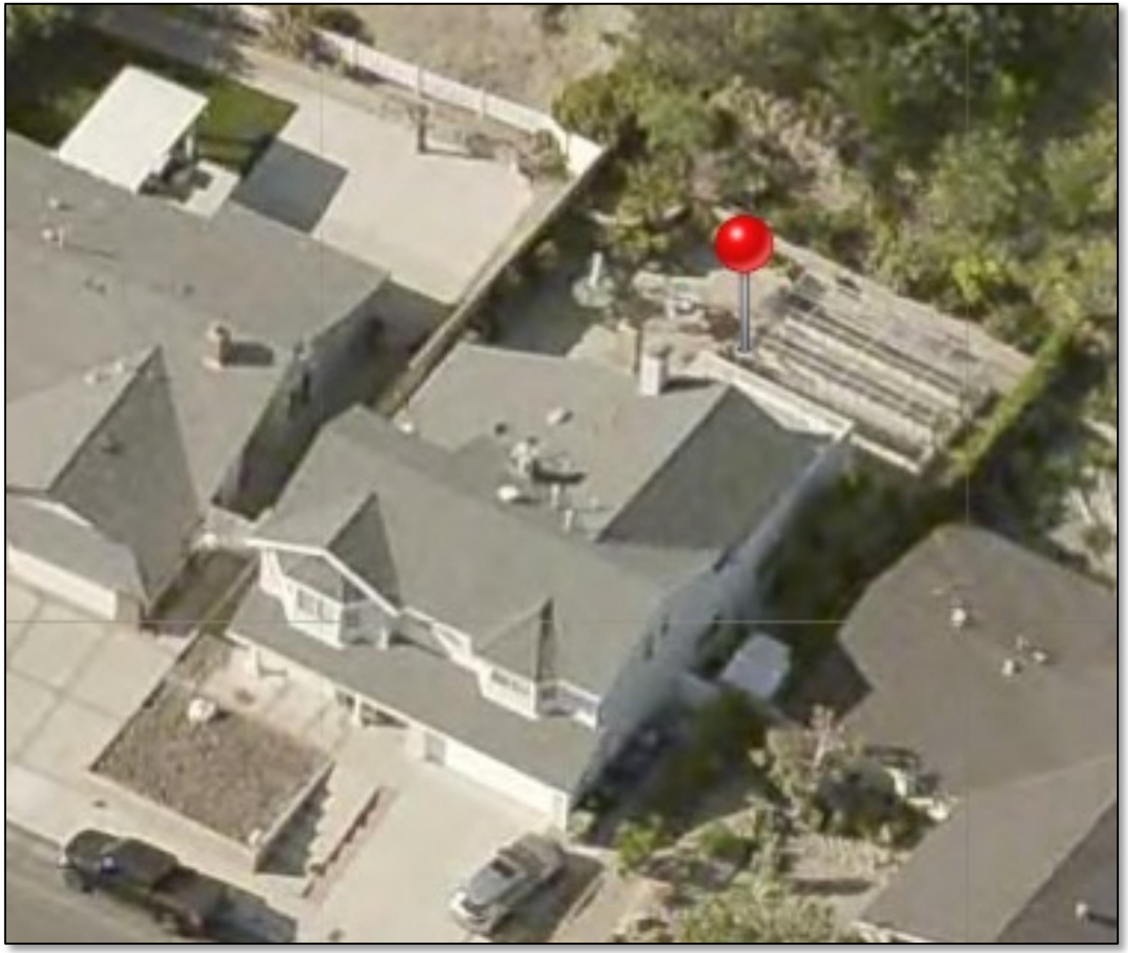
LOCATION

Latitude determines the amount of shade provided by overhangs.

The significance of this effect depends on exposure direction.



ORIENTATION



ELEVATION

Altitude affects air density.

Air density affects the constants in the sensible and latent heat equations used to estimate infiltration loads, engineered ventilation loads and the winter humidification load.

Air Density At Various Altitudes			
Altitude (Ft)	Lb / CuFt	Altitude (Ft)	Lb / CuFt
Sea Level	0.075	6,000	0.061
1,000	0.073	7,000	0.059
2,000	0.070	8,000	0.057
3,000	0.068	9,000	0.054
4,000	0.066	10,000	0.052
5,000	0.063	12,000	0.047

MEASURE AND DRAW

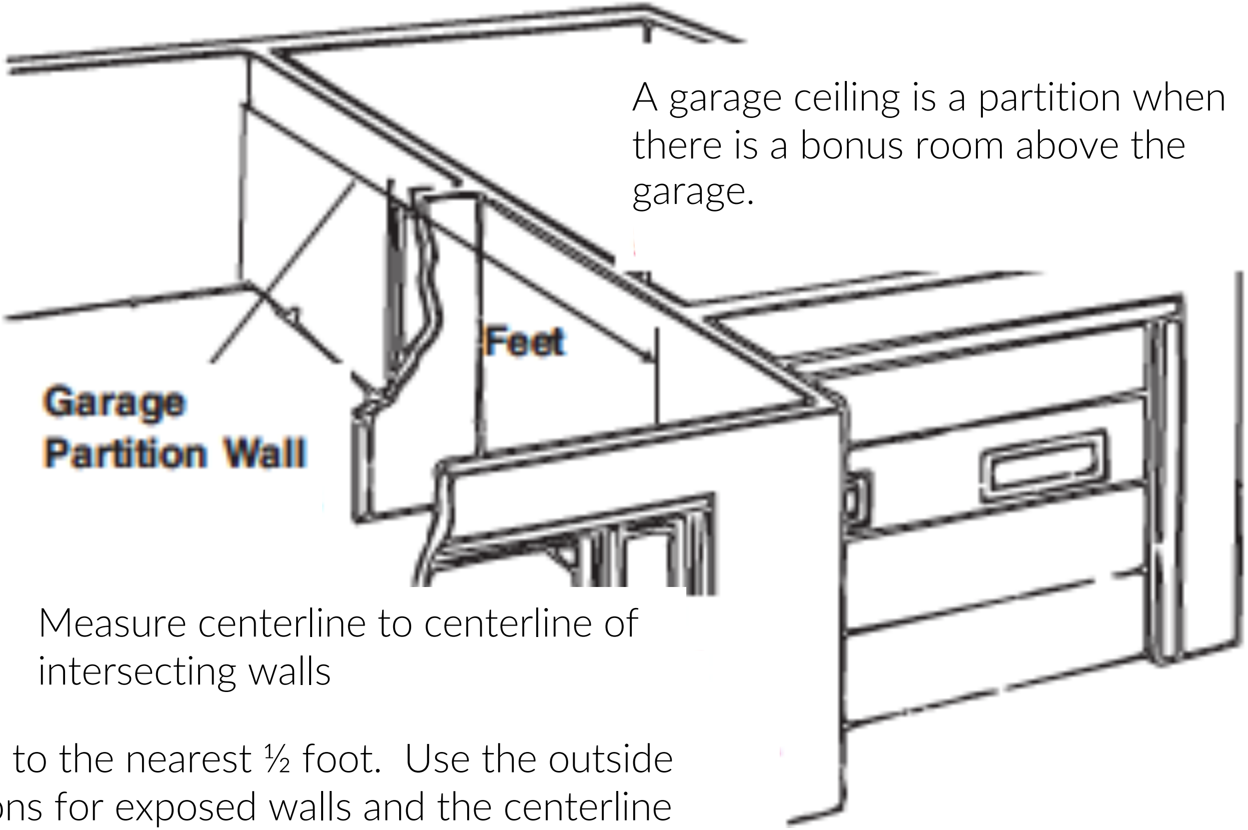
A dimensioned outline of the floor plan for each level

Block Load
- Exterior of house
- You can round to nearest foot
- Rough opening dimensions for exterior doors, windows, skylights and solar tubes

Room by Room Loads
- Length, width and height of every room
- Use centerline dimension for interior partitions

Wall height recorded to nearest half foot

WALLS



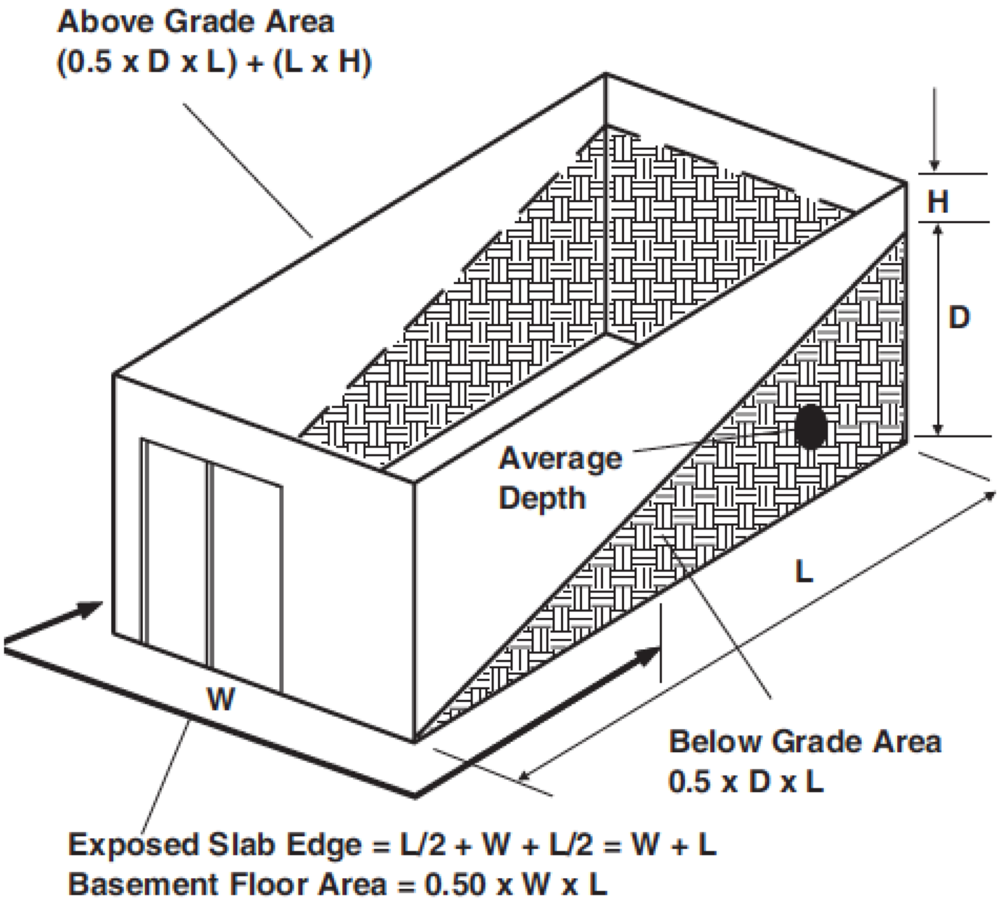
A garage ceiling is a partition when there is a bonus room above the garage.

Measure centerline to centerline of intersecting walls

Measure to the nearest ½ foot. Use the outside dimensions for exposed walls and the centerline dimension for interior partitions.

FOUNDATION WALLS

- Foundation walls may be entirely above grade, entirely below grade or partly above and partly below grade.
- Any portion of a foundation wall exposed to the outdoor air is an above grade wall. The gross area of the above grade portion of a foundation wall equals the measured length multiplied by the average above grade height.

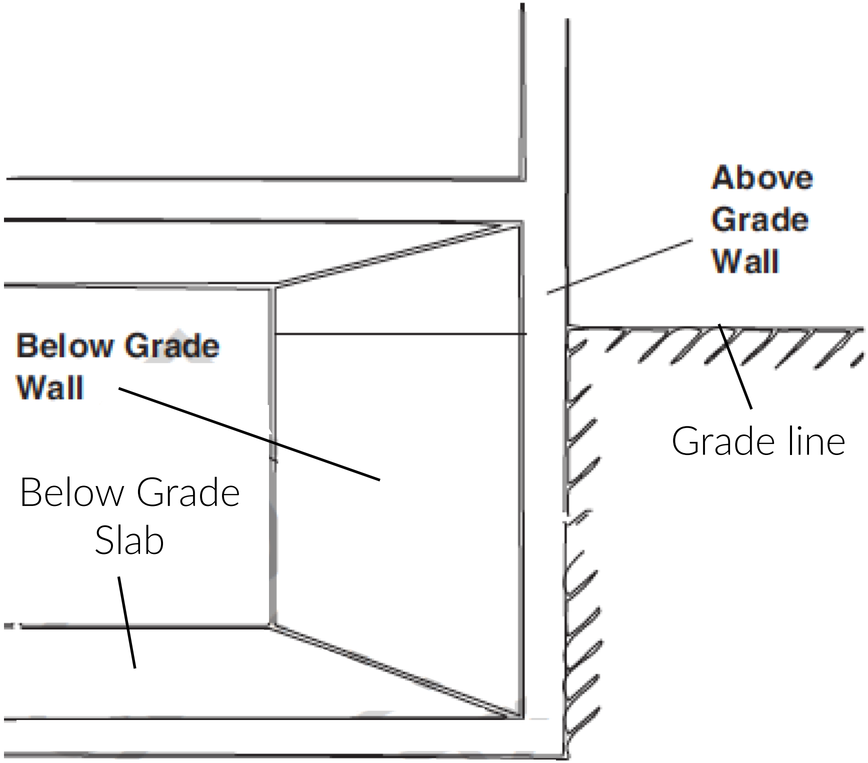


BELOW GRADE WALLS

The depth of a below grade wall determines if the wall is above grade or below grade.

If a foundation wall is two feet deep or less, the wall is classified as an above grade wall.

If the foundation wall is more than two feet deep, the wall is classified as a below grade wall, and the below grade area equals the length of the wall multiplied by the depth of the wall (measured from grade).

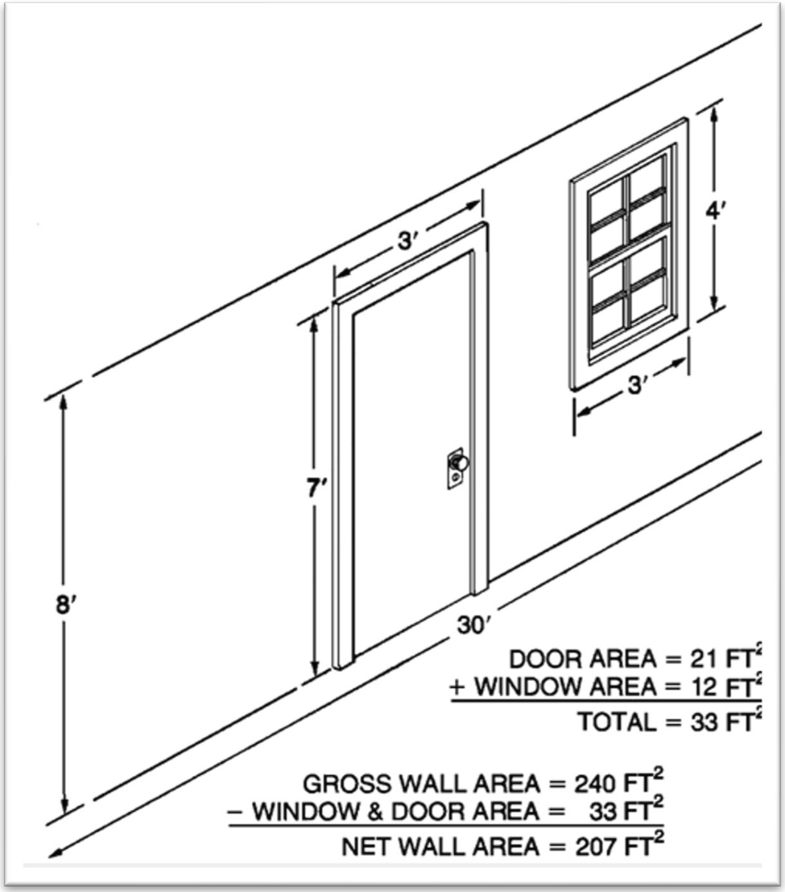


ATTACHED SPACES

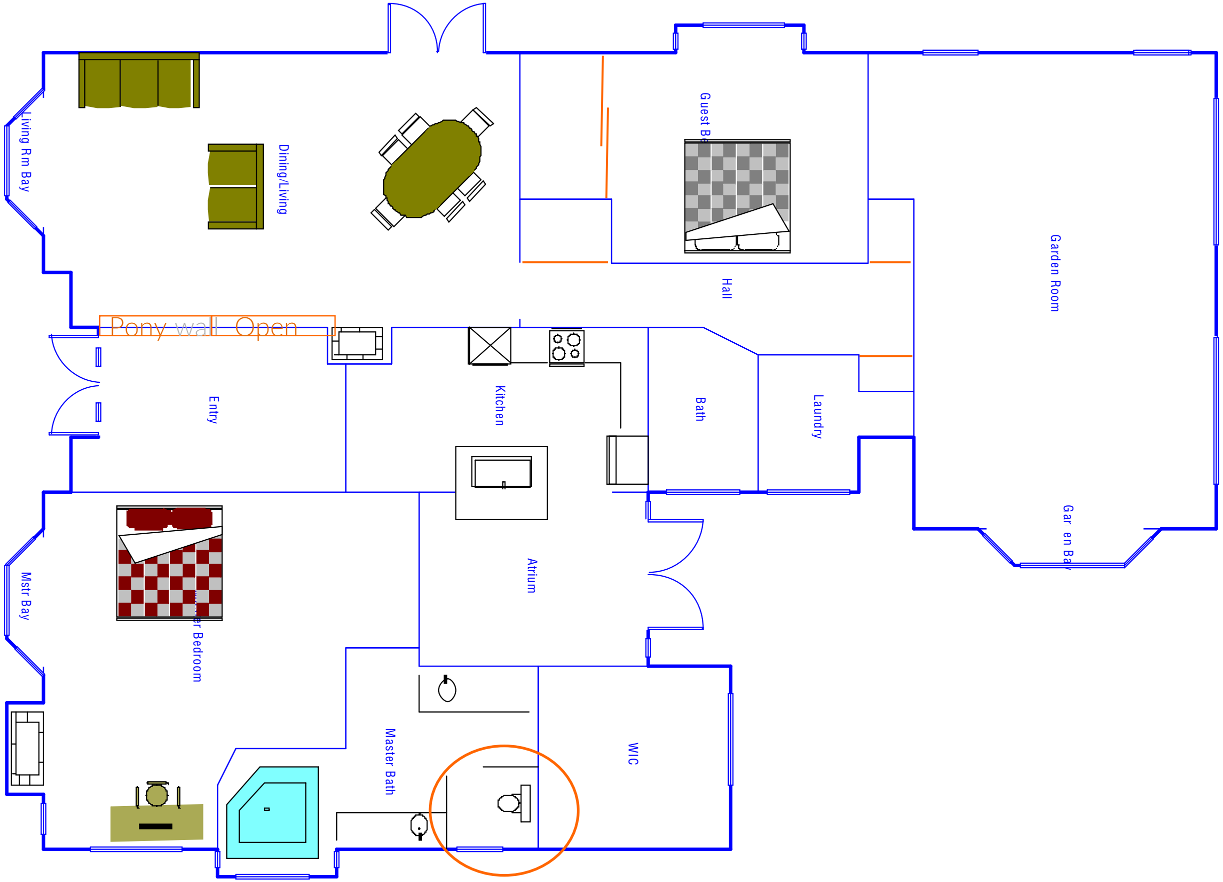
- Measure attached spaces.
- Describe the partition assembly construction details
- Note any details that will help determine the temperature in the attached space, i.e. conditioned or unconditioned

MEASURING FENESTRATIONS

- Measure the rough opening for doors, windows, skylights and daylight tubes.
- If an opening is over 50% glass draw it as a window.
- Multiply width by height for total area then round to nearest square foot



DRAWING ROOMS: CHOICES YOU MUST MAKE



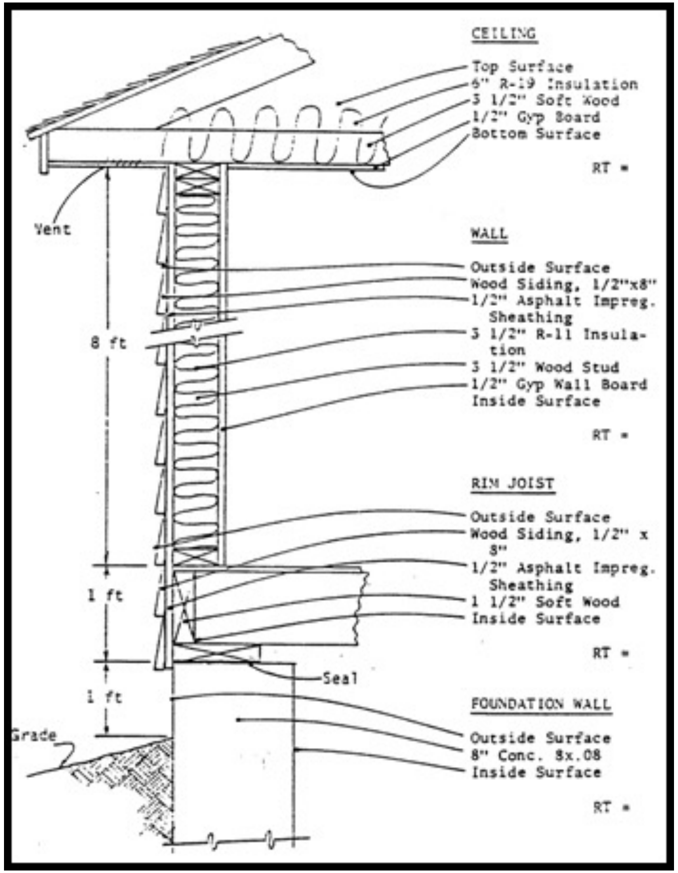
Small closets are usually combined with the adjoining room.

Large closets, entrance areas and hallways (100 SqFt to 150 SqFt, or more) should be treated as separate rooms.

ENCLOSURE DETAILS

DESCRIBE CONSTRUCTION ASSEMBLIES

- Roof/Ceilings
- Walls
- Floors
- Windows, Skylights, Daylight Tubes and Doors
- Partition or demising assemblies, i.e. Garages
- Enclosure leakage
- Duct leakage and duct system details
- Whole house ventilation



PROTOCOLS FOR ESTIMATING HEATING AND COOLING LOADS

Be honest and aggressive.

Manual J is an engineering tool that has an inherent and appropriate factor of safety.

Any attempt to add other safety factors or to manipulate the procedure may result in unacceptable performance (especially at part load).

Manual J v2 pg 7

ROOF / CEILING ASSEMBLY

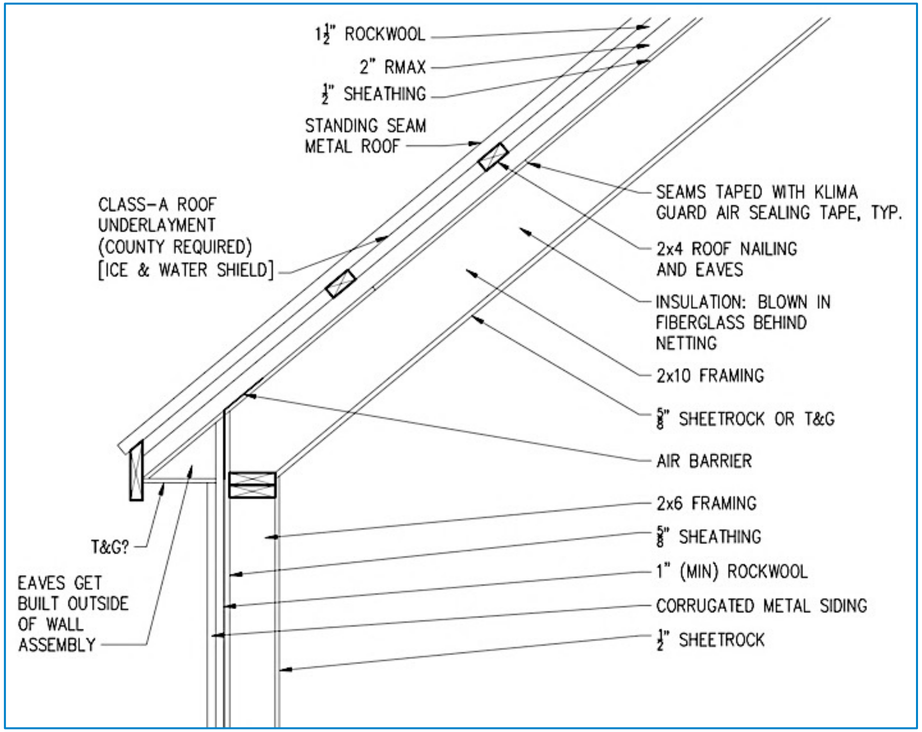
ROOF/CEILING ASSEMBLIES

TYPICAL ROOF ASSEMBLY (R1)

- STANDING SEAM METAL ROOF RATED FOR 1/2" / FT SLOPE
- GRACE HIGH TEMP ICE & WATER SHIELD (OR EQUAL)
- EPS RIGID FOAM INSULATION (25 PSI) (R-10)
- POLYSTICK XFR
- 5/8" ZIP SHEATHING (TAPE SEAMS), NAIL PER STRUCT.
- 11-7/8" TJI RAFTERS PER STRUCT.
- BLOWN IN BATT FIBERGLASS INSUL. (R-38)
- INSULATION NETTING
- 5/8" GYPSUM WALL BOARD

TOTAL R-VALUE = R-48

Construction note



Notated drawing detail

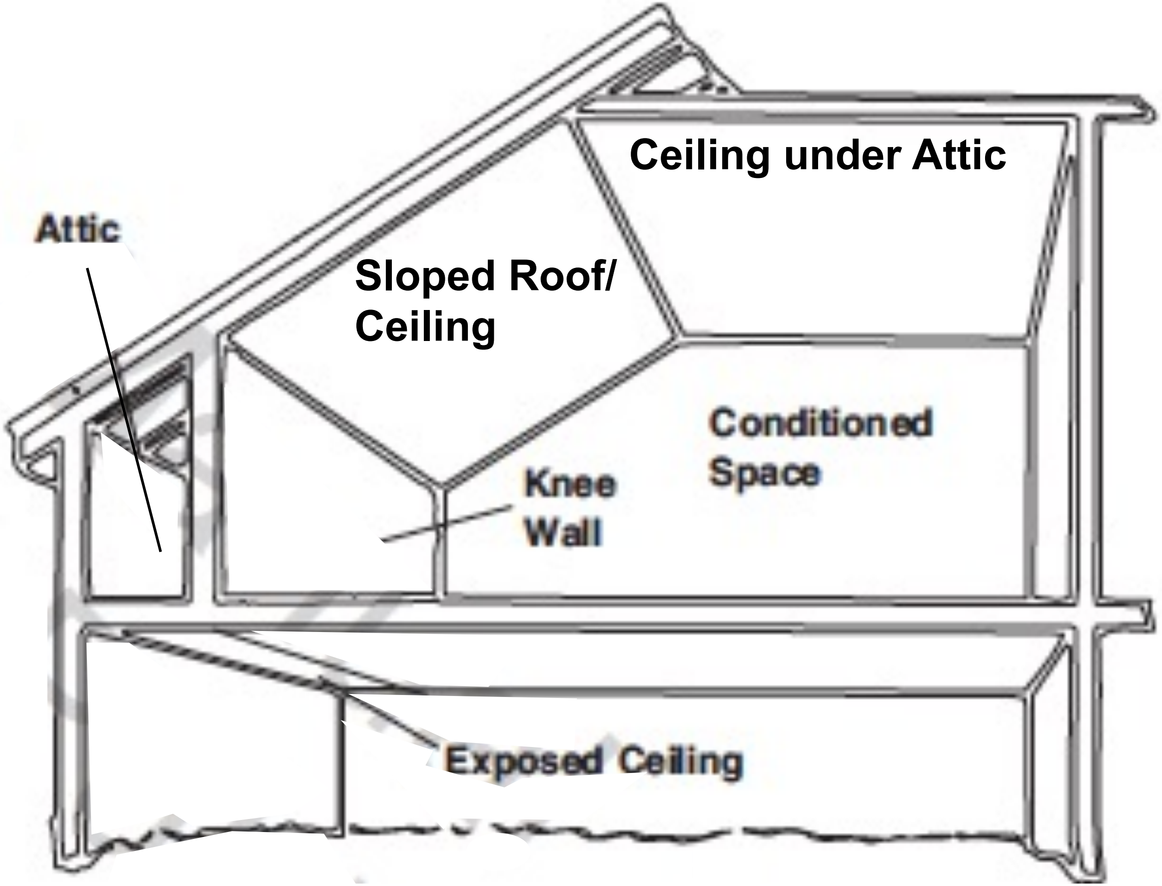
ROOF/CEILING ASSEMBLIES

- Type of assembly
- Roof material
- Color
- Structure
- Structure thickness
- Location and R-value of insulation
- Attic type
- Ceiling finish

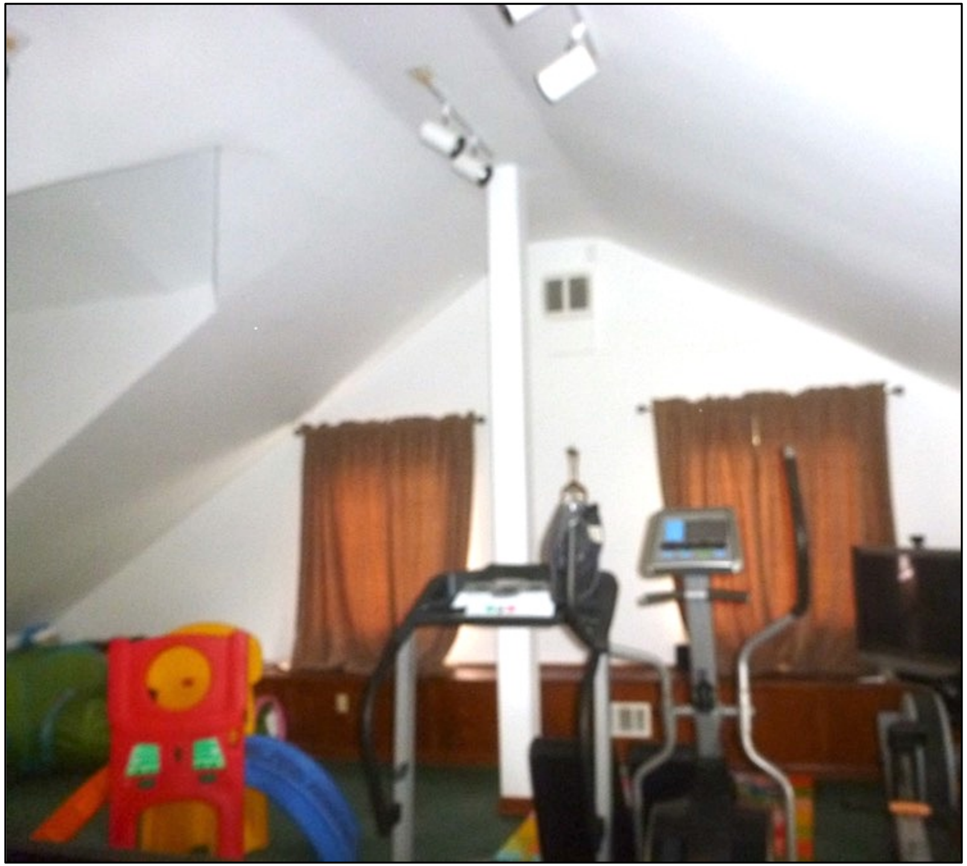
ROOF / CEILING

Data collection challenges

COMPLICATED HOUSES



DORMERS AND VAULTED CEILINGS



DO NOT REDUCE KNOWN CEILING, WALL OR FLOOR R-VALUES "JUST TO BE SAFE"

Manual J v2 pg 8

ESTIMATING EFFECTIVE R-VALUE

These batts are all suspended above the drywall by wiring and conduit.

The effective R-value is equivalent to the uninsulated area in the foreground.

ESTIMATING ATTIC BATT INSULATION R-VALUE

Use the following chart to determine effective R-values for batt insulation installed in attics:

Effective R-values for Batt Insulation*

Measured Batt Thickness (inches)	"Good" Effective R-value (2.5 per inch)	"Fair" Effective R-value (1.8 per inch)	"Poor" Effective R-value (0.7 per inch)
0	0	0	0
1	3	2	1
2	5	4	1.5
3	8	5	2
4	10	7	3
5	13	9	3.5
6	15	11	4
7	18	13	5
8	20	14	5.5
9	23	16	6
10	25	18	7
11	28	20	8
12	30	22	8.5

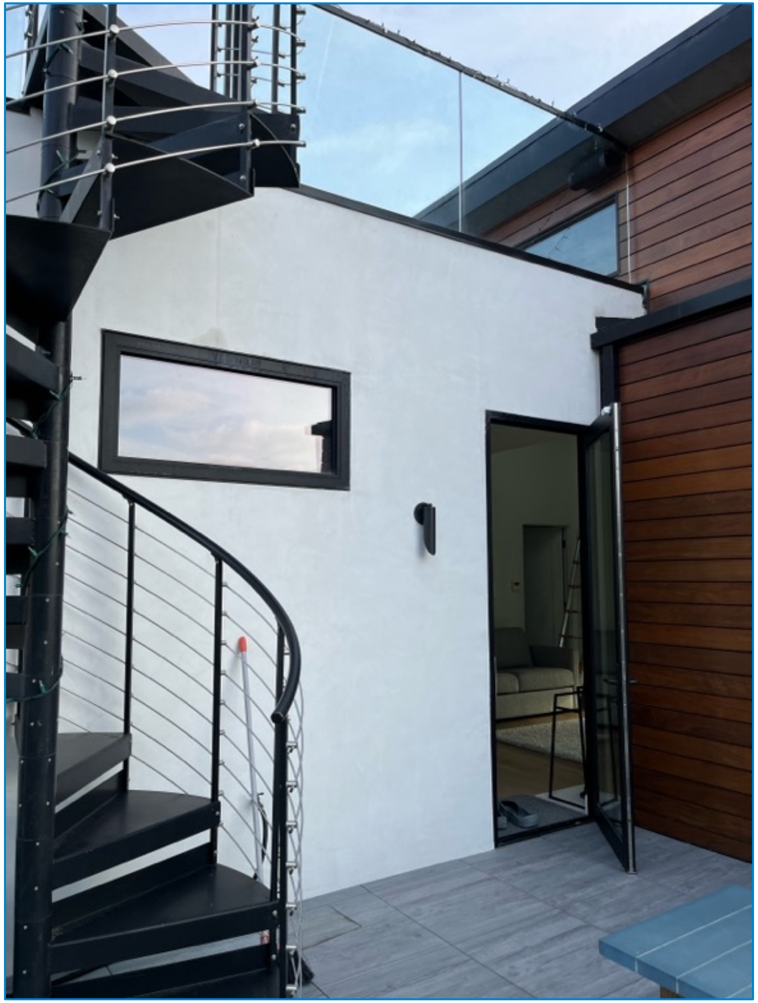
1. *Measure the insulation thickness.*
2. *Determine the condition of the installation using the following criteria:*
   - ✓ *Good – No gaps or other imperfections*
   - ✓ *Fair – Gaps over 2.5% of the insulated area. (This equals 3/8 inch space along a 14.5 inch batt.)*
   - ✓ *Poor – Gaps over 5% of the insulated area. (This equals ¾ inch space along a 14.5 inch batt.)*
3. *Look up the effective R-value of the installed insulation using the condition and measured inches.*

**Derived from ASHRAE document "Heat Transmission Coefficients for Walls, Roofs, Ceilings, and Floors" 1996*

WALLS

WALL ASSEMBLIES

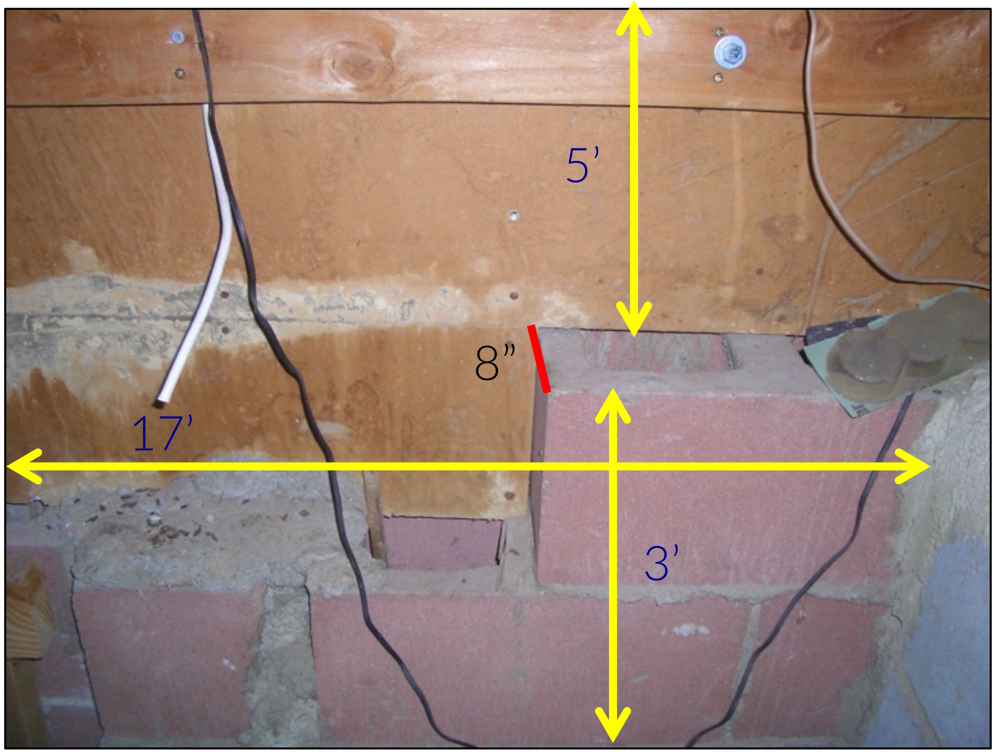
- Type of assembly
- Exterior surface
- Color
- Sheathing
- Locations and R-value of insulation
- Interior finish



WALL ASSEMBLIES

- Framing factor
  - 16” O. C. or 24” O. C.?
  - 2”x4”, 2”x6, double wall . . .?
  - Wood, metal?
  - Interior of a masonry or below grade wall?

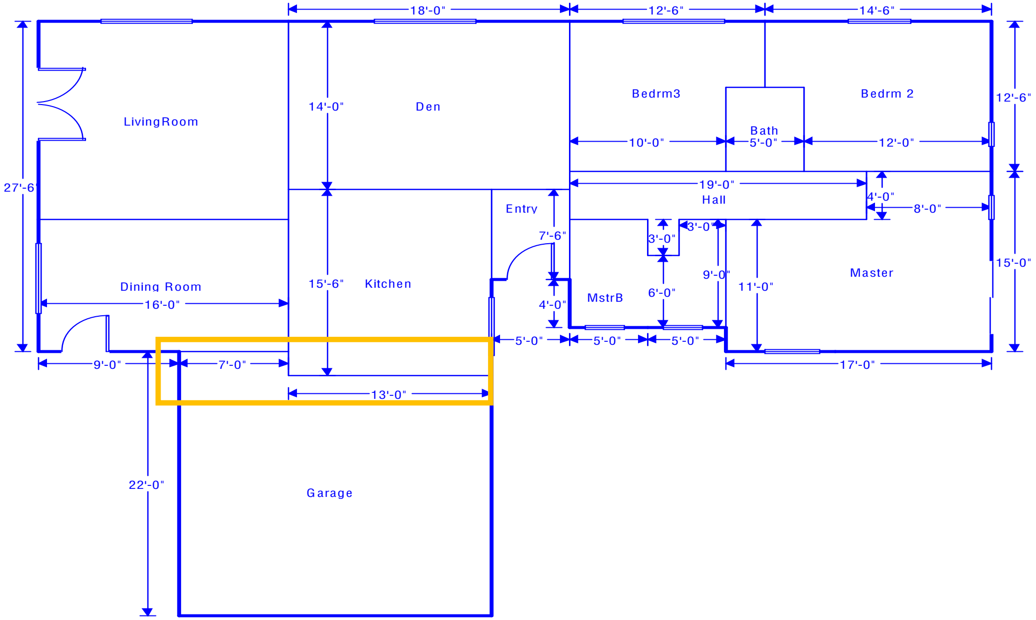
ROOMS / WALLS WITH MULTIPLE ASSEMBLIES



- Additions
- Partially below grade
- Partition walls to unconditioned spaces
- Chases or interstitial cavities

KNEE WALLS AND PARTITIONS

Are not directly exposed to the outdoors, but they do separate a conditioned space from an unconditioned space.



BELOW GRADE WALLS

Scour the floorplan for construction assembly details

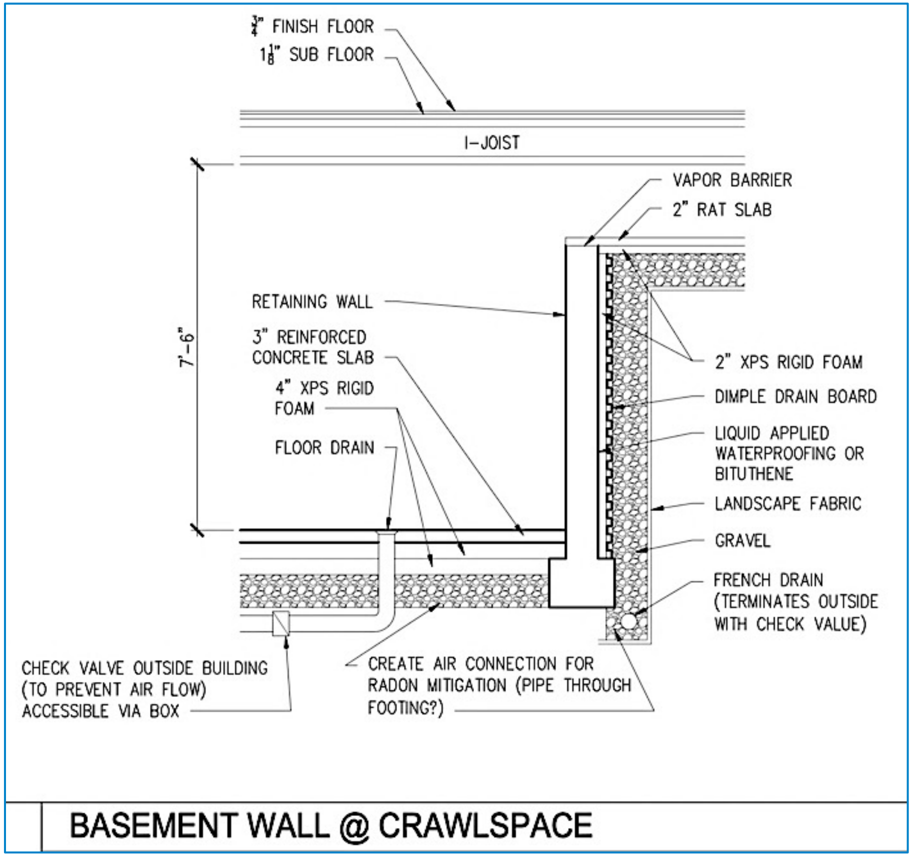
Structural wall thickness

Determine soil type for below grade walls

Below grade depth

Interior framing

Interior finish



WALLS

Data collection challenges

WALLS OFTEN HAVE MULTIPLE CLADDINGS

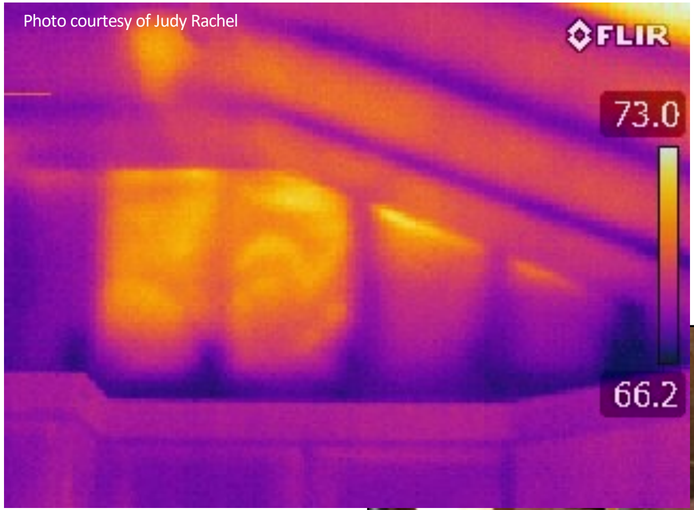
- ❑Exterior cladding is stucco and brick
- ❑ Is this a door or a window? If it is a door, you still have to include the windows.
- ❑The windows are ovals or ellipses. Area = π*a/2*b/2

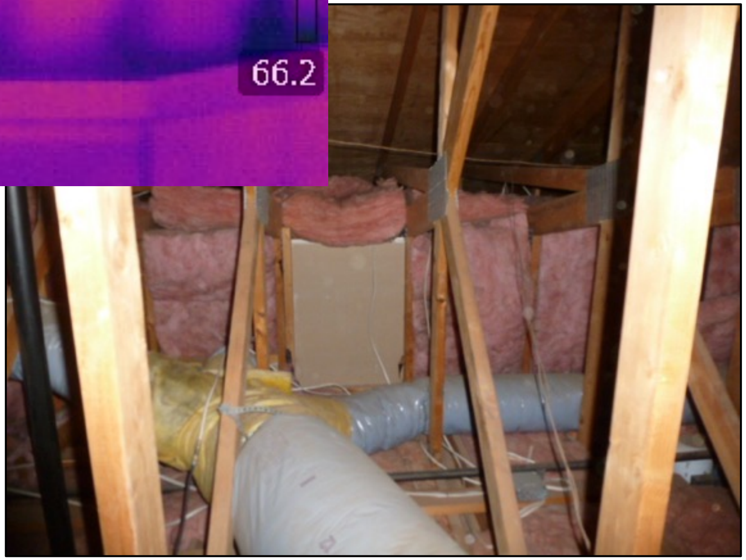
MULTIPLE WALL ASSEMBLIES

WHAT COMPASS DIRECTION(S)?

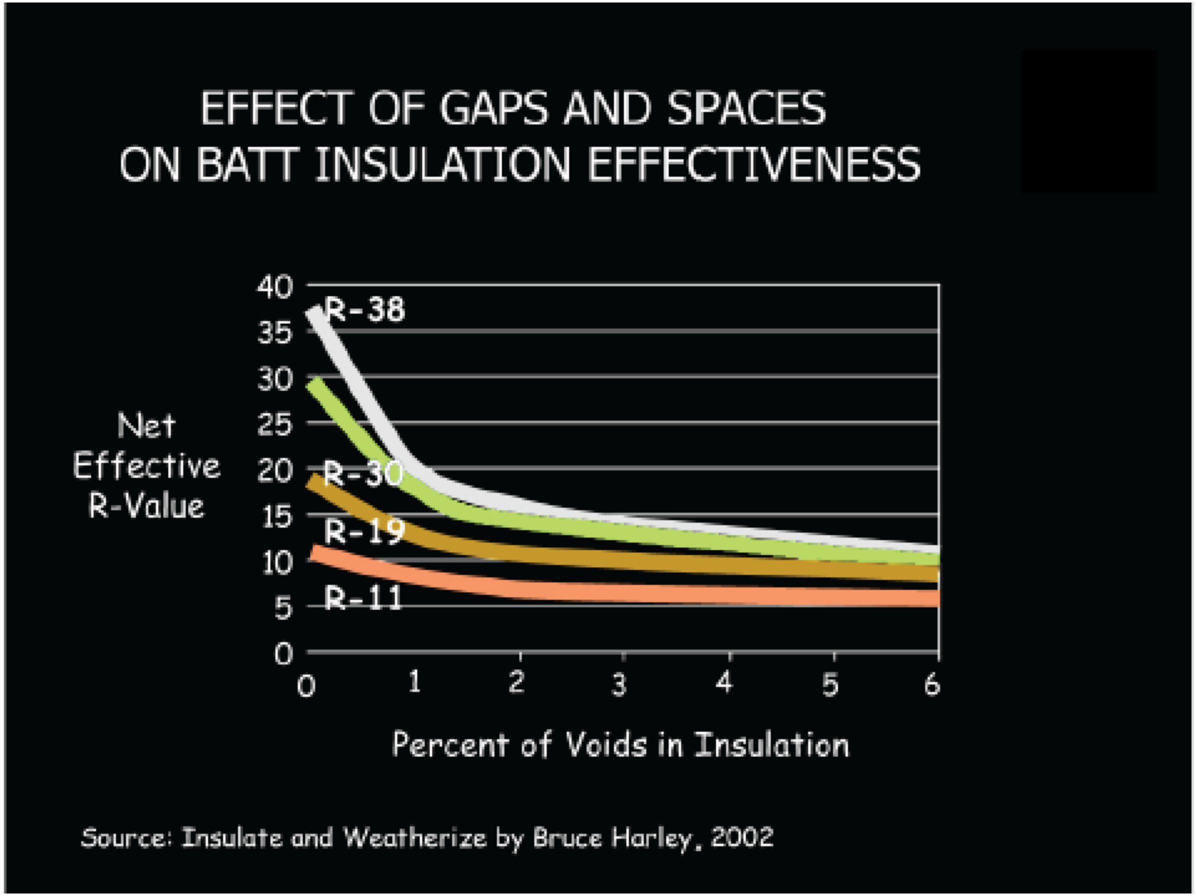
QUANTITY / QUALITY OF INSULATION

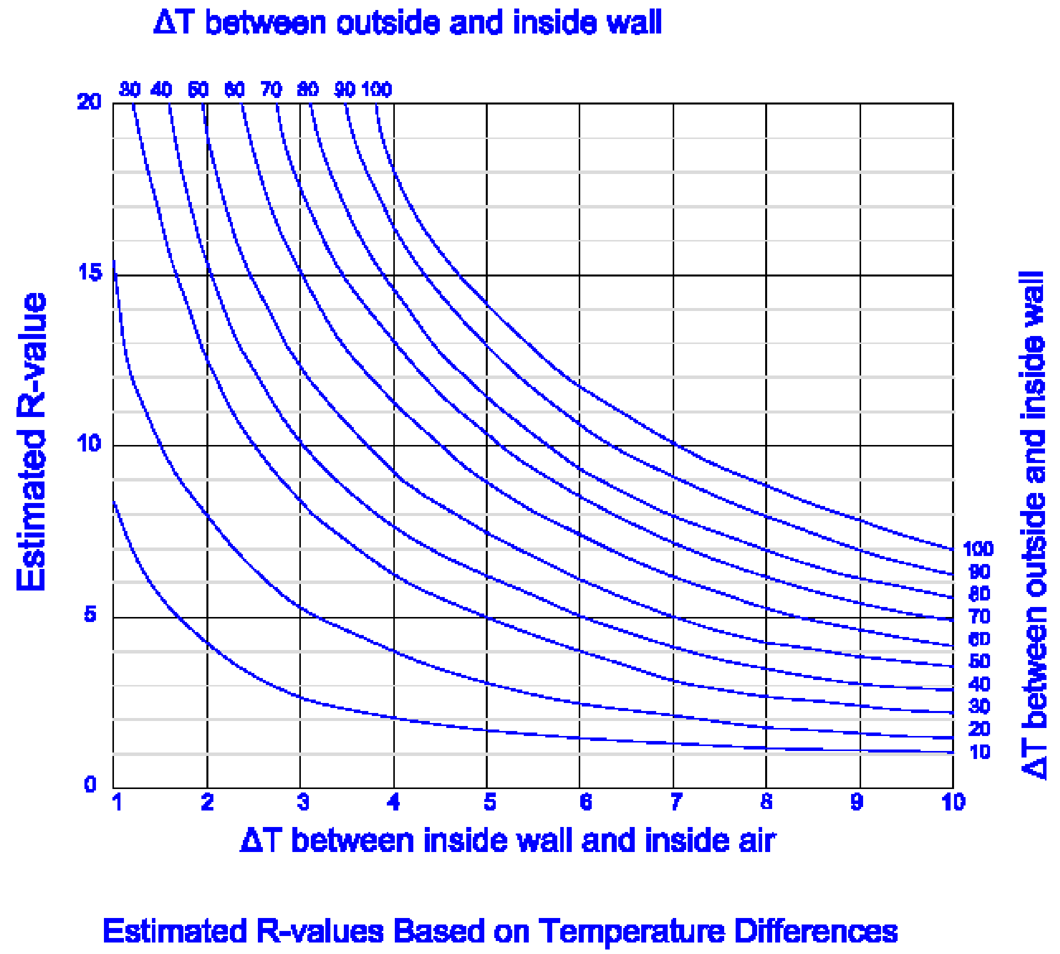
- Infrared aided with blower door
- Visual inspection
- Probing at switch plates in walls
- Asking questions



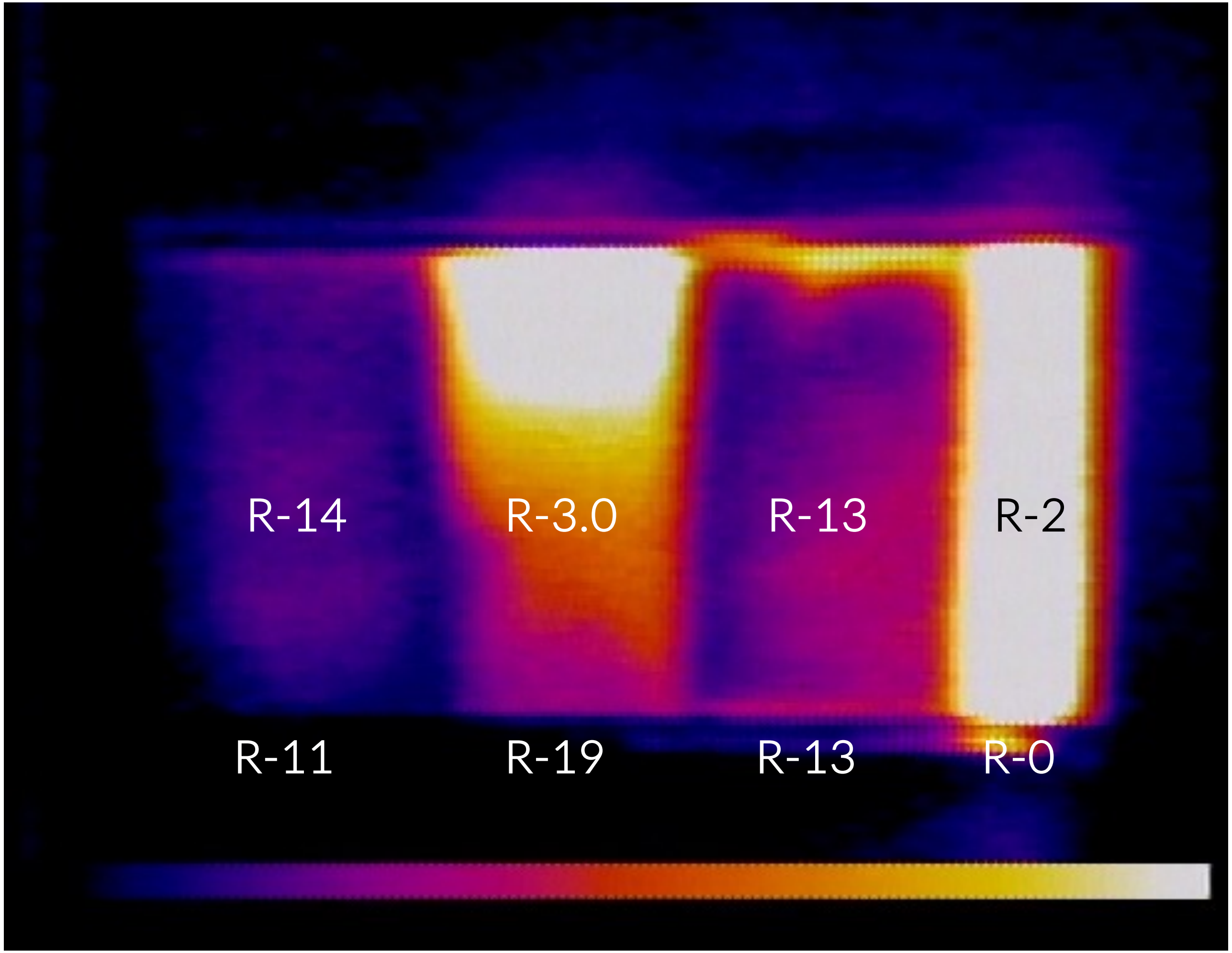


INSULATION INSTALLATION QUALITY

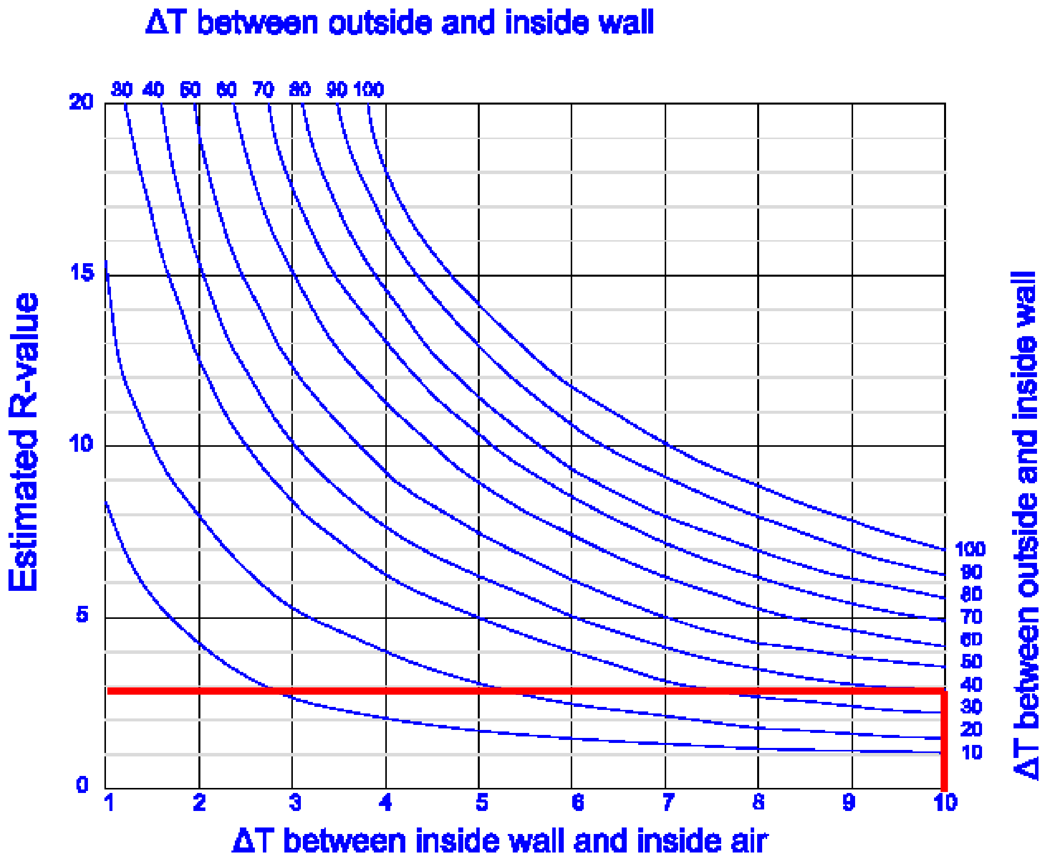




ΔT between outside and inside wall
30 40 50 60 70 80 90 100
20
15
10
5
0
Estimated R-value
1 2 3 4 5 6 7 8 9 10
ΔT between inside wall and inside air
100 90 80 70 60 50 40 30 20 10
ΔT between outside and inside wall
Estimated R-values Based on Temperature Differences


R-14
R-3.0
R-13
R-2
R-11
R-19
R-13
R-0


Raytek
MiniTemp



Estimated R-values Based on Temperature Differences

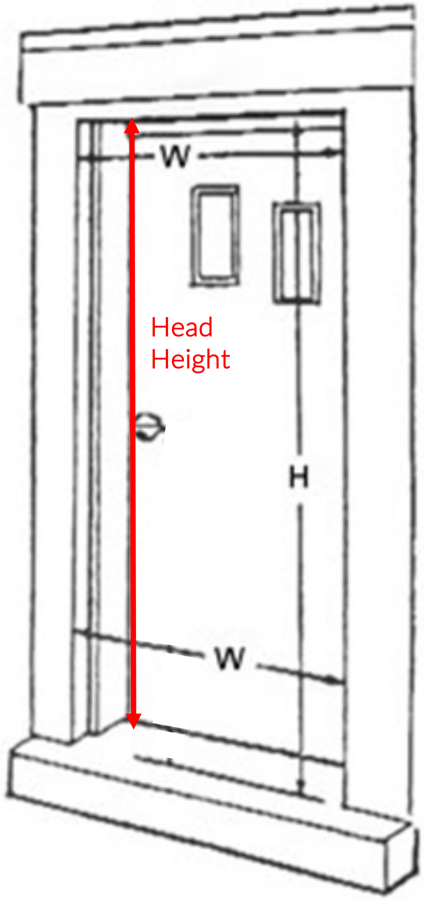
INTERSTITIAL CAVITIES / CHASES

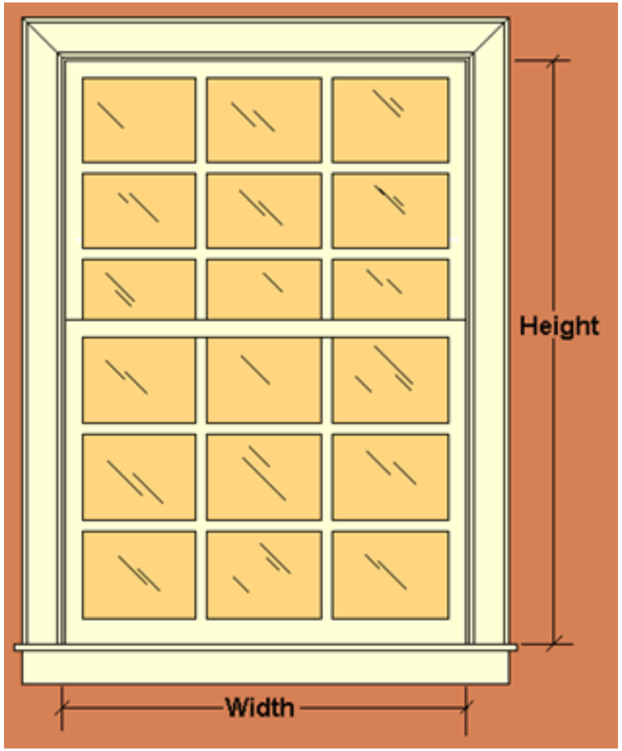
Part of the conditioned space or unconditioned space?

Insulated, poorly insulated or uninsulated?

FENESTRATIONS

FENESTRATION ATTRIBUTES





Jamb to jamb
Header to sill

Note compass direction and room

Note frame type

Number of glazing panes

Fixed or operable

Head height

FENESTRATION ATTRIBUTES

Internal shade device and/or sun screen at design conditions – (5pm in July)

Bug screen

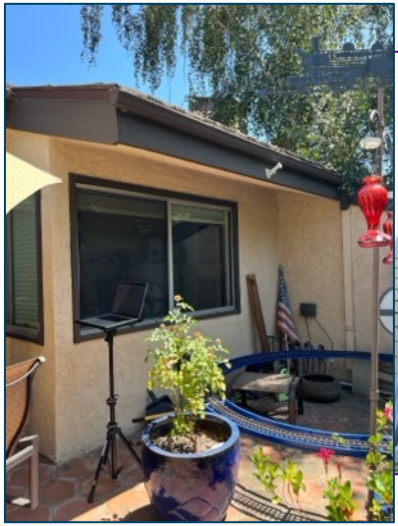
- % of window covered
- Interior or exterior

NFRC ratings for U-factor and SHGC

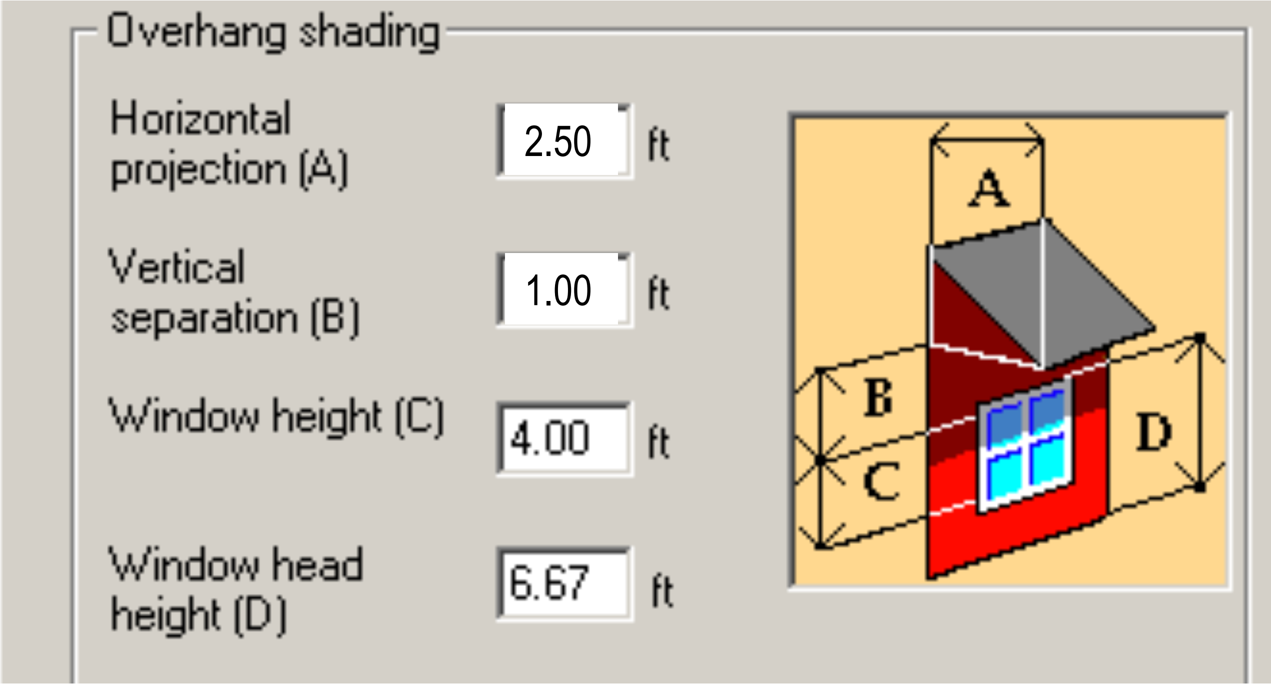
EXTERNAL SHADES, OVERHANG OR AWNING

External shade is the most effective method of reducing the solar gain for a window or glass door because direct radiation never reaches the glazing assembly.

Shaded glass heat gain is about equal to North glass heat gain.



OVERHANG MEASUREMENTS



Note: Vertical separation (B) is from the top of the window to the lowest point of the overhang.

GABLE END OVERHANGS

Eaves on the gable side of a space may, or may not, shade the glass below the eave.

For this scenario, the B value equals the average distance from the top of a window or glass door to the eave line.

SKYLIGHT DETAILS

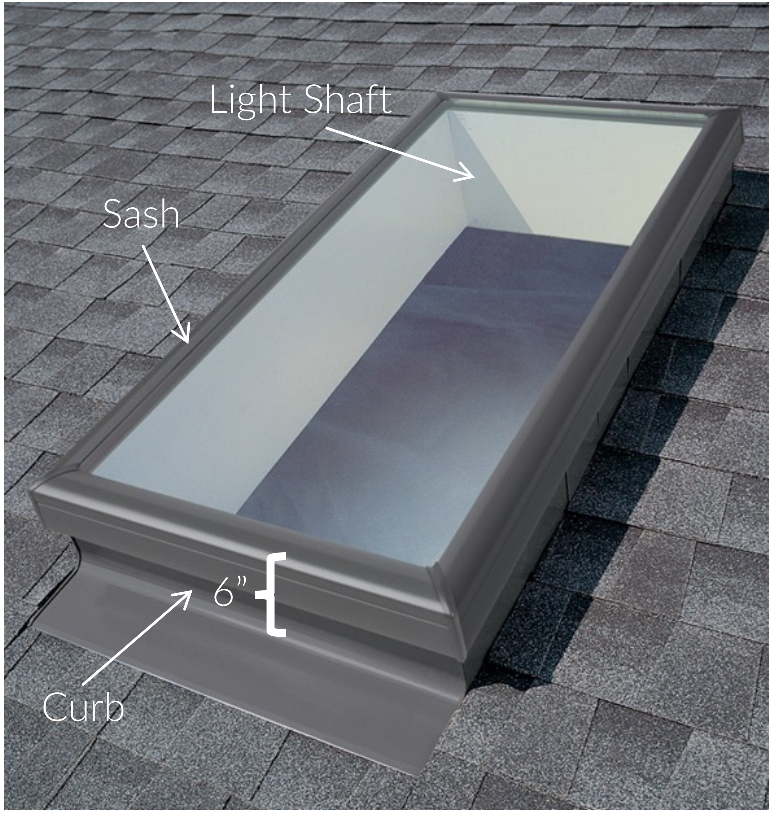
Measure the rough opening, width and length.

Note glazing type.

Measure the curb height.

Identify and note all materials in the curb and light shaft assemblies.

Note sash material.



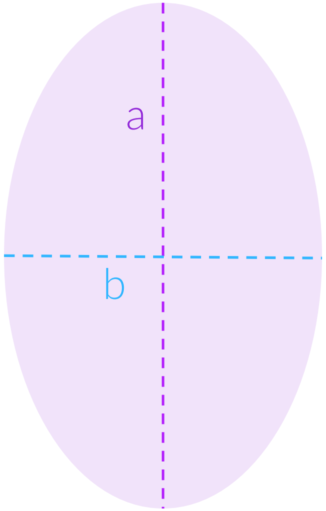
FENESTRATION

Data collection challenges

ODD SHAPED WINDOWS

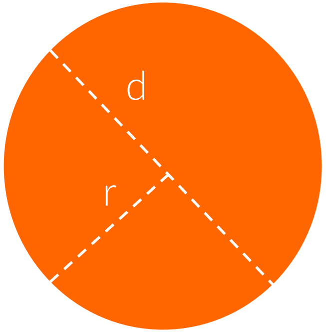
Ellipse

$A = \pi * a/2 * b/2$



Circle

Area: $A = \pi r^2$



$r = d/2$


3'6"
2'
8'

SKYLIGHT

Skylight shaft/Knee wall

SOLAR TUBES

Scour the internet for performance data

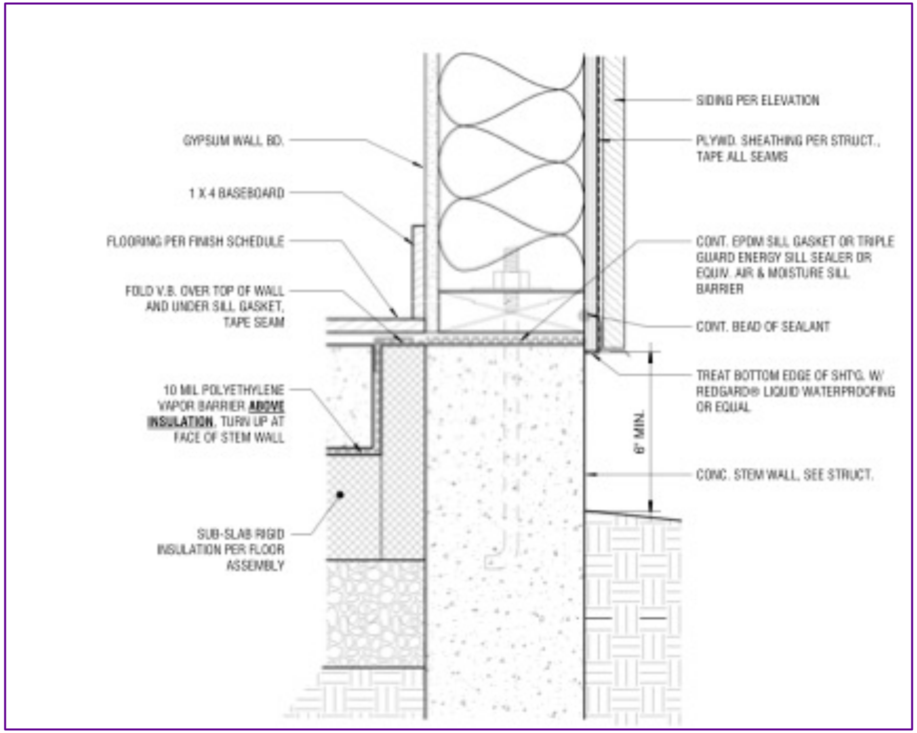
Product	Diffuser Type	U-Factor[1] (BTU/hr-sf-F)	Metric/SI (W/m-K)	R-Value (hr-sf-F/BTU)	SHGC[2]
Solatube 160 DS (10 in/250 mm) and 290 DS (14 in/350 mm)	Vusion™	0.61	3.46	1.64	0.27
Solatube 160 DS (10 in/250 mm) and 290 DS (14 in/350 mm)	Vusion™	0.61	3.46	1.64	0.23
Solatube 160 DS (10 in/250 mm) and 290 DS (14 in/350 mm)	OptiView®	0.61	3.46	1.64	0.27
Solatube 160 DS (10 in/250 mm) and 290 DS (14 in/350 mm)	JustFrost™	0.60	3.41	1.67	0.27

FLOORS

EXTERIOR FLOOR

- Structure
- Structure thickness
- Floor finish
- Exterior insulation
- Cavity insulation
- Exterior conditions
- Crawlspace/basement wall insulation

SLAB ON GRADE



- Soil type
- Below grade depth
- Edge insulation inches
- Edge insulation R-value
- Slab insulation location
- Slab insulation R-value
- Floor finish
- Edge ducts

FLOORS

Data collection challenges


OWENS CORNING

CANTILEVER

INFILTRATION

ENCLOSURE LEAKAGE EVALUATION

Infiltration depends upon:

- ✓ The height of the home (number of stories).
- ✓ The amount of wind shielding provided by adjacent structures or natural barriers.
- ✓ The tightness of the thermal enclosure.

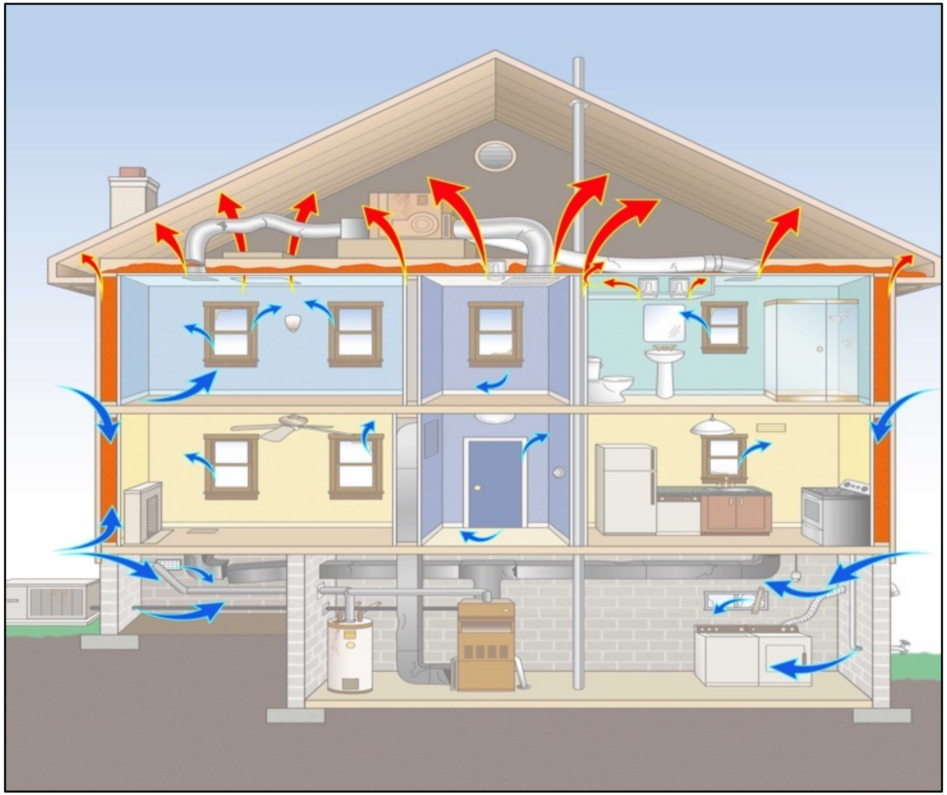
1	No shielding on any side
2	A few nearby obstructions (sheds, trees)
3	Obstructions within 25 ft (sheds, thick hedge, solid fence; or one nearby house)
4	Substantial number of obstructions shield most of the perimeter (buildings, hedges, solid fences -- typical suburban shielding)
5	House surrounded by large structures -- typical urban shielding

EFFECT OF BUILDING LEAKAGE

a. During the heating season infiltration increases the heating load

b. During the cooling season infiltration increases the **sensible** cooling load.

c. Summer infiltration may increase or decrease the **latent** cooling load depending upon the climate and indoor humidity.



ENCLOSURE LEAKAGE EVALUATION

Three methods are available to determine building leakage:

Simplified – least accurate

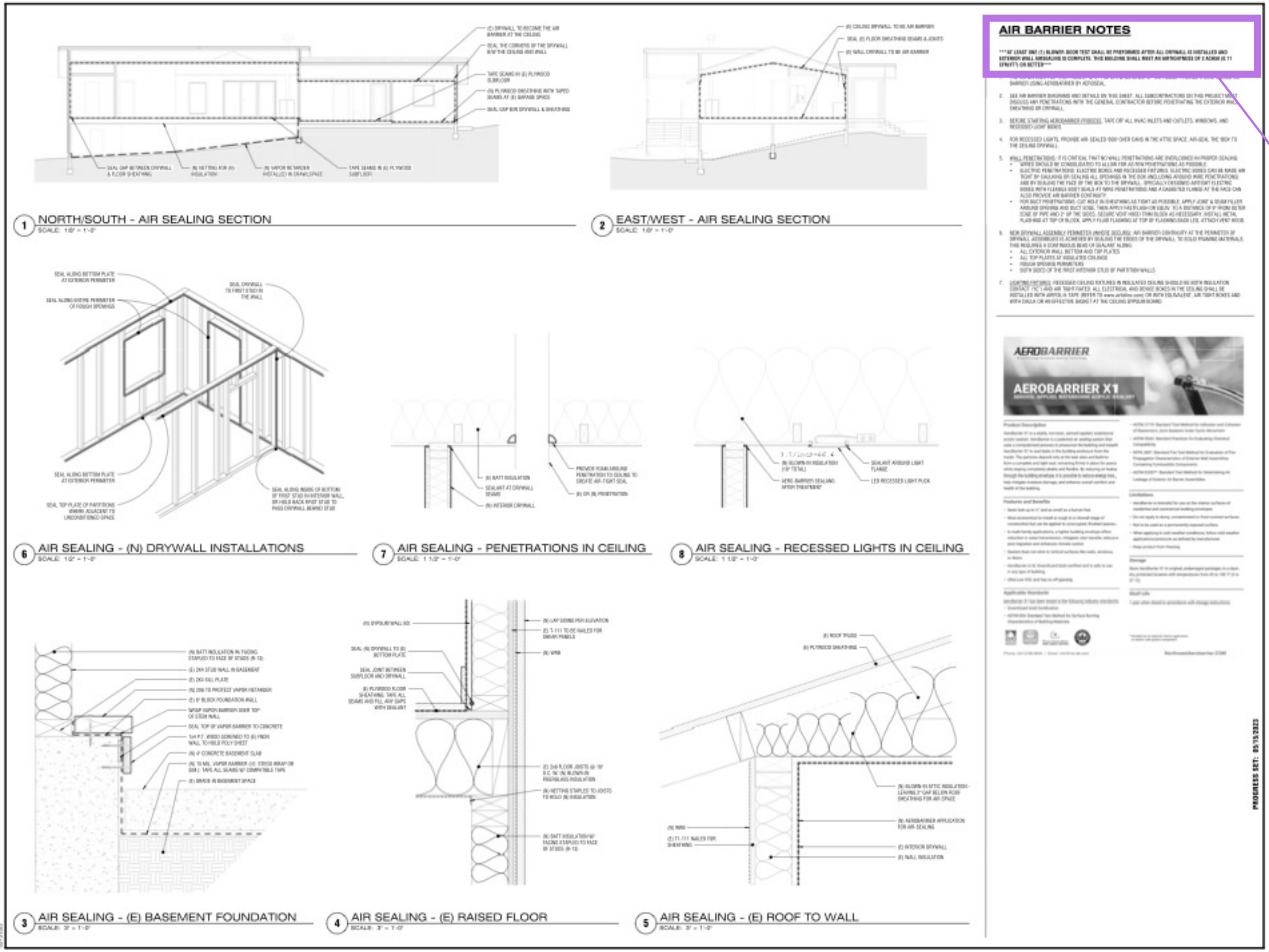
Detailed – difficult, inaccurate

Blower Door – most accurate

TAPE OFF DUCT SYSTEM

When duct runs are located in an unconditioned space, the supply air and return air openings should be sealed prior to conducting a blower door test.

This way, envelope leakage is decoupled from the duct leakage and the duct leakage effect will not be double counted by Manual J procedures.



AT LEAST ONE (1) BLOWER DOOR TEST SHALL BE PERFORMED AFTER ALL DRYWALL IS INSTALLED AND EXTERIOR WALL AIRSEALING IS COMPLETE.

THIS BUILDING SHALL MEET AN AIRTIGHTNESS OF 2 ACH_{50} OR BETTER

INFILTRATION

Data collection challenges

GUESSING OR DETAILING

Structural Leakage

Structural tightness is estimated by comparing the existing or expected construction details with the definitions of *tight, semi-tight, average, semi-loose* and *loose*.

Component Leakage Area

Leakage Area Calculation			
Table 5C Component	SqFt or Count	ELA_4 Ratio	ELA_4
Ceiling, no membrane, no caulking or sealing.	2,100	0.033	69.3
Exterior frame wall rigid sheathing, poorly caulked.	1,300	0.015	19.5
Window and door frames, caulked.	220	0.004	0.88
Electrical outlets, no gaskets.	30	0.38	11.4
Piping penetrations, well sealed.	3	0.30	0.9
Single door, weather-striped.	2	1.9	3.8
Casement windows, no weatherstrip.	120	0.033	3.96
Double hung windows, no weatherstrip.	60	0.152	9.1
Gas water heater.	1	3.1	3.1
Gas furnace with damper.	1	4.6	4.6
Kitchen exhaust, no damper.	1	6.2	6.2
Bath exhaust, with damper.	2	1.6	3.2
Total leakage area (SqIn)			135.9

BLOWER DOOR CHALLENGES

Wind

Rain

DUCT LOADS

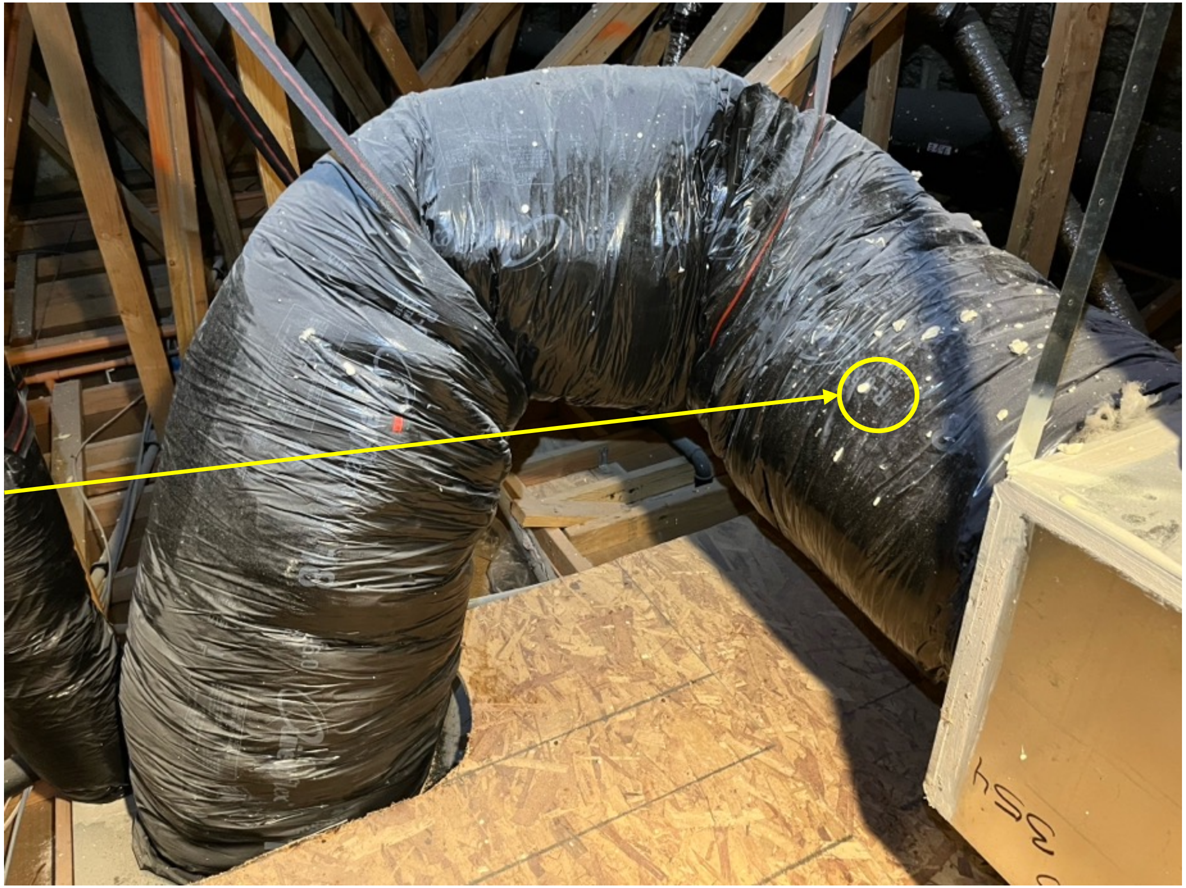
DUCT LOADS

Enclosure performance and duct system performance are evaluated separately.

A tight enclosure may have a leaky duct system or a leaky enclosure may have a tight duct system— or some other combination of an enclosure leakage scenario and a duct leakage scenario.

DUCT SYSTEM CHARACTERISTICS

- Take full credit for duct system sealing and insulation when such efforts are confidently anticipated or certifiable.
- Identify duct wall insulation R-value and (in dry climates, R-value of ducts buried in additional insulation)

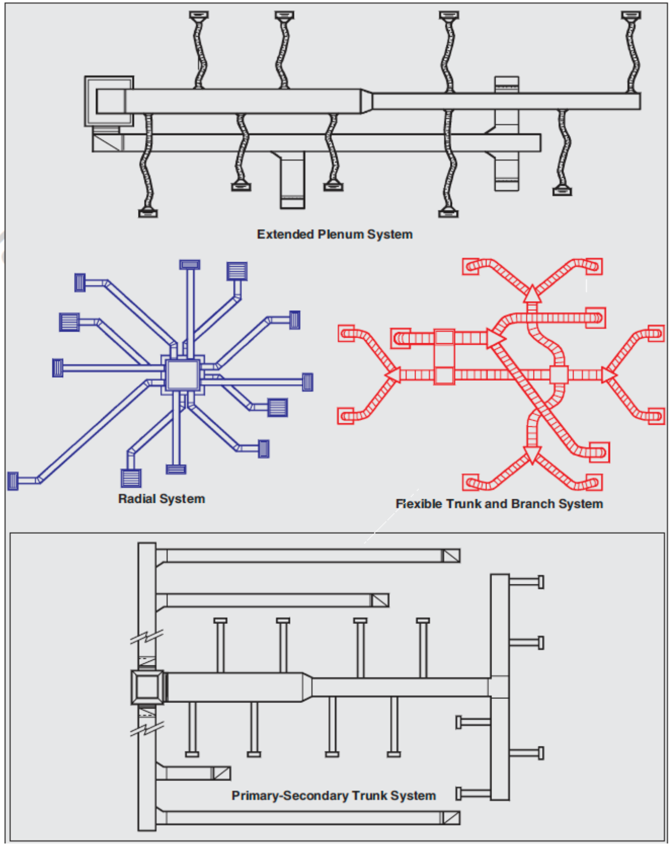


DIFFERENT DUCT LOADS

These ducts will be buried in insulation

These ducts are above the insulation

DUCT LAYOUT AND LOCATION



- Note duct system geometry
- Note location of duct system

DUCT LOADS

Data collection challenges

DEFAULT LEAKAGE RATE TABLE

Default leakage Rates (Cfm / SqFt) for Generic Duct Systems		
Tightness Category	SLR Cfm / SqFt	RLR Cfm / SqFt
1) Extremely sealed (seal shall be verified by leakage test).	0.06	0.06
2) Notably sealed (verification by leakage test recommended).	0.09	0.15
3) Average sealed system (default for sealed systems).	0.12	0.24
4) Partially sealed.	0.24	0.47
5) Unsealed system (default for unsealed systems – sealing recommended).	0.35	0.70
Industry standards for fabrication and sealing – see material produced by SMACNA, ADC, NAIMA, UL.		

Has no relationship to how anyone thinks about or can measure duct leakage

HOW MUCH ARE THESE DUCT SYSTEMS LEAKING IN CFM/SQFT?

CONDUCTIVE LOSSES

The temperature at the roof deck can be 40 degrees greater than the temperature at the attic floor.

WHOLE HOUSE VENTILATION

An engineered ventilation system controls the exchange of air between the outdoors and the occupied space.

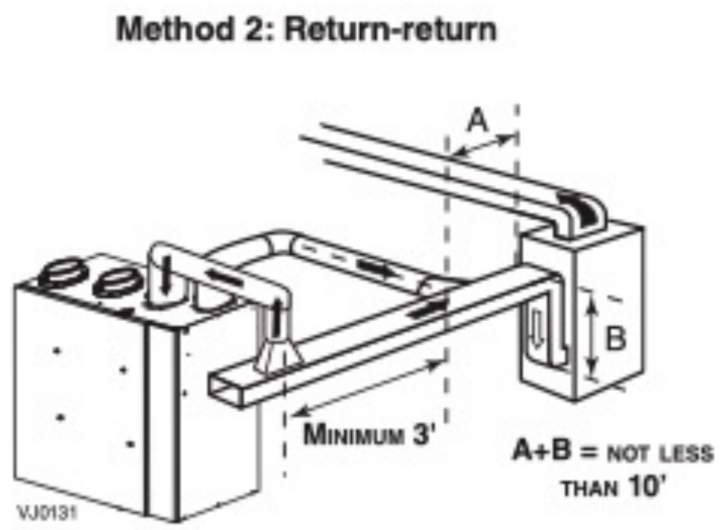
ENGINEERED VENTILATION

Fresh air (engineered ventilation) systems increase winter heating load and the winter humidification load.

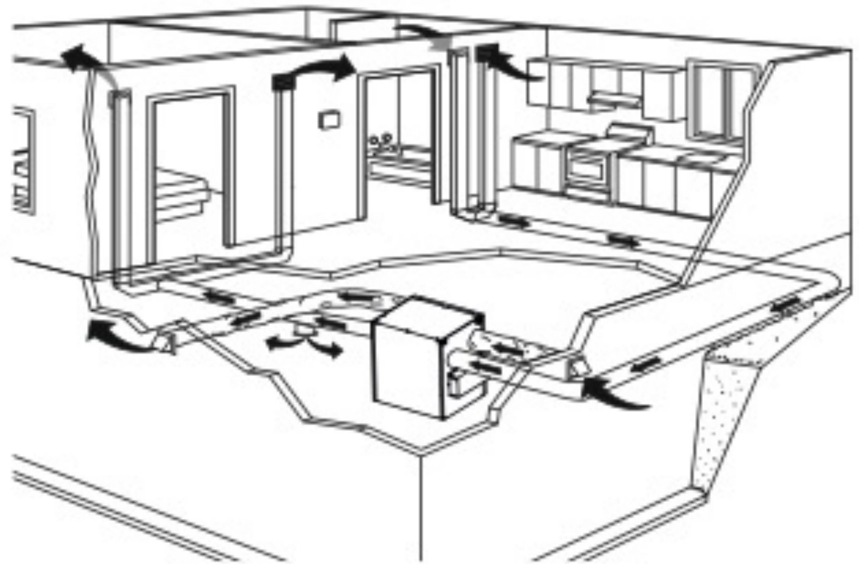
They also increase the summer sensible load and affect the latent cooling load, which may increase or decrease, depending on the type of climate, the indoor humidity, and the type of ventilation equipment.

TYPES OF VENTILATION LOADS

System load



Space load



IDENTIFY ENGINEERED VENTILATION

WHOLE HOUSE VENTILATION LOAD

Data collection challenges


balance point
home performance

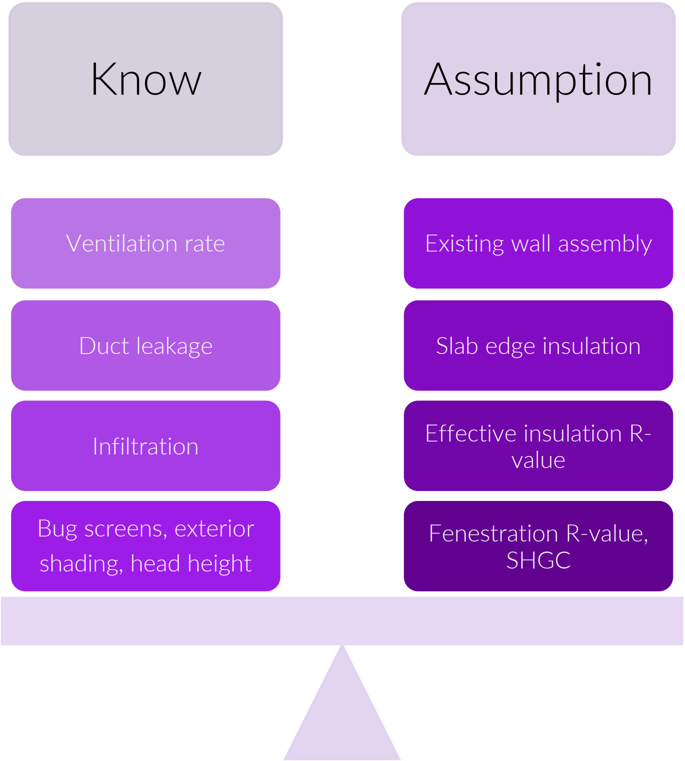
CONCLUDING COMMENTS

BALANCING ACT

Producing an accurate load calculation is a balance between:

1) Accurately describing what you do know about a building's assembly

2) Making informed, aggressive, best assumptions regarding the details of the building assembly you are unable to precisely determine.



SUMMARY

Creating an accurate load calculation takes time, detective work and attention to detail.

Measure what you can measure to tip the balance for accuracy in your favor.

A comprehensive site survey is essential for an accurate load calculation.

THANK YOU

CONNECT WITH ME:

judyrachel.com

judy@judyrachel.com

818-720-9320

Questions about Title 24?

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

Online:
3c-ren.org/code

Call:
805.781.1201

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

They can provide code citations and offer advice for your res or non-res projects.

Closing

Continuing Education Units Available

- Contact chloe.swick@ventura.org for AIA LUs

Coming to Your Inbox Soon!

- Slides, Recording, & Survey – Please Take It and Help Us Out!

Upcoming Courses:

- Building for the Future: Preparing for the 2025 Energy Code (4/30)
- **On-Site in Santa Barbara Blower Door Training (5/2)**
- All Electric ADUs, In-Person in Santa Barbara (5/16)
- Intro to Residential HVAC Systems (5/29)

Any phone numbers who joined? Please share your name!

Thank you!

More info: **3c-ren.org**

Questions: **info@3c-ren.org**

Email updates: **3c-ren.org/newsletter**

3C-REN

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