Xcel Energy®

What to Look for Series Commercial HVAC Sizing Calculations

Are calculations required?

What are the critical design parameters?

Does the number of people matter?

AHU-1 (FIRST FLOOR) — Variable Volume Reheat (30% Min Flow Default)

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 17
Outside Air: OADB/WB/HR: 88 / 59 / 45

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0
Skylite Cond	0	0	0	0
Roof Cond	0	17,671	17,671	2
Glass Solar	103,902	0	103,902	10
Glass/Door Cond	13,416	0	13,416	1
Wall Cond	4,073	2,413	6,485	1
Partition/Door	6,161		6,161	1
Floor	-10,243		-10,243	-1
Adjacent Floor	0.00	0.00	0.00	0.00
Infiltration	0		0	0
Sub Total ==>	117,309	20,084	137,393	14
Internal Loads				
Lights	71,165	0	71,165	7
People	452,436	0	452,436	45
Misc	313,951	0	313,951	32
Sub Total ==>	837,552	0	837,552	84
Ceiling Load	3,414	-3,414	0	0
Ventilation Load	0	0	0	0
Adj Air Trans Heat	0		0	0
Dehumid. Ov Sizing			0	0
Ov/Undr Sizing	19,438		19,438	2
Exhaust Heat		0	0	0
Sup. Fan Heat			0	0
Ret. Fan Heat		0	0	0
Duct Heat Pkup		0	0	0
Underflr Sup Ht Pkup			0	0
Supply Air Leakage		0	0	0
Grand Total ==>	977,713	16,670	994,383	100.00

CLG SPACE PEAK

Mo/Hr: 9 / 16
OADB: 77

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0
Skylite Cond	0	0
Roof Cond	0	0
Glass Solar	123,060	16
Glass/Door Cond	-997	0
Wall Cond	2,734	0
Partition/Door	6,161	1
Floor	-10,242.81	-1
Adjacent Floor	0.00	0.00
Infiltration	0	0
Sub Total ==>	120,716	16
Internal Loads		
Lights	71,165	9
People	232,287	31
Misc	313,951	41
Sub Total ==>	617,403	81
Ceiling Load	2,094	0
Ventilation Load	0	0
Adj Air Trans Heat	0	0
Ov/Undr Sizing	21,029	3
Grand Total ==>	761,241	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 1

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	-27,163	7.04
Glass Solar	0	0	0.00
Glass/Door Cond	-77,556	-77,556	20.11
Wall Cond	-8,525	-13,175	3.42
Partition/Door	6,835	6,835	-1.77
Floor	-6,829	-6,829	1.77
Adjacent Floor	0.00	0.00	0.00
Infiltration	-62,784	-62,784	16.28
Sub Total ==>	-148,858	-180,672	46.85
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	-10,467	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		1,418	-0.37
OA Preheat Diff.		0	0.00
RA Preheat Diff.		-9,490	2.46
Additional Reheat		-196,911	51.06
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-159,325	-385,655	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	81.5
Ra Plenum	75.3	68.4
Return	75.3	68.4
Ret/OA	75.3	68.4
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	41,924	16,136
Terminal	41,924	16,136
Main Fan	41,924	16,135
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	1,002
MinStop/Rh	16,135	16,135
Return	41,924	17,138
Exhaust	0	1,002
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	1.74	0.67
cfm/ton	505.93	
ft²/ton	290.57	
Btu/hr·ft²	41.30	-16.14
No. People	867	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	82.9	994.4	774.2	41,722	75.3	61.6	78.8	55.0	52.8	69.4
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	82.9	994.4								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	24,078		
Part	1,402		
Int Door	1		
ExFlr	1,378		
Roof	12,493	0	0
Wall	6,682	2,539	38
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-388.6	16,135	55.0	81.5
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Reheat	-219.7	16,135	55.0	70.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-388.6			

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Requirements
Mechanical Load Calculations

C103.2 Information on construction documents

- Construction documents shall be drawn to scale on suitable material.
- Electronic media documents are permitted to be submitted where approved by the code official.
- Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed.
- Details shall include, but are not limited to, the following as applicable:

    5. Mechanical system design criteria

C403.1.1 Calculation of heating and cooling loads

- Design loads associated with heating, ventilating and air conditioning of the building shall be determined in accordance with ANSI/ASHRAE/ACCA Standard 183 or by an approved equivalent computational procedure using the design parameters specified in Chapter 3.
- Heating and cooling loads shall be adjusted to account for load reductions that are achieved where energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE HVAC Systems and Equipment Handbook by an approved equivalent computational procedure.

Review

Many of us reviewing commercial HVAC calculations are not mechanical engineers. Without a deep dive we can verify several important design parameters.

- Summer outside design Dry Bulb and Wet Bulb Temperatures
- Winter outside design dry bulb Temperatures
- Winter and Summer inside design dry Bulb Temperatures
- Thermal Envelope Values used in the design

Two of the common Design software programs we see are:

- Trane Trace (Trace 700 is being phased out to Trace 3D Plus)
- Carrier HAP

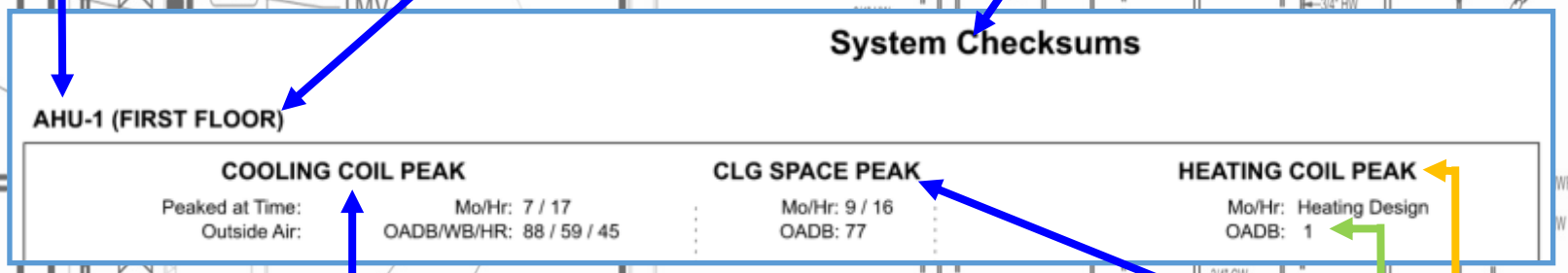
Both of these programs are ANSI/ASHRAE/ACCA Standard 183 compliant.

Plan Review
Trane Trace

Air
Handling
Unit

First Floor
Will include the area loads and design for the entire first floor

System Checksums is a summary of the of the loads and design parameters



COOLING COIL PEAK

Peaked at Time: **Mo/Hr: 7 / 17** Means the highest load was in July at 5:00 pm

Outside Air: **OADB/WB/HR 88 / 59 / 45**

OADB 88: Outside air Dry Bulb is 88°.

This should be your adopted summer outside design

WB 59: Outside air Wet Bulb

This is typically around 59 degrees for Colorado

HR 45: Design Relative Humidity

CLG SPACE PEAK: Just showing the room with the largest cooling load

HEATING COIL PEAK

OADB 1: Outside air Dry Bulb is 1°.

This should be your adopted winter outside design

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Plan Review
Trane Trace

AHU-1 (FIRST FLOOR)

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 17
Outside Air: OADB/WB/HR: 88 / 59 / 45

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h
Envelope Loads			
Skylite Solar	0	0	0
Skylite Cond	0	0	0
Roof Cond	0	17,671	17,671
Glass Solar	103,902	0	103,902
Glass/Door Cond	13,416	0	13,416
Wall Cond	4,073	2,413	6,485
Partition/Door	6,161		6,161
Floor	-10,243		-10,243
Adjacent Floor	0.00	0.00	0.00
Infiltration	0		0
Sub Total ==>	117,309	20,084	137,393
Internal Loads			
Lights	71,165	0	71,165
People	452,436	0	452,436
Misc	313,951	0	313,951
Sub Total ==>	837,552	0	837,552
Ceiling Load	3,414	-3,414	0
Ventilation Load	0	0	0
Adj Air Trans Heat	0		0
Dehumid. Ov Sizing			0
Ov/Undr Sizing	19,438		19,438
Exhaust Heat		0	0
Sup. Fan Heat			0
Ret. Fan Heat		0	0
Duct Heat Pkup		0	0
Underflr Sup Ht Pkup			0
Supply Air Leakage		0	0
Grand Total ==>	977,713	16,670	994,383

If design parameters are correct the loads will be correct. Need to look for loads that are missing or not detailed.

Seems odd that an above grade story has no infiltration loads. A comments asking the designer why would be a good one

This miscellaneous load seems very high. A comment asking the designer what is included in this load would be a good one.

Plan Review

Trane Trace

AHU-1 (FIRST FLOOR)

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 17
Outside Air: OADB/WB/HR: 88 / 59 / 45

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h
Envelope Loads			
Skylite Solar	0	0	0
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Roof Cond	0	17,671	17,671
Glass Solar	103,902	0	103,902
Glass/Door Cond	13,416	0	13,416
Wall Cond	4,073	2,413	6,485
Partition/Door	6,161		6,161
Floor	-10,243		-10,243
Adjacent Floor	0.00	0.00	0.00
Infiltration	0		0
Sub Total ==>	117,309	20,084	137,393
Internal Loads			
Lights	71,165	0	71,165
People	452,436	0	452,436
Misc	313,951	0	313,951
Sub Total ==>	837,552	0	837,552
Ceiling Load	3,414	-3,414	0
Ventilation Load	0	0	0
Adj Air Trans Heat	0		0
Dehumid. Ov Sizing			0
Ov/Undr Sizing	19,438		19,438
Exhaust Heat		0	0
Sup. Fan Heat			0
Ret. Fan Heat		0	0
Duct Heat Pkup		0	0
Underflr Sup Ht Pkup			0
Supply Air Leakage		0	0
Grand Total ==>	977,713	16,670	994,383

As you can see the number of people can have a large effect on the cooling load. The number of people used in the calculation can found in the **ENGINEERING CKS** Box.

A quick calculation shows about 521 Btu's per person.

452,436/867=521

Typically we see about 250 Btu's per person.

Need to verify that the number of people (occupant load) is correct.

A good comment would be to ask why 521 Btu's per person was used.

ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	1.74	0.67
cfm/ton	505.93	
ft²/ton	290.57	
Btu/hr·ft²	41.30	-16.14
No. People	867	

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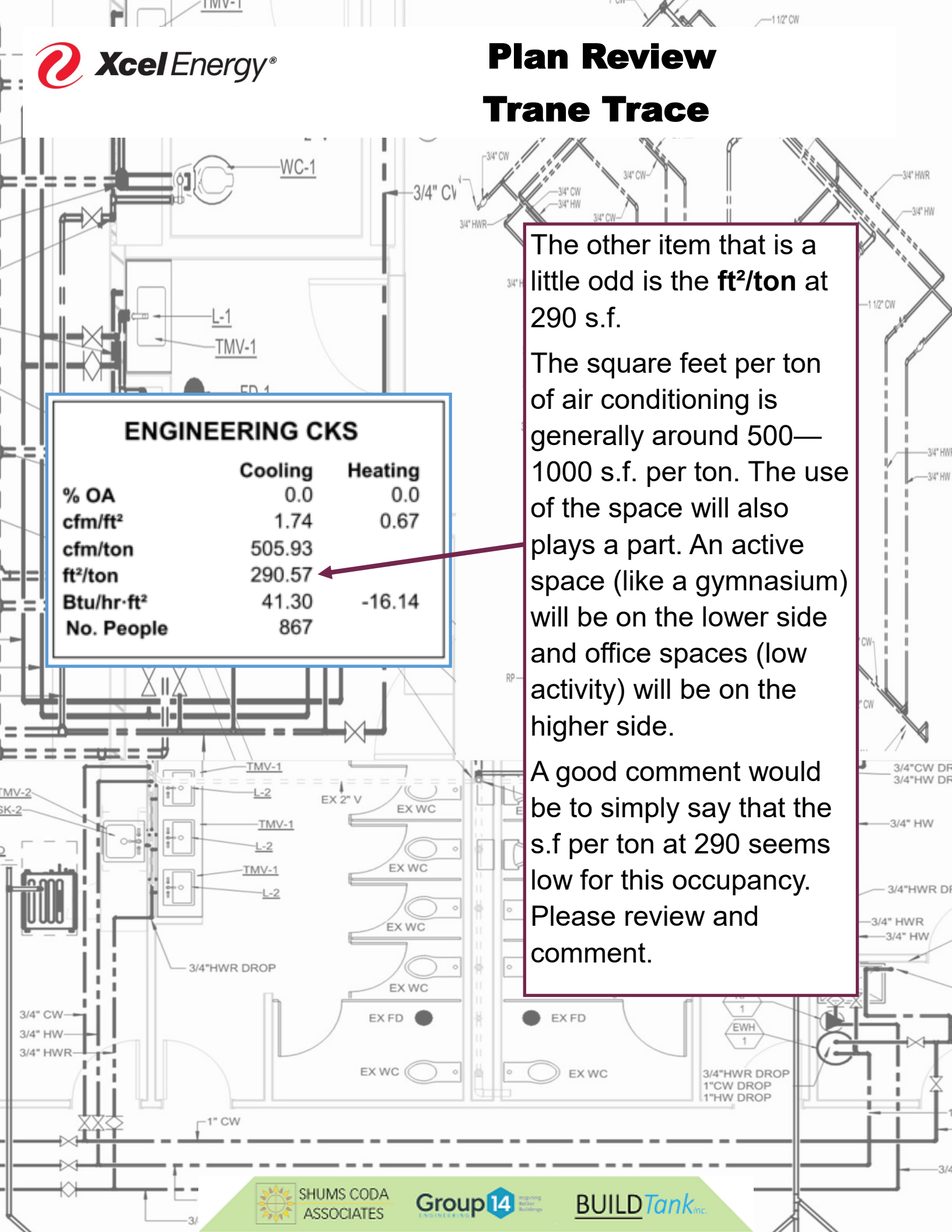
Plan Review
Trane Trace



ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	1.74	0.67
cfm/ton	505.93	
ft²/ton	290.57	
Btu/hr·ft²	41.30	-16.14
No. People	867	

The other item that is a little odd is the **ft²/ton** at 290 s.f.

The square feet per ton of air conditioning is generally around 500—1000 s.f. per ton. The use of the space will also plays a part. An active space (like a gymnasium) will be on the lower side and office spaces (low activity) will be on the higher side.

A good comment would be to simply say that the s.f per ton at 290 seems low for this occupancy. Please review and comment.

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Plan Review
Trane Trace

ENTERED VALUES
ROOM BY ROOM

Room Description: SECURITY | **Zone Description: No Zone** | **System Description: PTAC**

GENERAL INFORMATION

Floor Area:	325 ft²	Flr-Flr Height:	8.0 ft
Plenum Height:	0.0 ft	Height Above Flr:	
Slab Cnstr Type:	4" LW Concrete		
Room Mass:	Time delay based on actual mass		
Ceiling R-Value:	1.786 hr·ft²·°F/Btu		
Is There Carpet?:	NO		
Design Clg DB / Drift Point:	75.0 °F / 75.0 °F		
Design Htg DB / Drift Point:	72.0 °F / 72.0 °F		
Design Relative Humidity:	50 %		
Moisture Capacitance:	Medium		
Clg Tstat:	None		
Htg Tstat:	None		
Thermostat Location:	Room	Floor Multiplier:	1
Humidistat Location:	None	Room Multiplier:	1
CO2 Sensor Location:	None		
Room Type:	Conditioned		

PEOPLE

People Type:	None
# of People:	1 People
People Sensible:	250 Btu/h
People Latent :	250 Btu/h
People Schedule:	Cooling Only (Design)
Workstation:	1.0 workstation/person

LIGHTS

Lighting Type:	Recessed fluorescent, not vented, 80% load to space
Fixture Type:	RECFL-NV
% Load to RA:	20 %
Lighting Schedule:	Cooling Only (Design)
Lighting Amount:	1.5 W/sq ft
Ballast Factor:	1.0

AIRFLOW INFORMATION

	Cooling	Heating
Vent Type:	None	None
Vent Value:	0.00 cfm	0.00 cfm
Vent Schedule:	Available (100%)	
Infil Type:	Neutral, Poor Const.	Neutral, Poor Const.
Infil Value:	0.05 cfm/sq ft of wall	0.05 cfm/sq ft of wall
Infil Schedule:	Available (100%)	
Vav Airflow:		
Vav Sched:	Available (100%)	
Supply:	To be calculated	To be calculated
Aux Supply:	To be calculated	To be calculated
Room Exhaust:		
Rm Exh Sched:	Available (100%)	

Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h·ft²·°F	Alpha	Glass: Type / Energy Type	Glass: Area ft²	Glass: Shade Coef	Glass: U Value Btu/h·ft²·°F	Glass: External Shading	Glass: Internal Shading	Adj Temp/ Grnd Refl	Pct Sen/ Cool Tmp	Pct Rm/ Heat Tmp	Pct Ret/ Perm Len	Rad Frc/ Loss Coef
Roof - 1	325 ft²	0	90	Steel Sheet, 8" Ins	0.0333	0.90		0			Overhang - None	None					
E	250 ft²	90	0	4" HW Block, 3" Ins	0.0877	0.90											
Opening - 1				Window			3mm Tpl Low-E Film	9	0.61	0.38	Overhang - None	None	0.00				
Misc Load 1	300.000 W			Cooling Only (Design)			None							100	100	0	60.00
north	117 ft²			8" LW Conc Block	0.0877								Hourly OADB				
w	225 ft²			8" LW Conc Block	0.0877								Hourly OADB				
south	117 ft²			8" LW Conc Block	0.0877								Hourly OADB				
Floor - 1																25	0.50

The **ENTERED VALUES ROOM BY ROOM** report gives you the thermal envelope vales used in the calculation.

The bottom part of the report provides a description and U-factor values. Compare the assemblies shown in the calculation with those shown in the construction plans.

Description	Area/ Amount	Dir	Tilt	Const Type / Schedule	U Value Btu/h·ft²·°F	Alpha	Glass: Type / Energy Type	Glass: Area ft²	Glass: Shade Coef	Glass: U Value Btu/h·ft²·°F	Glass: External Shading	Glass: Internal Shading
Roof - 1	325 ft²	0	90	Steel Sheet, 8" Ins	0.0333	0.90		0			Overhang - None	None
E	250 ft²	90	0	4" HW Block, 3" Ins	0.0877	0.90						
Opening - 1				Window			3mm Tpl Low-E Film	9	0.61	0.38	Overhang - None	None
Misc Load 1	300.000 W			Cooling Only (Design)			None					
north	117 ft²			8" LW Conc Block	0.0877							
w	225 ft²			8" LW Conc Block	0.0877							
south	117 ft²			8" LW Conc Block	0.0877							
Floor - 1												

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Plan Review
Carrier HAP

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1700 COOLING OA DB / WB 92.2 °F / 59.8 °F			HEATING DATA AT DES HTG HEATING OA DB / WB -3.0 °F / -4.6 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	2800 ft²	141069	-	2800 ft²	-	-
Wall Transmission	3686 ft²	7357	-	3686 ft²	24147	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	2800 ft²	15227	-	2800 ft²	85848	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	17700 ft²	0	-	17700 ft²	21302	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	14514 W	45622	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	12390 W	40790	-	0	0	-
People	270	65107	72900	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	40700	0	-	0	0
Safety Factor	10% / 10%	35587	7290	10%	13130	0
>> Total Zone Loads	-	**391460**	**80190**	-	**144426**	**0**
Zone Conditioning	-	402979	80190	-	143699	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	25154 CFM	0	-	25154 CFM	0	-
Ventilation Load	6395 CFM	84408	-80193	6395 CFM	410937	0
Supply Fan Load	25154 CFM	18647	-	25154 CFM	-18647	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	2%	7829	-	2%	2889	-
>> Total System Loads	-	**513863**	**-3**	-	**538877**	**0**
Central Cooling Coil	-	513863	0	-	0	0
Central Heating Coil	-	0	-	-	538877	-
>> Total Conditioning	-	**513863**	**0**	-	**538877**	**0**
Key:	**Positive values are clg loads Negative values are htg loads**			**Positive values are htg loads Negative values are clg loads**		

The formatting for the Carrier HAP reports is different but provides the information needed for review. The above is just one of several reports that can be requested.

Plan Review
HVAC Calculations

Take aways:

- Require calculations for review
- Verify design temperatures
- Verify Thermal envelope values
- Now that the heat gains (air conditioning load) and heat losses (heating loads) have been verified, we can determine if the proposed heating and cooling appliances are properly sized. Not oversized

Do not hesitate to ask questions/make comments. Many of us are not mechanical engineers, but we can certainly verify the design parameters and make comments when loads seem out of the norm. Or the appliances are oversized.