



Mechanical Option-IP

#### **Table of Contents**

Executive Summary2
Mechanical System Overview
Design Load Estimation
Assumptions
Infiltration
Design Air Conditions
Loads and Schedules4
Design vs. Computed Loads6
Annual Energy Consumption and Operating Costs8
Assumptions8
Energy Costs
Annual Energy Consumption9
Monthly Energy Consumption11
Annual Carbon Footprint12
Summary13
References
Appendix
Lists of Figures & Graphs16
Supplementary Information and Images17

#### **Executive Summary**

In today's building design industry the capability of creating energy models is becoming a must. Energy models allow a designer to predict more accurately the cost of operation, efficiency and the carbon footprint of the building. If done at early stages of a design the energy model can serve as a tool throughout the entire design. The designer can test the feasibility of different systems and better understand the impact of using these systems on both an economic basis and an environmental basis. The designers of The Sunshine Elementary School developed an energy model through eQuest, which satisfied the LEED's energy requirements and thus received the maximum amount of points by LEED due to the buildings reduction of energy use, a predicted 47%.

In an attempt to better understand the eQuest model and building system utilized a TRACE 700 model was developed for this report. The results were then compared to the eQuest model. Although the eQuest model was seemingly far more advanced the results were similar in many regards. The cooling load was calculated to be 15% more than the original model while the heating load was calculated to be 9% less than the original model.

For this analysis the results of the TRACE 700 energy model are used to analyze the cost of operation, efficiency and the carbon footprint of the building. All of the analysis is an estimate and should be taken as so. The actual energy usage and building performance cannot truly be known until the construction is complete and an energy audit is taken of the building. Energy costs for the analysis are also subject to change.

### **Mechanical System Overview**

The Sunshine Elementary School uses a highly energy efficient system which was determined by an energy model, produced by the Mechanical Designer, to reduce the energy consumption by 47%, compared to a baseline model. The system utilizes ten ground source heat pumps located throughout the design to share both the heating and cooling loads of the building. In addition there are also nine air-to-air energy recovery units in place in nine of the HP zones. These units help reduce the humidity and save valuable energy that would otherwise be exhausted to the outside air. The other keys to success in the design are in the demand ventilation control by

the use of CO2 detection ensure ventilation is met by demand and over ventilation will not occur and also lighting control sensors allowing for a reduction of internal load.

The heat pumps placed throughout the building handle varying loads depending on the size and part of the building they are serving. The smallest load is handled by HP-1, which handles 200-250 cfm of air while the largest is HP-8 which handles 2000-21000 cfm of air.

The Air-to-Air energy recovery units are also placed within these zones and serve a varying amount of air to the spaces. ERU-8 is the smallest supplying 1400 cfm, while ERU-2 is the largest supplying 5730 cfm.

### **Design Load Estimation**

#### Assumptions

Trane TRACE 700 was used to calculate the design heating and cooling loads for The Sunshine Elementary School. This energy modeling software performs a yearly, 8760 hour analysis for the energy consumption, design loads and performance. A room by room analysis was calculated by assigning each of the 98 rooms to a generalized 10 room templates. The 98 rooms were then placed in a zone through a logical manner which attempted to separate the different solar heat gain areas throughout the building. The information used to construct the model was taken from both a preexisting REVIT model which was imported into TRACE 700, and the preexisting eQuest model was referenced throughout the process.

#### Infiltration

The infiltration for The Sunshine Elementary School was assumed to be 0.0 air changes an hour. This is because the construction was assumed to above average and allow for a positively pressurized building. This assumption was made within the previous model as well.

#### **Design Air Conditions**

The building is located near Harrisburg, PA so the design conditions for Harrisburg, PA were used in building the model. The outdoor design conditions were preset within the TRACE 700 weather data as can be seen below in Table 1.

TRACE 700 Design Conditions for Harrisburg, PA				
Summer Winter				
DB (°F)	DB (°F)			
91 74 11				

Table 1: TRACE 700 Weather Data

The indoor design conditions were obtained from the schedules provided by the designer.

Scheduled Indoor Designed					
	Coc	oling	Heat	ing	
	E,	AT	EAT	EWT	
	DB (°F)	WB ( <sup>°</sup> F)	DB ( <sup>°</sup> F)	(°F)	
HP-1	76	80	70	45	
HP-2	76	80	70	45	
HP-3	76	80	70	45	
HP-4	76 80		70	45	
HP-5	76 80		70	45	
HP-6	76	80	70	45	
HP-7	76	80	70	45	
HP-8	76 80		70	45	
HP-9	76	80	70	45	
HP-10	76	80	70	45	

Energy Wheel					
	Sum	imer	Wir	nter	
	EAT	LAT	EAT	LAT	
	DB/WB (°F)	DB/WB (°F)	DB (°F)	DB (°F)	
ERU-1	90/74	79	10	59	
ERU-2	90/74	79	10	59	
EERU-3	90/74	79	10	59	
ERU-4	90/74	80	10	59	
ERU-5	90/74	79	10	59	
ERU-6	90/74	79	10	59	
ERU-7	90/74	80	10	59	
ERU-8	90/74	80	10	59	
ERU-9	90/74	79	10	59	

Table 2: Scheduled Indoor Design Temperatures

#### Loads and Schedules

The internal loads of the spaces were determined by the functions of the space. In TRACE 700 templates were used to generalize these spaces into 10 types; Classrooms, Office, Corridors/Vestibules, Gym, Storage, Conference, Cafeteria, Kitchen, Restrooms and Electrical/Mechanical rooms. Table 3 shows the internal loads assigned to these templates based on occupancy and space type. The lighting loads used were calculated in several similar spaces and then averaged for the templates. The miscellaneous loads were assumed to be 0.5 W/SF for all spaces. Sensible and Latent loads used were given by TRACE 700 software for the space type as well as the SF/Person.

Internal Loads Based on Occupancy and Space						
	Classroom Office		Corr/Vest	Gym	Storage	
	Sensible/Latent	Sensible/Latent	Sensible/Latent	Sensible/Latent	Sensible/Latent	
Lighting (W/SF)	1.192	1.3	1.7	0.13	0	
Misc (W/SF)	0.5	0.5	0.5	0.5	0	
People (BTU/Hr)	250/200	250/200	250/200	250/200	0/0	
People (SF/Person)	75	143	75	75	0	
	Conference	Cafeteria	Kitchen	Elec/Mech	Restrooms	
	Sensible/Latent	Sensible/Latent	Sensible/Latent	Sensible/Latent	Sensible/Latent	
Lighting (W/SF)	1.1	1.4	0.303	0	1.61	
Misc (W/SF)	0.5	0.5	0.5	15	0.5	
People (BTU/Hr)	250/200	275/275	250/200	0/0	250/200	
People (SF/Person)	20	10	75	0	20	

Table 3: Internal Loads for Templates

The schedules used for the building were the preset schedules supplied by the TRACE software and can be seen below in Tables 4 and 5. These assumptions follow well with the functions of a school wherein the majority of the building is only fully occupied during the hours of 8am-5pm. Due to light sensors these times correspond for the lighting schedules as well.

Occupancy Schedule				
Time	People (%)			
Midnight-7am	0			
7am-8am	30			
8am-5pm	100			
5pm-6pm	30			
6pm-7pm	1			
7pm-Midnight	0			

Table 5: Occupancy Schedule

Lighting Schedule				
Time	Lights (%)			
Midnight-6am	0			
6am-7am	10			
7am-8am	50			
8am-5pm	100			
5pm-6pm	50			
6pm-7pm	10			
7pm-Midnight	0			

Table 4: Lighting Schedule

#### **Design vs. Computed Loads**

The design utilized eQuest to calculate to loads on the building and on the 10 different heat pumps. Using TRACE 700, I analyzed the space by creating my own zones in a logical manner. I created 10 systems in TRACE 700 that I feel are close to the systems chosen in eQuest. Heat Pumps with energy recovery units were utilized in the model closely resembling the design. After creating the systems I assigned each of the 98 rooms to a system creating zones that each HP will serve. The results can be seen below in Table 6.

Trace	Cooling (BTU/h) Net Peak	Heating (Btu/h) Coil Peak Tot Sens
HP1	170822	157168
HP2	185526	137875
HP3	305395	154479
HP4	348488	199290
HP5	317647	216880
HP6	477053	325661
HP7	370650	273413
HP8	416438	284860
HP9	223251	157365
HP10	233085	150062
Totals	3048355	2057053
eQuest	2599199	2258724
% Diff	15%	-9%

Table 6: Trace Peak Loads

A direct comparison for each individual heat pump cannot be evaluated due to the differences in zones. However, the Peak cooling and Peak heating loads can be summed and compared to the sum of the designed modeled. The eQuest model results in a 15% lower peak cooing load while the Peak heating load in TRACE 700 was calculated to 9% lower than in eQuest. Thus the final result is within 5% as can be seen in Table 7 below.

<b>Overall % Difference</b>				
Btu/Hr				
eQuest	4857923			
Trace 700	5105408			
% difference	5%			

Table 7: Overall Percent Difference

In General the Trane TRACE 700 model and the eQuest design model were very close in final results. With the cooling loads of eQuest being lower while the heating loads of TRACE 700 were lower a balance was created on an annual energy consumption basis.

#### **Annual Energy Consumption and Operating Costs**

#### Assumptions

The utility rates used for the analysis were based upon rates supplied by the designer. These rates are negotiated by the power company and the owner Sunshine Elementary School and a flat rate was created. The designer used a previous bill secured from owner of school in order to complete the energy cost analysis. The assumption has been made that the rates will stay the same for the new building. In the Appendix a copy of this bill is present with all billing information removed for privacy.

#### **Energy Costs**

The monthly energy cost analysis estimates can be seen below in Tables 8 and 9.

On Peak Monthly Electricity Energy Consumption Cost Analysis							
	Electrici	ity	Price	Demand	Monthly Co	ost (\$)	
Month	Consumption (kWh)	Demand (kW)	(\$/kWh)	(\$/kW)	Consumption	Demand	Total Monthly Cost
Jan	230546	648	0.0764	6.96	17614	4510	22124
Feb	194132	498.9	0.0764	6.96	14832	3472	18304
Mar	199377	521.2	0.0764	6.96	15232	3628	18860
Apr	185677	509.2	0.0764	6.96	14186	3544	17730
May	186920	557.7	0.0764	6.96	14281	3882	18162
June	226293	591.6	0.0764	6.96	17289	4118	21406
July	257974	435.4	0.0764	6.96	19709	3030	22740
Aug	252781	635.9	0.0764	6.96	19312	4426	23738
Sep	189787	638.8	0.0764	6.96	14500	4446	18946
Oct	177297	433.9	0.0764	6.96	13545	3020	16565
Nov	181376	472.4	0.0764	6.96	13857	3288	17145
Dev	212934	527.6	0.0764	6.96	16268	3672	19940
Total	2495094	638.8			190625	45035	235661

Table 8: Electricity Energy Cost Analysis

On Peak Monthly Natural Gas Consumption Cost Analysis						
Month	Consumption (Therms)	Price per Therm (\$)	Cost (\$)			
Jan	804	1.1787	948			
Feb	745	1.1801	879			
Mar	725	1.1807	856			
Apr	516	1.1891	614			
May	473	1.1917	564			
June	320	1.2068	386			
July	311	1.2083	376			
Aug	312	1.2083	377			
Sep	372	1.2003	447			
Oct	527	1.1885	626			
Nov	567	1.1864	673			
Dev	739	1.1803	872			

Table 9: Natural Gas Cost Analysis

#### **Annual Energy Consumption**

The distribution of electricity was also analyzed. The largest consumer of electricity is the miscellaneous equipment using 35% followed closely behind by the area lighting using 27%, while pumps and auxiliary equipment only used 2% of the energy. Graph 1 on the following page shows the distribution of electricity thorough out the system. Cooling and Heating are only using a total of 17% of the energy for the entire building. This is possible due to the highly efficient ground source heat pumps and the air to air energy recovery units placed in each zone. The yearly amounts of electricity used by the system can be seen in Graph 2, indicating the amounts of electricity consumed by each of the systems different components. The usage of Natural gas was analyzed in the same way as the electric. Graphs 4 and 5 show the estimated breakdown of the distribution of the natural gas used by The Sunshine Elementary School. Also the amount used by each component is shown. It can been seen from the graphs that the Natural Gas is primarily being used for hot water using 389.5 MBtu's annually. Some of the space heating also uses natural gas using 244.4 MBtu's annually.



Graph 1: Electric Consumption Distribution



Graph 2: Electric Consumption







Graph 4: Gas Consumption

#### **Monthly Energy Consumption**

A monthly energy consumption analysis was also performed. This reveals that the peak of electricity consumption is in the month of July while the lowest consumption is in November. This can be seen below in Graph 5. Interestingly the natural gas usage is lowest in the summer months. This is due to the lack of need for space heating during these months, which is a major user of the resource. The peak usage for natural gas in January as is expected due to the extreme cold weather and high need for space heating. This can be seen in Graph 6.









Graph 6: Monthly Natural Gas Consumption

#### **Annual Carbon Footprint**

The annual Carbon footprint or emission for The Sunshine Elementary School has also been estimated. The emission profiles were based upon data from the Source Energy and Emission Factors for Energy Use in Buildings that has been provided. The amount of yearly kWh were total and then multiplied by the lb per kWh given in the data.

Total Emission Factors for Delivered Electricity					
	lb per				
Pollutant	kWh	Consumption	Amounts of pollutant		
CO <sub>2</sub>	1.74E+00	2495094	4341463.56		
NO <sub>x</sub>	3.00E-03	2495094	7485.28		
SO <sub>x</sub>	8.57E-03	2495094	21382.96		
CH <sub>4</sub>	3.59E-03	2495094	8957.39		
N <sub>2</sub> 0	3.87E-05	2495094	96.56		
СО	8.45E-04	2495094	2108.35		
Lead	1.39E-07	2495094	0.35		
Mercury	3.36E-08	2495094	0.08		
PM10	9.26E-05	2495094	231.05		
Solid					
waste	2.05E-01	2495094	511494.27		
Table 10: Estimated Emissions					

Table 10: Estimated Emissions

#### **Summary**

The analysis for all parts of this report are simplifies estimates. As stated in the beginning of this report all cost information is subject to change. The Trane TRACE 700 proved to be a good tool for modeling The Sunshine Elementary School, although some of the software could be more complete. Although the design model and TRACE 700 model results ended with a similar total output many of the inputs are different and will have to be evaluated further to understand which energy modeling software is more comprehensive.

The eQuest software allows the user to see a 2-D and 3-D representation of the building, while the TRACE 700 software does not. For this reason it is not possible to conclude that the REVIT model imported into TRACE 700 was complete. For this report it has been assumed to be complete.

#### References

- 1. ASHRAE Handbook of Fundamentals 2005
- 2. Trane TRACE 700
- 3. eQuest 63.4
- 4. Reese Engineering Mechanical Drawings
- 5. Past Thesis Technical Reports, e-studio Archives, 2009-2010

# Appendix

## **Lists of Figures & Graphs**

- Table 1: TRACE 700 Weather Data
- Table 2: Scheduled Indoor Design Temperatures
- Table 3: Internal Loads for Templates
- Table 4: Lighting Schedule
- Table 5: Occupancy Schedule
- Table 6: Trace Peak Loads
- Table 7: Overall Percent Difference
- Table 8: Electricity Energy Cost Analysis
- Table 9: Natural Gas Cost Analysis
- Graph 1: Electric Consumption Distribution
- Graph 2: Electric Consumption
- Graph 3: Gas Consumption Distribution
- Graph 4: Gas Consumption
- Graph 5: Monthly Electric Consumption
- Graph 6: Monthly Natural Gas Consumption
- Table 10: Estimated Emissions

## **Supplementary Information and Images**

Sample bill provided by designer

#### **Basic Charges**

Customer Number: 0801106685 000	6324849 - General Se	condary Medium - ME	-GSMF	
Distribution Total Distribution Charges Consumer Education Charge Transition Generation Transmission State Tax Surcharge	Cust 53,568 KWH 278.7 KW 53,568 KWH 278.7 KW 53,568 KWH 53,568 KWH	omer Charge x 0.000570 x 3.820000 x 0.000020 x 3.140000 x 0.048690 x 0.027810	21.52 30.53 <u>1,064.63</u> 1,116.68	1,116.68 1.07 875.12 2,608.23 1,489.73 -4.87
Total Charges	al - #6.96/k	w \$0.077	09/KWH tot	\$ 6,085.96
Detail P	ayment and Adjust	stment Informatio	ń	
Date	Reference		Amount	
Payments: 10/15/09			-6,033.94	
Total Payments				-6.033.94
Total Payments and Adjustments				-\$6,033.94
	Meter Readin	g Information		a saturate
General Secondary Medium				
Meter Number	G23659499			
Present KWH Reading (Actual)	6,001			
Previous KWH Reading (Actual)	5,908			
Difference	93			
Multiplier	576			
Kilowatt Hours Used	53,568			
Metered Load in KW	0.407			
Measured Load in KW	234.4			
Present KVARH Reading (Actual)	5,330			
Previous KVARH Reading (Actual)	5,239			
Difference	91			
Kilovar Hours Used	52,416			
Average Power Factor	71.5 <b>%</b>			
Billed Load in KW/KVA	278.7			

Floor One Heat Pump Zones



Floor Two Heat Pump Zones





#### Templates for TRACE 700

ernal Load 1	remplates	-								
Alternative	Alternati	ve 1		•					Appl	y
Description	Cafeteria	3		•					Close	•
People										
Туре	Cafeteria							-	New	
Density	10 s	q ft/person	• 9	Schedule C	ooling Only (	Design)		•	Сору	<u> </u>
Sensible	275 B	tu/h	L	atent 2	75 Btu/	h			Delet	e
Workstations.									Add Glo	bal
Density	1 w	orkstation/person	•							
Lighting										
Туре	Recessed	fluorescent, not ver	nted, 80%	load to spac	e			•		
Heat gain	1.4 V	//sq.ft	• 9	Schedule C	iooling Only (	Design)		•		
Miscellaneou	s loads									
Туре	None							•		
Energy	0.5 V	//sq.ft	<b>▼</b> 9	Schedule C	ooling Only (	Design)		•		
Energy meter	None		•							
Internal I	Load	Arriow		L nermosi	rar I	Lonstruc	tion i		Hoom	
				<u></u>						
		- Desired		Tucinios						
ternal Load	l Template	es - Project		Tuomos		2				
ternal Load Alternative	I Template	es - Project ative 1		Turentes						Арр
ternal Load Alternative Description	I Template Altern Classr	es - Project ative 1 ooms								App
ternal Load Alternative Description People	I Template Altern Classr	ative 1								App Clos
ternal Load Alternative Description People Type	I Template Altern Classro	ative 1								App Clos Nev
ternal Load Alternative Description People Type Density	I Template	ative 1 pooms sq ft/person		  Schedula	e Cooling (		)		- - -	App Clos New Cop
ternal Load Alternative Description People Type Density Sensible	I Template Altern Classroo 75 250	es - Project ative 1 pooms m sq ft/person Btu/h		names	<ul> <li>Cooling ( 200</li> </ul>	 Dnly (Design Btu/h	)		• •	App Clos New Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstatior	I Template Altern Classroo 75 250	s - Project ative 1 coms m sq ft/person Btu/h			e Cooling (	 )nly (Design Btu/h	)		•	App Clos Nev Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density	I Template Altern Classroo 75 250	m sq ft/person Btu/h	on v	Schedul Latent	Cooling ( 200	 )nly (Design Btu/h	)		• •	App Clos Nev Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting	I Template Altern Classroo 75 250 18 1	ts - Project ative 1 poms m sq ft/person Btu/h workstation/pers	▼ on ▼	Schedul	e Cooling ( 200	]nly (Design Btu/h	)		•	App Clos Nev Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting Type	I Template Altern Classroo 75 250 18 1	ative 1 coms m sq ft/person Btu/h workstation/pers	on vented 8	Scheduli Latent	e Cooling ( 200	]nly (Design Btu/h	)		- - - - -	App Closs New Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting Type Heat gair	Classroor 75 250 18 Recesse	ts - Project ative 1 coms m sq ft/person Btu/h workstation/pers d fluorescent, not	on vented, 8	Scheduli Latent	e Cooling ( 200	)nly (Design Btu/h				App Closs Nev Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstatior Density Lighting Type Heat gair	I Template Altern Classroon 75 250 18 1 Recesse 1 1.132	ts - Project ative 1 coms m sq ft/person Btu/h workstation/pers d fluorescent, not W/sq ft	on vented, 8	Scheduli Scheduli O% load to s Scheduli	e Cooling ( 200 space e Cooling (	)nly (Design Btu/h )nly (Design			•	App Closs New Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting Type Heat gair Miscellaneo	I Template Altern Classroo 75 250 15 1 Recesse 1.192 us loads	ts - Project ative 1 coms m sq ft/person Btu/h workstation/pers d fluorescent, not W/sq ft	on V vented, 8	Scheduli Latent	e Cooling ( 200 space e Cooling (	)nly (Design Btu/h )nly (Design				App Clos New Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneo Type	Classroor 75 250 18 Recesse 1.192 uus loads None	ts - Project ative 1 poms m sq ft/person Btu/h workstation/pers d fluorescent, not W/sq ft	on vented, 8	Scheduli Scheduli O% load to s Scheduli	e Cooling ( 200 space e Cooling (	]nly (Design Btu/h ]nly (Design				App Closs Nev Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting Type Heat gair Miscellaneo Type Energy Energy	I Template Altern Classroo 75 250 18 1 Recesse 1 1.192 us loads None 0.5	ss - Project ative 1 coms m sq ft/person Btu/h workstation/pers d fluorescent, not W/sq ft	on vented, 8	Schedule Schedule Schedule Schedule	e Cooling ( 200 space e Cooling ( e Cooling (	Dnly (Design Btu/h			Image: state	App Closs New Cop Dele
ternal Load Alternative Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneo Type Energy Energy meter	I Template Altern Classroo 75 250 1s 1 Recesse 1.192 us loads None 0.5 None	es - Project ative 1 coms m sq ft/person Btu/h workstation/pers d fluorescent, not W/sq ft	on v vented, 8	Scheduli Scheduli Latent O% load to s Scheduli	e Cooling C	Dnly (Design Btu/h Dnly (Design			•	App Clos New Cop Dele

November 27, 2010

Internal Load	Templates	s - Project					×
Alternative	Alterna	tive 1	•				Apply
Description	Confere	ence	•				Close
People							New
Туре	Conference	ce Room				-	
Density	20	sq ft/person 🛛 💌	Schedule	Cooling Only	(Design)	•	Сору
Sensible	250	Btu/h	Latent	200 Btu	/h	_	Delete
Workstations	s					Ŀ	Add Global
Density	1	workstation/person 💌					
Lighting							
Туре	Recessed	d fluorescent, not vented, 8	30% load to sp	ace		•	
Heat gain	1.0966	W/sq ft  ▼	Schedule	Cooling Only	(Design)	•	
Miscellaneou	us loads						
Туре	None					•	
Energy	0.5	W∕sq ft 🔹 💌	Schedule	Cooling Only	(Design)	-	
Energy meter	None	•					
<u>I</u> nternal	Load	Airflow	<u>T</u> herm	ostat	Construction	<u>B</u>	oom
Internal Load	Template	s - Project					
Alternative	Alterna	ative 1	•				Apply
Description	Corrido	or∕Vest	•				Close
People							
Туре	None					-	New
Density	75	sq ft/person 💌	] Schedule	Cooling Or	ıly (Design)	-	Сору
Sensible	250	Btu/h	Latent	200 B	tu/h		Delete
Workstation	S						Add Global
Density	1	workstation/person 💌	]				
Lighting							
Туре	Recesse	d fluorescent, not vented,	80% load to s	pace		-	
Heat gain	1.6867	W/sq.ft 💌	] Schedule	e Cooling Or	ly (Design)	-	
Miscellaneou	us loads						
Туре	None					•	
Energy	0.5	W/sq.ft 💌	] Schedule	Cooling Or	ıly (Design)	-	
Energy meter	None	•	]				
		110				_	
Internal	Load	I Airtiow	l lher	mostat	Lonstruction		Hoom

November 27, 2010

	Template	s - Project					×
Alternative	Alterna	ative 1	•				Apply
Description	Gym						Close
	1-4						
People							New
Туре	None	<u></u>	L Calvad		(D) 1 1		Сору
Density	250	sq it/person	✓ Schedi		y (Design)	<b>–</b>	Delete
Sensible	250	Btu/n	Latent	200 Bt	u/n		
Workstation	S						Add Global
Density	1	workstation/person	•				
Lighting							
Туре	Fluoresce	ent, hung below ceiling, "	100% load to	space		•	
Heat gain	0.1229	W/sq.ft	- Sched	ile Cooling Onl	y (Design)	-	
Missellaneo	ua la arda						
Tune	None					-	
Enerau		W/eaft	- Sched	ile Cooling Opt	u (Design)		
Energy	Mana	wysqit		ine Teoping out	y (Design)		
meter	INone		•				
Internal	Load	Airflow	Ih	ermostat	<u>C</u> onstruction		Boom
		)					
Internal Load	Template	es - Project			1000		×
Alternative				ĩ			
Alternative	0.00	- King - H	_				Applu
Description	Altern	ative 1	-	ſ			Apply
Description	Kitche	ative 1 n	<u>•</u>				Apply Close
Description People	Kitche	ative 1 n	•	Ĩ			Apply Close
Description People Type	Altern  Kitche	ative 1	<u>•</u>			-	Apply Close New
Description People Type Density	Altern Kitche None	ative 1 n sq ft/person	▼ ▼ Scheo	l Iule Cooling Oi	nly (Design)	•	Apply Close New Copy
Description People Type Density Sensible	Altern Kitche None 20 250	ative 1 n sq ft/person Btu/h	▼ Scheo Laten	dule Cooling OI	nly (Design) Itu/h	•	Apply Close New Copy Delete
Description People Type Density Sensible Workstation	Altern Kitche 20 250 s	ative 1 n sq ft/person Btu/h	Schee Laten	lule Cooling Ol	nly (Design) Itu/h	<b>•</b>	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density	Altern Kitche 20 250 s	ative 1 n sq ft/person Btu/h workstation/person	▼ Scher Laten	tule Cooling OI	nly (Design) Itu/h	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density	Altern Kitche 20 250 s 1	ative 1 n sq ft/person Btu/h workstation/person	Schee Laten	lule Cooling O : 200 E	nly (Design) Itu/h	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting	Altern Kitche 20 250 s 1	ative 1 n sq ft/person Btu/h workstation/person diffuerescent_ent_uerth	Scher     Scher	tule Cooling OI	nly (Design) Itu/h	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type	Altern Kitche 20 250 s 1 Recesse 0 3029	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente	Sched Laten  d, 80% load l Cohe	Jule Cooling Of 200 E	nly (Design) Itu/h	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type Heat gain	Altern Kitche 20 250 s 1 Recesse 0.3029	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente W/sq ft	Scher  d, 80% load l  Scher	tule Cooling O 200 E o space tule Cooling O	nly (Design) Itu/h nly (Design)	• •	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneor	Altern Kitche 20 250 s 1 Recesse 0.3029 us loads	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente W/sq ft	Sched Laten  d, 80% load l Sched	Jule Cooling O 200 E 0 space Jule Cooling O	nly (Design) Itu/h nly (Design)	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneou Type	Altern Kitche 20 250 s 1 Recesse 0.3029 us loads None	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente W/sq ft	Scher  d, 80% load l  Scher	iule Cooling O 200 E o space iule Cooling O	nly (Design) Itu/h nly (Design)	• •	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneou Type Energy	Altern Kitche 20 250 s 1 Recesse 0.3029 us loads None 0.5	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente W/sq ft W/sq ft	Scheel  d, 80% load l  d, 80% load l  Scheel  Scheel  Scheel  Scheel  Scheel  Scheel  Scheel  Scheel  Scheel	Jule Cooling Of 200 E o space Jule Cooling Of Jule Cooling Of	nly (Design) Itu/h nly (Design)	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneou Type Energy Energy meter	Altern Kitche 20 250 s 1 Recesse 0.3029 us loads None 0.5 None	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente W/sq ft W/sq ft	Scheel Caten  Caten Caten  Caten Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Caten  Cat	tule Cooling O 200 E 200 E tule Cooling O	nly (Design) htu/h nly (Design)	• •	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstation Density Lighting Type Heat gain Miscellaneou Type Energy Energy meter	Altern Kitche 20 250 s 1 Recesse 0.3029 us loads None 0.5 None	ative 1 n sq ft/person Btu/h workstation/person d fluorescent, not vente W/sq ft W/sq ft	Sched  Sched Sched  Sched Sched  Sched Sc	tule Cooling Ou : 200 E o space tule Cooling Ou tule Cooling Ou	nly (Design) htu/h nly (Design)	•	Apply Close New Copy Delete Add Global

Nicholas Scheib | Mechanical Option | November 27, 2010 21

November 27, 2010

Internal Load	Template	es - Project						×
Alternative	Altern	ative 1		<b>•</b>				Apply
Description	Mech	/Elec		•				Close
People								New
Туре	None						•	INEW
Density	0	People	•	Schedule	Cooling O	Inly (Design)	-	Сору
Sensible	250	Btu/h		Latent	200	Btu/h		Delete
Workstations	s							Add Global
Density	0	workstation/person	•					
Lighting								
Туре	Recesse	ed fluorescent, not ve	nted, 8	30% load to sp	pace		-	
Heat gain	0	W/sq ft	•	Schedule	Cooling O	Inly (Design)	•	
Miscellaneou	us loads							
Туре	None						-	
Energy	15	W/sq.ft	-	Schedule	Cooling 0	Inly (Design)	-	
Energy meter	None		-					
<u>Internal</u>	Load	<u>A</u> irflow		<u>I</u> hern	nostat			<u>H</u> oom
Internal Load	Template	s - Project						<b>X</b>
Internal Load	Template	s - Project		<b>.</b>		-		Apply
Internal Load	Template Altern	is - Project ative 1		•		-		
Internal Load	Template Altern Office	s - Project ative 1		•				Apply Close
Internal Load	Template Altern Office	ative 1		•			<b>•</b>	Apply Close New
Internal Load Alternative Description People Type Density	Altern Office General	ative 1 Diffice Space	•	▼ ▼ Schedule	Cooling Or	nly (Design)	<b>•</b>	Apply Close New Copy
Internal Load Alternative Description People Type Density Sensible	Altern Office General 143 250	s - Project ative 1 Office Space sq ft/person Btu/h	•	Schedule Latent	Cooling Or 200 B	nly (Design) tu/h	•	Apply Close New Copy Delete
Internal Load Alternative Description People Type Density Sensible Workstations	Altern Office General 1 143 250	s - Project ative 1 Difice Space sq ft/person Btu/h	•	Schedule Latent	Cooling Or 200 B	nly (Design) tu/h	•	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density	Altern Office	s - Project ative 1 Difice Space sq ft/person Btu/h workstation/person	•	Schedule Latent	Cooling Or 200 B	nly (Design) tu/h	•	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting	Altern. Office General I 143 250	ative 1 Diffice Space sq ft/person Btu/h workstation/person	•	Schedule Latent	Cooling Or 200 B	nly (Design) tu/h	V	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type	Altern Office General 143 250 1 Recesse	s - Project ative 1 Difice Space sq ft/person Btu/h workstation/person d fluorescent, not ver	▼ Ited, 8	Schedule Latent	Cooling Or 200 B	nly (Design) tu/h	•	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type Heat gain	Altern Office	s - Project ative 1 Difice Space sq ft/person Btu/h workstation/person d fluorescent, not ver W/sq ft	v nted, 8	Schedule Latent 0% load to sp Schedule	Cooling Or 200 B ace Cooling Or	nly (Design) tu/h	• •	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type Heat gain Miscellaneou	Altern. Office	ative 1 Diffice Space sq ft/person Btu/h workstation/person d fluorescent, not ver W/sq ft	▼ Ited, 8	Schedule Latent 0% load to sp Schedule	Cooling Or 200 B ace Cooling Or	nly (Design) tu/h	<b>v</b> <b>v</b>	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type Heat gain Miscellaneou Type	Template         Altern.         Office         General I         143         250            1         Recesse         1.2974         Is loads         None	s - Project ative 1 Diffice Space sq ft/person Btu/h workstation/person d fluorescent, not ver W/sq ft	v nted, 8	Schedule Latent	Cooling Or 200 B ace Cooling Or	nly (Design) tu/h	• •	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type Heat gain Miscellaneou Type Energy	Alterni Office	s - Project ative 1 Difice Space sq ft/person Btu/h workstation/person d fluorescent, not ver W/sq ft	Thed, 8	Schedule Latent	Cooling Or 200 B ace Cooling Or Cooling Or	nly (Design) tu/h	• •	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type Heat gain Miscellaneou Type Energy Energy meter	Template         Altern.         Office         General I         143         250         x         1         Recesse         1.2974         us loads         None         0.5         None	s - Project ative 1 Difice Space sq ft/person Btu/h workstation/person d fluorescent, not ver W/sq ft	▼ nted, 8	Schedule Latent	Cooling Or 200 B ace Cooling Or	nly (Design) tu/h nly (Design)	• •	Apply Close New Copy Delete Add Global
Internal Load Alternative Description People Type Density Sensible Workstations Density Lighting Type Heat gain Miscellaneou Type Energy Energy meter	Alterni Office	s - Project ative 1 Diffice Space sq ft/person Btu/h workstation/person d fluorescent, not ver W/sq ft		Schedule Latent 0% load to sp Schedule Schedule	Cooling Or 200 B ace Cooling Or Cooling Or	nly (Design) tu/h nly (Design) nly (Design)		Apply Close New Copy Delete Add Global

Nicholas Scheib | Mechanical Option | November 27, 2010 22

November 27, 2010

Internal Load	Template	es - Project						×
Alternative	Alterr	native 1		-				Apply
Description	Restro	ooms		-				Close
People								
Туре	None						-	New
Density	20	sq ft/person	•	Schedule	Cooling Onl	y (Design)	•	Сору
Sensible	250	Btu/h		Latent	200 Bt	u/h		Delete
Workstations	s							Add Global
Density	1	workstation/person	-					
Lighting								
Туре	Recesse	ed fluorescent, not ver	nted, 8	0% load to sp	ace		-	
Heat gain	1.606	W/sq ft	•	Schedule	Cooling Onl	y (Design)	•	
Miscellaneou	us loads							
Туре	None						-	
Energy	0.5	W/sq.ft	•	Schedule	Cooling Onl	y (Design)	•	
Energy meter	None		•					
Internal	Lood	Airflow		Therm	ostat	Construction		Boom
Internal	LUdu			<u></u>		Construction		<u>11</u> 00m
nternal Load	Template	es - Project						<b></b> X
Alternative								
	Altern	ative 1		-				Apply
Description	Altern	ative 1 ge		• •				Apply Close
Description People	Altern Storag	ative 1 ge		•				Apply Close
Description People Type	Altern Storag	ative 1 je		•			T	Apply Close New
Description People Type Density	Altern Storag None	ative 1 je People	•	▼ ▼ Schedule	Cooling Only	(Design)	<b>•</b>	Apply Close New Copy
Description People Type Density Sensible	Altern Storac None 0 250	ative 1 ge People Btu/h	•	Schedule Latent	Cooling Only 200 Btu	(Design) /h	<b>•</b>	Apply Close New Copy Delete
Description People Type Density Sensible Workstations	Altern Storag	ative 1 ge People Btu/h	•	Schedule	Cooling Only 200 Btu	(Design) /h	•	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstations Density	Altern Storag None 250	ative 1 ge People Btu/h workstation/person	•	Schedule Latent	Cooling Only 200 Btu	(Design) /h	<b>•</b>	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstations Density	Altern Storag	ative 1 ge People Btu/h workstation/person	•	Schedule Latent	Cooling Only 200 Btu	(Design) /h	v	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstations Density Lighting Type	Altern Storag	ative 1 ge People Btu/h workstation/person	▼ ▼	Schedule   Latent	Cooling Only 200 Btu	(Design) /h	<b>•</b>	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstations Density Lighting Type Heat gain	Altern Storag None 250  0 Recesse 0	ative 1 ge People Btu/h workstation/person ed fluorescent, not ven W/sq ft	▼ ▼ ted, 80	Schedule Latent	Cooling Only 200 Btu ace Cooling Only	(Design) /h (Design)	• •	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstations Density Lighting Type Heat gain	Altern Storag None 250 250 Recesse 0	ative 1 ge People Btu/h workstation/person d fluorescent, not ven W/sq ft	• • ted, 80	Schedule Latent	Cooling Only 200 Btu ace Cooling Only	(Design) /h (Design)	<b>v</b>	Apply Close New Copy Delete Add Global
Description People Type Density Sensible Workstations Density Lighting Type Heat gain Miscellaneou Type	Altern Storag	ative 1 ge People Btu/h workstation/person d fluorescent, not ven W/sq ft	▼ ▼ ted, 80	Schedule   Latent	Cooling Only 200 Btu ace Cooling Only	(Design) /h (Design)	• •	Apply Close New Copy Delete Add Global

Energy

Internal Load

meter

None

-

<u>T</u>hermostat

Airflow

<u>R</u>oom

<u>Construction</u>