Right Sizing AC Systems for Profit and Energy Star Certification

Part II

RESNET 2007

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CALCS-PLUS

Venice Florida

Reading the Reports

Project Page

Lists data entered in the inputs on the Project, Client, Company and Design tabs of the General Project Data window, as well as Check Figures and total building heating and cooling loads.

Miscellaneous Page

Lists design conditions for each system, duct sizing inputs, and infiltration and ventilation data for each system.

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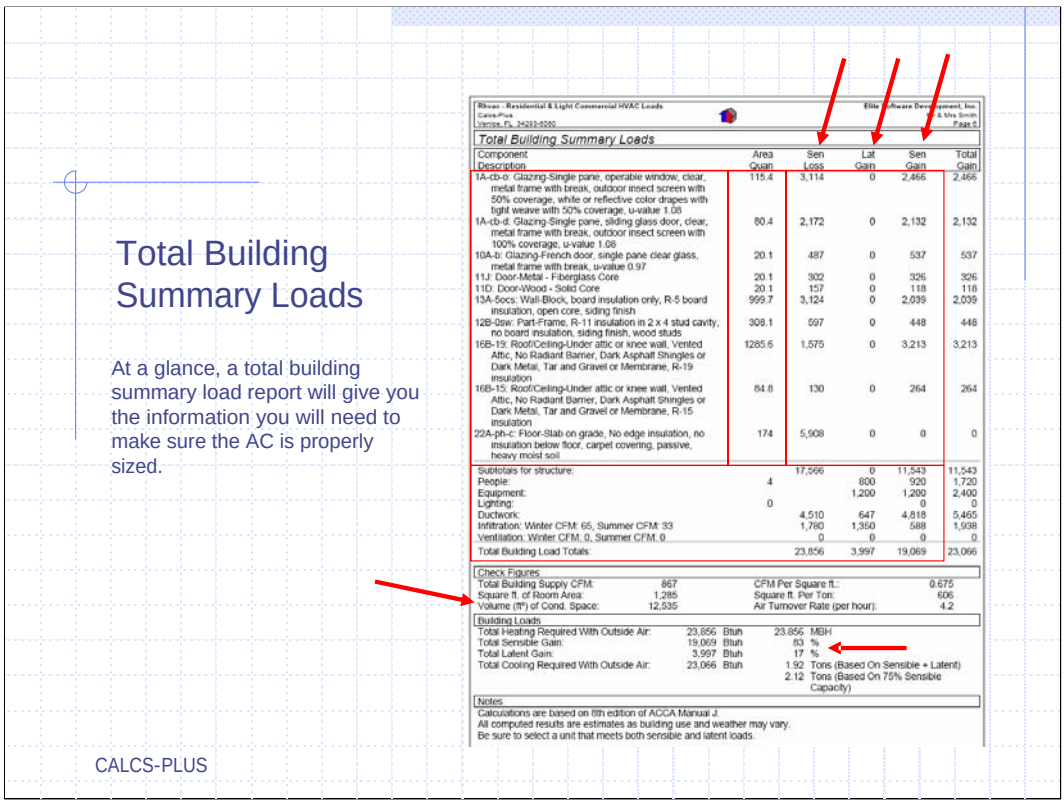
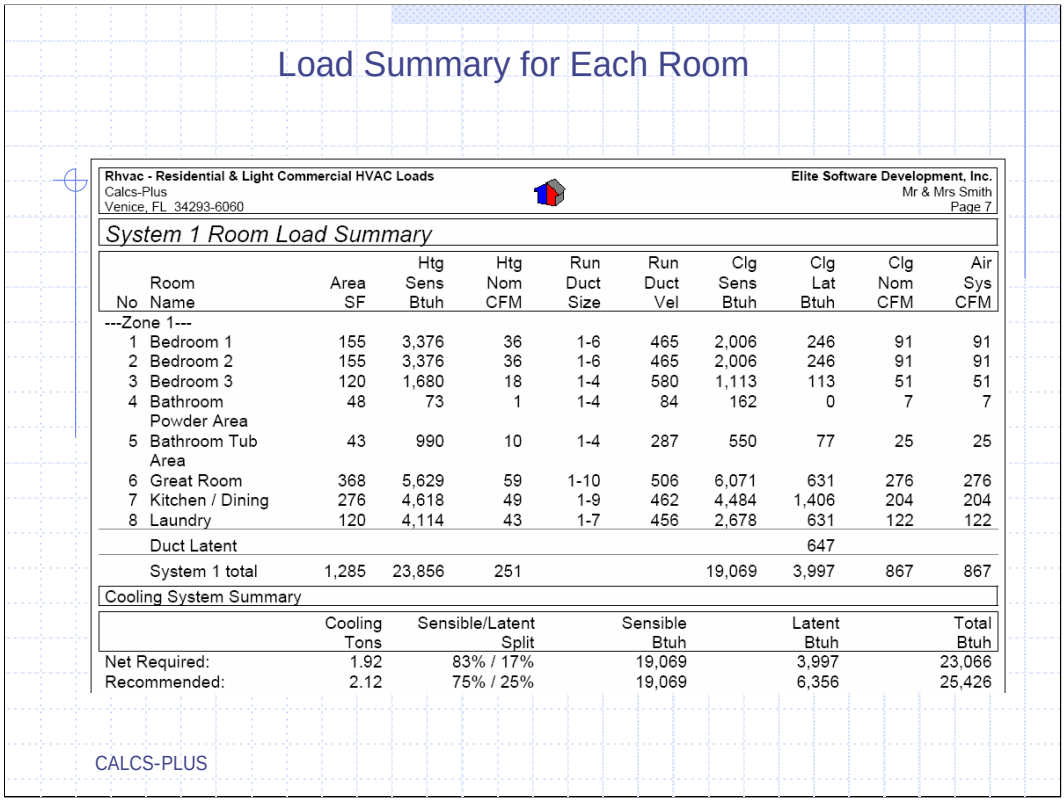
The calculation is finished (for now) so it's time to make some sense out of the reports. The practitioner who understands the results of the calculation will use it as a tool for consulting and to identify problems having to do with system sizing, airflow, temperature un-balances, etc.

All calculation programs (ACCA certified that is) gives general or miscellaneous information that pertains to the project location, who it is for, who did the calculation, some check figures, etc. But they don't mean much unless you have the rest of the meat of the calculation to back it up.



At a glance, a total building summary load report will give you the information you will need to make sure the AC is properly sized. For heating you will look at the sensible loss and for cooling the sensible and latent gain must be considered. The report will give the materials used, area or quantity, and the loss or gain of those materials. It will also include internal gains, duct gains, and infiltration/ventilation gains that were used to calculate the total HVAC load. Other important information on this summary should include conditioned area & volume and the cooling sensible heat ratio (SHR) of the building load.

Load Summary for Each Room



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System 1 Room Load Summary

No	Room Name	Area SF	Htg Sens Btuh	Htg Nom CFM	Run Duct Size	Run Duct Vel	Clg Sens Btuh	Clg Lat Btuh	Clg Nom CFM	Air Sys CFM
---Zone 1---										
1	Bedroom 1	155	3,376	36	1-6	465	2,006	246	91	91
2	Bedroom 2	155	3,376	36	1-6	465	2,006	246	91	91
3	Bedroom 3	120	1,680	18	1-4	580	1,113	113	51	51
4	Bathroom Powder Area	48	73	1	1-4	84	162	0	7	7
5	Bathroom Tub Area	43	990	10	1-4	287	550	77	25	25
6	Great Room	368	5,629	59	1-10	506	6,071	631	276	276
7	Kitchen / Dining	276	4,618	49	1-9	462	4,484	1,406	204	204
8	Laundry	120	4,114	43	1-7	456	2,678	631	122	122
	Duct Latent							647		
	System 1 total	1,285	23,856	251			19,069	3,997	867	867

Cooling System Summary

	Cooling Tons	Sensible/Latent Split	Sensible Btuh	Latent Btuh	Total Btuh
Net Required:	1.92	83% / 17%	19,069	3,997	23,066
Recommended:	2.12	75% / 25%	19,069	6,356	25,426

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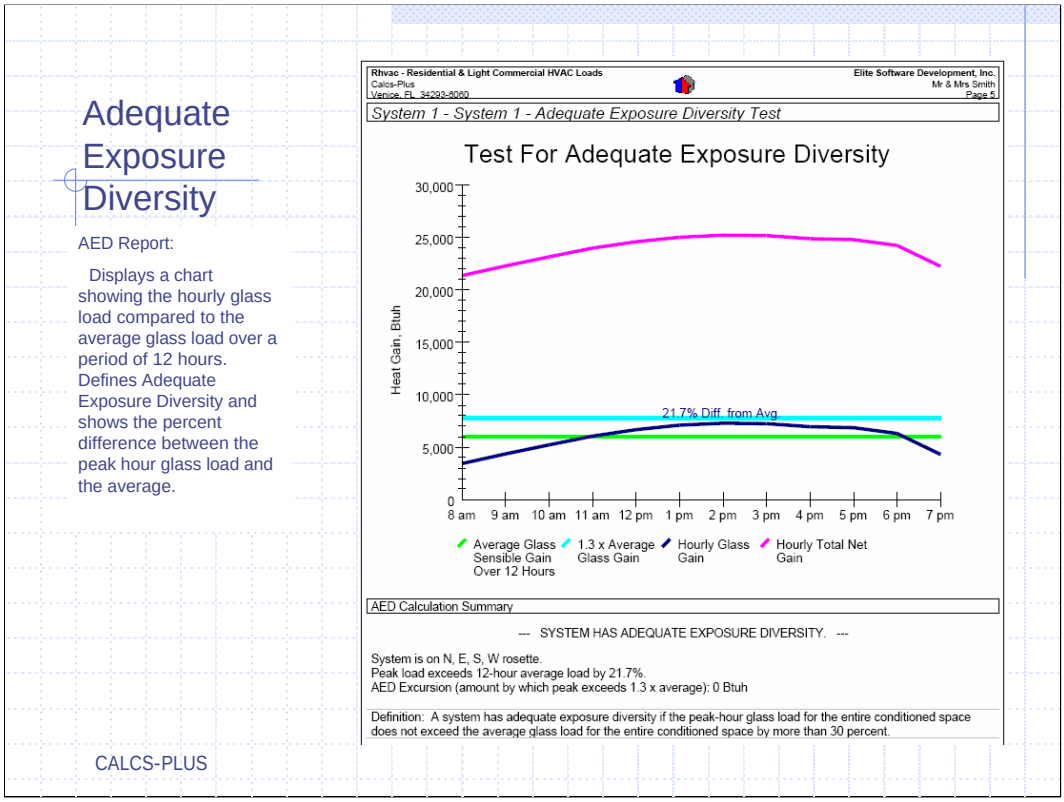
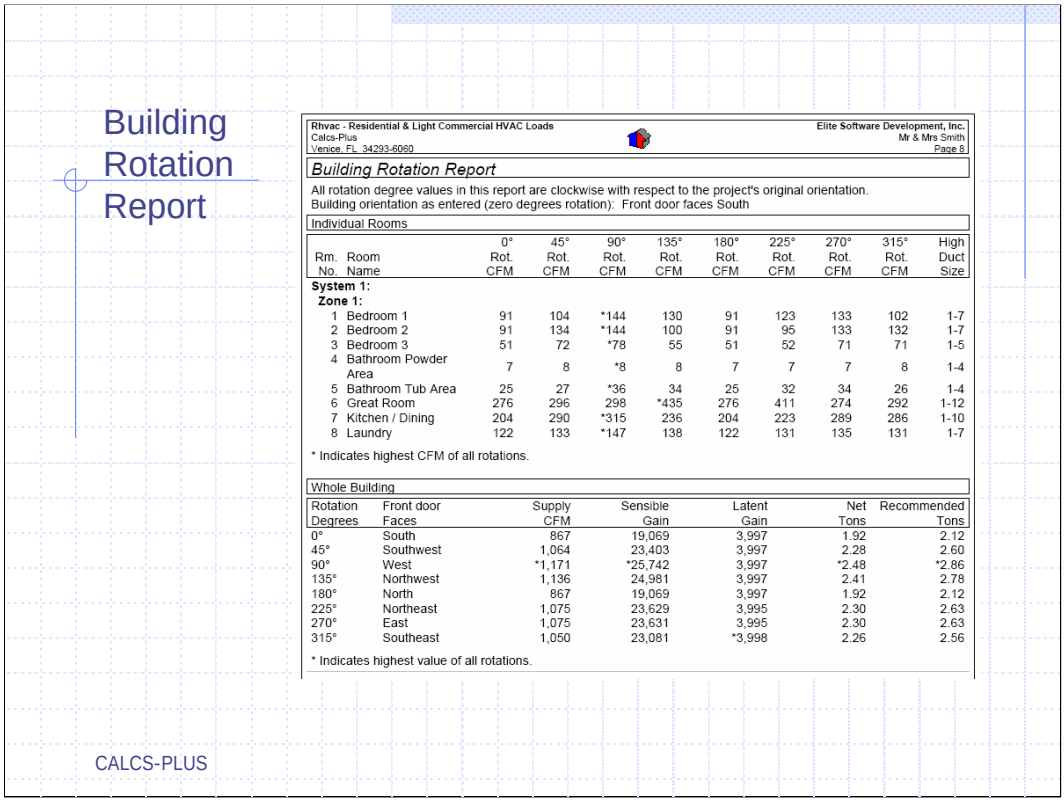
The room summary report should give the area, heating BTUH, heating CFM, run-out duct size (if you are using that feature), run-out duct velocity (again if you are using that feature), sensible cooling BTUH, latent cooling BTUH, nominal cooling CFM, and system CFM for each room (if it was set to a fixed CFM).



Adequate exposure diversity (AED) is the comparison of the peak load to the average load. The chart above shows the average sensible gain of the glass (the green line) over a 12 hour period during the day (8AM to 7PM). The cyan colored line marks where 30% above the average glass load would follow. The dark blue line is the actual glass load during various times of the day. Note that the in this house the glass peaks out sometime between 1 and 3 PM. Also notice that the peak load does not go above the 30% line, it falls shore by about 8.3%. The hourly glass gain curve is positioned at the start of the average load line which projects the deviation of the total building load during the day with respect to peak load.

Building Rotation Report



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Building Rotation Report

All rotation degree values in this report are clockwise with respect to the project's original orientation.
Building orientation as entered (zero degrees rotation): Front door faces South

Individual Rooms

Rm. No.	Room Name	0° Rot. CFM	45° Rot. CFM	90° Rot. CFM	135° Rot. CFM	180° Rot. CFM	225° Rot. CFM	270° Rot. CFM	315° Rot. CFM	High Duct Size
System 1:										
Zone 1:										
1	Bedroom 1	91	104	*144	130	91	123	133	102	1-7
2	Bedroom 2	91	134	*144	100	91	95	133	132	1-7
3	Bedroom 3	51	72	*78	55	51	52	71	71	1-5
4	Bathroom Powder Area	7	8	*8	8	7	7	7	8	1-4
5	Bathroom Tub Area	25	27	*36	34	25	32	34	26	1-4
6	Great Room	276	296	298	*435	276	411	274	292	1-12
7	Kitchen / Dining	204	290	*315	236	204	223	289	286	1-10
8	Laundry	122	133	*147	138	122	131	135	131	1-7

* Indicates highest CFM of all rotations.

Whole Building

Rotation Degrees	Front door Faces	Supply CFM	Sensible Gain	Latent Gain	Net Tons	Recommended Tons
0°	South	867	19,069	3,997	1.92	2.12
45°	Southwest	1,064	23,403	3,997	2.28	2.60
90°	West	*1,171	*25,742	3,997	*2.48	*2.86
135°	Northwest	1,136	24,981	3,997	2.41	2.78
180°	North	867	19,069	3,997	1.92	2.12
225°	Northeast	1,075	23,629	3,995	2.30	2.63
270°	East	1,075	23,631	3,995	2.30	2.63
315°	Southeast	1,050	23,081	*3,998	2.26	2.56

* Indicates highest value of all rotations.

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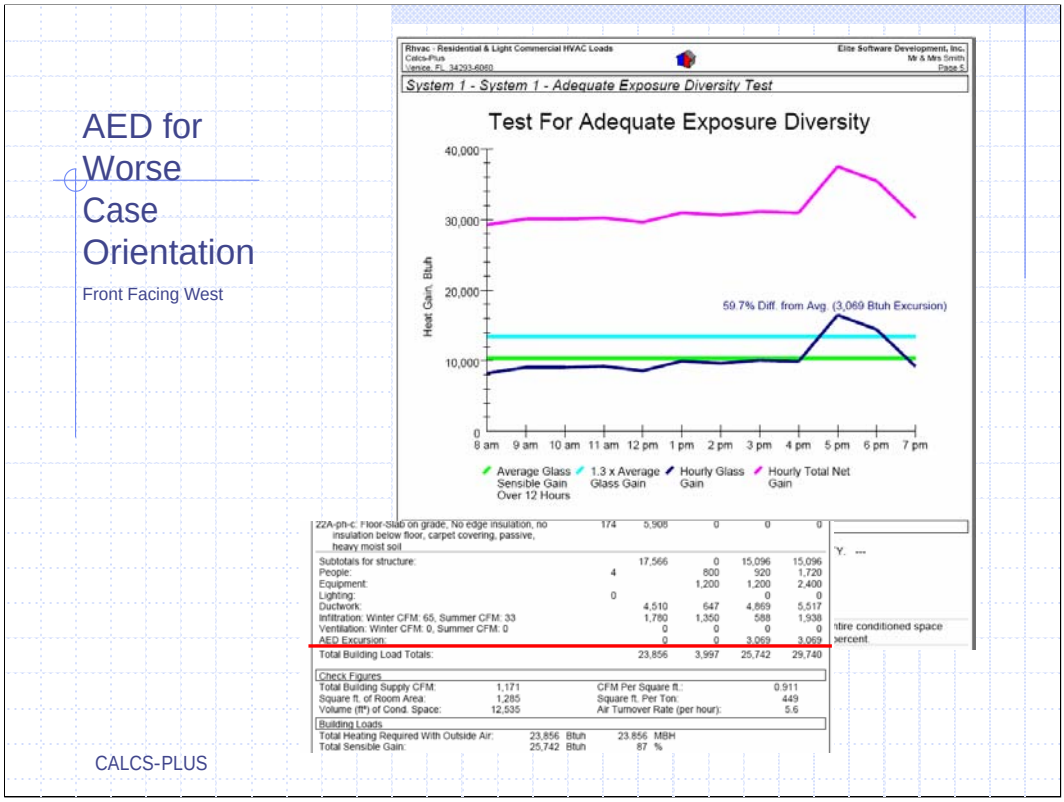
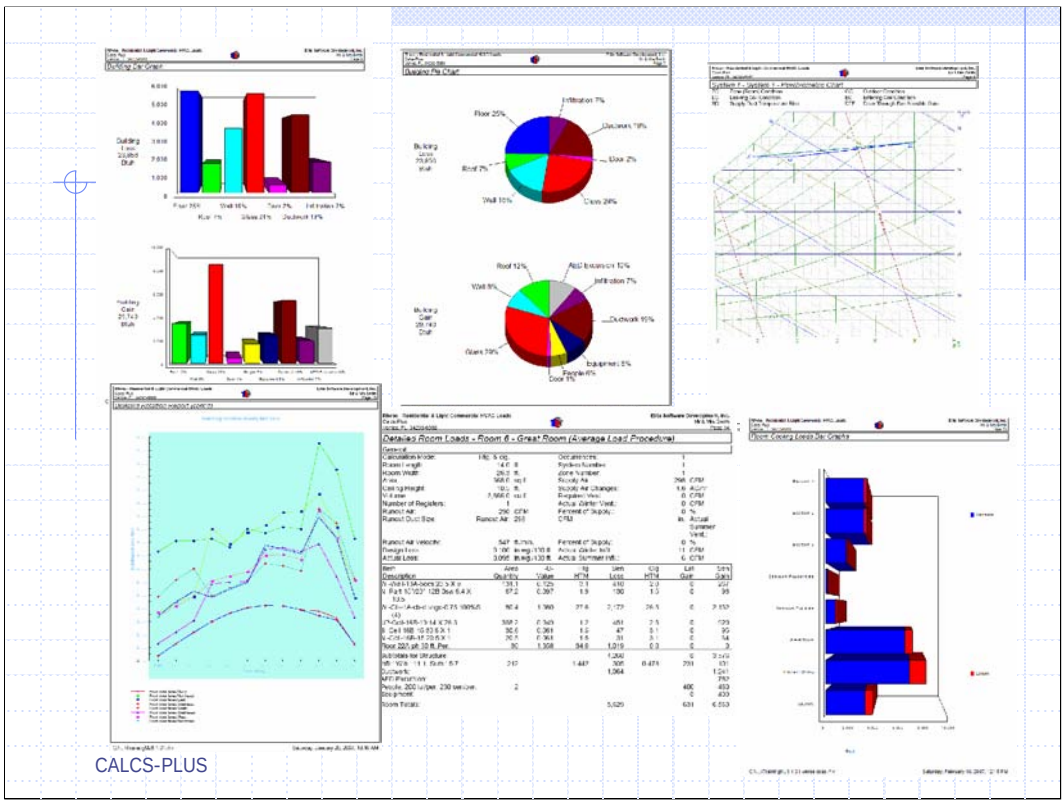
If you do consulting for a builder that has several models that will be placed in a subdivision in any one of the 8 orientations this report will be a real value. In our initial set-up we told the program that the front door would face south. The above report shows that the worse direction the home can face is west. The load on the building increases from 2.12 tons (recommended) when south facing to 2.86 tons (recommended) facing west. Lets see why.

Note: Recommended Tons will be discussed in the section on Equipment selection.



Here is the AED test for the home after we have rotated the front from south to west. The glass peaks over the 30% line by 3,069 BTUH. When this happens we call the 3,069 the “Excursion and it is added back to the calculation. This can be seen on the output with the total building summary loads. If building does not have AED the Excursion becomes a line item in the “Total Building Load Totals”. If the building does have AED the Excursion line is not added to the report.



There are many other useful reports that can come out of the MJ8 calculation such as graphs that show where the loads are coming from, graphs that show room loads, Psychrometric process relating to infiltration and or ventilation, and detailed report for each room. These reports are useful when analyzing to identify problems.

Equipment Selection

Matching the MJ8 Results to Manufacturer's Performance Data

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Total Building Summary Loads

Component Description					
1A-cb-o: Glazing-Single pane, operable window, cle metal frame with break, outdoor insect screen w 50% coverage, white or reflective color drapes v tight weave with 50% coverage, u-value 1.08	80.4	2,172	0	2,132	2,132
1A-cb-d: Glazing-Single pane, sliding glass door, clear, metal frame with break, outdoor insect screen with 100% coverage, u-value 1.08	20.1	487	0	537	537
10A-b: Glazing-French door, single pane clear glass, metal frame with break, u-value 0.97					
11J: Door-Metal - Fiberglass Core					
11D: Door-Wood - Solid Core					
13A-5ocs: Wall-Block, board insulation only, insulation, open core, siding finish					
12B-0sw: Part-Frame, R-11 insulation in 2 x no board insulation, siding finish, wood s					
16B-19: Roof/Ceiling-Under attic or knee wa Attic, No Radiant Barrier, Dark Asphalt S... Dark Metal, Tar and Gravel or Membrane, R-19 insulation					
16B-15: Roof/Ceiling-Under attic or knee wall, Vented Attic, No Radiant Barrier, Dark Asphalt Shingles or Dark Metal, Tar and Gravel or Membrane, R-15 insulation	84.8	130	0	264	264
22A-ph-c: Floor-Slab on grade, No edge insulation, no insulation below floor, carpet covering, passive, heavy moist soil	174	5,908	0	0	0
Subtotals for structure:		17,566	0	11,543	11,543
People:	4		800	920	1,720
Equipment:			1,200	1,200	2,400
Lighting:	0			0	0
Ductwork:			4,510	647	4,818	5,465
Infiltration: Winter CFM: 65, Summer CFM: 33			1,780	1,350	588	1,938
Ventilation: Winter CFM: 0, Summer CFM: 0			0	0	0	0
Total Building Load Totals:			23,856	3,997	19,069	23,066

Check Figures

Total Building Supply CFM:	867	CFM Per Square ft.:	0.675
Square ft. of Room Area:	1,285	Square ft. Per Ton:	606
Volume (ft³) of Cond. Space:	12,535	Air Turnover Rate (per hour):	4.2

Building Loads

Total Heating Required With Outside Air:	23,856 Btuh	23.856 MBH	
Total Sensible Gain:	19,069 Btuh	83 %	
Total Latent Gain:	3,997 Btuh	17 %	
Total Cooling Required With Outside Air:	23,066 Btuh	1.92	Tons (Based On Sensible + Latent)
		2.12	Tons (Based On 75% Sensible Capacity)

Notes
Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

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February 10, 2007

(Capacities are net in btuh/1300 - indoor fan heat deducted)

Outdoor Model 2TTR3030A1 — **Indoor Model** TWE031F13

...tion Factors - Other Airflows

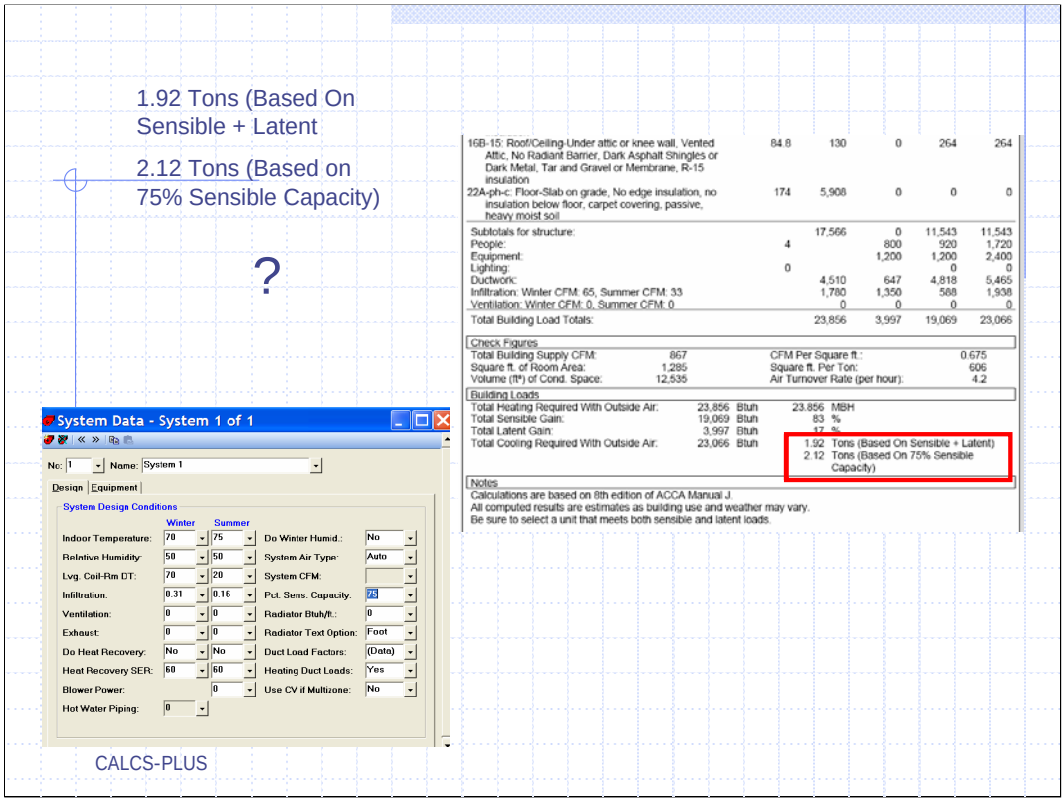
		875	1125
...apacity		0.98	1.02
...e Capacity		0.94	1.06
Compressor Kw		0.99	1.01

Indoor Fan Power = 236 watts
Outdoor Fan Power = 150 watts
S.E.E.R. = 14.00

Rated with 25 feet of 3/4 suction and 5/16 liquid lines

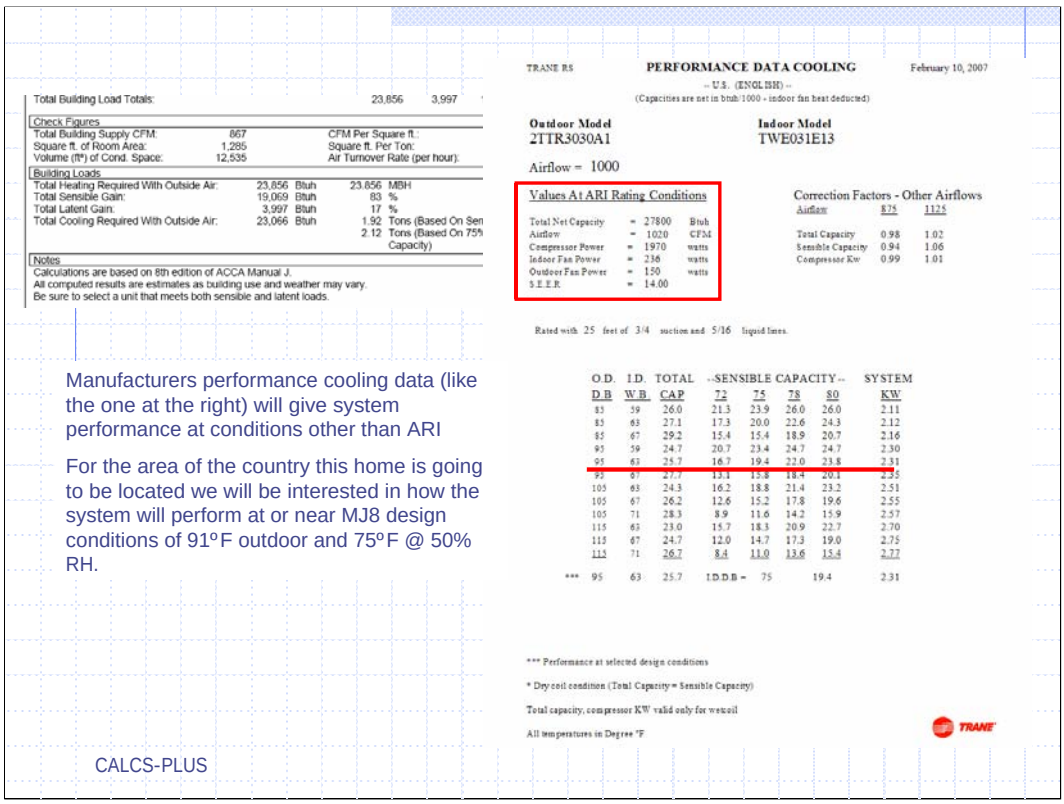
O.D. D.B	I.D. W.B.	TOTAL CAP	SENSIBLE CAPACITY 72	75	78	80	SYSTEM KW
85	59	26.0	21.1	23.9	26.0	26.0	2.11
85	63	27.1	17.3	20.0	22.6	24.3	2.12
85	67	29.2	15.4	15.4	18.9	20.7	2.16
95	59	24.7	20.7	23.4	24.7	24.7	2.30
95	63	25.7	16.7	19.4	22.0	23.8	2.31
95	67	27.7	13.1	15.8	18.4	20.1	2.35
105	63	24.3	16.2	18.8	21.1	23.2	2.51
105	67	26.2	12.6	15.2	17.8	19.6	2.55
105	71	28.3	8.9	11.6	14.2	15.9	2.57
115	63	23.0	15.7	18.2	20.9	22.7	2.70
115	67	24.7	12.0	14.7	17.3	19.0	2.75
115	71	26.7	8.4	11.0	13.6	15.4	2.77
*** 95	63	25.7	I.D.D.B. = 75		19.4		2.31

*** Performance at selected design conditions
* Dry coil condition (Tota. Capacity = Sensible Capacity)
Total capacity, compressor KW valid only for wet coil
All temperatures in Degree °F



This program gives a recommended tonnage size for cooling based on the idea that typical air conditioning systems remove heat at 75% sensible relative to the total BTUH output. This would also mean that the latent removal is 25% of the output. Keep in mind that a 75% SHR may not fit the model line that the owner/builder may want.

If you know the actual SHR of the equipment line that will be installed it can be entered in a “System Data” and the recommended tonnage will be based on it.



Total Building Load Totals: 23,856 3,997

Check Figures

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Square ft. of Room Area:	1,285	Square ft. Per Ton:	
Volume (ft³) of Cond. Space:	12,535	Air Turnover Rate (per hour):	

Building Loads

Total Heating Required With Outside Air:	23,856	Btuh	23.856	MBH
Total Sensible Gain:	19,069	Btuh	83	%
Total Latent Gain:	3,997	Btuh	17	%
Total Cooling Required With Outside Air:	23,066	Btuh	1.92	Tons (Based On Sen
			2.12	Tons (Based On 75% Capacity)

Notes

Calculations are based on 8th edition of ACCA Manual J.
All computed results are estimates as building use and weather may vary.
Be sure to select a unit that meets both sensible and latent loads.

TRANE RS **PERFORMANCE DATA COOLING** February 10, 2007

-- U.S. (ENGLISH) --
(Capacities are net in btuh/1000 - indoor fan heat deducted)

Outdoor Model 2TTR3030A1 **Indoor Model** TWE031E13

Airflow = 1000

Values At ARI Rating Conditions

Total Net Capacity	=	27800	Btuh
Airflow	=	1020	CFM
Compressor Power	=	1970	watts
Indoor Fan Power	=	236	watts
Outdoor Fan Power	=	150	watts
S.E.E.R.	=	14.00	

Correction Factors - Other Airflows

Airflow	875	1125
Total Capacity	0.98	1.02
Sensible Capacity	0.94	1.06
Compressor Kw	0.99	1.01

Rated with 25 feet of 3/4 suction and 5/16 liquid lines.

O.D. D.B	I.D. W.B	TOTAL CAP	--SENSIBLE CAPACITY-- 72	75	78	80	SYSTEM KW
85	59	26.0	21.3	23.9	26.0	26.0	2.11
85	63	27.1	17.3	20.0	22.6	24.3	2.12
85	67	29.2	15.4	15.4	18.9	20.7	2.16
95	59	24.7	20.7	23.4	24.7	24.7	2.30
95	63	25.7	16.7	19.4	22.0	23.8	2.31
95	67	27.7	13.1	15.8	18.4	20.1	2.35
105	63	24.3	16.2	18.8	21.4	23.2	2.51
105	67	26.2	12.6	15.2	17.8	19.6	2.55
105	71	28.3	8.9	11.6	14.2	15.9	2.57
115	63	23.0	15.7	18.3	20.9	22.7	2.70
115	67	24.7	12.0	14.7	17.3	19.0	2.75
115	71	26.7	8.4	11.0	13.6	15.4	2.77
*** 95	63	25.7	I.D.D.B = 75		19.4		2.31

*** Performance at selected design conditions
* Dry coil condition (Total Capacity = Sensible Capacity)
Total capacity, compressor KW valid only for wet coil
All temperatures in Degree °F

TRANE

Manufacturers performance cooling data (like the one at the right) will give system performance at conditions other than ARI

For the area of the country this home is going to be located we will be interested in how the system will perform at or near MJ8 design conditions of 91ºF outdoor and 75ºF @ 50% RH.

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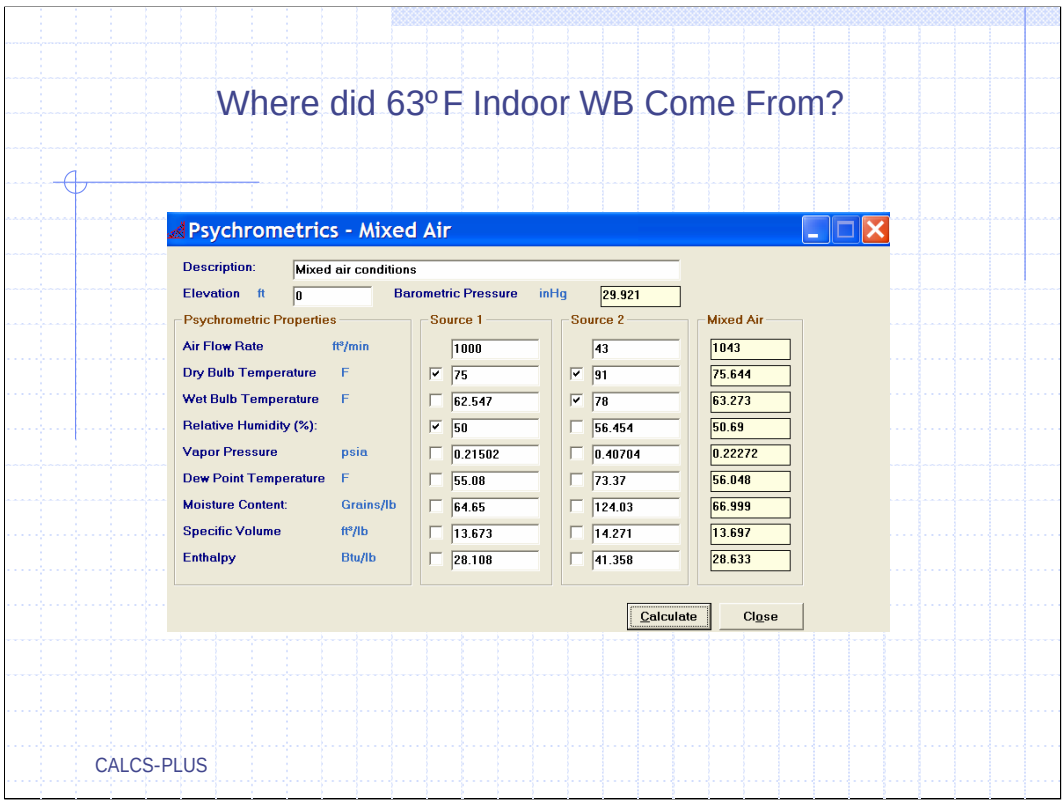
Manufacturers' performance date shows equipment output at various outdoor and indoor conditions; conditions outside ARI testing. The difference is plainly shown on this manufacturers performance sheet for a nominal 2.5-ton system. The “Values At ARI Rating Conditions” shows that this system has a total net capacity 27,800 BTUH and a SEER rating of 14.00 at 1020 CFM. This is good information but we really need to know how the system is going to perform at design conditions. At 95ºF DB outdoor, and 75ºF DB & 63ºF WB indoor. This system match produces 25,700 BTUH total and 19,400 BTUH sensible output which gives it a 75.5% SHR. So it will work well for this application.



MJ8 indoor design conditions of 75ºF DB @ 50% RH yields an indoor wet bulb temperature of 62.5. We guessed at the building infiltration rate, .16, semi tight for buildings under1500 SQ FT. This equates out to 33 CFM which doesn't meet ASHRAE 62.2 minimum of 7.5 CFM per person and .01 CFM per SQ FT. The home has three bedrooms so four people are considered which gives 30 CFM + .01 CFM x 1285 SQ FT = 43 CFM. The condition of the mixed air at the return plenum just before the evaporator coil is 75.6º DB and 63.3º WB.

Wrap Up

- Understand the load calculation program you are using.
- Do a good take off from plans or as-built measurements.
- Understand the outputs and have faith in your work.
- Ask for manufactures performance data.
- Typically, if you choose a piece of equipment that will meet the sensible and net load the latent load will be handled by runtime.
- Do not exceed 15% of the total building cooling load.
- Remember that the cooling systems ability to control indoor relative humidity is through long run times.

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Thank You

Questions?

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