Technical Report 2

MECHANICAL

Building and Plant Energy & Emissions Analysis

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Executive Summary

This technical report is the analysis of building loads and energy consumption. The analysis is preformed with the computer program Trane TRACE 700. This is a HVAC design based program that allows for accurate building modeling. Many inputs to this program are available in libraries that evaluate the occupancy categories of the building.

Twin Rivers Elementary/Intermediate will have a very large heating load during the school year. The cooling load is considerably lower due to in-occupancy during summer break. The outcome of the calculations is a little skewed due to over simplification of the building model and system design.

The cost of the

Mechanical Systems Summary

The Twin Rivers Elementary/Intermediate School will house 800 students of the Mckeesport Area School District. It is a two story building of 30,000 sq. ft. The Mechanical system is designed to save 30% of energy when compared to ASHRAE standard 90.1-2007. ASHRAEs Advanced Energy Design Guide for K-12 School Buildings also had a major impact on the design.

The main heating and cooling will come from a geothermal system. This will be an earth coupled water loop directly connected to water-to-air heat pumps. There will be 2 well fields located slightly north of the building's foundation. The earth coupled water loop will also be connected to a chiller, serving air handling units.

The ventilation system consists of 2 dedicated outside air systems (DOAS) which serve the classrooms and most of the building. The library, cafeteria, gymnasium, and offices each have individual air handling units (AHU). The library and office AHUs will have zone reheat coils. The gym and cafeteria AHUs will consist of just a single zone.

Building Load Calculations

This building energy analysis was preformed using the computer program Trane TRACE 700. This program is able to calculate both load design and energy analysis. Input data came from Construction Documents of the Twin Rivers Project and also assumptions were made for any missing information by taking ASHREA standards into account.

Design Conditions

Twin Rivers Elementary/Intermediate is in Mckeesport, PA. This is less than 20 miles from downtown Pittsburgh, PA. This area is mostly a urban area. For this report, weather data is taken from Pittsburgh. The climate that the school is located in is zone 5A according to 90.1's table B-1. Type A is considered to be very humid in the summers, where the OA needs to be air conditioned to be considered comfortable. Table 1 demonstrates the necessary design conditions of the indoor air.

	Summer	Design	Winter	Design
Space	db (deg F)	% RH Max	db (deg F)	% RH Max
Computer				
Labs/Classrooms	75	60	72	20
Offices	75	60	72	20
Library	75	60	72	40
Gymnasium	75	60	72	20
Cafeteria	75	60	72	20
Restrooms	78	60	70	20

Table 1: Design Interior Temp and Relative Humidity

Model Design

The calculations performed for this report were based on a block load and energy analysis. This is a simplified design. Similar areas were formed into blocks for the entire school. for example, a large grouping of classrooms are considered to be one block. Within Trace, templates for different zone types were created (see appendix B and C). Eleven zone types summarize the school. These include:

1. Cafeteria	5. Gymnasium	9. Nurse's area
2. Classroom	6. Kitchen	10 Officer
3. Computer Lab	7. Library	10. Onices
4. Corridor	8. Mechanical & Electrical	11. Water Closets

The building can be broken into blocks using these zone types. Twin Rivers has 61 blocks and can be seen below. The different colors represent the different zone types.



Figure 1: Zone Type Key

First Floor South Blocks



Figure 2: Building Plan Key



First Floor North Blocks



Second Floor South Blocks



Second Floor North Blocks



The school is nearly oriented to the cardinal directions. For simplicity, the TRACE model uses 0 °, 90°, 180 °, and 270 ° to represent the North, East, South, and West sides of the building respectfully. The main entrance to the building is located on the eastern side.

Load Assumptions

Data was taken from mechanical drawings and schedules. If information was not available, ASHREA standards were taken into consideration.

Occupancy Assumptions

There were no occupancy values given in the construction documents. Because of this, assumptions were made. In ASHREA standard 62.1, table 6-1 gives density values for certain occupancy categories in persons per 1000 sqft. However, TRACE automatically fills in a correct density for this value. My zones correlated to these categories so this table was not needed. The exception to this was the mechanical spaces and the restrooms(water closets). Both of these are not available in the ASHREA table. The mechanical spaces were assumed to have 2 people within the space. The restrooms were assumed to have the density equivalent to a reception area, which was available in the TRACE library.

Ventilation Assumptions

The building was designed to use ASHREA standard 62.1. The given value for breathing zone CFM rate in the documents is exactly the same as the automatic fill in of TRACE of the CFM/person and CFM/sqft values within the airflow tab. Flow rates not given in the document, such as for mechanical spaces, were taken from the automatic fill by occupancy. The zone type mechanical/electrical was placed under the occupancy of "Electrical Equipment Rooms". The ventilation values are shown in the table below. All of these zones will have air supplied through the ceiling and also have a ceiling return.

Zone Type	Minimum Ventilation Rates (CFM/person)	Minimum Ventilation (cfm/SF)	Infiltration (ACH)
Cafeteria	7.5	0.18	13
Classroom	10	0.12	6
Computer Lab	10	0.12	10
Corridor	0	0.06	4
Gym	0	0.3	8
Kitchen	7.5	0.12	15
Library	5	0.12	4
Mech/Elec	0	0.06	4
Nurse	10	0.18	8
Office	5	0.06	4
Water Closet	20	0.06	10

Table 2. Modeled Ventillation flates

Lighting and Equipment Electrical Load Assumptions

Due to incomplete electrical drawings, the true lighting values are unknown. ASHREA Standard 90.1 gives design values for lighting power densities for specific spaces. These were used in the TRACE model. Extra load was applied where it was known to have either computers or printers. A laser printer adds an additional 300 Watts. (load of workstations is not tabulated below)

Zone Type	LPD (W/SF)	Misc. Loads (W/SF)
Cafeteria	0.9	0
Classroom	1.24	0.22
Computer Lab	1.23	300 [W]
Corridor	0.66	0
Gym	1.2	0
Kitchen	0.99	0
Library	1.18	300 [W]
Mech/Elec	0.95	Per Equip.
Nurse	0.87	0
Office	1.11	300 [W]
Water Closet	0.98	0

Table	3.	Lighting	and	Misc	Loads
Table	J.	Lighting	anu	misc.	LUaus

Construction

For simplicity, there was only one wall type considered in the model. This was the exterior wall construction. The glazing was also reduced to one single type. The chosen construction model were the ones that best resembled the U-values of the designed building's values. A view of the TRACE construction tab is available in Appendix A.

			Shading
Wall type	R-Value	U-Value	coefficient
Exterior	14.5	0.0690	
Roof	30	0.03333	
Windows		0.293	0.48

Heating and Cooling Model Design

Multiple ventilation systems were created for this model. There is 2 DOASs and 4 AHU. These were all supplied with hot and chilled water from the geothermal system. The ground source heat pumps from the vertical, closed loop geothermal system, were modeled by a water source heat pump. In reality, this is a hybrid system with direct piping to the room heat pumps and piping to a chiller which then supplies the AHU's coils. This is a complex system and difficult to model in this program. In this model, there is only cooling from the wells and all hot water coils are connected to a back up boiler. This causes the model to be slightly inaccurate.

Calculated Load Vs. Designed Load

There is no load calculation from the mechanical engineers of the Twin Rivers Project with which to compare these results.

The building peak load for heating is calculated to be 10,998 MBh. The building peak load for cooling is 430 tons. The cooling load is about half of the heating load. This makes sense because a school building is not needed for the hot summer days.



Average Heating and Cooling Load per Month

It is assumed that a more advanced model done by the mechanical engineers would be more accurate portrayal of the building load. The peak heating load is rather high. This may be due to the lack of an exact heating and cooling model, blocking instead of individual room analysis, one wall and window type construction, and other inaccuracies.

Other TRACE Load Calculation Outputs can be viewed in appendix D

Energy Calculation and Operating Cost

Energy Consumption

The following table summarizes the school's energy consumption for the entire year. The building runs mainly on electricity but, it also has a natural gas line to the auxiliary boiler. This gas line should be minimal compared to the electricity going into the building.

Cost Analysis

Appendix A

Miscellaneous TRACE input data

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盘	Create	e Rooms		61 Rooms					
σ	Create	e Systems	5	6 Systems					
	Assigr	n Rooms	to Systems	61 Assigne	dRooms				
	Create	e Plants		2 Plants					
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Roof	6	' HW Co	nc, 6" Ins, 6"	HW RTS	•	0.033			Delete
Wall	F	ace brick	, 2.42'' Ins		-	0.0692529			
Partit	ion 0	75'' Gyp	Frame		-	0.387955			
Glass ty	ре					U-factor Btu/h-ft ^{e.} *F	Shading coeff		
Wind	low 6	mm Dbl L	ow-E (e2=.04) Clr 13mm Ai	r 💌	0.293	0.48		
Skylig	ght S	ingle Clea	ar 1/4''		•	0.95	0.95		
Door	S	tandard [)oor		•	0.2	0		
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		Misc loads 0.22	W/sq ft 💌	Cooling VAV min	% Clg Air	flow 💌
				Heating VAV max	% Clg Air	flow 🔄
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Operating mode		-	Capacity			Energy rate		Packaged
Cooling		10.00	tons		0.761	kW/ton		Breakout
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Appendix B

Internal Load Templates

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Sensible	275	Btu/h		Latent 2	75 Btu	/h		Delete	
Workstation	s							Add Global	
Density	0	workstation/person	-						
Lighting									
Туре	Fluores	cent, hung below ceili	ng, 100	% load to space	č.		•		
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Miscellaneo	us loads								
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Description	Gym			·			Close
People							
Туре	None					•	New
Density	15	sq ft/person	- Sch	edule Lights - El	ementary Gymnasium	•	Сору
Sensible	250	Btu/h	Late	nt 100 E	}tu/h		Delete
Workstation	s						Add Global
Density	0	workstation/person	•				
Lighting							
Туре	Fluoresc	ent, hung below ceiling	, 100% load	to space		•	
Heat gain	1.2	W/sq.ft	 Sch 	edule Cooling O	nly (Design)	-	
Miscellaneo	us loads						
Туре	None					-	
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Alberta	A.1:		1000				Apple
Alternative	Alterna	ative 1					Apply
Description	Library		<u> </u>				Close
^D eople	-						Maur
Туре	Library			22		•	
Density	50	sq ft/person 📃 💌] Schedule	Misc - Elen	nentary School	•	Сору
Sensible	245	Btu/h	Latent	155 B	tu/h		Delete
Workstations	s						Add Globa
Density	30	workstations 🔹	I				
Liahtina							
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Miscellaneou _	us loads						
Туре	Laser Prin	nter	7	-		_	
Energy	300	w _	Schedule	Cooling On	nly (Design)	_	
meter	Electricity	, 🚽					
<u>I</u> nternal	Load	Airflow	<u>I</u> herm	nostat	Construction]	<u>B</u> oom
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<u>Internal</u> ternal Load	Load Template Alterna	<u>Airflow</u> es - Project ative 1	<u>I</u> herr	nostat	Construction		<u>B</u> oom
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Internal Load	Template	es - Project					X
Alternative	Alterna	ative 1	•				Apply
Description	Nurse		•				Close
People							
Туре	General 0	Office Space				-	New
Density	143	sq ft/person 👻	Schedule	People - M	iddle School	-	Сору
Sensible	250	 Btu/h	- Latent	200 B	tu/h		Delete
Workstation	•						Add Global
Density	• 1	work stations	1				
l islations	1.	workstations	1				
Lighting				1-12-1			
Type	Fluoresce	ent, hung below ceiling, 10	JU% load to spa 1	ace			
Heat gain	0.87	W/sq.ft 👱	Schedule	Lights - Ho	spital lobby	<u> </u>	
Miscellaneou	us loads						
Туре	None					•	
Energy	0	W/sq.ft 💽 💌	Schedule	Cooling On	ıly (Design)	•	
Energy	None	-	I				
<u>Internal</u>	Load	<u>A</u> irflow	<u>I</u> hern	nostat	<u>C</u> onstruction		<u>R</u> oom
Internal Load	l lemplate	es - Project					
Alternative	Altern	ative 1	-				Apply
Description	Office		•				Close
People							
Туре	General	Office Space				-	New
Density	143	sq ft/person 🖉 💌] Schedule	People - M	fiddle School	•	Сору
Sensible	250	Btu/h	Latent	200 B	ltu/h		Delete
Workstation	IS						Add Global
Density	0.8	workstation/nerson	1				
12-14-5	1		-				
Lighting							
rype	Fluoresce	ent, hung below celling, T	UU% load to sp	ace	c.		
Heat gain	i ji li li	w/sq rt	_ Schedule	Lights - Un	nce	-	
Miscellaneo	us loads						
Туре	Laser Pri	nter				-	
Energy	300	w _] Schedule	Cooling Or	nly (Design)	•	
Energy	Electricity	y 🔫]				
motor		2					
motor							
motor							

Internal Load	Templ	ates - Project						×
Alternative	Alte	mative 1		•				Apply
Description	Wa	ter Closet		•				Close
People								
Туре	Recep	otion Area					•	New
Density	16.7	sq ft/person	•	Schedule	People - N	1iddle School	-	Сору
Sensible	245	Btu/h		Latent	155 E	}tu/h		Delete
Workstations								Add Global
Density		workstation/pers	on 🔻					
(1		Thomason boo						
Lignting	-							
туре	Fluore	scent, hung below c	eiling, 100	% load to spa	ace			
Heat gain	0.98	W/sq ft	_	Schedule	Misc - Mid	ldle School	_	
Miscellaneou	us loads.							
Туре	None						•	
Energy	0	W/sq.ft	-	Schedule	Cooling O	nly (Design)	-	
Energy meter	None		•					
						1		
<u>I</u> nternal	Load	<u>A</u> irflow		<u>T</u> herm	nostat	<u>Construction</u>		<u>R</u> oom

Appendix C

Airflow Templates

inflow Templa	ites - Fit						
Alternative	Alterna	itive 1		•			Apply
Description	Cafeter	ia		•			Close
Main supply				Auxiliary supply			
Cooling		To be calculated	•	Cooling 🗍	To be calculated	·	New
Heating		To be calculated	•	Heating 🗌	To be calculated	·	Сору
/entilation				Std 62.1-2004/2007			Delete
Apply ASHF	RAE Stde	2.1-2004/2007 Yes	-	Clg Ez Ceiling o	lg supply, ceiling retu 💌 🕇	100 %	Add Global
Туре	Cafete	ria/fast food dining	•	Htg Ez Ceiling s	upply > trm+15°F(8°C 💌	80 %	Addictional
Peop-based	7.5	cfm/person	-	Er Default	based on system type 💌 🛛	~ %	
Area-based	0.18	cfm/sq ft	•	DCV Min OA Int	ake None	-	
Schedule	Availat	ole (100%)	-	Room exhaust			
Infiltration				Rate 0	air changes/hr 🔄	·	
Туре	None		-	Schedule Avai	able (100%) 📃 💌	·	
Cooling	13	air changes/hr	•	VAV control			
Heating	13	air changes/hr	•	Clg VAV min	Clg Airflow	•	
Schedule	Availat	ole (100%)	•	Htg VAV max	% Clg Airflow	-	
				Schedule	Available (100%)	•	
				Туре	Default	•	
Internal Lo	ad	<u>A</u> irflow		<u>T</u> hermostat	Construction	1	<u>R</u> oom
Internal Lo	ad ites - Pro	<u>A</u> irflo w		<u>I</u> hermostat	Construction]	<u>R</u> oom
<u>I</u> nternal Lo rflow Templa	ad ites - Pro	<u>A</u> irflo w		<u>T</u> hermostat	Construction	J	<u>R</u> oom
<u>I</u> nternal Lo flow Templa Alternative	ad tes - Pro Alterna	<u>A</u> irflow		<u>T</u> hermostat	<u>C</u> onstruction	J	<u>R</u> oom
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irflow Templat	tes - Pro	ject				2
Alternative	Alternal	tive 1	•		ł	Apply
Description	Comput	er Lab	•			Close
Main supply			Auxiliary supply			
Cooling		To be calculated 💌	Cooling	To be calculated 💌		New
Heating		To be calculated 💌	Heating 🗌	To be calculated 💌		Сору
Ventilation			Std 62.1-2004/2007.)elete
Apply ASHR	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling o	lg supply, ceiling retu 💌 10	10 %	
Туре	Comput	ter lab 🗾	Htg Ez Ceiling s	upply > trm+15°F(8°C 💌 80) % <u>Add</u>	1 GIODAI
Peop-based	10	cfm/person 💌	Er Default I	based on system type 💌	~ %	
Area-based	0.12	cfm/sq ft 🗾	DCV Min OA Inta	ake None	-	
Schedule	Availab	le (100%) 🔹	Room exhaust			
Infiltration			Rate 0	air changes/hr 💌		
Туре	None	•	Schedule Avail	able (100%) 📃 💌		
Cooling	10	air changes/hr 🔹	VAV control			
Heating	10	air changes/hr 🔹	Clg VAV min	% Clg Airflow	-	
Schedule	Availab	le (100%)	Htg VAV max	% Clg Airflow	Ţ	
			- Schedule	Available (100%)		
			Tune	Default		
			.,µ-	[Dordak		
1. 11	-					
Internal Loa		Aimow	Inermostat		<u>n</u> oor	n
irflow Templa	tes - Pro	oject				
Alternative	Alterna	tive 1	•			Apply
Description	Corrido	r	•			Close
Main supply			Auxiliary supply			
Cooling		To be calculated 💌	Cooling	To be calculated 💌		New
Heating		To be calculated 💌	Heating	To be calculated 👻	i —	Сору
Ventilation	,		Std 62.1-2004/2007		· _	Delete
Apply ASHR	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling o	olg supply, ceiling retu 💌 1	00 %	Jelete
Туре	Corrido	rs 🔻	Htg Ez Ceiling :	supply > trm+15°F(8°C 💌 8	Ad	d Globa
Peop-based	0	cfm/person 🔹	Er Default	based on system type 💌	- %	
Area-based	0.06	cfm/sq ft 🔹	DCV Min OA Int	ake None	-	
Schedule	Availat	, ble (100%) ↓	Boom exhaust		_	
Infiltration			Rate 0	air changes/hr 💌		
Type	None	-	Schedule Avai	lable (100%)	1	
Cooling	4	air changes/hr 🔍	VAV control			
Heating	4	air changes/hr	Clg VAV min	% Cla Airflow	-	
Schedule	Availab	le (100%)	Htg VAV may	Cla Airflow		
Schodule) andu		Schedule	Available (100%)		
			Tupe			
			Type		_	
				1		
Internal Lo	ad	<u>A</u> irflow	<u>T</u> hermostat	<u>Construction</u>	<u> </u>	m

irflow Templat	tes - Pro	ject			— ×
Alternative	Alternal	tive 1	•		Apply
Description	Gym		•		Close
Main supply			Auxiliary supply		
Cooling		To be calculated 💌	Cooling	To be calculated 💌	New
Heating		To be calculated 💌	Heating	To be calculated 💌	Сору
Ventilation			Std 62.1-2004/2007	·	Delete
Apply ASHR	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling	clg supply, ceiling retu 💌 100 🕺	Add Global
Туре	Gym, st	adium (play area) 📃 💌	Htg Ez Ceiling	supply > trm+15°F(8°C 💌 80 🕺	
Peop-based	0	cfm/person 🔹	Er Default	based on system type 💌 🛛 🎗	
Area-based	0.3	cfm/sq ft 🔹	DCV Min OA Int	take None 💌]
Schedule	Availab	ile (100%) 📃	Room exhaust		
Infiltration			Rate 0	air changes/hr 💌	
Туре	None	•	Schedule Avai	ilable (100%) 🔹 💌	
Cooling	8	air changes/hr 💌	VAV control		
Heating	8	air changes/hr 💌	Clg VAV min	Clg Airflow]
Schedule	Availab	le (100%) 🔹	Htg VAV max	📃 🛛 🗶 Clg Airflow]
			Schedule	Available (100%)]
			Туре	Default	-
				-	-
Internal Loa	ad	Airflow	Thermostat	Construction	Boom
- 	 D		±)	
intow Templa	tes - Pro	oject			<u> </u>
Alternative	Alterna	tive 1	•		Apply
Description	Kitcher	1	•		Close
Main supply			Auxiliary supply		
Cooling		To be calculated 💌	Cooling	To be calculated 💌	New
Heating		To be calculated 💌	Heating	To be calculated 💌	Сору
Ventilation			Std 62.1-2004/2007	7	Delete
Apply ASHR	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling	clg supply, ceiling retu 💌 100 🖇	Add Global
Туре	Kitcher	n - cooking 📃 💌	Htg Ez Ceiling	supply > trm+15°F(8°C 💌 80 🏾 %	
Peop-based	7.5	cfm/person 🗨	Er Default	based on system type 💌 🕺	\$
Area-based	0.12	cfm/sq ft 🛛 👻	DCV Min OA In	take None 💌	·
Schedule	Availab	ole (100%) 🔹 💌	Room exhaust		
Infiltration			Rate 0	air changes/hr 💌	
Туре	None	•	Schedule Ava	ilable (100%) 📃 💌	
Cooling	15	air changes/hr 📃 💌	VAV control		
Heating	15	air changes/hr 💌	Clg VAV min	% Clg Airflow	·
Schedule	Availab	ile (100%)	Htg VAV max	% Clg Airflow	·
			Schedule	Available (100%)	
			Туре	Default	·
				-	
Internal Los		Airflow	Thermostat	Construction	Boom
Turoniaricor		0000	Tuennestat		<u>11</u> 00111

Airflow Templat	tes - Pro	ject			×
Alternative	Alternal	tive 1	•		Apply
Description	Library		•		Close
Main supply			Auxiliary supply		
Cooling		To be calculated 💌	Cooling	To be calculated 💌	New
Heating		To be calculated 💌	Heating	To be calculated 💌	Сору
Ventilation			Std 62.1-2004/2007.		Delete
Apply ASHR	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling o	olg supply, ceiling retu 💌 100	%
Туре	Librarie	s 💌	Htg Ez Ceiling s	supply > trm+15°F(8°C 💌 80	
Peop-based	5	cfm/person 💌	Er Default	based on system type 💌	~
Area-based	0.12	cfm/sq ft 💽 👻	DCV Min OA Int	ake None	•
Schedule	Availab	le (100%) 🔹	Room exhaust		
Infiltration			Rate 0	air changes/hr 🗨	
Туре	None	-	Schedule Avail	lable (100%) 🗾 💌	
Cooling	4	air changes/hr 🗨	VAV control		
Heating	4	air changes/hr 🛛 💌	Clg VAV min	% Clg Airflow	•
Schedule	Availab	le (100%) 🔹	Htg VAV max	% Clg Airflow	•
			Schedule	Available (100%)	•
			Туре	Default	-
Internal Loa	ad	Airflow	Thermostat	Construction	Room
		L))_	_
amow rempia	tes - Pit	Ject			
Alternative	Alterna	tive 1	<u> </u>		Apply
Description	Mech/	Elec	-		Close
Main supply			Auxiliary supply		
Cooling		To be calculated 💌	Cooling	To be calculated 💌	New
Heating		To be calculated 💌	Heating	To be calculated 💌	Сору
Ventilation			Std 62.1-2004/2007		Delete
Apply ASHF	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling	clg supply, ceiling retu 💌 100) % — Add Global
Туре	Electric	al Equipment Rooms 💌	Htg Ez Ceiling :	supply > trm+15°F(8°C ▼ 80	-
Peop-based		cfm/person	Er Default	based on system type	%
Area-based	0.06	cfm/sq ft	DCV Min OA Int	ake None	_
Schedule	Availat	ole (100%) 📃 👤	Room exhaust		
Infiltration			Rate 0	air changes/hr ▼	
Туре	None	<u> </u>	Schedule Avai	ilable (100%)	
Cooling	4	air changes/hr 🔄	VAV control	p	
Heating	4	air changes/hr	Clg VAV min	Clg Airflow	-
Schedule	Availat	le (100%) 🔹	Htg VAV max	% Clg Airflow	<u> </u>
			Schedule	Available (100%)	<u> </u>
			Туре	Default	<u> </u>
Internal Lo	ad	Airflow	<u>T</u> hermostat	<u>C</u> onstruction	<u>R</u> oom

Airflow Templat	tes - Pro	ject			×
Alternative	Alternal	ive 1	•		Apply
Description	Nurse				Close
Main supply			Auxiliary supply		
Cooling		To be calculated 💌	Cooling	To be calculated 💌	New
Heating		To be calculated 💌	Heating	To be calculated 💌	Сору
Ventilation			Std 62.1-2004/2007.		Delete
Apply ASHR	AE Std6;	2.1-2004/2007 Yes 💌	Clg Ez Ceiling d	olg supply, ceiling retu 💌 100 %	
Туре	Daycar	e (through age 4) 🛛 💌	Htg Ez Ceiling s	supply > trm+15°F(8°C ▼ 80 %	Add Global
Peop-based	10	cfm/person 💌	Er Default	based on system type 💌 🕺	
Area-based	0.18	cfm/sq ft 💽	DCV Min OA Int	ake None 💌	
Schedule	Availab	le (100%) 🗾	Room exhaust		
Infiltration			Rate 0	air changes/hr 💌	
Туре	None	-	Schedule Avail	able (100%) 🔹	
Cooling	8	air changes/hr 💌	VAV control		
Heating	8	air changes/hr 💌	Clg VAV min	🛛 🛛 🗶 Clg Airflow 💌	
Schedule	Availab	e (100%) 🔹	Htg VAV max	% Clg Airflow	
			Schedule	Available (100%)	
			Туре	Default 🗾	
Internal Loa	ad	Airflow	Thermostat	Construction	Room
Airflow Templa	tes - Pro	ject			
Alternative	Alterna	tive 1	-		Apply
Description	Office		•		Close
Main supply		NA	Auxiliary supply		
Cooling		To be calculated 💌	Cooling	To be calculated 💌	New
Heating		To be calculated 💌	Heating	To be calculated 💌	Сору
Ventilation			Std 62.1-2004/2007		Delete
Apply ASHR	AE Std6	2.1-2004/2007 Yes 💌	Clg Ez Ceiling o	olg supply, ceiling retu 💌 100 🕺	Add Global
Туре	Office s	pace 🗾	Htg Ez Ceiling s	supply > trm+15°F(8°C 🛨 80 %	
Peop-based	5	cfm/person 💌	Er Default	based on system type 💌 📃 🕺	
Area-based	0.06	cfm/sq ft 🗾 👻	DCV Min OA Int	ake None 💌	
Schedule	Availab	le (100%) 📃 💌	Room exhaust		
Infiltration			Rate 0	air changes/hr 🔄	
Туре	None	_	Schedule Avai	lable (100%) 📃	
Cooling	4	air changes/hr 💽	VAV control		
Heating	4	air changes/hr 💌	Clg VAV min	│	
Schedule	Availab	le (100%) 📃 💌	Htg VAV max	📃 🕺 Clg Airflow 💌	
			Schedule	Available (100%)	
			Туре	Default	
Internal Lo	əd	Airflow	Thermostat	Construction	Room

Alternative	Alterna	ative 1		•			Apply
Description	Water	Closet		•			Close
Main supply				Auxiliary supply			
Cooling		To be calculated	-	Cooling 🗌	To be calculated 💌		New
Heating		To be calculated	-	Heating	To be calculated 💌		Сору
Ventilation				Std 62.1-2004/200	7		Delete
Apply ASHR	AE Stdf	52.1-2004/2007 Ye	3 💌	Clg Ez Ceiling	clg supply, ceiling retu 💌 100	1%	Add Globa
Туре	Health	n club/ weight rooms	•	Htg Ez Ceiling	supply > trm+15°F(8°C ▼ 80	%	
Peop-based	20	cfm/person	•	Er Defaul	t based on system type 💌	%	
Area-based	0.06	cfm/sq ft	-	DCV Min OA Ir	ntake None	•	
Schedule	Availa	ble (100%)	-	Room exhaust			
Infiltration				Rate 0	air changes/hr 💌		
Туре	None		-	Schedule Ava	ailable (100%) 📃 💌		
Cooling	10	air changes/hr	•	VAV control			
Heating	10	air changes/hr	-	Clg VAV min	% Clg Airflow	•	
Schedule	Availa	ble (100%)	•	Htg VAV max	% Clg Airflow	•	
				Schedule	Available (100%)	•	
				Туре	Default	•	
Internal Loa	hd	Airflow	Г	Thermostat	Construction		Room

Appendix D

TRACE Calculation Output



Alternative 1

Building Airside Systems and Plant Capacities

	() ()			Peak	Plant Loa	ds						E	Block Plan	nt Loads			
					Stg 1	Stg 2			Time					Stg 1	Stg 2		
	Main	Aux	Opt Vent	Misc	Desic	Desic	Base	Peak	Of	Main	Aux	Opt Vent	Misc	Desic	Desic	Base	Block
	Coil	Coil	Coil	Load	Cond	Cond	Utility	Total	Peak	Coil	Coil	Coil	Load	Cond	Cond	Utility	Total
Plant System	ton	ton	ton	ton	ton	ton	ton	ton	mo/hr	ton	ton	ton	ton	ton	ton	ton	ton
Ground Source Heat Pump	429.8	0.0	0.0	0.0	0.0	0.0	0.0	429.8	7/15	413.1	0.0	0.0	0.0	0.0	0.0	0.0	413.1
DOAS_1	128.6	0.0	0.0	0.0	0.0	0.0	0.0	128.6	7/15	125.7	0.0	0.0	0.0	0.0	0.0	0.0	125.7
DOAS_2	169.0	0.0	0.0	0.0	0.0	0.0	0.0	169.0	7/15	165.3	0.0	0.0	0.0	0.0	0.0	0.0	165.3
AHU_1	60.1	0.0	0.0	0.0	0.0	0.0	0.0	60.1	7/15	60.1	0.0	0.0	0.0	0.0	0.0	0.0	60.1
AHU_2	17.2	0.0	0.0	0.0	0.0	0.0	0.0	17.2	7/15	17.2	0.0	0.0	0.0	0.0	0.0	0.0	17.2
AHU 3	39.9	0.0	0.0	0.0	0.0	0.0	0.0	39.9	7/15	39.9	0.0	0.0	0.0	0.0	0.0	0.0	39.9
AHU 4	15.1	0.0	0.0	0.0	0.0	0.0	0.0	15.1	7/15	5.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Building totals	429.8	0.0	0.0	0.0	0.0	0.0	0.0	429.8	101100	413.1	0.0	0.0	0.0	0.0	0.0	0.0	413.1
	Building p	eak load	l is 429.8 tons	e.					Buildin	g maximu	um block	load of 413.	1 tons oc	curs in Ju	ily at ho	ur 15	
									based	on system	n simulat	tion			5		

								В	y AC		С								
AHU_1						14.12			c							Single Zone	Variable Ai	r Vo	lume
	COOLING COIL PEAK						.G SPACE	PEAK				HEATING	COIL	PEAK	TEM	IPERATURE	S		
	Peaked Ou	l at Time: Itside Air:	OADB/WB	o/Hr: 7 / 15 /HR: 86 / 71 /	95		Mo/Hr: OADB:	7 / 15 86	-			Mo/Hr.	Heatir 5	ng Design		SADB Ra Plenum	Cooling 55.0 75.1	He	eating 264.1 69.3
		Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Perc Of To	ent otal (%)	Space Sensible Btu/h	Percen Of Tota (%	nt 11 1)			Space Peak Space Sens Btu/h		Coil Peak Tot Sens Btu/h	Percent Of Total (%)	Return Ret/OA Fn MtrTD	75.1 78.7 0.0		69.3 7.9 0.0
Skylite Solar 0 Skylite Cond 0		0	0		0	0		Skylite So Skylite Co		olar olar ond	0		0	0.00	Fn BldTD Fn Frict	0.0		0.0	
Glass Solar Glass/Door	Cond 0 4,722 4,722 4,722 sSolar 21,884 0 21,884 0 21,884 srDoor Cond 1,361 0 1,361 0 1,361 Cond 551 449 999 99 100/Door 0 0 0		3	21,884	5:		Glass/Doc	ar ar Cond	-13 638	1	-15,742 0 -13,638	0.00	4	IRFLOWS					
Wall Cond Partition/Do				0	551	1 0		Wall Cond Partition/E	d Door	-3,068		-5,544	0.36	Diffuser	18,98	g H 4	5,695		
Floor Adjacent Floor	oor	0 0 242 975	0	242 975		0:	0	4	0	Floor Adjacent I	Floor	-1 161 735		-1 161 735	0.00 0 74 58	Main Fan	18,984	4	5,695
Sub Total =	Total ==> 266,770 5,171 271,941		38	220,397	5	54 Sub Total =			-1,178,441		-1,196,659	76.83	Nom Vent AHU Vent	6,236	B	5,439 5,439			
Internal Load	ds								In	ternal Loa	ds					Infil	16,745	5	16,745
Lights People Misc		23,513 338,346	0	23,513 338,346 0		3 47 0	23,513 161,024 0	4	0	Lights People Misc		0		0	0.00	MinStop/Rh Return Exhaust	5,695 35,728 22,985	5	5,695 22,440 22,184
Sub Total =		361,859	0	361,859		50	184,537	4	6	Sub Total		0		0	0.00	Rm Exh Auxiliary	(0	0
Ceiling Load Ventilation L Adi Air Trans	oad s Heat	300	-300	90,595		13:	300	A		entilation L di Air Tran	i .oad s Heat	-1,620		-377,357	24.23	Leakage Dwn Leakage Ups		ם	0
Dehumid. Ov	v Sizing			0		0			0	/Undr Siz	ing	0		0	0.00				_
Ov/Undr Sizi	ing	0	-3 137	-3 137		0	0		E	haust Heat	Diff			16,401	-1.05	ENG	NEERING C	KS	
Sup. Fan Hea Ret, Fan Hea	at		0,101	0		0			R	A Preheat	Diff.			0	0.00	% OA	Cooling 32.9	He	eating 95.5
Duct Heat Pl Underfir Sup	kup ht Pkup	0	0	0		0:			U	nderfir Su	p Ht Pkup			0	0.00	cfm/ft ² cfm/ton	2.56 315.84		0.77
Supply Air L	Supply Air Leakage		1734	721 258	100	0	405 235	100.0	Supply Air		eakage	-1 180 069		-1 557 616	100.00	ft²/ton Btu/hr-ft²	123.42 97.23 651	-2	89.90
onuna rotar		020,000	COOLIN		ECTI	201	100,200	100.01		1		ADEA		1,007,010	100.00	EATING COU	SELECTIC	M	
	To	otal Capacity	Sens Cap.	Coil Airflow	ECIN	ter DB/W	B/HR	Lear	ve DE	B/WB/HR	(Gross Total	Gla	SS (P()	п	Capacity MBb	Coil Airflow	En	nt Lvo
Main Clg	60.	1 721.3	480.2	18,984	78.7	68.4	92.4	55.0	55.0	67.4	Floor	7,418		(30)	Main Htg	-1,557.6	5,695	7.9	264.
Aux Clg	0.	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part Int Door	0			Aux Htg	0.0	0	0.0	0.0
Total	60.	1 721.3	0.0	U	0.0	0.0	0.0	0.0	0.0	0.0	ExFir	0 7,418	0	0	Humidif	0.0	0	0.0	0.0
											Ext Door	1,040	0	0	Total	-1 557 6	U	0.0	0.0

System Checksums

Project Name: Elementary Dataset Name: Thesis.trc TRACE® 700 v6.2.10 calculated at 10:56 PM on 10/03/2013 Alternative - 1 System Checksums Report Page 1 of 6



System Checksums By ACADEMIC

							S	Syster By	n C	heck ADEMI	c C								
AHU_3																Single Zone	Variable Ai	ir Vol	ume
	(COOLING	OIL PEAK			C	LG SPACE	PEAK				HEATING	COIL	PEAK		TEM	PERATURI	ES	
Peaked : Out		at Time: tside Air:	M OADB/WE	o/Hr: 7 / 15 /HR: 86 / 71 / 9	95		Mo/Hr: OADB:	7 / 15 86	-			Mo/Hr: Heating Desig OADB: 5				SADB Ra Plenum	Cooling 49.1 75.2	He. 2	ating 237.4 68.9
Envelope Lo Skylite Sola Skylite Con	Space Plenum N Sens. + Lat. Sens. + Lat. Tot ope Loads Btu/n Btu/n Btu te Solar 0 0 0		Net Total Btu/h	Perce Of Tol (nt tal %)	Space Sensible Btu/h 0	Percent Of Total (%)	Envelope Lo Skylite So Skylite Co		oads Iar	Space Peak Space Sens Btu/h		Coil Peak Tot Sens Btu/h	Percent Of Total (%) 0.00	Return Ret/OA Fn MtrTD Fn BldTD Fn Frict	75.2 77.3 0.0 0.0 0.0		68.9 31.0 0.0 0.0 0.0	
Roof Cond Glass Solar Glass/Door	Cond	0 9,903 626	5,270	5,270 9,903 626	L	1 2	0 9,903 626	0 0 Roof Cond 9,903 3: Glass Solar 626 0 Glass Door Cond		d ar	6 277		-17,547	1.95	A	IRFLOWS			
Wall Cond Partition/Do Floor Adjacent Flo	Otessicol Cond 200 200 1,3 Partition/Door 0 1,3 1,3 Floor 0 0 1,3 Floor 0 0 1,3 Infination 204,446 204,4 204,4 Sub Total ==> 215,868 5,729 221,5 Internal Loads Lights 32,775 0 32,7 Vende Cond 1456 0 1456 146 Sub Total ==> 209,429 0 209,4 209,429 Ceiling Load 0 604 -604 50,4 Af Air Trans Heat 0 0 50,4		1,352 0 0		0	893 0 0	0000	Wall Co Partition Floor Adiace		i Door Floor	-4,834 0 0		-7,312 0 0	0.81 0.00 0.00	Diffuser Terminal Main Fan	Cooling 13,615 13,615 13,615	9 H 5 5 5	4,085 4,085 4,085	
Infiltration Sub Total =			204,446 221,597		43 46	122,491 133,913	42 46	Inte	nfiltration Sub Total	==> ds	-723,812 -734,924		-723,812 -754,949	80.41 83.87	Sec Fan Nom Vent AHU Vent	2,59 2,59	0 8 8	0 2,424 2,424	
Lights People Misc Sub Total =			0000	32,775 175,197 1,456 209,429		7 37 0 44	32,775 122,469 1,456 156,701	11 42 1 54	L F M S	ights People Aisc Sub Total		00000		000000	0.00 0.00 0.00 0.00	MinStop/Rh Return Exhaust Rm Exh	4,08 24,04 13,03	5 8 1 1 1	4,085 14,517 12,857
Ceiling Load Ventilation L Adj Air Trans Dehumid Ox			604 0 -604 0 50,			0	604 0 0	0000	Ceiling Loa Ventilation Adj Air Trar		a oad s Heat	-2,912 0 0 7,824	1	0 -168,190 0 7 824	0.00 18.68 0	Auxiliary Leakage Dwn Leakage Ups		0 0 0	0 0 0
Ov/Undr Sizing Exhaust Heat Sup. Fan Heat Ret. Fan Heat Duct Heat Pkup		0	-3,187 0 0	-3,187 0 0		0 -1 0 0	0	0	Exh OA RA Add	Preheat Preheat ditional F	at Diff. Diff. Reheat			15,156 0 0	-0.87 -1.68 0.00 0.00 0.00 0.00	ENGI % OA cfm/ft ²	NEERING C Cooling 19.1 1.64	:KS He	ating 59.4 0.49
Supply Air L	Underfir Sup Ht Pkup Supply Air Leakage		0	478 258	100	0	201 210	100.00	Sup	oply Air L	eakage	.730.012	6	.900 159	0.00	ft²/ton Btu/hr-ft²	208.81 57.47	-10	08.17
Grand Total	/	423,301	1,357	470,230	FCTIO		201,210	100.00	Gra	no rotan		-750,012		-300,133	100.00		CELECTI		
	To	tal Capacity MBh	Sens Cap. MBh	Coil Airflow	EC IIO Enti °F	er DB/W °F	/B/HR gr/lb	Leav °F	e DB/ °F	WB/HR gr/lb	G	AREAS iross Total	Glas ft ²	s (%)	н	EATING COIL Capacity MBh	Coil Airflow	JN Ent °F	t Lv
Main Clg Aux Clg Opt Vent	39.9 0.0 0.0	9 478.3 0 0.0 0 0.0	323.7 0.0 0.0	13,615 0 0	77.3 0.0 0.0	66.7 0.0 0.0	85.8 0.0 0.0	49.1 4 0.0 0.0	0.0 0.0	53.9 0.0 0.0	Floor Part Int Door	8,322 0 0			Main Htg Aux Htg Preheat	-900.2 0.0 0.0	4,085 0 0	31.0 0.0 0.0	237. 0. 0.
Total	39.9	9 478.3									ExFlr Roof Wall	0 8,322 1,960	0 326	0 17 0	Humidif Opt Vent	0.0	0	0.0 0.0	0. 0.

System Checksums By ACADEMIC

AHU_4										Variab	le Volum	e Reheat (30	% Min Flow	Default)		
	COOLING	COIL PEAK			CLG SPACE	PEAK			HEATING C	OIL PEAK	TEMPERATURES					
Pea	aked at Time: Outside Air:	M OADB/WB	o/Hr: 7 / 15 /HR: 86 / 71 / !	95	Mo/Hr: OADB:	7 / 15 86			Mo/Hr: Heating Design OADB: 5			SADB Ra Plenum	Cooling 55.0 75.3	Heating 315.8 68.4		
_	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total	Space Sensible Btu/h	Percent Of Total			Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Of Total	Return Ret/OA Fn MtrTD	75.3 78.6 0.0	68.4 24.9 0.0		
Envelope Loads Skylite Solar Skylite Cond	0	8	8	0	0	0	Envelope L Skylite S Skylite O	oads olar ond	6	8	0.00	Fn BldTD Fn Frict	0.0 0.0	0.0 0.0		
Roof Cond Glass Solar	0	3,993	3,993 0	2	0	0	Roof Cor Glass So	nd Iar	0	-13,258	2.63 0.00	A	IRFLOWS			
Glass/Door Con Wall Cond Partition/Door Floor	d 0 806 0	312	0 1,117 0 0	01000	806 0	0 1 0 0	Glass/Do Wall Con Partition/ Floor	ior Cond d Door	-5,402 0	-7,509 0	0.00 1.49 0.00 0.00	Diffuser Terminal	Cooling 5,043 5,043	Heating 1,513 1,513		
Adjacent Floor Infiltration Sub Total ==>	96,421 97,226	0 4,305	0 96,421 101,531	53 56	65,707 66,513	61 62	Adjacent Infiltration Sub Tota	Floor ==>	-388,270 -393,672	0 -388,270 -409,037	76.97 81.09	Sec Fan Nom Vent	0,043 0 1,562	1,013		
Internal Loads							Internal Loa	ads			10.00	AHU Vent Infil	1,562 5,596	1,038 5,596		
Lights People Misc Sub Total ==>	22,099 31,654 1,024 54,777	0	22,099 31,654 1,024 54,777	12 18 1 30	22,099 17,360 1,024 40,483	21 16 1 38	Lights People Misc Sub Tota	/==>	0000	0	0.00	MinStop/Rh Return Exhaust Rm Exh	1,513 10,639 7,158 0	1,513 7,109 6,635 0		
Ceiling Load Ventilation Load Adi Air Trans Hea	647 0	-647 0	0 26,904	0	647 0	1 0 0	Ceiling Loa Ventilation Adi Air Trar	d Load	-3,215 0 0	0 -72,035 0	0.00 14.28	Auxiliary Leakage Dwn Leakage Ups	0 0 0	0000		
Dehumid. Ov Sizi Ov/Undr Sizing Exhaust Heat	ng O	0 -2.461		0 0 -1	0	0	Ov/Undr Sit Exhaust He OA Preheat	at Diff.	0	0 11,339 -27,926	0.00 -2.25 5.54	ENGI	NEERING C	KS		
Sup. Fan Heat Ret. Fan Heat Duct Heat Pkup		0	0	0			RA Preheat Additional	Diff. Reheat		-6,786 0	1.35 0.00	% OA cfm/ft ²	Cooling 31.0 0.80	Heating 68.6 0.24		
Underflr Sup Ht P Supply Air Leaka	'kup ge	0	0	0			Underfir Su Supply Air	ip Ht Pkup Leakage		0	0.00	cfm/ton ft²/ton Btu/hr-ft²	334.78 420.71 28.52	-79.60		
Grand Total ==>	152,650	1,197	180,751	100.00 '	107,643	100.00	Grand Tota	==>	-396,887	-504,445	100.00	No. People	81			
	Total Capacity ton MBh	COOLIN Sens Cap. MBh	Coil Airflow	ECTION Enter D °F	B/WB/HR °F gr/lb	Leave °F	DB/WB/HR °F gr/lb		AREAS Gross Total	Glass ft ² (%)	H	EATING COIL Capacity MBh	SELECTIO Coil Airflow cfm	N Ent Lvg °F °F		
Main Clg Aux Clg Opt Vent	15.1 180.8 0.0 0.0	127.2 0.0	5,043 0 0	78.6 6 0.0 0	7.8 89.6 0.0 0.0	55.0 50 0.0 0	5.0 67.4 0.0 0.0	Floor Part	6,337 0		Main Htg Aux Htg Preheat	-421.1 0.0 -83.3	1,513 0 1,562	55.0 315.8 0.0 0.0		
Total	15.1 180.8	0.0		0.0	0.0	5.5	0.0	ExFlr Roof Wall	0 6,337 1,680	0 0	Reheat Humidif Opt Vent	-24.2 0.0 0.0	1,513 0 0	55.0 70.0 0.0 0.0 0.0 0.0		
-								Ext Doo	r O	0 0	Total	-504.4				

							S	syst	em By A	Check	csums C								
DOAS_1	C					C	LC SDACE	DEA	K				C C 011	DEAK		Wate	DEDATUDE	eat Pi	Jmp
	Peaked Out	at Time: side Air:		o/Hr: 7 / 15 /HR: 86 / 71 / 9	95		Mo/Hr: OADB:	Sum o Peaks	f			Mo/i OAD	Hr: Heati B: 5	ng Design		SADB	Cooling 57.1	LO Hea 1	ating 120.4
Envelope Lo Skylite Sola	Space Plenum Ne Sens. + Lat. Sens. + Lat Tota Btuh Btuh Btuh Btuh Vite Solar 0 0 0		Net Total Btu/h	Percer Of Tota (%	nt al 0	Space Sensible Btwh	Percen Of Tota (%	ent otal (%) E	Envelope L Skylite So	oads blar	Space Pe. Space Ser Btu ar		Coil Peak Tot Sens Btu/h	k Percent s Of Total h (%) 0 0.00 0 0.00	Return Ret/OA Fn MtrTD Fn BldTD Fn Frict	75.3 76.5 0.1 0.1 0.3	6 5	69.1 56.6 0.0 0.0 0.0	
Roof Cond Glass Solar Glass/Door Wall Cond Partition/Do	r r Cond oor	0 86,095 5,650 2,964 0	25,878 0 1,838	25,878 86,095 5,650 4,802 0		2 6 0 0 0	0 86,095 5,650 2,964 0		09100	Roof Con Glass So Glass/Do Wall Con Partition/	id lar or Cond d Door	-56,6 -22,4	0 0 30 39 0	-86,533 0 -56,630 -35,844 0	2.54 0.00 1.66 1.05 0.00	Diffuser	IRFLOWS Cooling 49,956	а Не 6 4	eating 49,956
Floor Adjacent Flo Infiltration Sub Total =	loor ==>	0 0 607,495 702,204	0 27,716	0 0 607,495 729,920	3	0	0 0 439,290 533,999		0 46 56	Floor Adjacent Infiltration Sub Tota	Floor ==>	-2,595,8 -2,674,8	0 0 08 77	0 0 -2,595,808 -2,774,814	0.00 0 76.28 81.54	Main Fan Sec Fan Nom Vent AHU Vent	49,956 49,956 16,686 16,686		19,956 19,956 0 16,686 16,686
Lights People Misc Sub Total =		138,242 495,246 17,808 651,296	00000	138,242 495,246 17,808 651,296	3	9 2 1 2	138,242 261,345 17,808 417,396		14 27 2 44	Lights People Misc Sub Tota			00000	000000	0.00 0.00 0.00 0.00	MinStop/Rh Return Exhaust Rm Exh Auxiliary	87,37 54,100		0 37,371 54,100 0
Ceiling Load Ventilation L Adj Air Trans Dehumid, Ov	Ceiling Load 3,384 4 4 Ventilation Load Adj Air Trans Heat 0 0 0 4 2 Ventilation Load Adj Air Trans Heat 0 0 0 0 Exhaust Heat -15,066 Sup, Fan Heat 1 1 Duck Heat PRup 0 Underfirs Sup Ht Pkup 0 Underfirs Sup Ht Pkup 0 0 Underfirs Sup Ht Pkup 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		0 151,526 0 0	0 0 526 10 0 0		3,384 0 0		0 0	Ceiling Loa Ventilation Adj Air Tran Dv/Undr Siz	d Load is Heat ting	-12,2	0200	-682,540 0 0	0.00 0 20.06 0 0.00	Leakage Dwr Leakage Ups))	0	
Ov/Undr Sizi Exhaust Hea Sup. Fan Hea Ret. Fan Hea Duct Heat Pi Underfir Sup Supply Air L			-15,066 1 0 0	0 -15,066 25,164 1 0 0	-	0 1 2 0 0 0 0	0			Exhaust He DA Preheat RA Preheat Additional F Underfir Su Supply Air	at Diff. Diff. Reheat IP Ht Pkup Leakage			54,326 0 0 0 0	-1.60 0.00 0.00 0.00 0.00 0.00	ENGI % OA cfm/ft ² cfm/ton ft ² /ton	VEERING C Cooling 33.4 1.22 388.55 318.38 37.30	KS Hei	ating 33.4 1.22 33.13
Grand Total	==>	1,356,884	9,267	1,542,841	100.0	0'	954,778	100	.00 ' 0	Grand Tota	==>	-2,687,0	79	-3,403,028	100.00	No. People	4,979	10	583435
Tot		tal Capacity MBh	COOLIN Sens Cap. MBh	G COIL SEL Coil Airflow cfm	ECTIOI Ente °F	N r DB/V °F	WB/HR gr/lb	Le 9	eave D F °f	B/WB/HR F gr/lb	8	AREAS Gross Total		(%)	Н	EATING COII Capacity MBh	SELECTIC Coil Airflow cfm)N Ent °F	Lve
Main Clg Aux Clg Opt Vent <i>Total</i>	128.6 0.0 0.0 128.6	1,542.8 0.0 0.0 1,542.8	1,062.1 0.0 0.0	49,956 0 0	76.7 0.0 0.0	64.8 0.0 0.0	77.0 0.0 0.0	56, 0, 0,	8 54.0 0 0.0 0 0.0	6 62.8 0 0.0 0 0.0	Floor Part Int Door ExFlr Roof	40,934 0 0 40,934 40,934	0	0	Main Htg Aux Htg Preheat Humidif	-3,403.0 0.0 0.0	49,956 0 0	56.6 0.0 0.0	120.4 0.0 0.0
											Wall Ext Doo	10,948	2,942	2/	Opt Vent	-3403.0	0	0.0	0.0

System Checksums By ACADEMIC

DOAS_2																Wate	r Source He	at P	ump	
	C	OOLING C	OIL PEAK			(CLG SPACE	PEAK				HEATING	G COIL	PEAK	TEMPERATURES					
Pe	eaked a Out	at Time: side Air:	M OADB/WB	o/Hr: 7/15 WHR: 86/71/9	95		Mo/Hr: OADB:	Sum of Peaks				Mo/H OADE	Mo/Hr: Heating Design OADB: 5			SADB Ra Plenum	Cooling 56.5 75.3	He	ating 119.5 69.1	
		Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Perce Of To	ent tal	Space Sensible	Percen Of Tota	t			Space Pea Space Sen	ik IS	Coil Peak Tot Sens	Percent Of Total	Return Ret/OA	75.3 76.6		69.1 55.9	
Envelope Loads	5	Btu/h	Btu/h	Btu/h		(%)	Btu/h	(%) E	invelope Lo	ads	Btu	/h	Btu/h	(%)	Fn MtrTD Fn BldTD	0.1		0.0	
Skylite Solar Skylite Cond		0	30.262	30.262		0	0	0 Skylit 0 Skylit		Skylite So Skylite Co Boof Con	and d		0	-101 171	0.00	Fn Frict	0.3	_	0.0	
Glass Solar	s Solar 122,936 0		122,936	936 6		122,936	1	:	Glass Sol	ar		O	0	0.00	A	IRFLOWS	FLOWS			
Glass/Door Co Wall Cond	nd	8,959	2 974	8,959		0	8,959			Glass/Doc Wall Conc	or Cond	-89,80	7	-89,807	2.12	10000000	Cooling	a He	eating	
Partition/Door		0	2,014	0		0:	0	1	D :	Partition/E	Door	-00,00	0	0	0.00	Diffuser	62,343	3 F	52,343	
Floor		0		0		0:	0		:	Floor	-		0	0	0.00	Terminal Main Fan	62,343	3 6	52,343	
Adjacent Floor		753 386	U	753 386		37	534 358	4	3	Infiltration	Floor	-3 157 57	3	-3 157 573	74 59	Sec Fan	02,040	5	0	
Sub Total ==>		890,033	33,236	923,270		46	671,006	5	4	Sub Total	==>	-3,280,74	2	-3,402,683	80.38	Nom Vent	22,346	5	22,346	
Internal Loads						1			i ir	nternal Loa	ds					Infil	45,512	2 4	45,512	
Lights		171,781	0	171,781		8	171,781	1.	4	Lights			0	0	0.00	MinStop/Rh	107 955)	07 855	
Misc		25,180	0	25,180		1	25,180		2:	Misc			0	0	0.00	Exhaust	67,857	7 1	87,857	
Sub Total ==>		885,171	0	885,171		44	559,322	4	5	Sub Total	>		0	0	0.00	Rm Exh Auxiliary	C	נ	0	
Ceiling Load Ventilation Load	1	3,868 0	-3,868 0	0 206,804		10	3,868 0			eiling Load	oad	-14,19	0	-898,148	0.00	Leakage Dwn Leakage Ups	c c	2	0	
Adj Air Trans He	eat	0		0		0	0		A	dj Air Tran	s Heat		0	0	0 00				_	
Ov/Undr Sizing	zing	0		0		0:	0	111	DE	xhaust Hea	at		U	67,792	-1.60	ENG	NEERING C	KS		
Exhaust Heat			-18,476	-18,476		-1			0	A Preheat	Diff.			0	0.00		Casling		ation	
Sup. Fan Heat			1	31,403		0			R	A Preheat	Diff.			0	0.00	% OA	35.8	ne.	35.8	
Duct Heat Pkup			Ó	0		0			1	uuuuunai n	teneat			°	0.00	cfm/ft ²	1.30		1.30	
Underfir Sup Ht	Pkup			0		0			L	Inderfir Su	p Ht Pkup			0	0.00	cfm/ton	368.86			
Supply Air Leak	age		U	U		•				supply Air L	eakage			U	0.00	ft²/ton	283.14	5	88.46	
Grand Total ==>	>	1,779,072	10,893	2,028,172	100	.00	1,234,195	100.0	G	Grand Total	==>	-3,294,93	14	-4,233,040	100.00	No. People	4,902		10.40	
			COOLIN	G COIL SEL	ECTIO	ON				1		AREA	S		H	ATING COIL	SELECTIC	N		
	Tot	tal Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	°F	ter DB/ °F	WB/HR gr/lb	Lea °F	ve D °F	B/WB/HR gr/lb		Gross Total	GL	ass ² (%)		Capacity MBh	Coil Airflow cfm	Ent °F	t Lvg °F	
Main Clg	169.0	2,028.2	1,374.1	62,343	76.8	65.0	77.6	56.1	54.2	62.2	Floor	47,855			Main Htg	-4,233.0	62,343	55.9	119.5	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0			Aux Htg	0.0	0	0.0	0.0	
Upt vent	169.0	2 028 2	0.0	U	0.0	0.0	0.0	0.0	0.0	0.0	ExFir Roof	0	0	0	Preneat	0.0	0	0.0	0.0	
rotar	105.0	2,020.2									Wall	16,758	4,665	28	Opt Vent	0.0	Ő	0.0	0.0	
1											I Fut Daw		0	0	Tedal	4 233 0				