HVAC LOAD CALCULATIONS AND THE ENERGY RATER

RESNET 2008

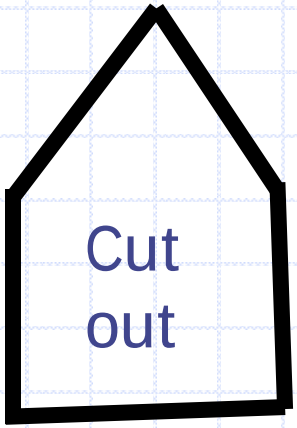
Dennis J Stroer

CALCS-PLUS

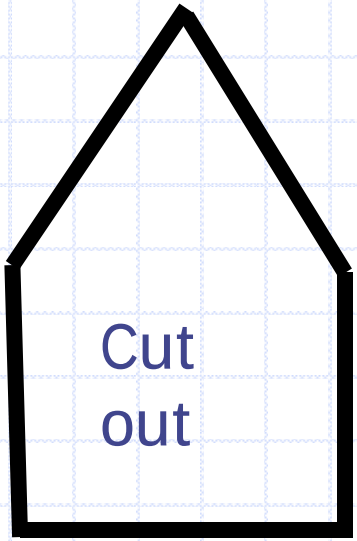
Venice Florida

Billy-Bob's Professional HVAC Load Calculation Sizing Chart

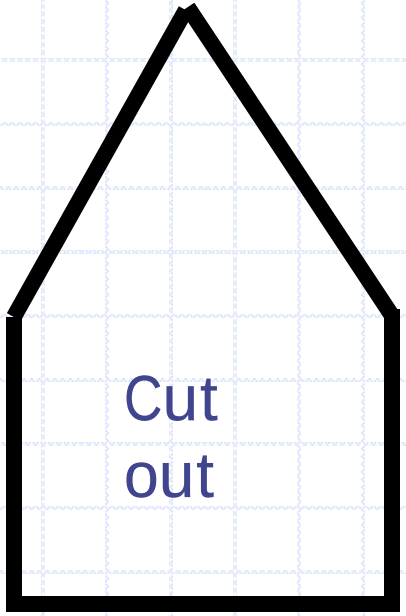
Trim with care on black lines follow instructions below



1.5 to 2 Ton



2.5 to 3.5 Ton



4 to 5 Ton

Stand on curb and look through sizing holes

Whatever hole the house fits in is the size unit to use

NOTE: For larger homes and/or for zoning use two or more holes.

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Accu-Size Heating & Cooling Hor

Cooling load (heat gain) - 95 degree day

SQUARE FOOTAGE OF WINDOWS			HEAT GAIN
North (single)	X 26	=	
North (double)	X 21	=	
NE & NW (single)	X 45	=	
NE & NW (double)	X 35	=	
East & West (single)	X 60	=	
East & West (double)	X 49	=	
SE & SW (single)	X 50	=	
SE & SW (double)	X 40	=	
South (single)	X 36	=	
South (double)	X 25	=	

SQUARE FOOTAGE OF DOORS			HEAT GAIN
Wood (no storm door)	X 13	=	
Wood (w/storm door)	X 9	=	
Insulated metal door	X 6	=	

SQUARE FOOTAGE OF NET WALLS			HEAT GAIN
Wall perimeter ____ X __height ____ less ____ glass and door area = net wall ____			
No insulation	X 8	=	
R-13 (3.5" insulation)	X 3	=	
R-19 (6" insulation)	X 2	=	

SQUARE FOOTAGE OF CEILING			HEAT GAIN
No insulation	X 22	=	
R-11 (3" insulation)	X 4.1	=	
R-19 (6" insulation)	X 2.6	=	
R-30 (10" insulation)	X 1.6	=	

SQUARE FOOTAGE OF FLOOR			HEAT GAIN
No insulation	X 3	=	
Carpet (no insu			
R-11 (3"+ insula			
Floor on slab _			

INFILTRATION
Home square fe

INTERNAL G
Number of p
Kitchen & ba

Subtotal E

GAINS FROM DUCTWORK		HEAT GAIN
In crawl space - (subtotal BTU/h X .09)		
In attic - (subtotal BTU/h X .13)		
Total BTU/h heat gain	=	

Heating load (h

SQUARE FOOTAGE C
Single glass ____
Double glass ____

SQUARE FOOTAGE C
Single glass patio _
Double glass patio _
Wood (no storm do
Wood (w/storm doo
Insulated metal doo

SQUARE FOOTAGE C
Frame (no insulatio
Frame (3.5" insulati
Frame (6" insulatior
Masonry (no insulat
Masonry (1" insulat

SQUARE FOOTAGE C
No insulation ____
R-11 (3" insulation)
R-19 (6" insulation)
R-30 (10" insulation)

SQUARE FOOTAGE C
No insulation ____
Carpet (no insulatio
R-11 (3"+ insulation)

SQUARE FOOTAGE C
No insulation ____
Carpet or insulation

HEAT LOSS

80% furnace efficiency loss X .25 =
90% furnace efficiency loss X .12 =

Total BTU/h input needed =

OR, Just do the old stand-by!

X SQ FT PER TON

Accu-Size Heating

Cooling load (heat gain) - 95 degree day

SQUARE FOOTAGE OF WINDOWS			HEAT G
North (single)	X 26	=	
North (double)	X 21	=	
NE & NW (single)	X 45	=	
NE & NW (double)	X 35	=	
East & West (single)	X 60	=	
East & West (double)	X 49	=	
SE & SW (single)	X 50	=	
SE & SW (double)	X 40	=	
South (single)	X 36	=	
South (double)	X 25	=	

HVAC Load Calculations.

- Why should an Energy Rater perform HVAC Load Calculations?
- What is meant by a Room x Room calculation?
- Why use ACCA Manual J Version 8?
- MJ8 Sensitivities.
- How can an Energy Rater benefit?

Energy Raters and Air Flow

Energy raters are already familiar with airflow. We use air flow as a tool to do energy ratings.

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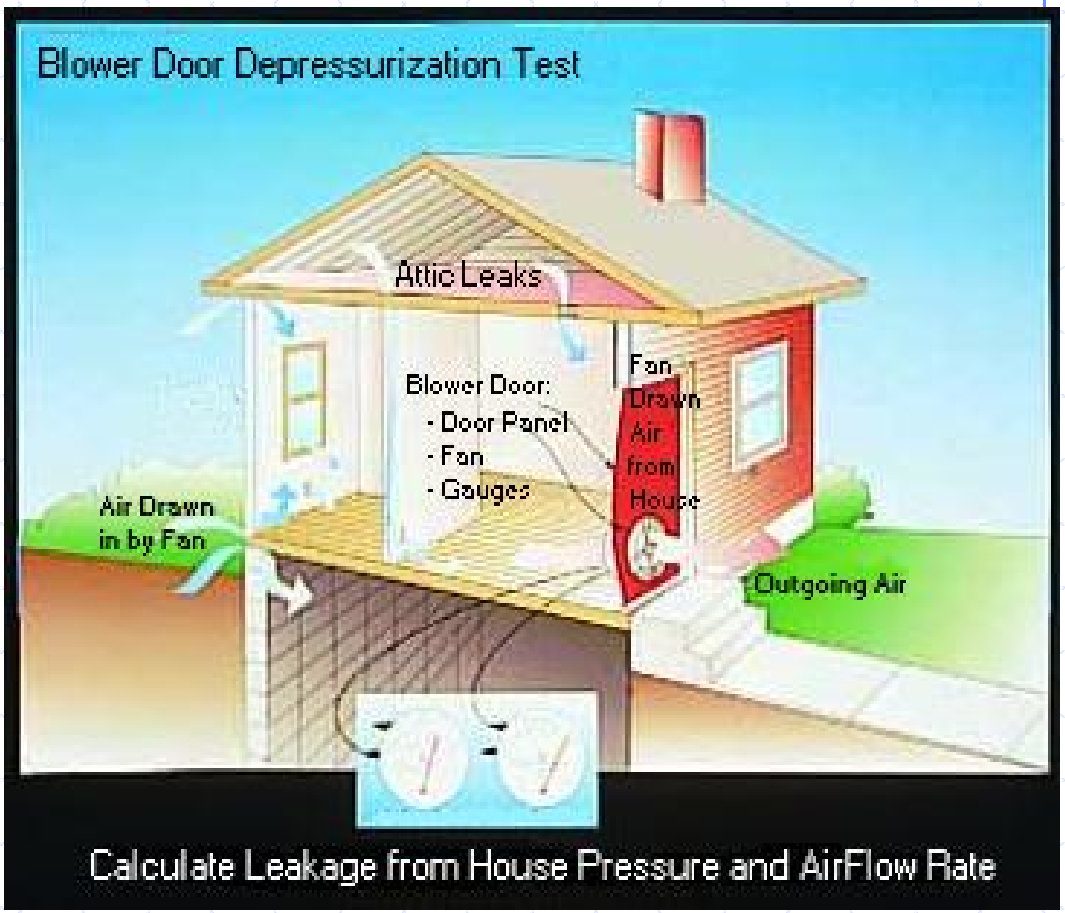


Two types of Airflow.

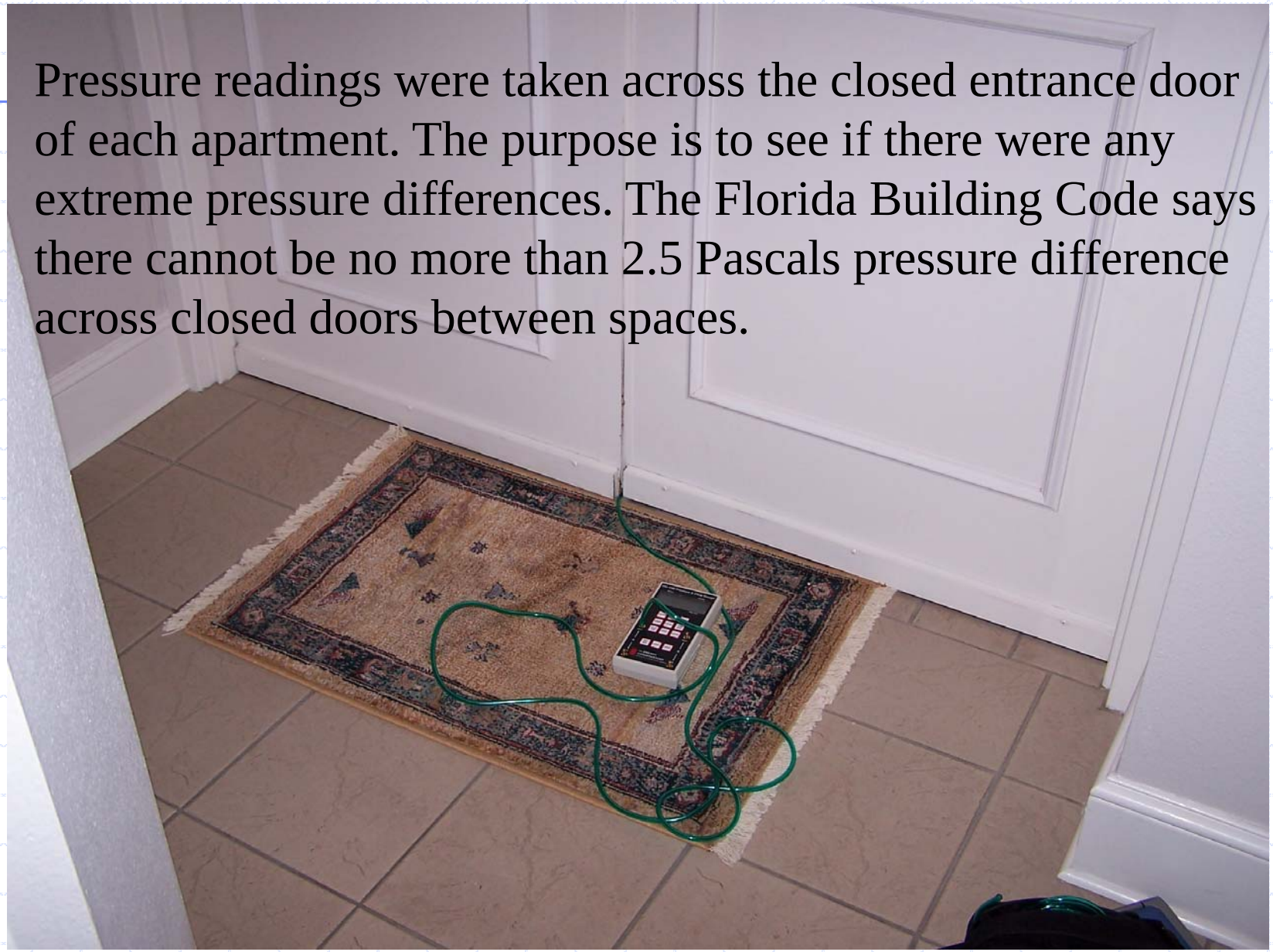
With respect to residential and commercial construction there are two kinds of airflow.

Controlled and Uncontrolled

Energy Raters use controlled airflow to estimate the amount of uncontrolled airflow.

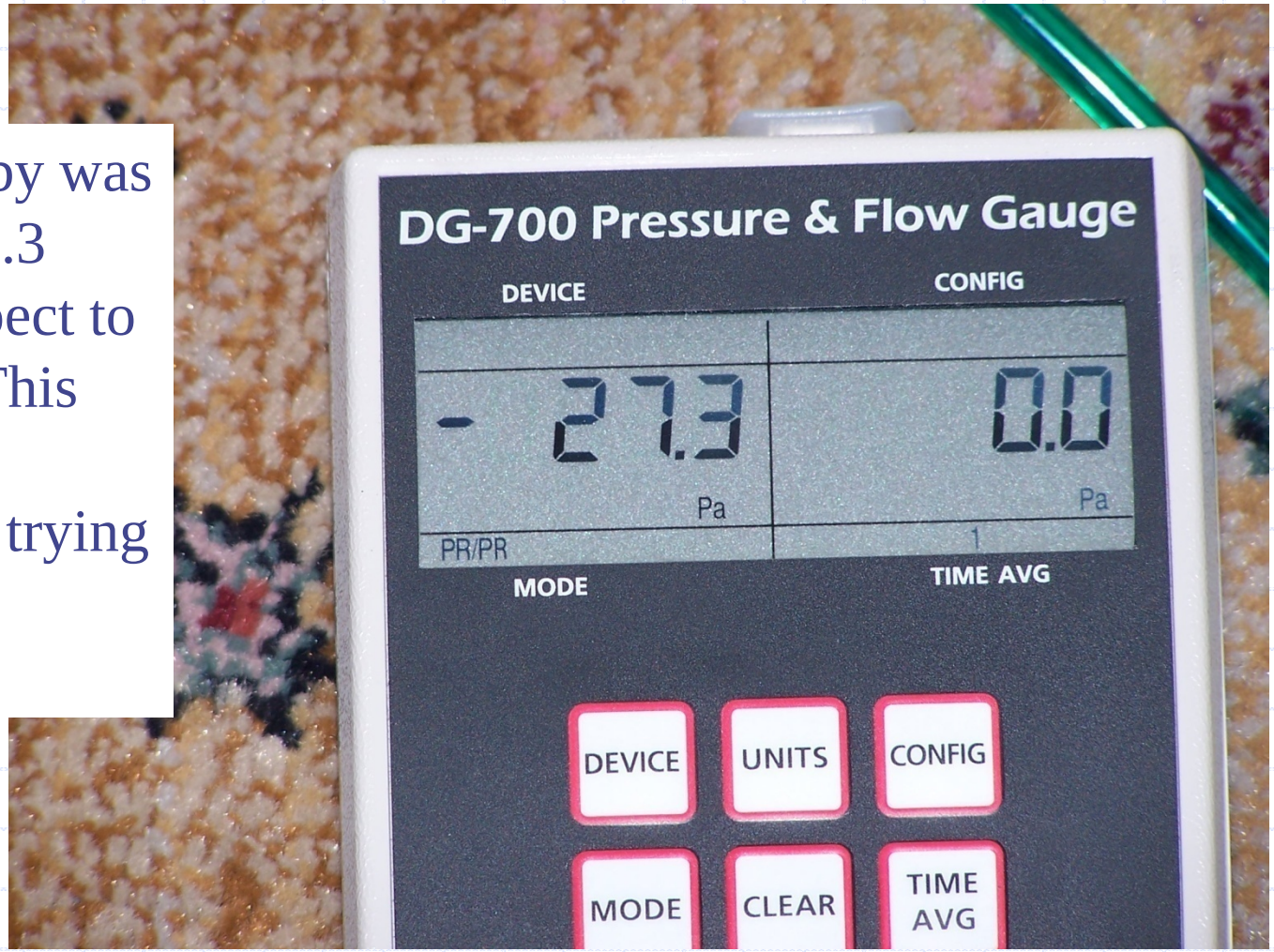
Uncontrolled Airflow

Pressure readings were taken across the closed entrance door of each apartment. The purpose is to see if there were any extreme pressure differences. The Florida Building Code says there cannot be no more than 2.5 Pascals pressure difference across closed doors between spaces.



Uncontrolled Airflow

The elevator lobby was found to be a -27.3 Pascals with respect to the apartments. This means air in the elevator lobby is trying to go into the apartment.

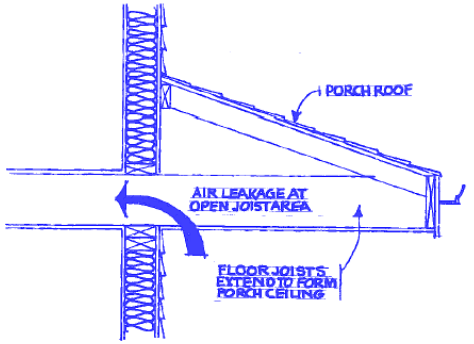


Uncontrolled Airflow

Leaky buildings

Leaky Duct Systems

Unbalanced building pressures.



Uncontrolled Airflow = Infiltration

Infiltration influences how the building reacts in terms of health, safety, durability, comfort, and energy efficiency.

- Can be estimated with a high degree of accuracy.
- Can be tested with a high degree of accuracy.
- Can be eliminated or controlled.

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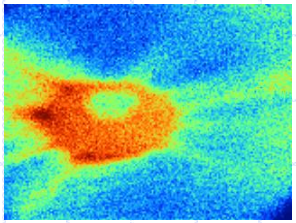
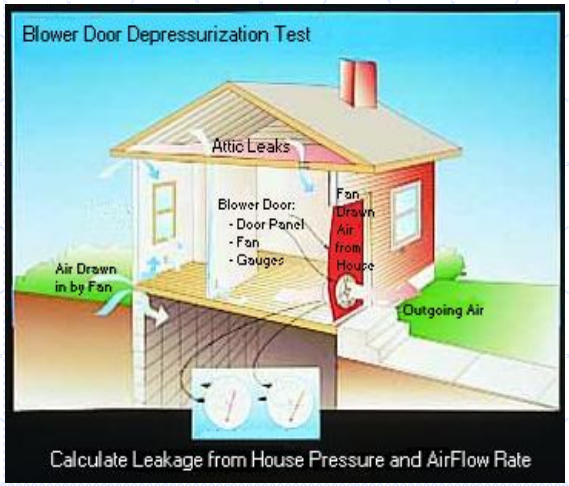




Duct Leakage

Influences how the building reacts in terms of health, safety, durability, comfort, and energy efficiency.

- Can be estimated with a high degree of accuracy.
- Can be tested with a high degree of accuracy.
- Can be eliminated.

As Energy Raters we understand uncontrolled airflow.

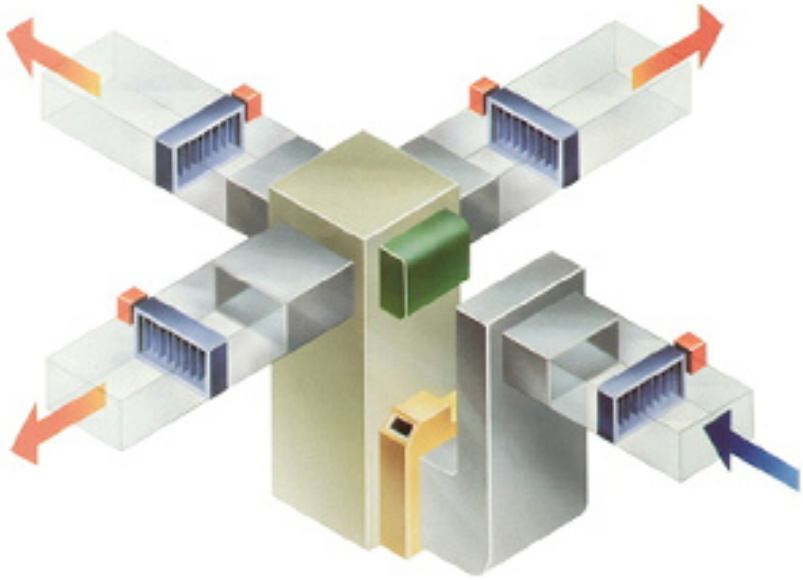
So lets talk about controlled airflow.

Controlled Airflow

Open and closing windows

Table fan

Air conditioning systems.



Room Airflow

Determined by the estimated Heat Gain/Loss; Cooling or heating which ever has been chosen to dominate the system design.

HVAC Load calculations performed on a Room x Room basis.

Based on the Heat Loss/Gain through the building envelope relative to each room.

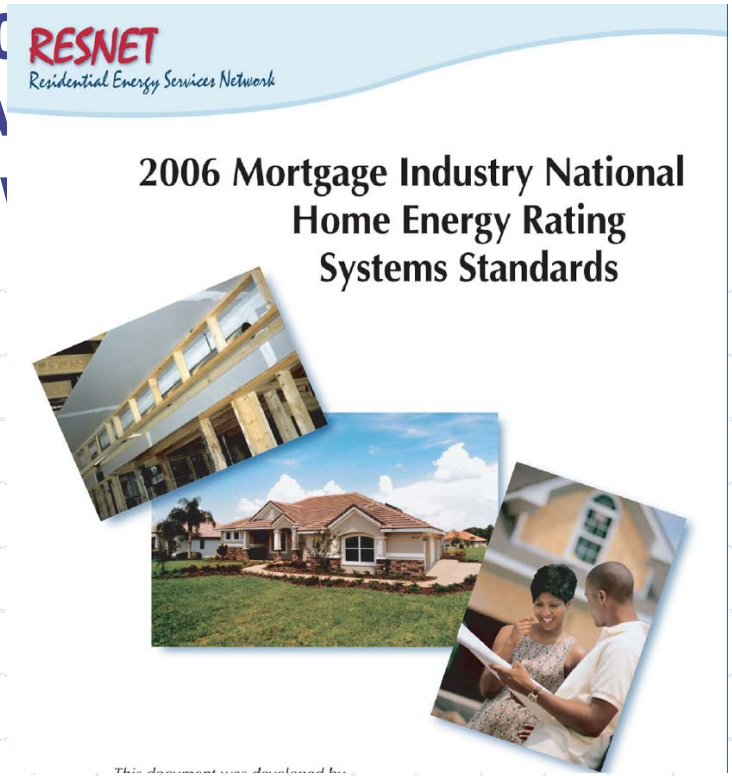
Room x Room Loads

If the HVAC system is the backbone of the house as a system. The HVAC load calculation is the backbone of the HVAC system

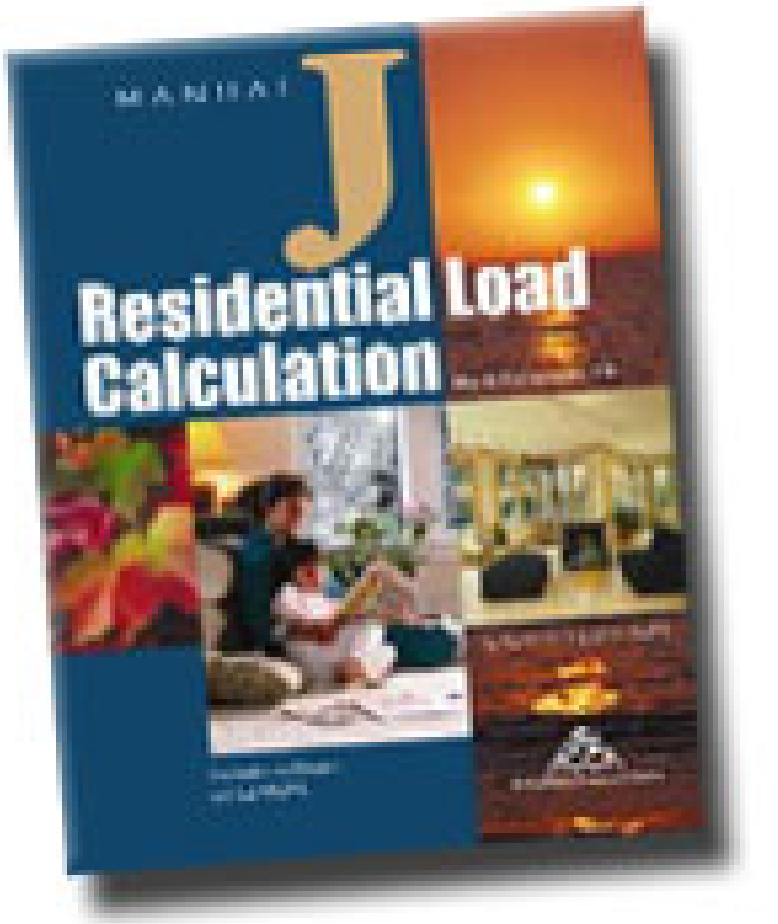
- Required to determine supply CFM for each room
- Required to select Supply Outlets
- Required to select Return Inlets
- Required to design a Duct System
- Required to diagnose comfort problems

303.5.1.5 Manufacturer's Equipment Performance Ratings (e.g., HSPF, SEER, AFUE) shall be corrected for local climate conditions and mis-sizing of equipment. To determine equipment mis-sizing, the capacity of heating and cooling vapor compression equipment shall be calculated in accordance with ACCA Manual J, Eighth Edition, ASHRAE 20 Fundamentals, or an equiv procedure, using the follo .

Recognize This?

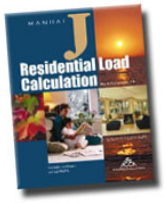


ACCA Manual J V8



The Standard in the Industry

Why Use MJ8

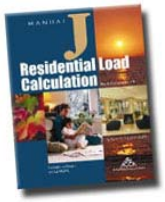


The heating and cooling load estimates affect every aspect of the system design procedure

- From system selection
- To equipment selection procedures
- To placement and selection of air distribution hardware
- To duct routing and airway sizing or pipe layout and sizing

Because of this the load calculation must be as accurate as possible

Value of Manual J



- Eliminate Under-sizing of Heating & Cooling Equipment
- Eliminate Over-sizing of Heating & Cooling Equipment
- Humidity Control During the Cooling Season
- Eliminate Comfort Problems

Under Sizing Equipment

The obvious problem with undersized equipment is that it will not maintain the desired temperature. However, slightly undersized cooling equipment (by a margin of 10% or less) may actually provide more comfort at a lower cost.

Oversized Equipment Causes

- short-cycles
- marginalized temperature control
- pockets of stagnate air
- degrades humidity control during the cooling season
- requires larger duct runs

Oversized Equipment Causes

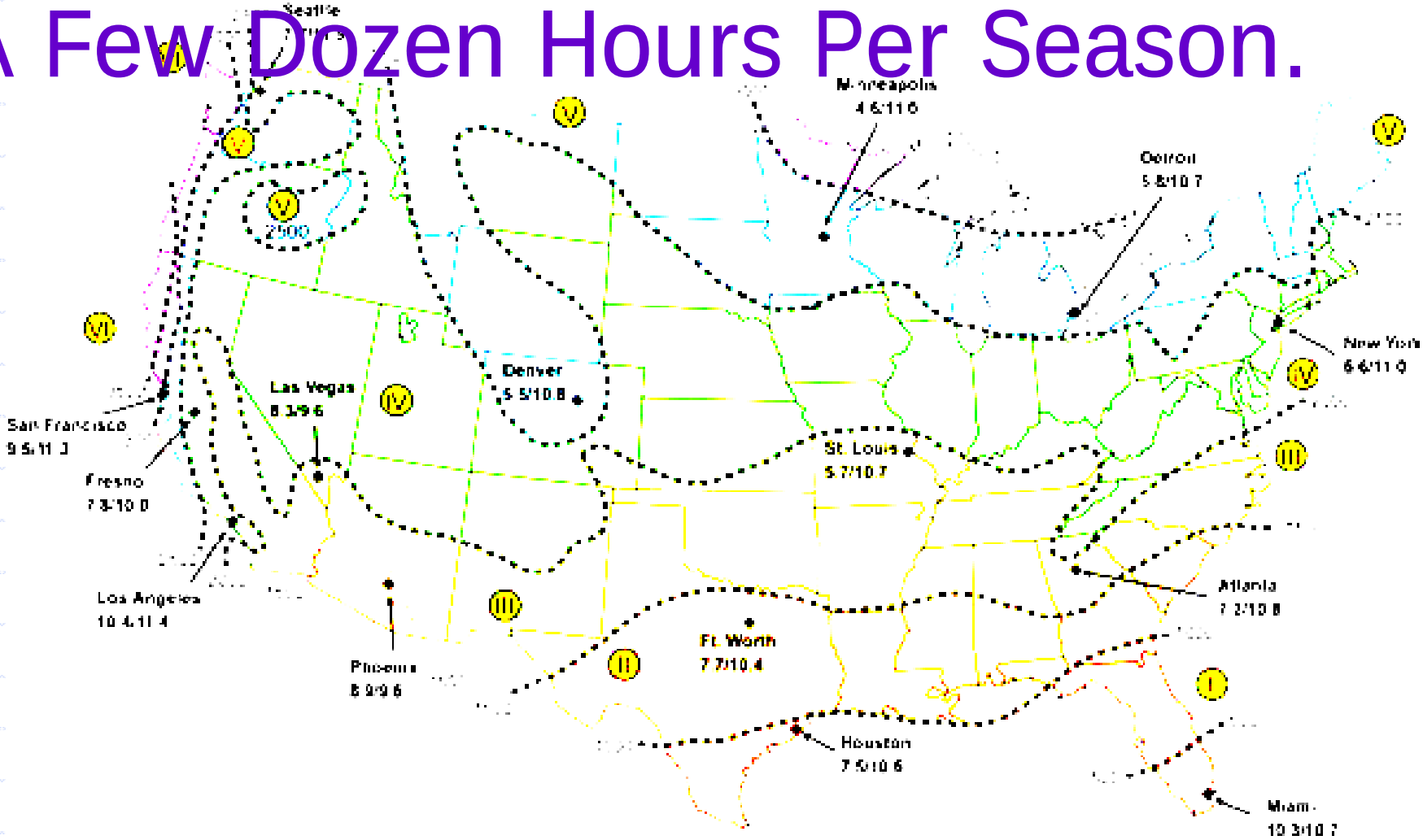
- increases the installed cost
- increases the operating cost
- increases the demand on our utilities
- adds unnecessary stress on equipment

Humidity Control

Humidity Control During The Cooling Season

- Sensible and latent cooling loads are imposed on buildings located in hot humid climates. When the summer design condition occurs, properly sized equipment will operate continuously or almost continuously, both loads will be neutralized, and the occupants will be comfortable.

BUT,
Design Conditions Only Occur For A Few Dozen Hours Per Season.



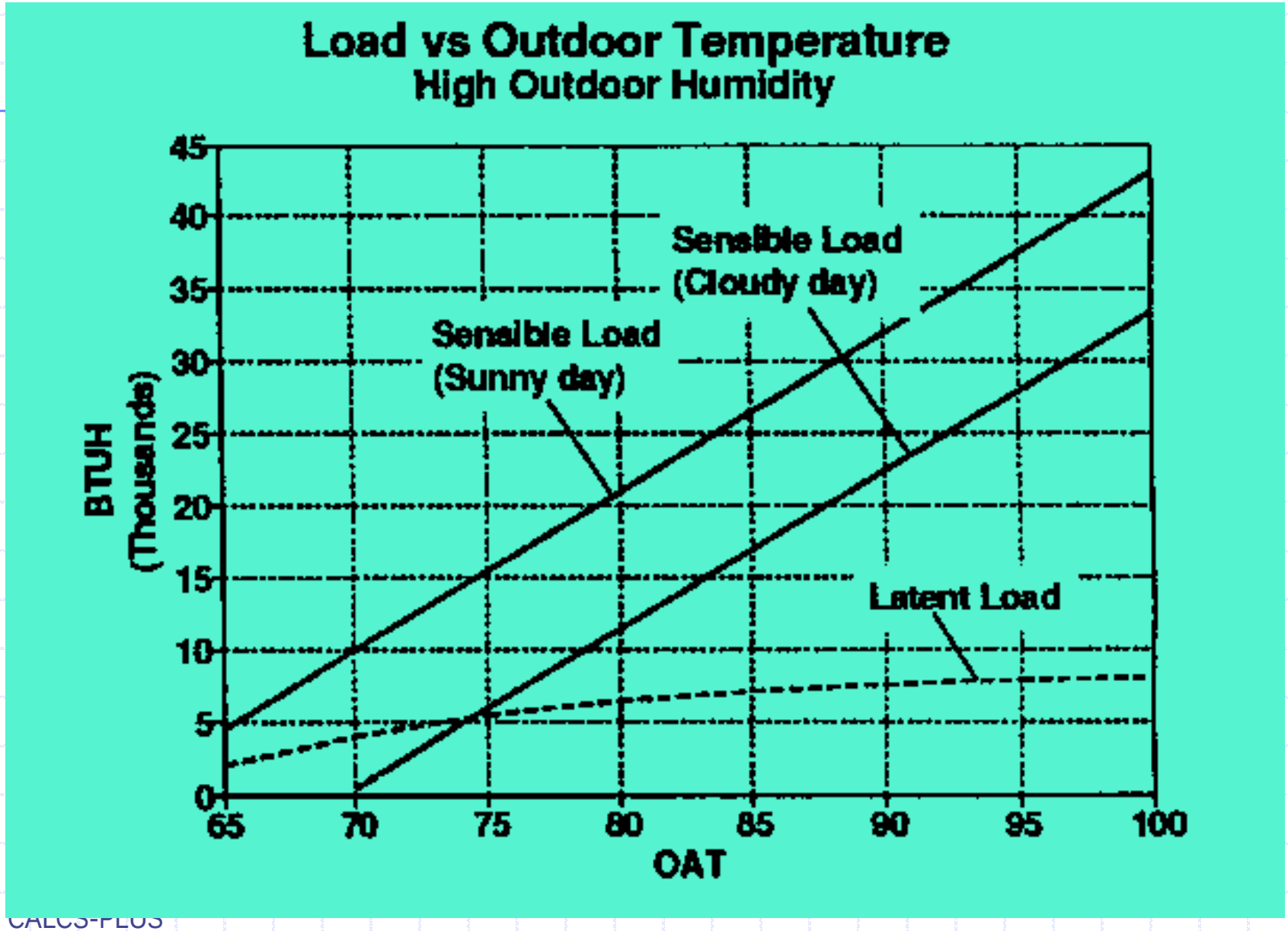
Design Conditions

Table 1A

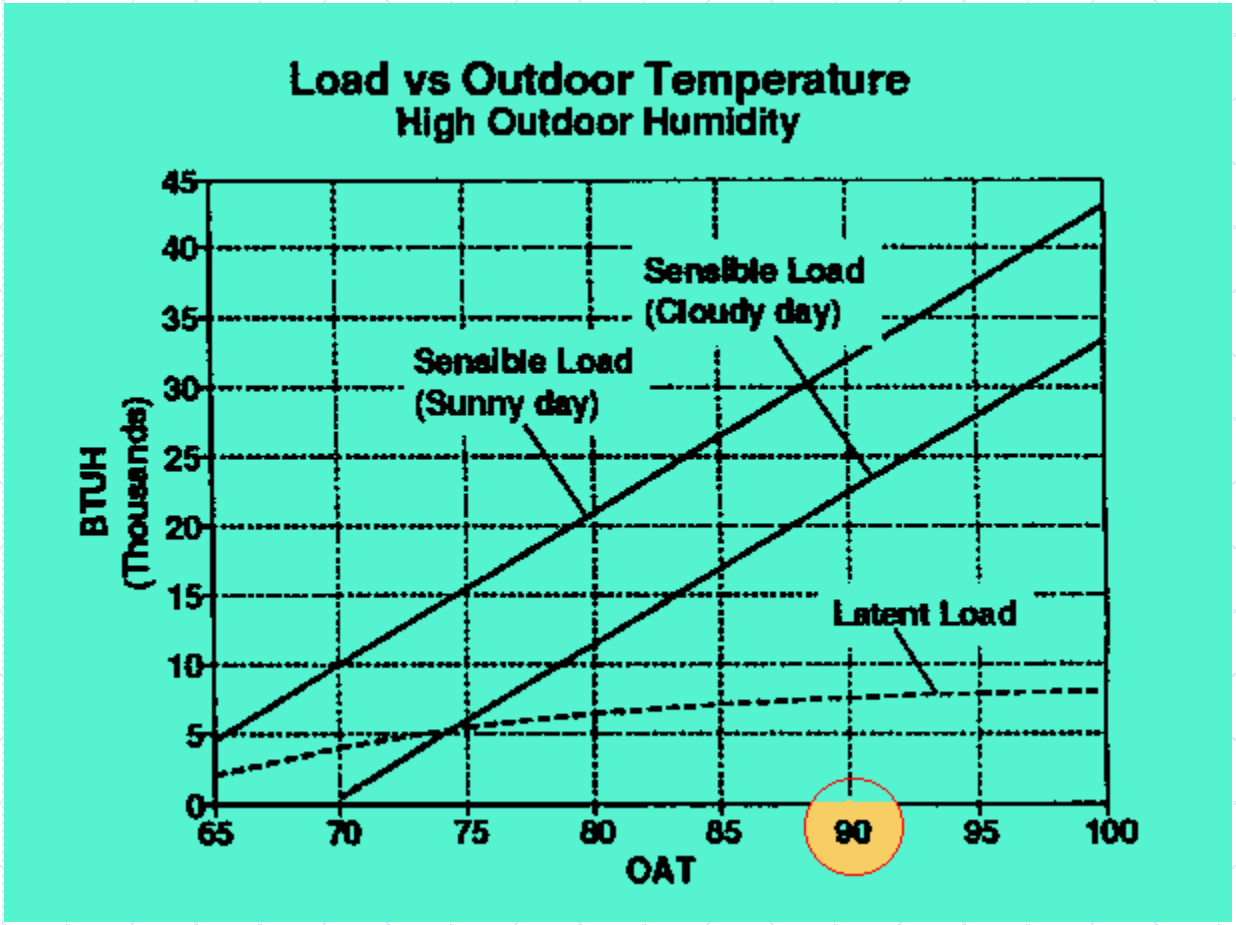
Outdoor Design Conditions For the United States and Canada

Location	Elevation	Latitude	Winter	Summer					
	Feet	Degrees North	Heating 99% Dry Bulb	Cooling 1% Dry Bulb	Coincident Wet Bulb	Design Grains 55% RH	Design Grains 50% RH	Design Grains 45% RH	Daily Range (DR)
St. Augustine	10	29	35	89	78	59	66	72	M
St. Petersburg	11	28	47	93	79	59	66	72	M
Sanford	55	28	38	93	76	39	46	52	M
Sarasota/Bradenton	30	27	43	92	79	61	68	74	M
Tallahassee AP	55	30	28	93	76	39	46	52	M
Tampa AP	19	28	40	91	77	49	56	62	M
Valparaiso, Eglin AFB	85	30	33	90	78	57	64	70	M
Vero Beach	13	27	43	90	78	57	64	70	M
West Palm Beach AP	15	26	47	90	78	57	64	70	M

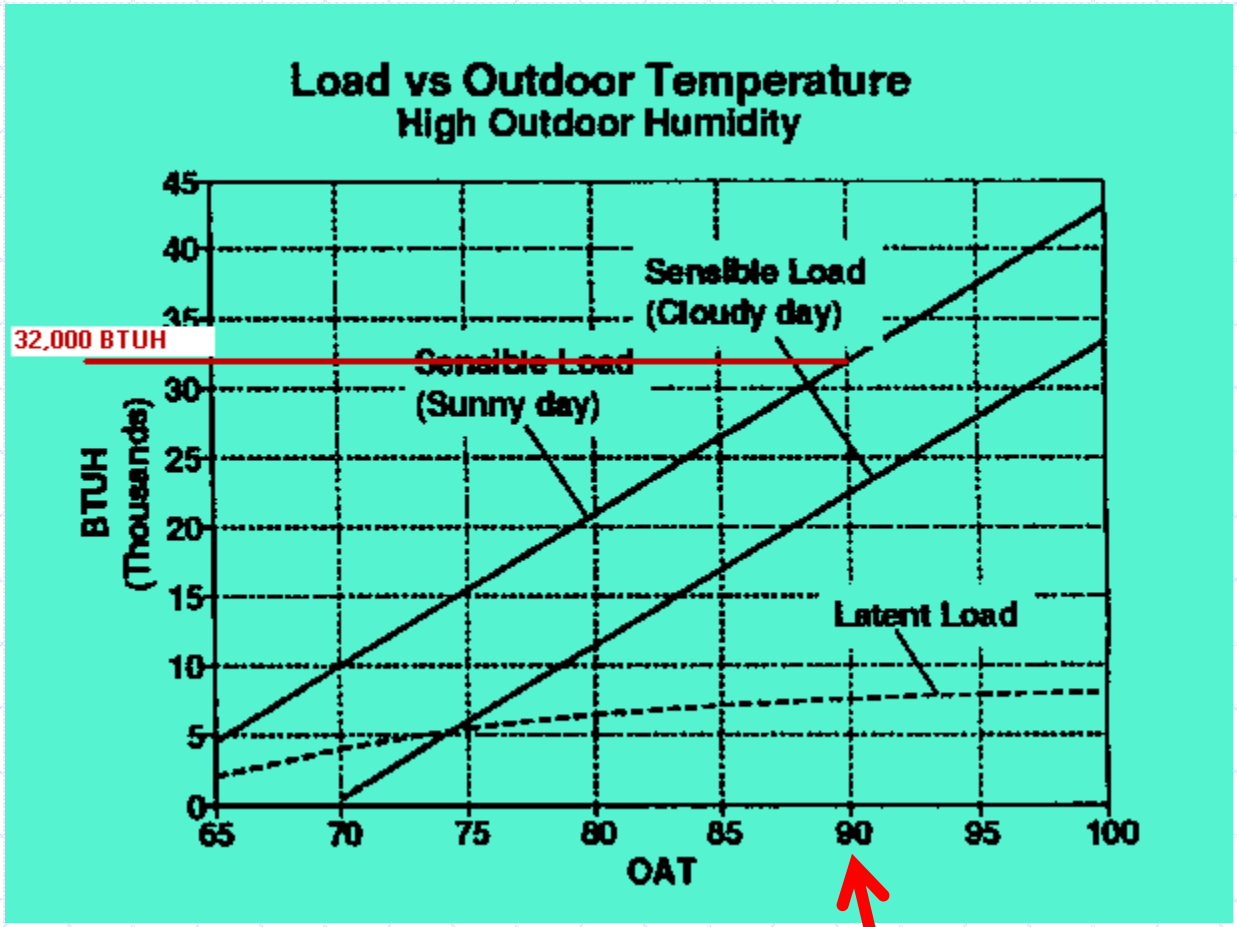
Load vs Outdoor Temperature



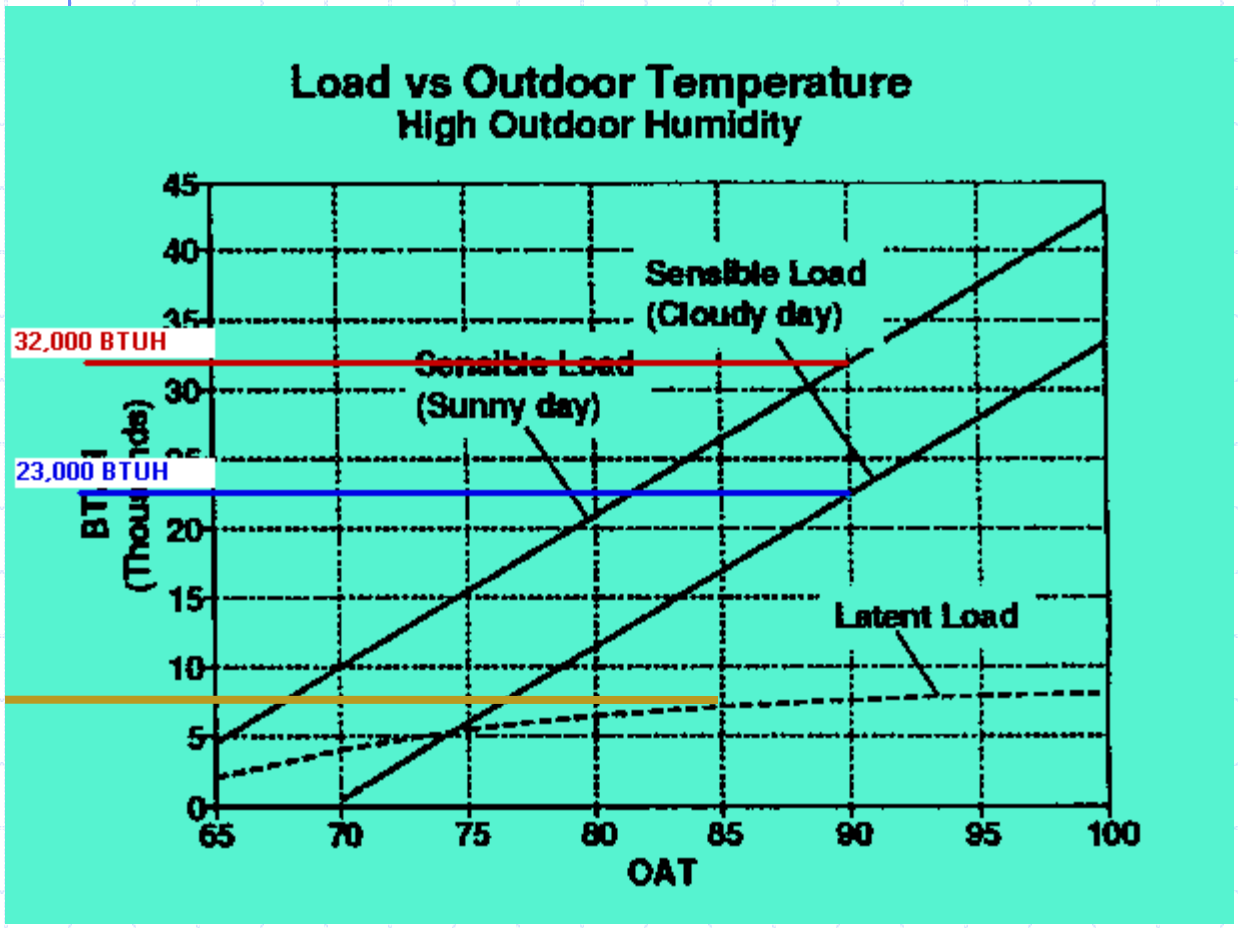
Using table 1 from ACCA Manual J for West Palm Beach the summer outdoor dry bulb temperature is 90º



At Peak Load Conditions, Sunny Day, the load on a given building is 32,000 BTU/H



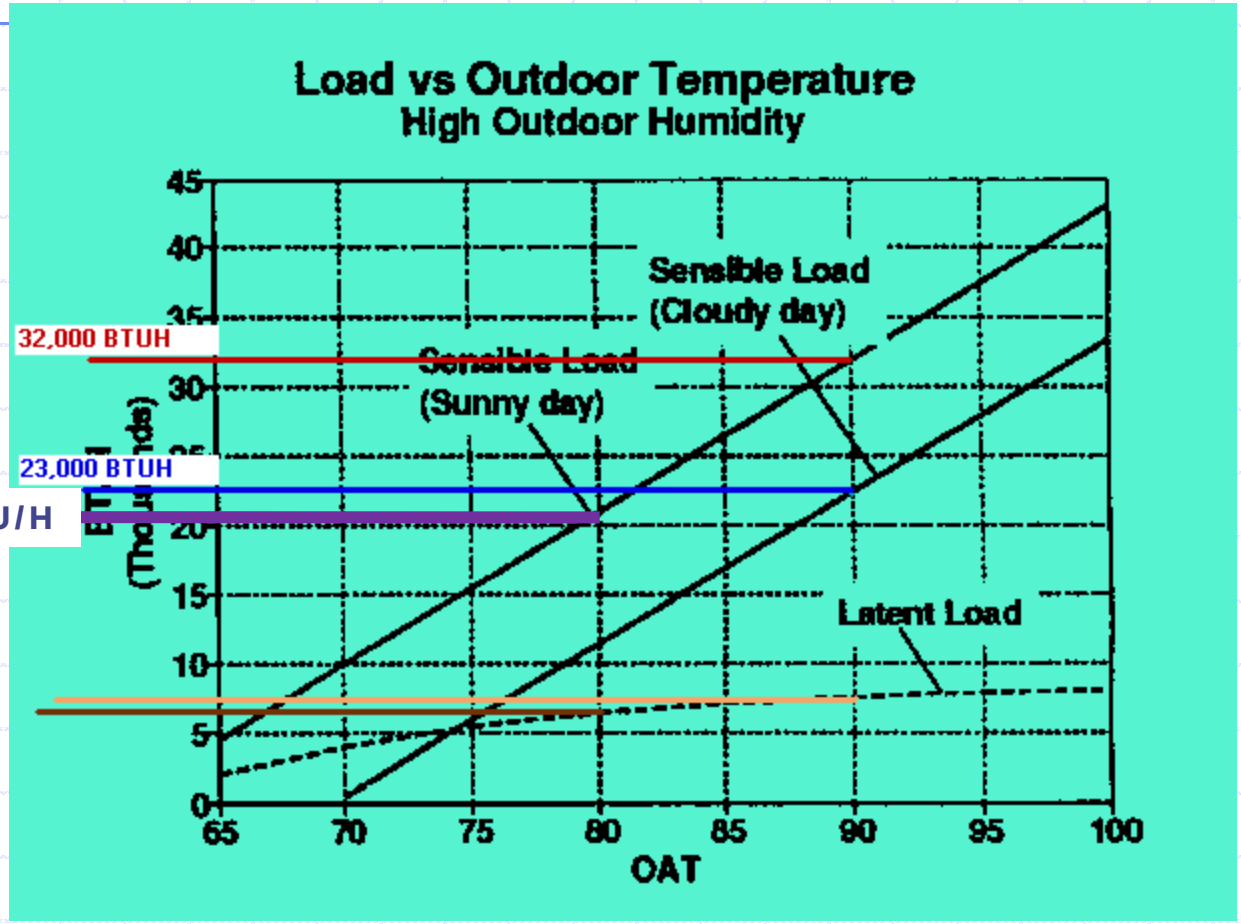
50% of the time or more temperatures are moderate; look how the sensible load drops on a 90° cloudy day!



9,000 BTU/H Difference

However, the Latent Load doesn't drop at all.

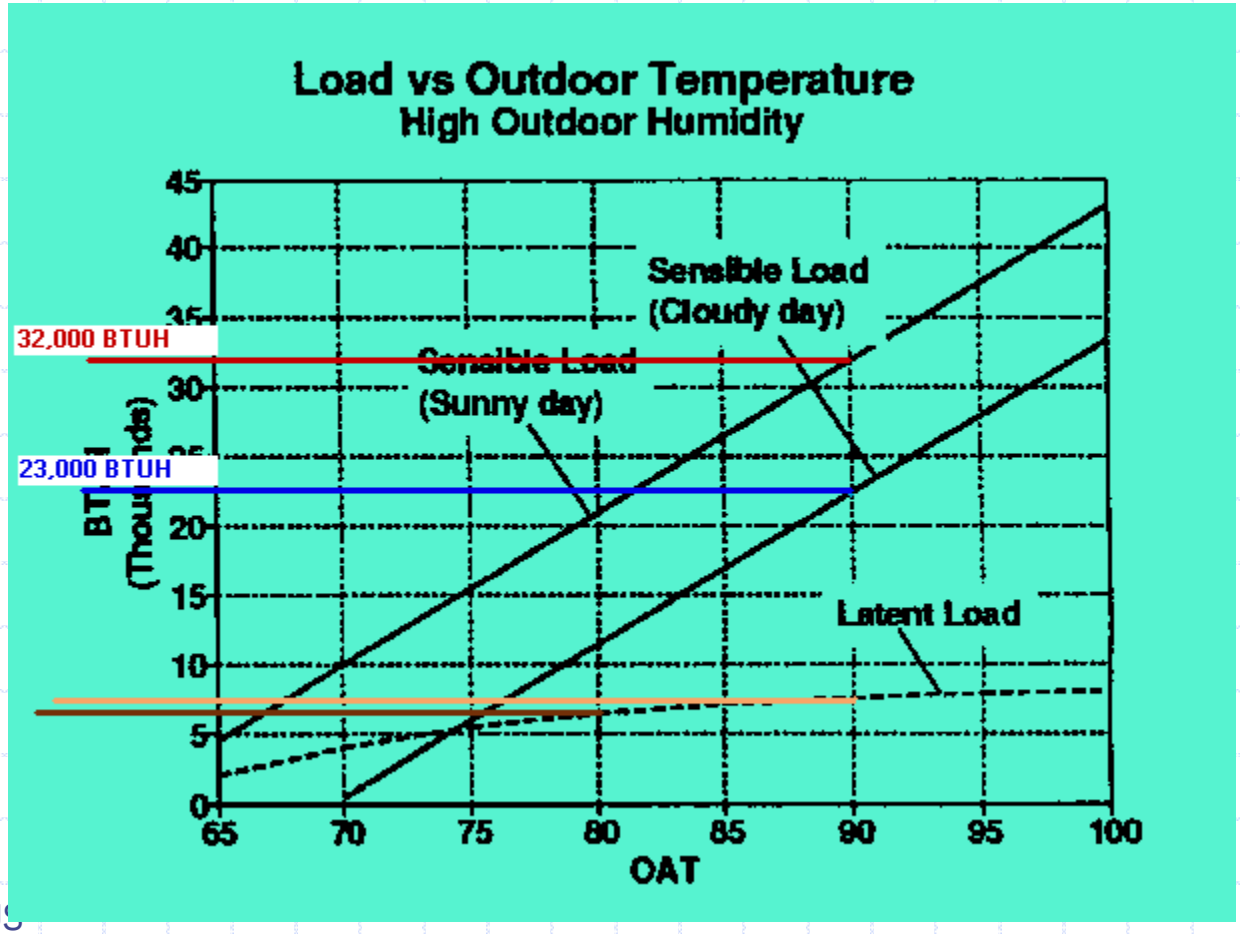
On a 80° Sunny Day the load drops by 11,000 BTU/H



The Latent Load only drops by 500 BTU/H

Could this be an Issue?

Sensible load variation shows a difference of 9000 BTUH while our latent difference is barley 500 BTUH



MJ8 Sensitivities

- Design conditions
- Building tightness
- Fenestration
- Air System Design & Installation

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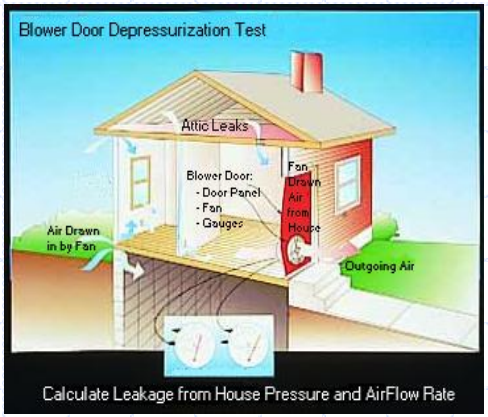


Guidelines

- Use outdoor design conditions recommended by Table 1 Manual J.
- Use the default indoor design conditions recommended by Manual J.
- Take full credit for all internal shading devices and external overhangs.
- Use internal shading devices that are compatible with the type of room.

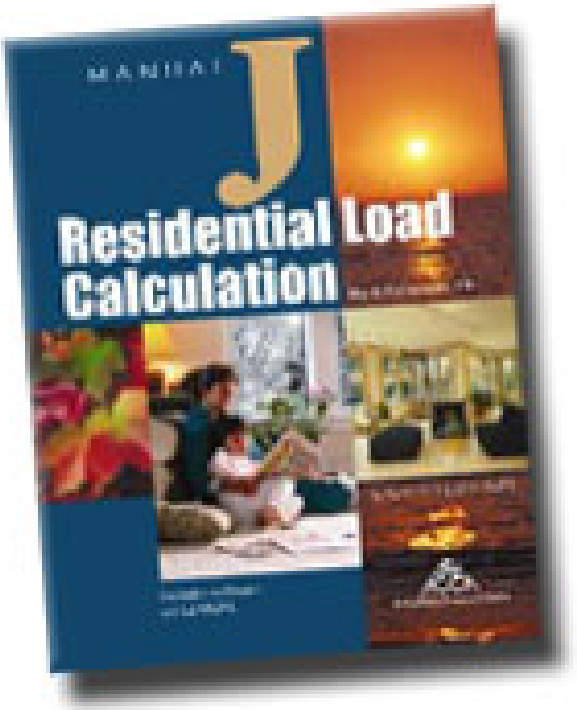
Guidelines

- Do not use internal shade if the room is specifically used for day lighting.
- Use the tested performance coefficients when known.
- Take full credit for all insulation & sealing efforts.
- Take full credit for insulated & sealed duct runs located in unconditioned space.

Guidelines

- Take full credit for load factors and diversity when estimating internal loads.
- Take full credit for diversity when estimating the cooling load on central equipment.

ACCA Manual J V8



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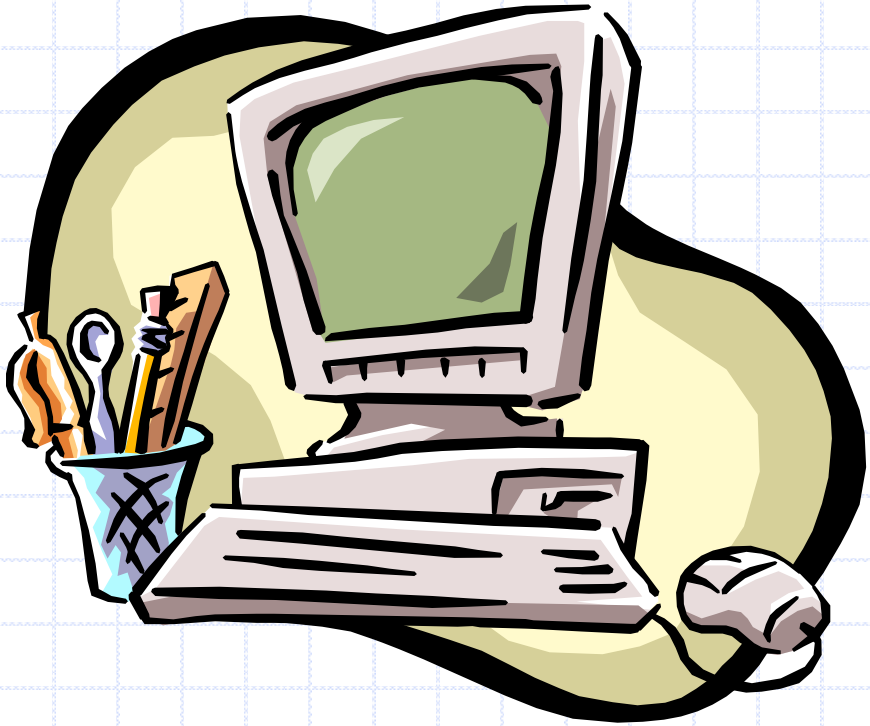


A Computer Only Procedure

From “Addendum B” from ACCA Manual J®

Addendum B to

ACCA Manual J®
Residential Load Calculation
Eighth Edition

ANSI/ACCA Man J 2-2004

ISBN# 1-892765-27-6

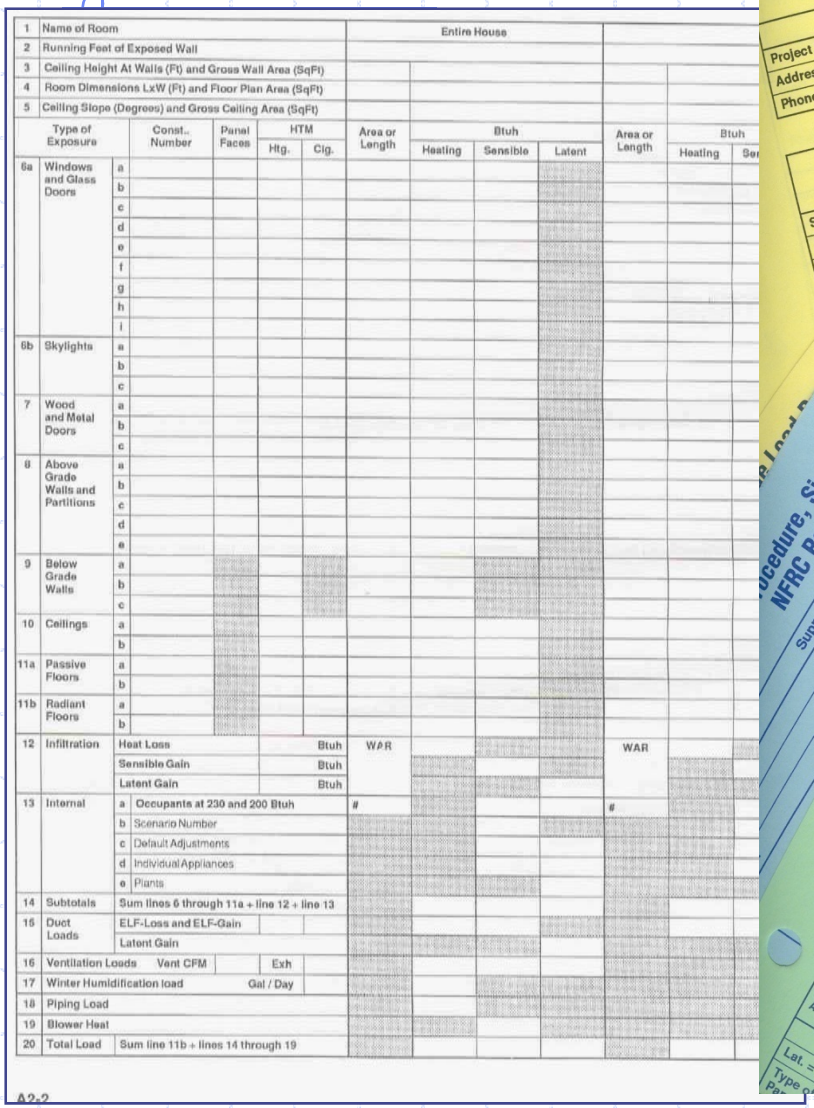
This addendum updates Version 1.10 of Manual J Eighth Edition (MJ8™) and addresses *AED Protocol Revisions* to the MJ8™ procedures.

Executive Summary

Now that the industry and software houses have had time to work with the Eighth Edition of *Manual J*®, ACCA has determined that AED simplifications would ease implementation by third-party software vendors and improve the understanding and use of MJ8 by practitioners. This addendum revises the adequate exposure diversity (AED) approach on window/glass exposures in the following manners:

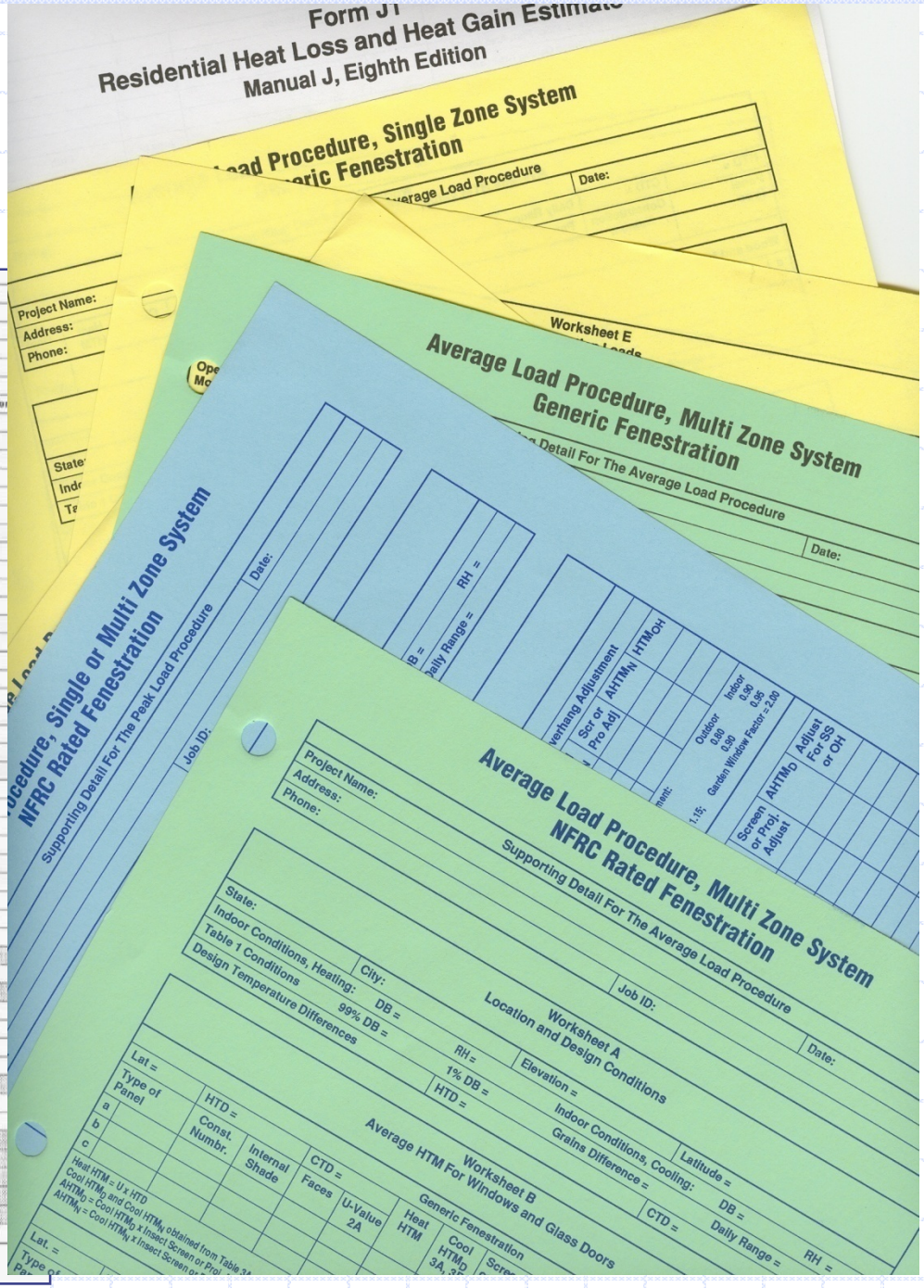
a) MJ8 shall become a computer-only procedure. (Note: A shorter, abridged version of MJ8 is under development that supports a hand calculation procedure aimed at single-family, detached dwellings with single-zone, constant-volume systems).
b) A computer-only, hourly fenestration gain (HFG) procedure shall be used for all application scenarios.
c) Calculations shall be made for midsummer, unless southerly-facing fenestration causes a peak gain in the fall.
d) Hand calculation procedures for applications other than single family detached dwellings served by a single zone, constant volume system shall be abandoned in favor of computerized solutions.

Forms & Worksheets

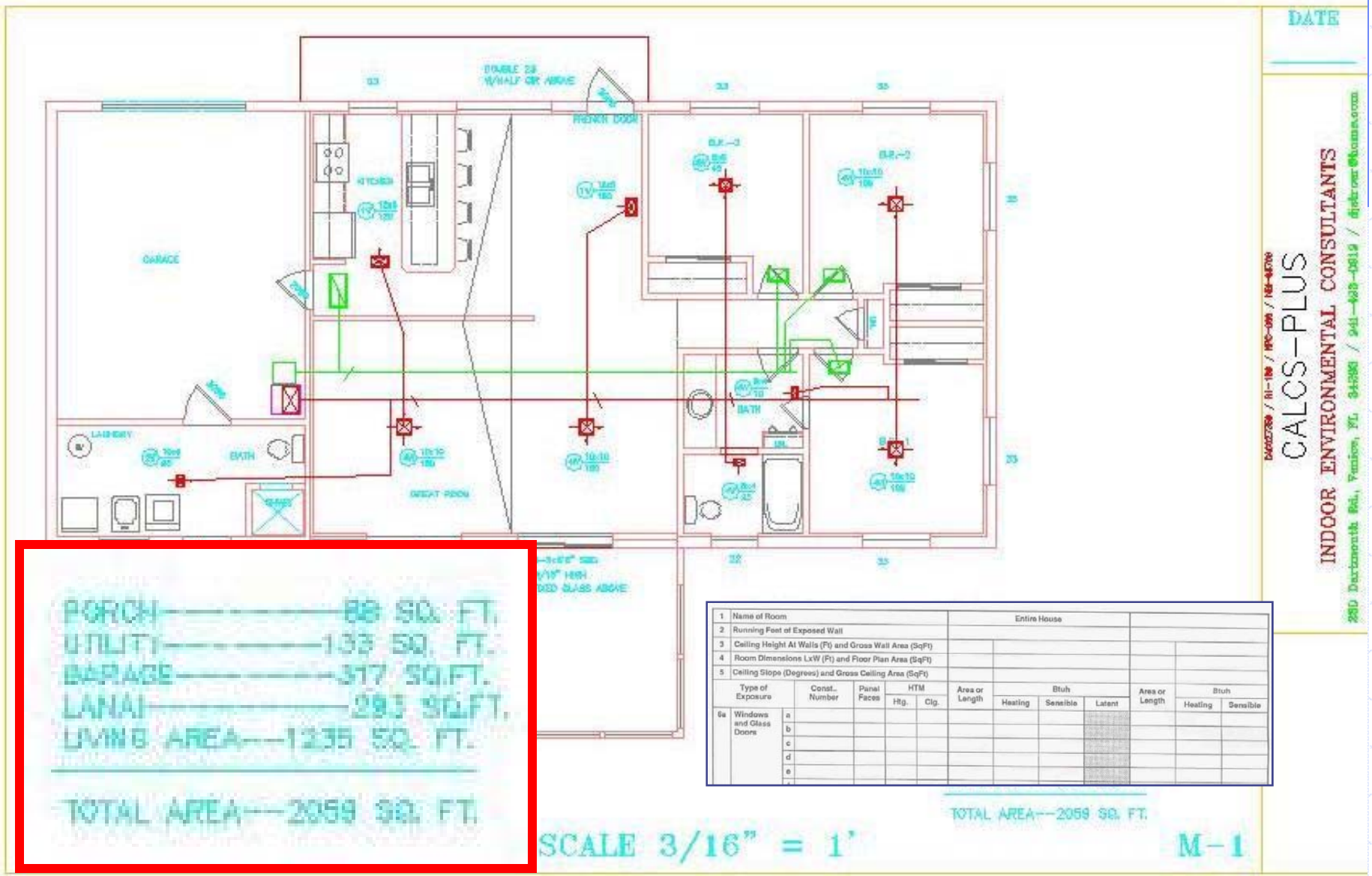


1	Name of Room					Entire House							
2	Running Feet of Exposed Wall												
3	Ceiling Height At Walls (Ft) and Gross Wall Area (SqFt)												
4	Room Dimensions LxW (Ft) and Floor Plan Area (SqFt)												
5	Ceiling Slope (Degrees) and Gross Ceiling Area (SqFt)												
	Type of Exposure		Const., Number	Panel Faces	HTM Htg.	HTM Clg.	Area or Length	Btuh Heating	Btuh Sensible	Btuh Latent	Area or Length	Btuh Heating	Btuh Sen
6a	Windows and Glass Doors	a											
		b											
		c											
		d											
		e											
		f											
		g											
		h											
		i											
6b	Skylights	a											
		b											
		c											
7	Wood and Metal Doors	a											
		b											
		c											
8	Above Grade Walls and Partitions	a											
		b											
		c											
		d											
		e											
9	Below Grade Walls	a											
		b											
		c											
10	Ceilings	a											
		b											
11a	Passive Floors	a											
		b											
11b	Radiant Floors	a											
		b											
12	Infiltration	Heat Loss				Btuh	WAR				WAR		
		Sensible Gain				Btuh							
		Latent Gain				Btuh							
13	Internal	a	Occupants at 230 and 200 Btuh				#				#		
		b	Scenario Number										
		c	Default Adjustments										
		d	Individual Appliances										
		e	Plants										
14	Subtotals	Sum lines 6 through 11a + line 12 + line 13											
15	Duct Loads	ELF-Loss and ELF-Gain											
		Latent Gain											
16	Ventilation Loads	Vent CFM			Exh								
17	Winter Humidification load				Gal / Day								
18	Piping Load												
19	Blower Heat												
20	Total Load	Sum line 11b + lines 14 through 19											

A2-2



Floor Plan Required.



Room x Room Entry

No.	Item		Const. Number	Panel Faces	HTM Htg.	HTM Clg.	Area or Length	Btuh Heating	Btuh Sensible	Btuh Latent	Area or Length	Btuh Heating	Btuh Sensible
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11b	Radiant Floors	a											
		b											
12	Infiltration	Heat Loss				Btuh	WAR				WAR		
		Sensible Gain				Btuh							
		Latent Gain				Btuh							
13	Internal	a Occupants at 230 and 200 Btuh					#				#		
		b Scenario Number											
		c Default Adjustments											
		d Individual Appliances											
		e Plants											
14	Subtotals	Sum lines 6 through 11a + line 12 + line 13											
15	Duct Loads	ELF-Loss and ELF-Gain											
		Latent Gain											
16	Ventilation Loads	Vent CFM			Exh								
17	Winter Humidification load				Gal / Day								
18	Piping Load												
19	Blower Heat												
20	Total Load	Sum line 11b + lines 14 through 19											

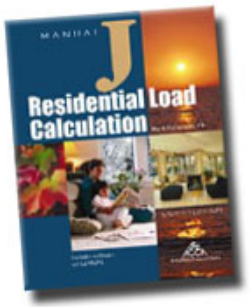
A2-2

Area or Length	Btuh Heating	Btuh S-Clg.	Area or Length	Btuh Heating	Btuh S-Clg.	Area or Length	Btuh Heating	Btuh S-Clg.	Area or Length	Btuh Heating	Btuh S-Clg.
WAR			WAR			WAR			WAR		
#			#			#			#		

A2-3

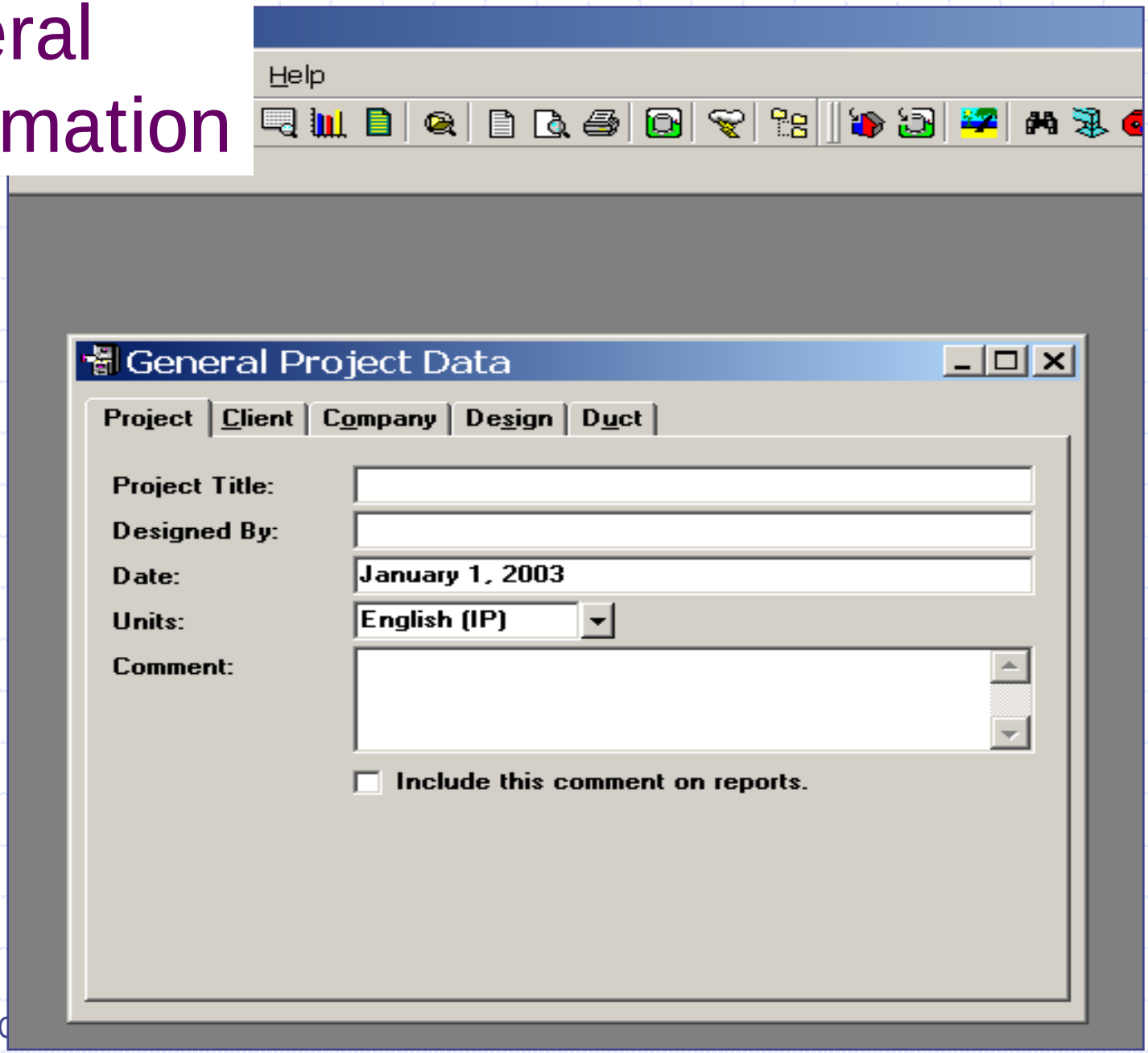
From Part of Section 1-16 ACCA Manual J 8th Edition

- Computerized method calculates load by month of year and time of day associated with each room load and with the equipment sizing load.
- Computer can generate solutions for 288 scenarios (12 month year and 24 hour day)



+

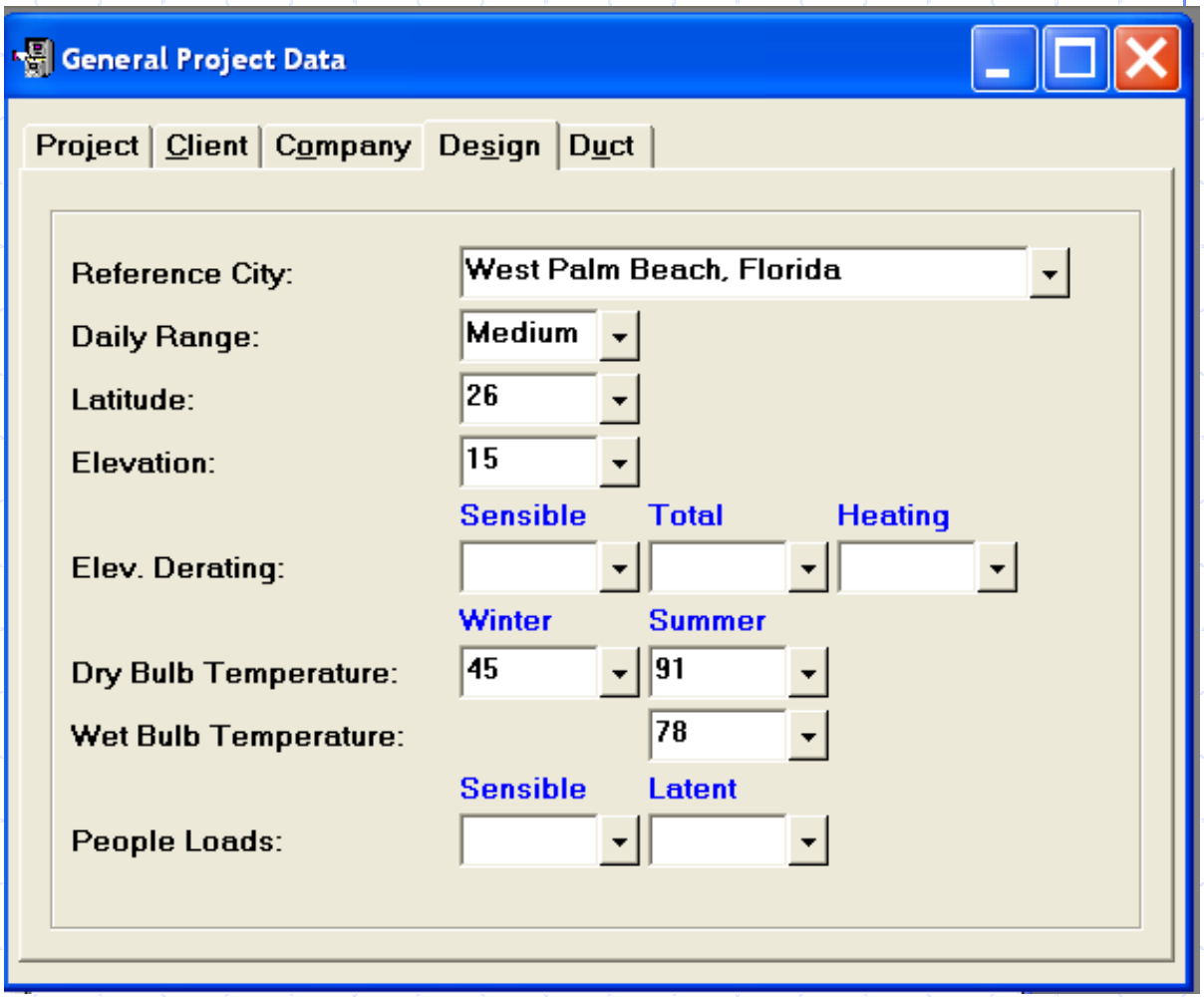
General Information



The Design Tab

The Data that is automatically filled in comes from Table 1A in ACCA Manual J 8th edition.

Outdoor Design Conditions For the United States and Canada.



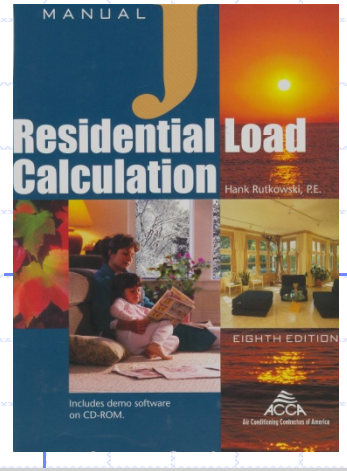


Table 1A

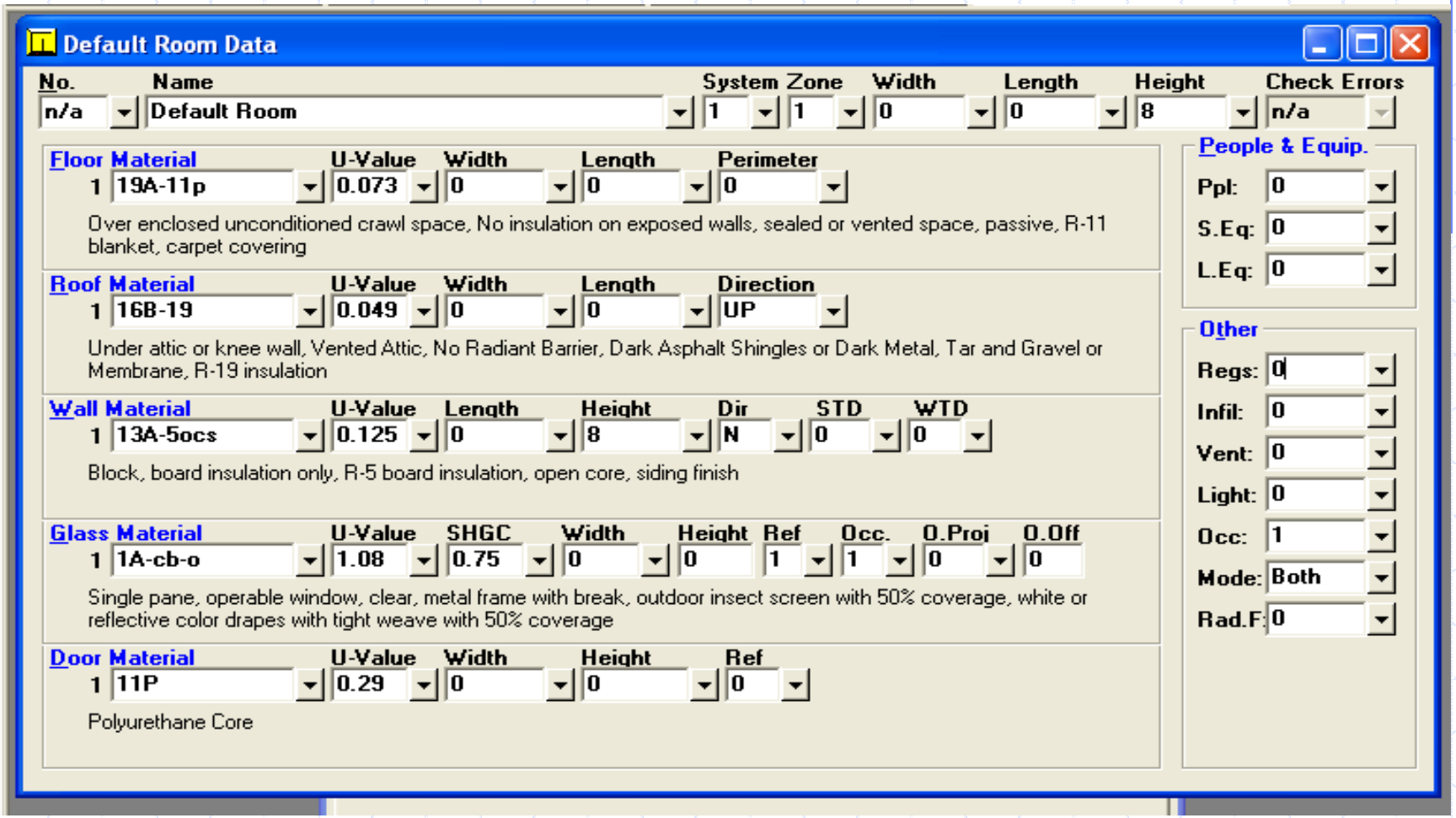
RHVAC weather data base comes directly from ACCA Manual J version 8 Table 1A & 1B(micro climates).

Table 1A

Outdoor Design Conditions For the United States and Canada

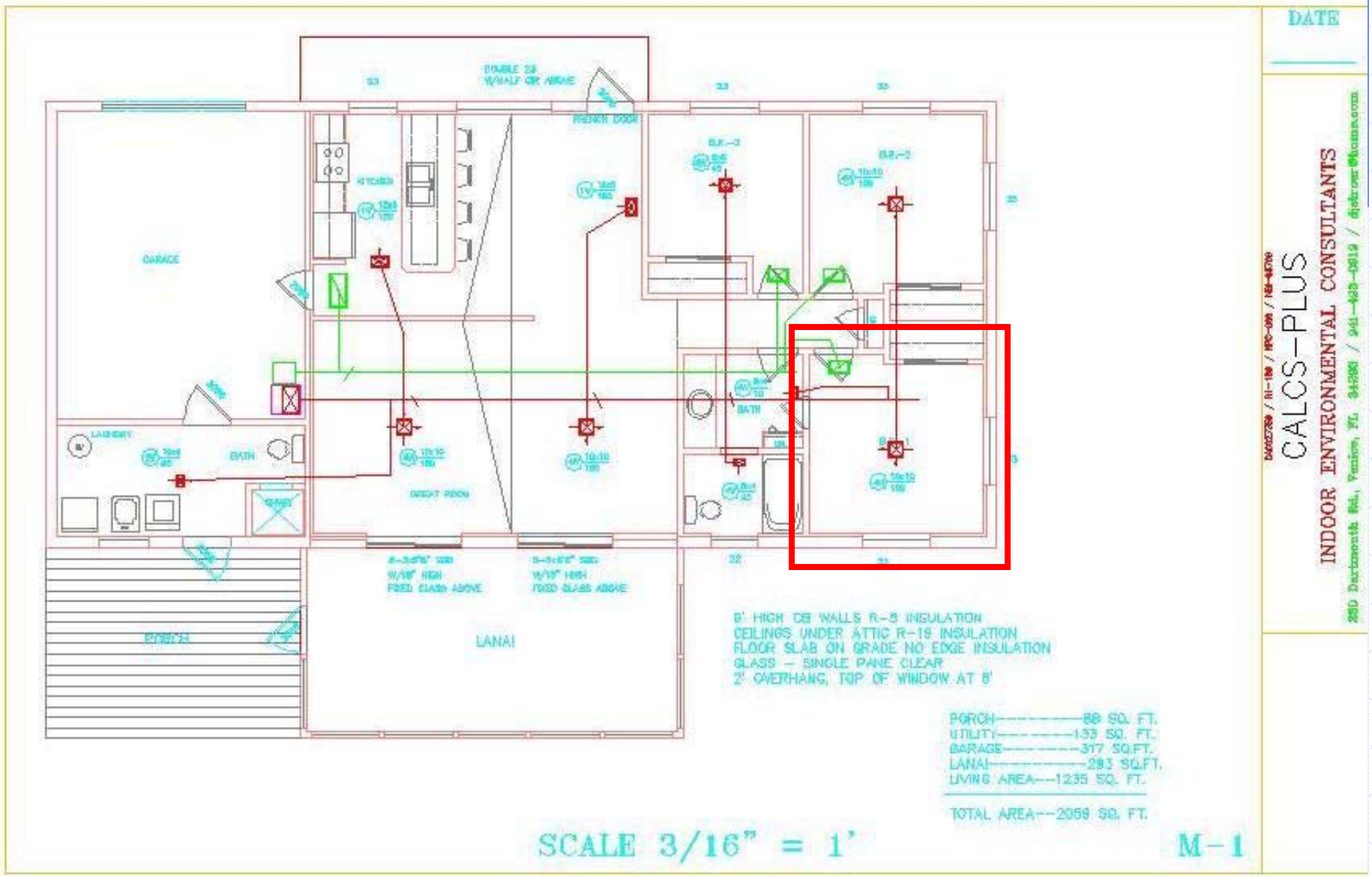
Location	Elevation Feet	Latitude Degrees North	Winter Heating 99% Dry Bulb	Summer Cooling 1% Dry Bulb	Coincident Wet Bulb	Design Grains 55% RH	Design Grains 50% RH	Design Grains 45% RH	Daily Range (DR)
St. Augustine	10	29	35	89	78	59	66	72	M
St. Petersburg	11	28	47	93	79	59	66	72	M
Sanford	55	28	38	93	76	39	46	52	M
Sarasota/Bradenton	30	27	43	92	79	61	68	74	M
Tallahassee AP	55	30	28	93	76	39	46	52	M
Tampa AP	19	28	40	91	77	49	56	62	M
Valparaiso, Eglin AFB	85	30	33	90	78	57	64	70	M
Vero Beach	13	27	43	90	78	57	64	70	M
West Palm Beach AP	15	26	47	90	78	57	64	70	M

Default Room Data



Set up default data so you don't have to do repetitive inputs.

From the Floor Plan



Room Entry Data

Room Data - Room 1 of 1

No.	Name	System	Zone	Width
1	Bedroom 1	1	1	11.5

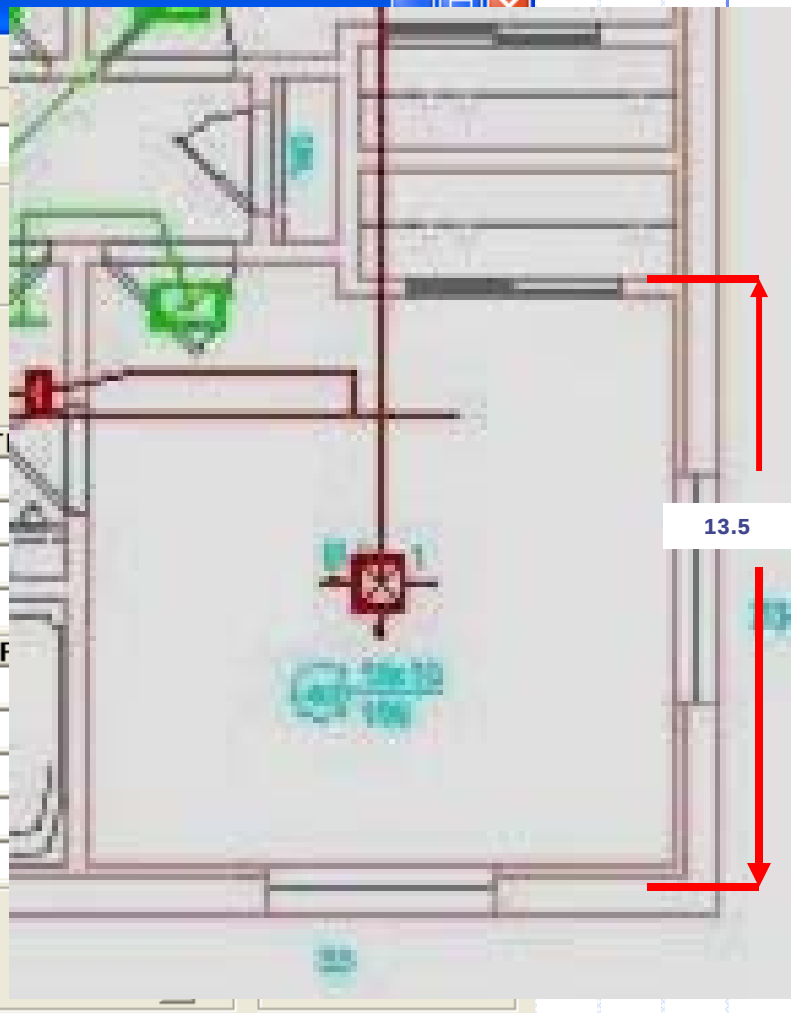
Floor Material	U-Value	Width	Length	Perimeter
1 22A-ph	1.358	11.5	13.5	25
2	0	0	0	0

Roof Material	U-Value	Width	Length	Direction
1 16B-19	0.049	11.5	13.5	UP
2	0	0	0	UP

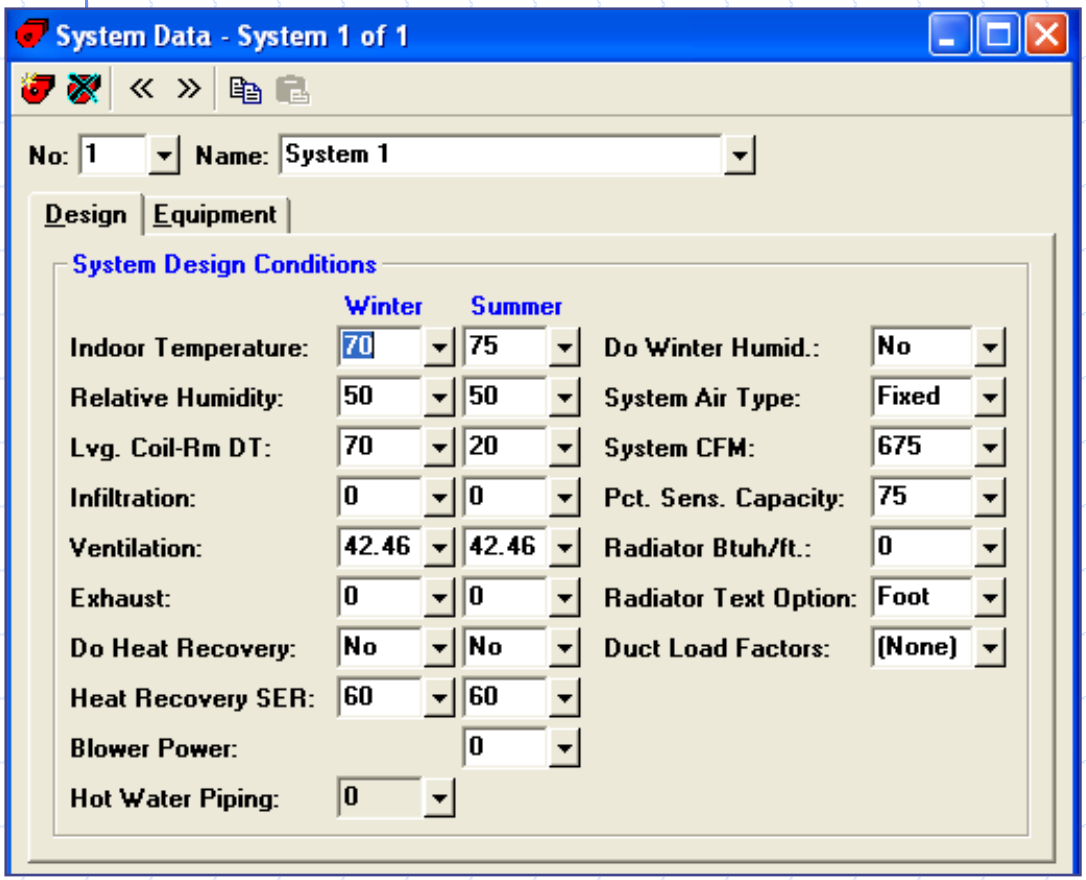
Wall Material	U-Value	Length	Height	Dir	STD	WTI
1 13A-5ocs	0.125	11.5	9	S	0	0
2 13A-5ocs	0.125	13.5	9	E	0	0
3	0	0	0	N	0	0
4	0	0	0	N	0	0

Glass Material	U-Value	SHGC	Width	Height	Ref	Occ.	O.F
1 1A-cb-o	1.08	0.75	4.4	3.2	1	1	2
2 1A-cb-o	1.08	0.75	4.4	3.2	1	1	2
3	0	0	0	0	0	1	0
4	0	0	0	0	0	1	0
5	0	0	0	0	0	1	0

Door Material	U-Value	Width	Height	Ref
1	0	0	0	0
2	0	0	0	0

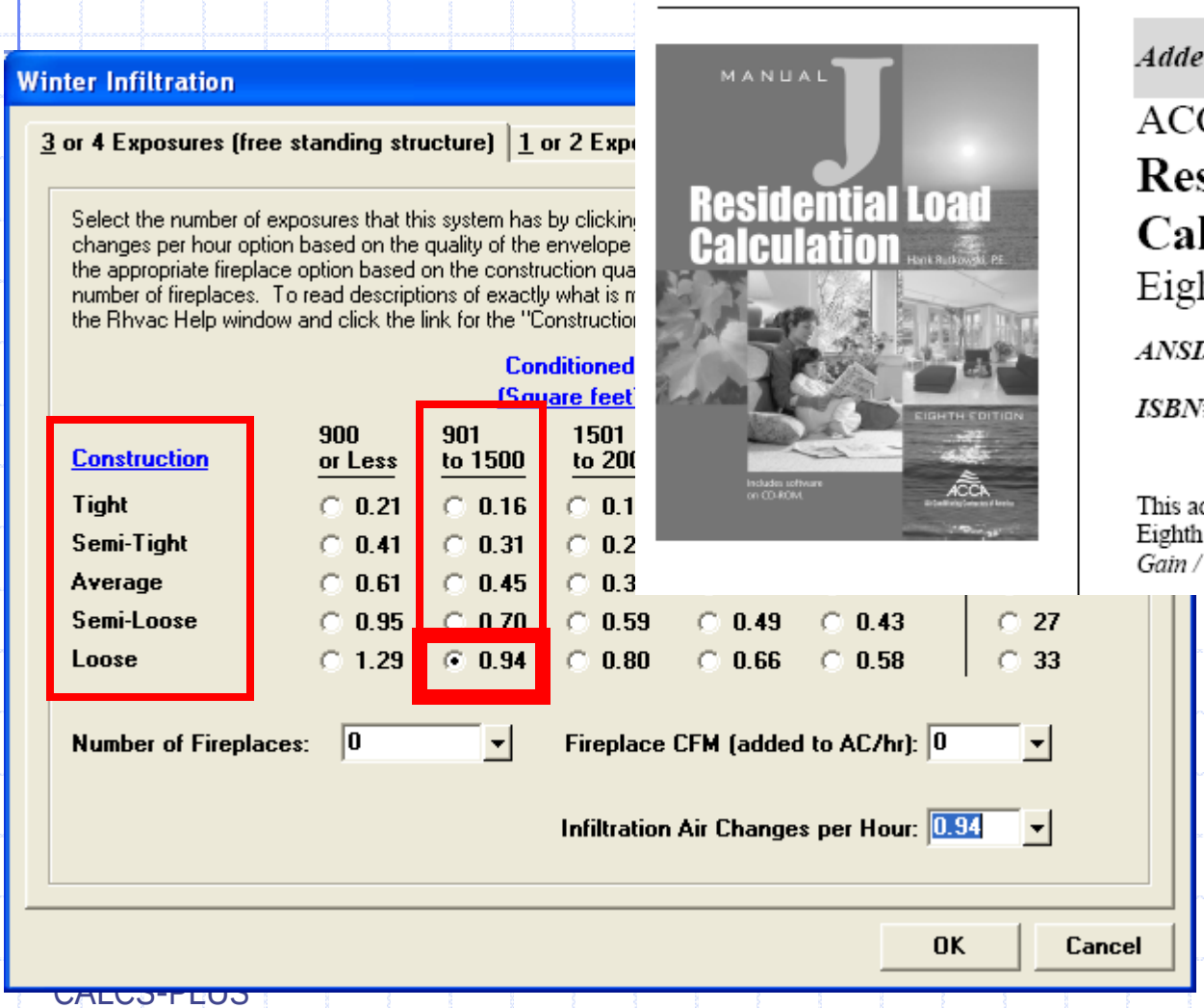


System Information



- Design Conditions
- Infiltration
- Ventilation
- Airflow

MJ8 & Infiltration For Winter



Addendum D to

ACCA Manual J®

Residential Load Calculation

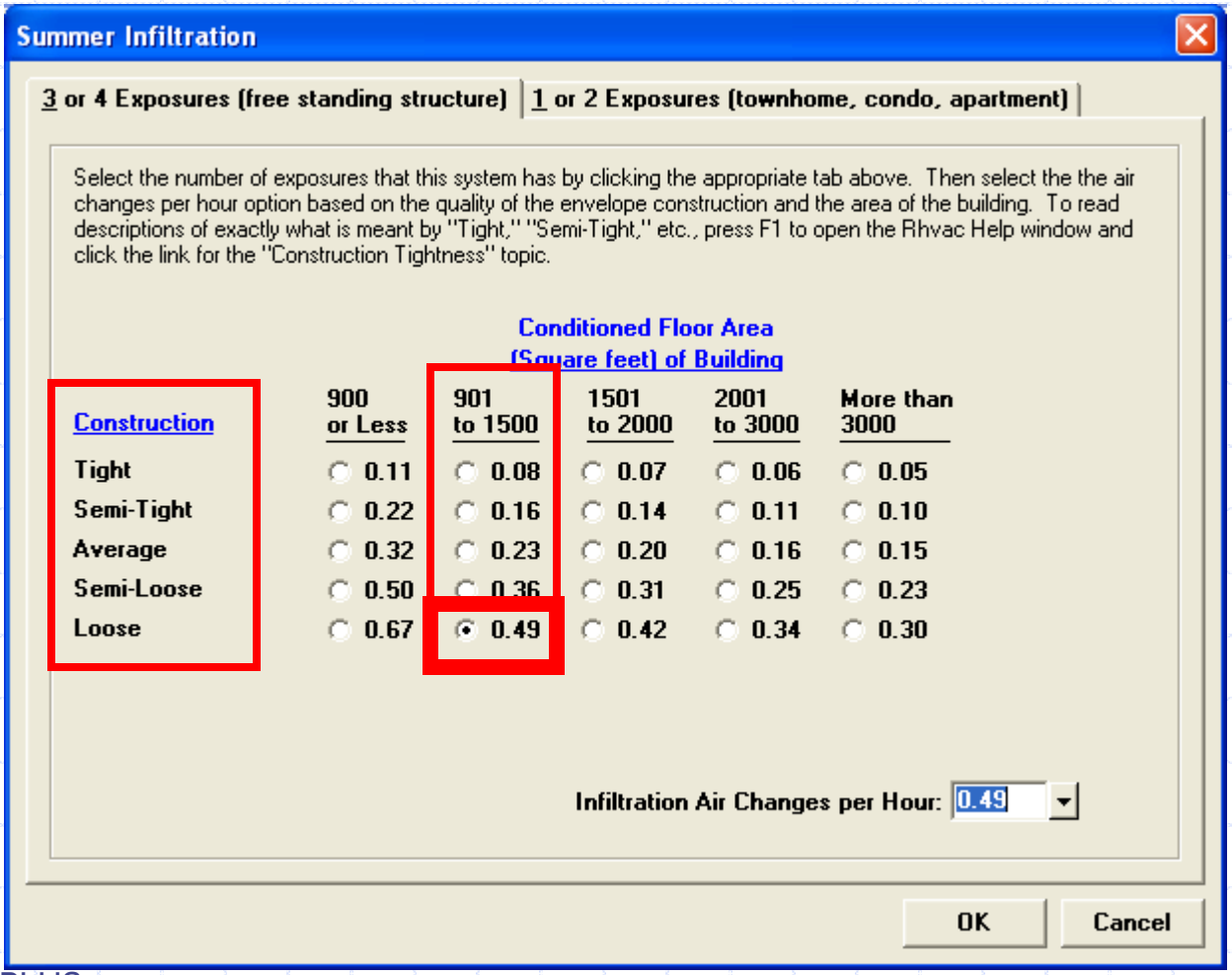
Eighth Edition

ANSI/ACCA Man J 2-2004

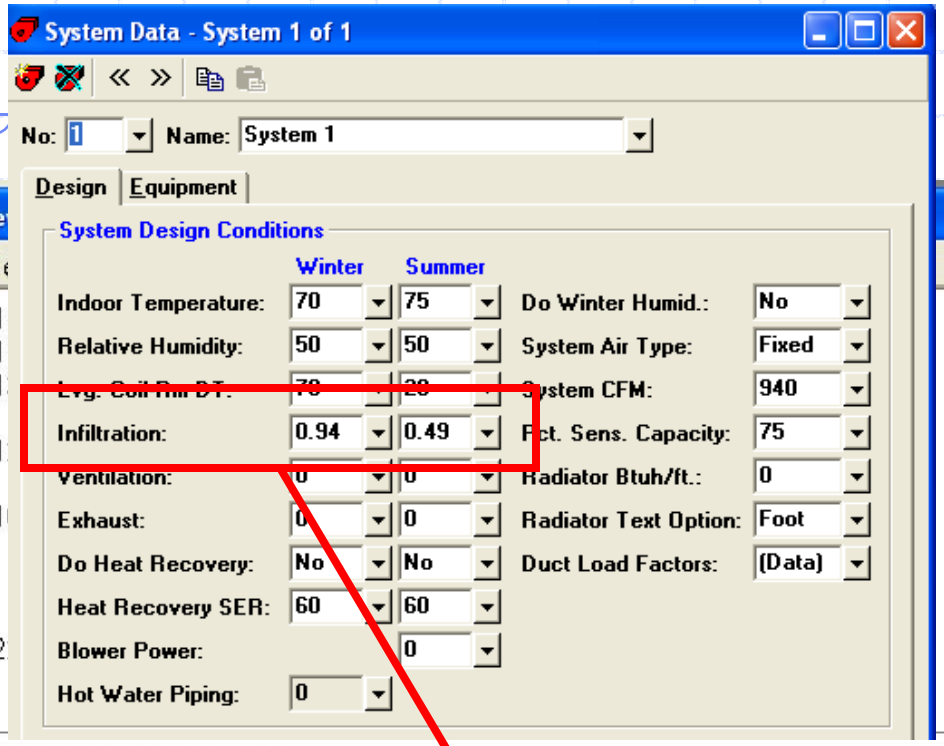
ISBN# 1-892765-27-6

This addendum updates Version 1.10 of Manual J Eighth Edition (MJ8™) and addresses *Infiltration Gain / Loss Revisions* to the MJ8 procedures.

MJ8 & Infiltration For Summer Loose Construction



MJ8 & Infiltration



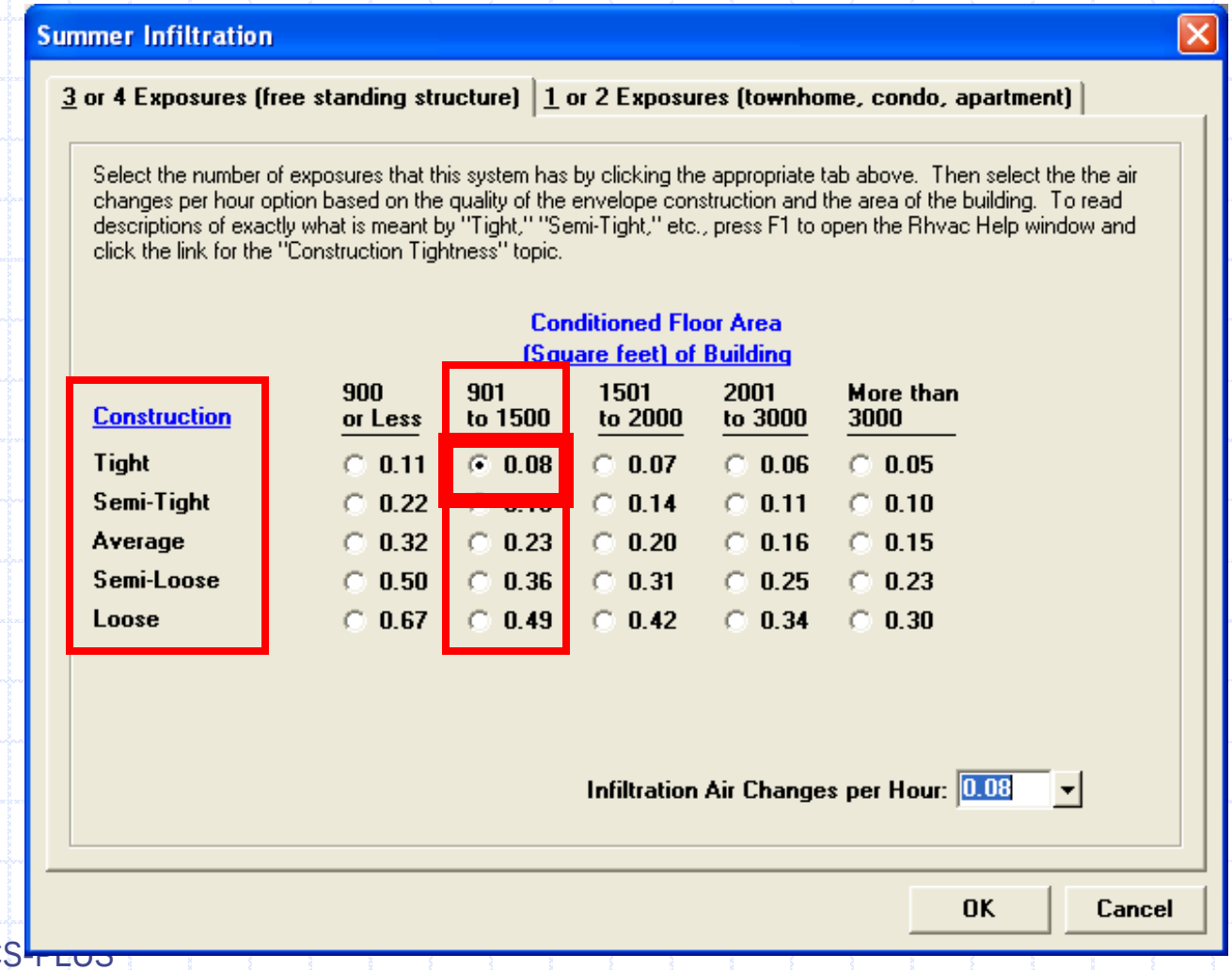
		5,908	0	0	0
Subtotals for structure:		17,491	0	11,924	11,924
People:	4		800	920	1,720
Equipment:			800	1,600	2,400
Lighting:	0			0	0
Ductwork:		5,660	999	5,162	6,161
Infiltration: Winter CFM: 190, Summer CFM: 99		5,222	3,998	1,741	5,739
Ventilation: Winter CFM: 0, Summer CFM: 0		0	0	0	0
Total Building Load Totals:		28,373	6,597	21,347	27,944

Check Figures

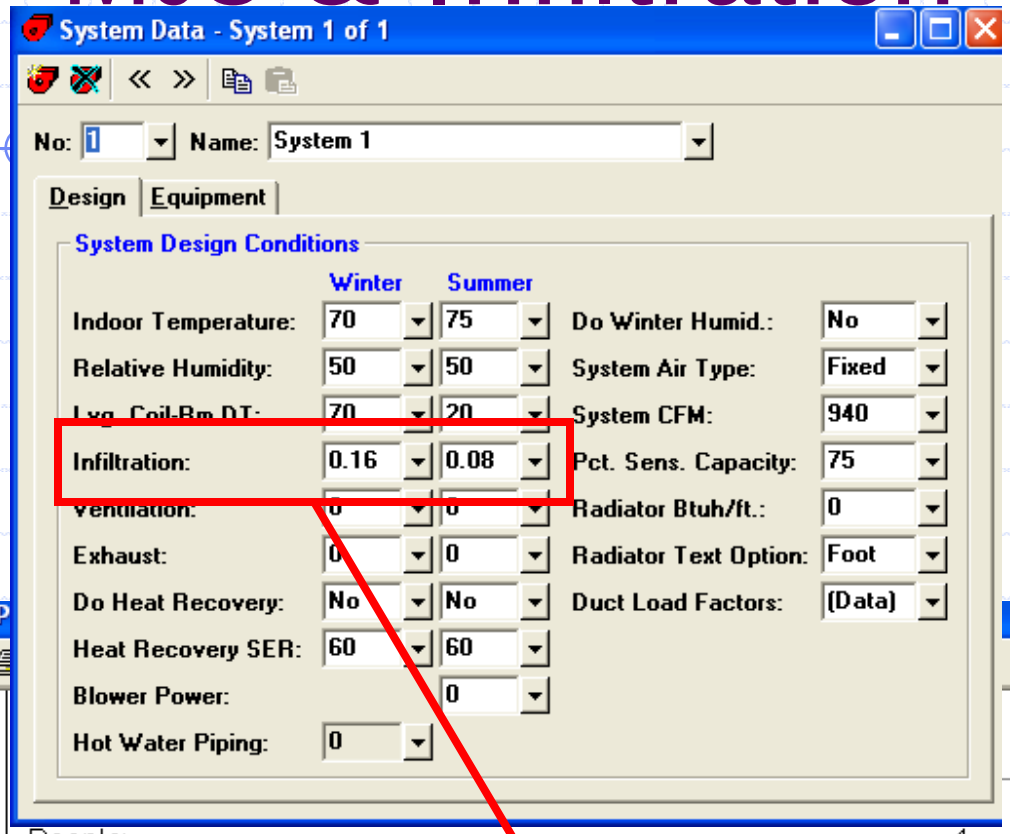
Total Building Supply CFM:	940	CFM Per Square ft.:	0.754
Square ft. of Room Area:	1,246	Square ft. Per Ton:	525
Volume (ft³) of Cond. Space:	12,124	Air Turnover Rate (per hour):	4.7

5,739 BTUH gain from a loosely built building by today's standards

MJ8 & Infiltration For Summer Tight Construction



MJ8 & Infiltration

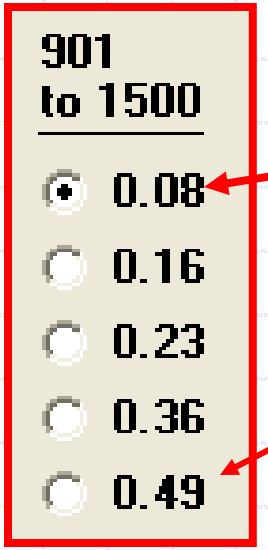


939 BTUH gain from a loosely built building by today's standards

		17,491	0	11,924	11,924
People:	4		800	920	1,720
Equipment:			800	1,600	2,400
Lighting:	0			0	0
Ductwork:		5,682	1,223	5,234	6,457
Infiltration: Winter CFM: 32, Summer CFM: 16		888	654	285	939
Ventilation: Winter CFM: 0, Summer CFM: 0		0	0	0	0
Total Building Load Totals:		24,061	3,477	19,963	23,440

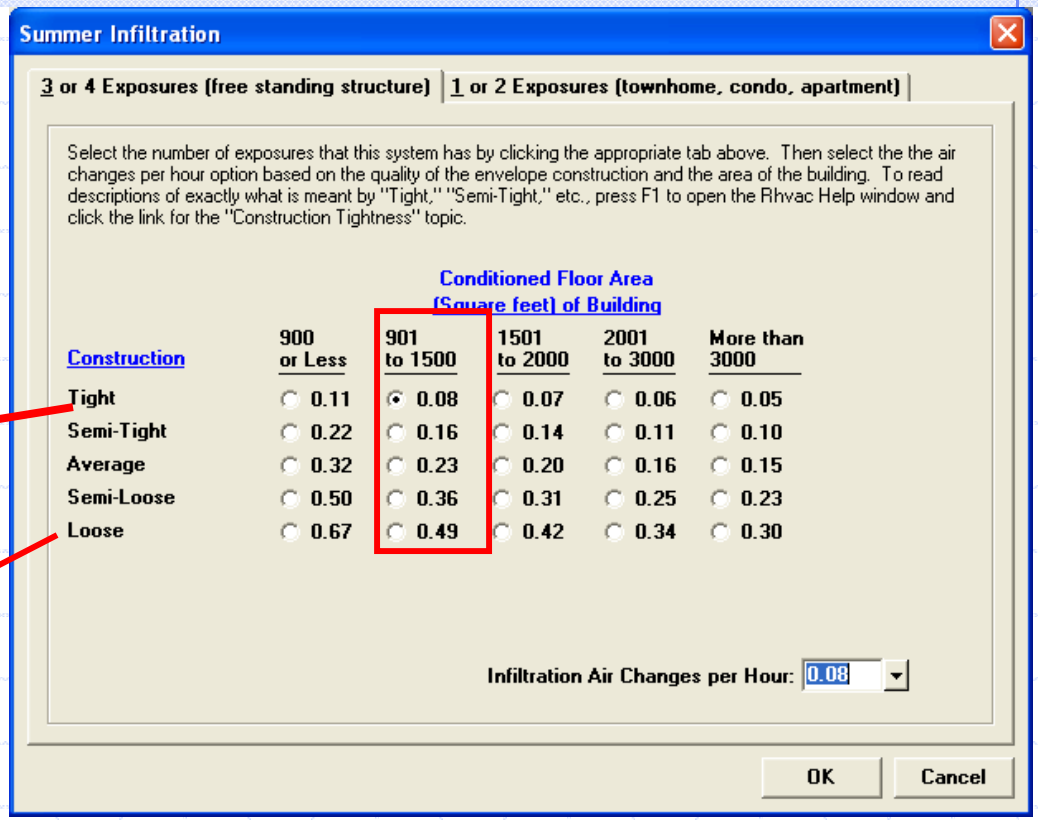
Check Figures

Infiltration Sensitivity



TIGHT

LOOSE



Loose Construction

Infiltration: Winter CFM: 190, Summer CFM: 99	5,222	3,998	1,741	5,739

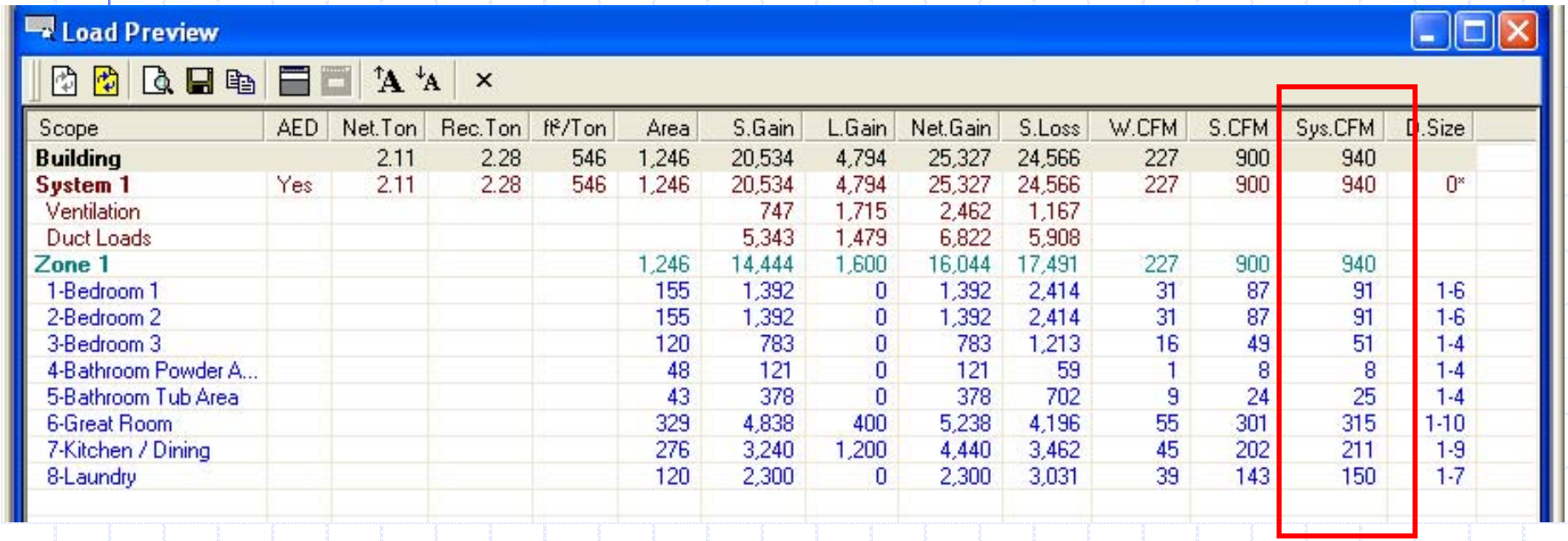
Tight Construction

Infiltration: Winter CFM: 32, Summer CFM: 16	888	654	285	939

CALCS-PLUS

MJ8 & Duct Leakage

MJ8 & Duct Design



Scope	AED	Net.Ton	Rec.Ton	ft²/Ton	Area	S.Gain	L.Gain	Net.Gain	S.Loss	W.CFM	S.CFM	Sys.CFM	D.Size
Building		2.11	2.28	546	1,246	20,534	4,794	25,327	24,566	227	900	940	
System 1	Yes	2.11	2.28	546	1,246	20,534	4,794	25,327	24,566	227	900	940	0"
Ventilation						747	1,715	2,462	1,167				
Duct Loads						5,343	1,479	6,822	5,908				
Zone 1					1,246	14,444	1,600	16,044	17,491	227	900	940	
1-Bedroom 1					155	1,392	0	1,392	2,414	31	87	91	1-6
2-Bedroom 2					155	1,392	0	1,392	2,414	31	87	91	1-6
3-Bedroom 3					120	783	0	783	1,213	16	49	51	1-4
4-Bathroom Powder A...					48	121	0	121	59	1	8	8	1-4
5-Bathroom Tub Area					43	378	0	378	702	9	24	25	1-4
6-Great Room					329	4,838	400	5,238	4,196	55	301	315	1-10
7-Kitchen / Dining					276	3,240	1,200	4,440	3,462	45	202	211	1-9
8-Laundry					120	2,300	0	2,300	3,031	39	143	150	1-7

Design room CFM (airflow)

Duct Loads

Addendum C to

ACCA Manual J®

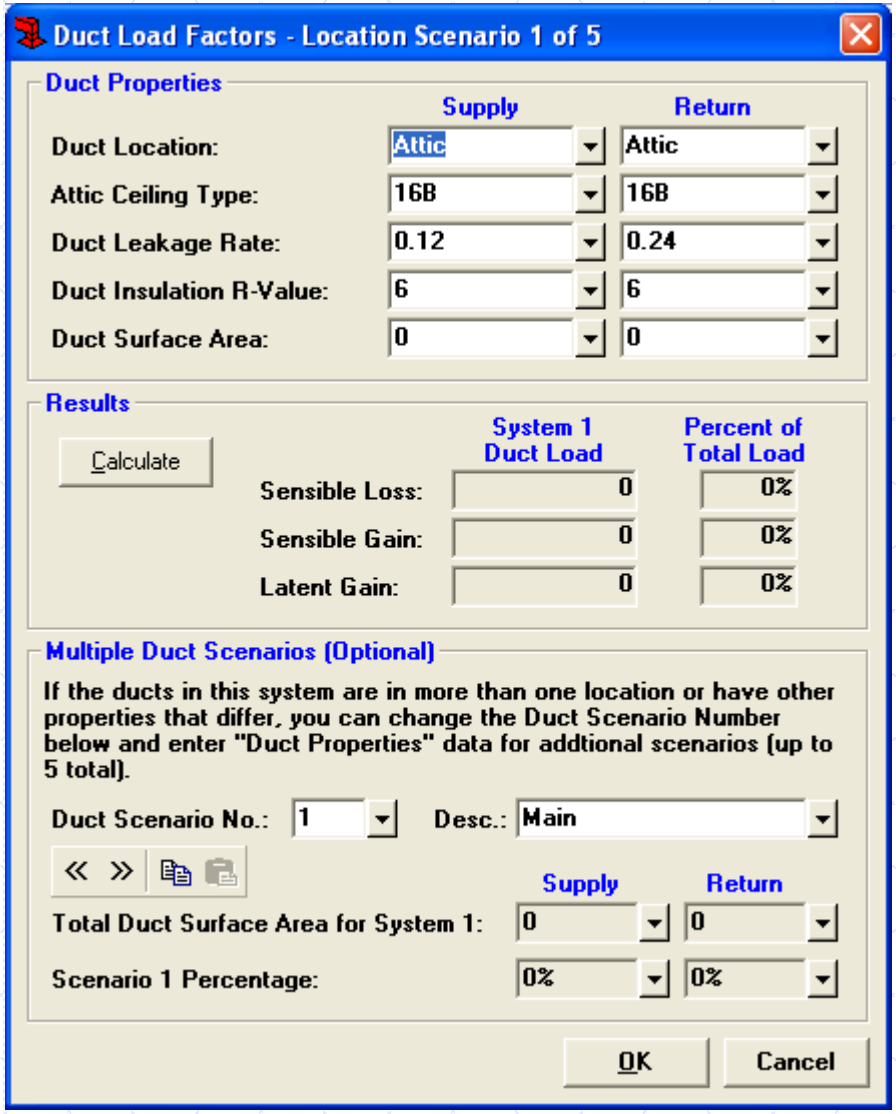
Residential Load Calculation

Eighth Edition

ANSI/ACCA Man J 2-2004

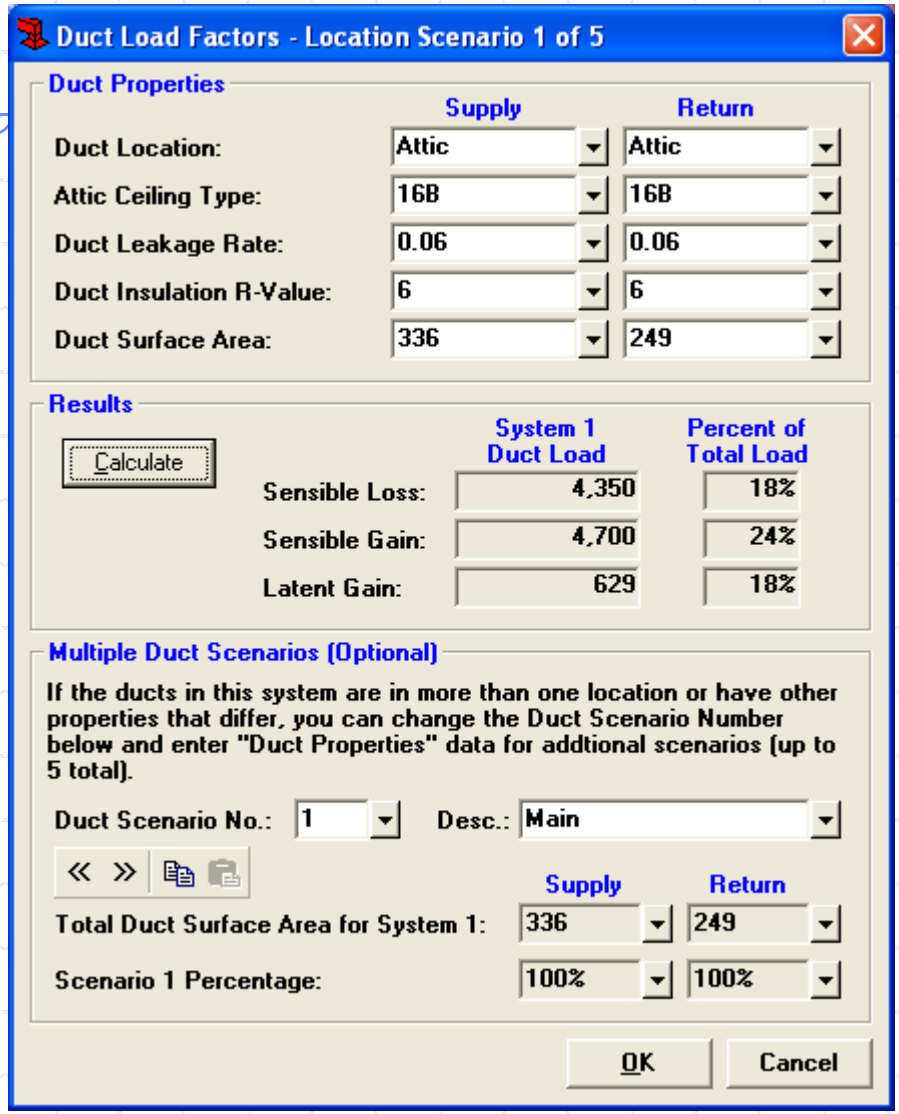
ISBN# 1-892765-27-6

This addendum updates Version 1.10 of Manual J Eighth Edition (MJ8™) and addresses *Duct Gain / Loss Revisions* to the MJ8 procedures.



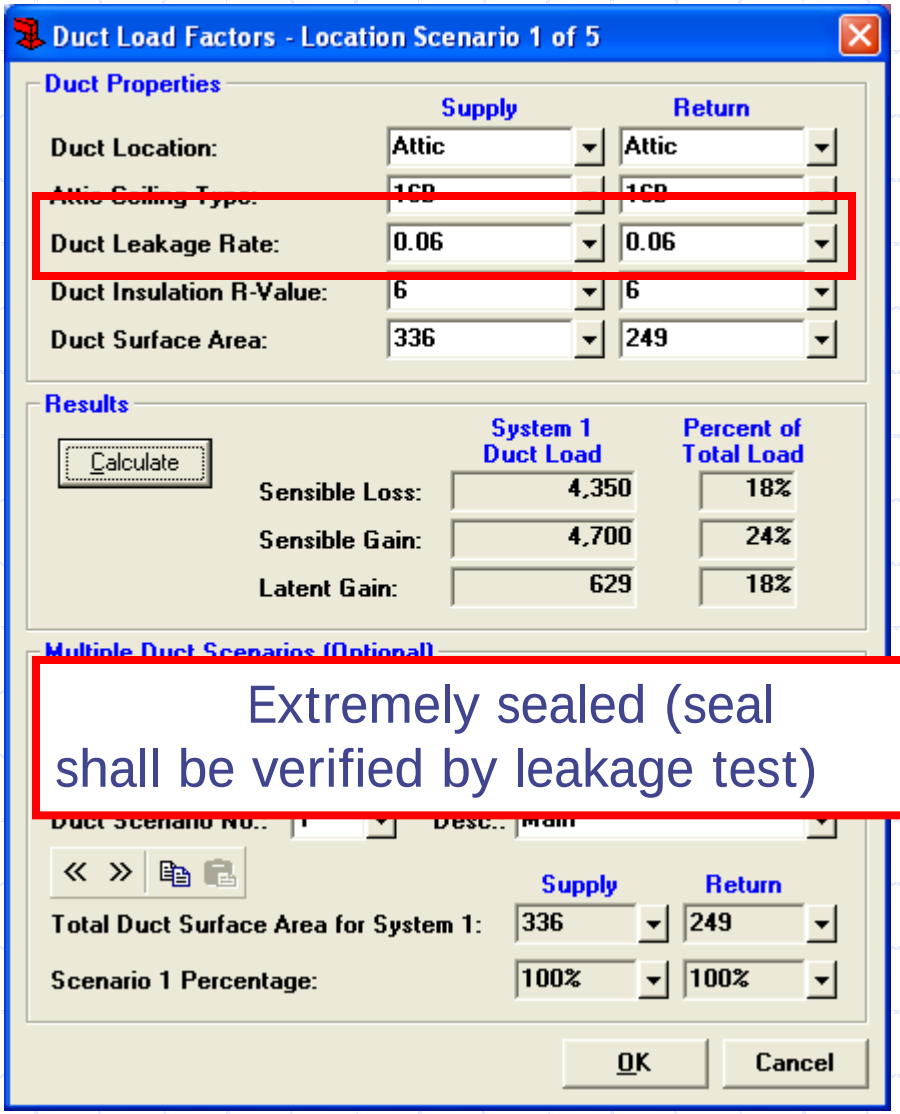
Ducts located in the unconditioned space also have a heat gain that adds to the cooling load of the building.

Calculate Duct Loads

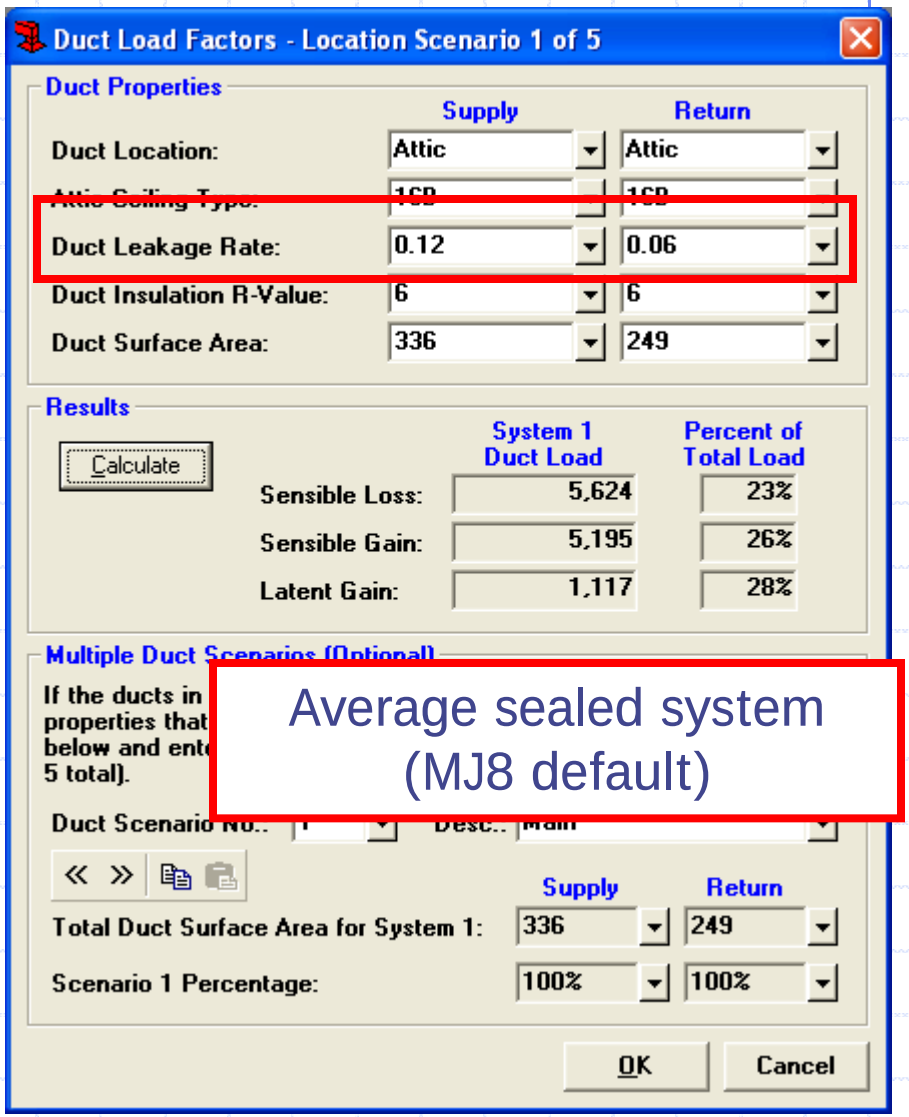


The Sensible Loss, Sensible Gain, and the Latent Gain are calculated for the duct system.

What If?



Extremely sealed (seal shall be verified by leakage test)



Average sealed system (MJ8 default)

MJ8 & the Energy Rater

The information you gather to do a energy rating is the same as required for an HVAC Load Calculation.

Do it to set yourself apart from your competition.

Do it to become a better Energy Rater.

Do it to provide another avenue for income.

Larger Customer Base

AC Contractors know or at least had to have learned load calculations if they carry a licenses or certification.

AC contractors are busy running a company and don't have time to do room x room calculations.

If they were provided room x room calculations they would use them as a design tool.

Diagnostic Tool

Start every diagnostic investigation with a room x room HVAC load calculation.

You will understand the construction of the building much better.

You will have a better understanding of the results of all the data gathered.

A Plug for MJ8

- The possibility for experiencing comfort problems at part load conditions can be minimized by observing the guidelines set forth in Manual J.
- The Manual J calculation should take full advantage of legitimate opportunities to minimize the size of the estimated loads.

Thank You

Questions?