TECHNICAL REPORT TWC

BUILDING AND PLANT ENERGY ANALYSIS

ED SCIENCE CEN SCRANTON, PA

THE UNIVERSITY OF SCRANTON



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PENN STATE UNIVERSITY ARCHITECTURAL ENGINEERING

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EXECUTIVE SUMMARY

This purpose of this report is to provide a summary of modeled loads, energy consumption, operating costs, and emissions for the Unified Science Center in Scranton, PA. This building is a university science center housing laboratories, classrooms, computer rooms, and office spaces.

Analysis was performed using Trane TRACE 700 to simulate loads and energy usage on an annual basis. Room dimensions, occupancy, and glazing areas were entered into the program along with information about the primary heating, cooling, and ventilation systems used in the building. All information was taken directly from the design documents when provided; otherwise, default values provided by ASHRAE were used for analysis.

Results of the TRACE analysis were then compared with design document values. In most cases, the simulation results are within range of the design documents. Difficulty in accurately modeling the complex loads and systems of the Unified Science Center accounts for the discrepancies in heating loads.

According to the simulation, the Unified Science Center will consume approximately 8,666,768 kWh per year and approximately 124,195 MBTU of natural gas. The building will cost nearly \$9.00/ft² to operate. Detailed information about modeling methods and results is found in the following report.

MECHANICAL SYSTEMS SUMMARY

The majority of the Unified Science Center is supplied with 100% outside air from five rooftop AHUs with energy recovery wheels and variable frequency drives. AHUs 1 and 2 serve the same supply air ducts with a total of 100,000 CFM. AHUs 3 and 4 operate identically to supply similar spaces including offices, laboratories, and classrooms. AHU 5 provides 5,150 CFM to a ground floor Vivarium. Figure 1 shows the areas served by each unit.

Other systems include a 750 CFM constant air volume unit which serves a room on the first floor and a small variable air volume unit which serves existing variable volume supply terminals. Due to the relatively small size of these units and the areas they serve, they were not considered in the following analysis.



	AHUs 1 and 2	AHUs 3 and 4	AHU 5
Area Served	87,625 ft ²	85,757 ft ²	3,346 ft ²
	Total Floor Area	176728 ft ²	

Fig. 1

DESIGN LOAD ESTIMATION

Trane TRACE was chosen for analysis because of my previous experience with the program and its ease of use. A block load simulation was performed to estimate the design heating and cooling loads. The REVIT model used for analysis was constructed using information provided by the architectural engineers.

Design Conditions

The Unified Science Center is located in Scranton, PA, as indicated in Fig. 2. The design outdoor air conditions used for analysis were obtained from ASHRAE Fundamentals 2007, and are listed in Table 1. Design setpoints were taken from the project documentation.



Fig. 2

ASHRAE Design Conditions – Scranton, PA				
	Dry Bulb Temperature (°F)			
Cooling	88.9 (0.4%)	72.1 (0.4)		
Heating	3.5 (99.6%)	-		
Indoor Design Temperature	70-75 @ 50% RH	-		

Building Materials

Materials used for the Unified Science Center are shown in Table 2 along with their corresponding U-values. Though different types of glazing are used throughout the building, all glazing has excellent thermal performance characteristics; for the purposes of this report, all glazing was estimated to have the U-value shown below. The roof was not considered in this analysis, because a penthouse covers most of the rooftop and limits heat conduction; in addition, the white PVC roof material will reflect the majority of incident solar radiation.

Building Materials Characteristics				
Building Component	Construction	U-value (BTU/(h*ft²*°F)		
Façade Wall	Stone Veneer, Rigid Insulation, Weatherproofing	0.0693		
Partition	¾" Gypsum Wall Board	0.388		
Floor Slab	3-4" NW Concrete	0.212615		
Glazing	Double Pane Low-E Fritted Glass (typ.)	0.29 Shading Coefficient = 0.95		

Table 2

Internal Loads

Where not specified in the project documentation, internal loads were estimated using typical data based on space type provided by ASHRAE Fundamentals. Typical occupancy loads and airflows were taken from the project documentation when available; otherwise default TRACE values were used. Table 3 provides a summary of loads according to room type. Samples of TRACE inputs can be found in the Appendix.

Internal Loads					
	Lighting	Miscellaneous	Peo (BTU	ple /hr)	People
	(W/ft²)	(W/ft²)	Sensible	Latent	(ft²/person)
Classroom	1.25	0.22	250	200	20
Coffee Shop	1.25	0.1	275	275	15
Computer Classroom	1.25	8	250	200	20
Corridor	1.25	0	250	250	0
Laboratory	1.25	9	250	250	33
Mechanical Room	1	10	250	250	0
Office Suite	1.25	0.5	250	200	143
Student Study Space	1	0.22	250	200	10
Toilet Room	1	3	250	250	50
Vestibule	1	0	250	200	33
Vivarium	1.25	10	250	250	33

Schedules

Schedules were generally based on typical values provided by TRACE. Since occupancy and daylight sensors will be utilized to control the lighting levels, the default TRACE schedule "College" was used to designate lighting and people loads. Miscellaneous loads including computers, servers, and laboratory equipment are scheduled for 100% of the time. All loads for the Vivarium space are scheduled for 100% of the time. Table 4 summarizes the schedules used. Samples of TRACE inputs can be found in the Appendix.

Lighting & Occupancy Schedules					
Time	Lights	People			
	(%)	(%)			
Midnight-6 AM	0	0			
6-7 AM	10	50			
7-8 AM	50	50			
8AM-Noon	100	100			
Noon-1 PM	30	30			
1-4 PM	100	100			
4-5 PM	50	100			
5-6 PM	10	50			
6 PM – Midnight	0	0			

Table 4

Design vs. Modeled Loads

The building was modeled using Trane TRACE 700. With the exception of the heating load and the Vivarium supply air rate, the modeled load and ventilation indices are comparable with those of the design documents. Results of the TRACE analysis are summarized for the entire building in Table 5. Additional information about modeling methods and examples of inputs can be found in the Appendix.

The model was created by combining spaces with similar uses, including office clusters and adjacent laboratories, to perform a block load analysis for the entire building. The AHUs were each assigned rooms based on the design documents, and were treated as three separate units. Rooms on the 4th and 5th floors of the renovation were not included in the model because these floors are slated for future expansion and have not yet been assigned space types or ventilation rates. They will be served by AHUs 3 and 4; accordingly, the overall cooling load and the supply air for these AHUs differ from the design documents by approximately 25%.

The modeled heating load is considerably lower than the design documents; this is due to difficulties in accurately modeling the heating system of the building. Hot water produced by 8 natural gas fired boilers serves all the air handlers and terminal units. Space heating is achieved in a variety of manners according to space type, including VAV terminal boxes with hot water reheat, fan coil units, cabinet heaters, and finned tube radiation. The model was simplified as a 100% outside air unit with VAV terminal reheat, and underestimated heating loads as a result.

The Vivarium was scheduled for 100% occupancy based on 100 people in the space – this was not a reasonable assumption, and the analysis resulted in an overestimation of supply air. To a lesser extent, this error also affected the overall building cooling load.

	Cooling Load	Heating Load	Si (upply Ai CFM/ft ^t)	r
			AHUs 1&2	AHUs 3&4	AHU 5
Designed*	180	70	1.14	1.17	1.54
Modeled [†]	135	24	1.31	1.62	4.5
*Based on design square footage = 200,000 ft² (includes future expansion) †Based on modeled square footage					

Table 5

ANNUAL ENERGY CONSUMPTION AND OPERATING COSTS

The annual energy consumption and operating costs were estimated using the same TRACE model that was used for load calculations. The building is not yet occupied, so actual energy bills are not available for comparison with the model. Information pertaining to energy modeling performed by the architectural engineers was not available at the time of this writing.

Analysis shows that energy consumption and costs are dominated by natural gas use. However, delivered electricity accounts for the majority of annual source emissions due to electricity use and distribution losses.

Assumptions

All of the equipment was modeled using information from the design documents, including efficiencies and horsepowers. Representative TRACE inputs can be found in the Appendix.

Utility rates were estimated based on average values for Northeastern Pennsylvania, and can be found in Table 6. Though electricity rates fluctuate yearly, they average at \$0.10/kWh, which was the value used for estimation. Current natural gas rates are likely to decrease in the future as a result of developments in local Marcellus shale mining, but a conservative rate was used in analysis nonetheless.

Gas and Electricity Rates					
Electricity Demand \$10.00/kW					
Electricity Supply	\$0.10/kWh				
Gas	\$0.72/therm				
Water	\$11.00/1000 gallons				

Table 6

Annual Energy Consumption

Table 7 provides a breakdown of annual energy consumption by load type. The heating load easily dominates modeled annual energy usage with 80% of the total. Though the overall cooling, auxiliary, lighting and receptacle loads are typical, the natural gas usage seems excessively high, and skews the percentage values of each load type. Given the location in northeastern Pennsylvania and the focus on daylighting and energy conservation, the other results are generally reasonable.

Annual Energy Consumption						
Load	Electricity (kWh)	Natural Gas (kBTU)	Water (1,000 gal)	% of Total		
Heating				80		
Primary		124,195,200		79.5		
Other	127,024			0.6		
Cooling				6		
Compressor	1,615,573			3.6		
Cooling Tower/ Condenser Fans	398,595		16,550	0.9		
Condenser Pump	220,635			0.5		
Auxiliary				9		
Supply Fans	3,489,151			7.7		
Pumps	569,932			1.3		
Other				5		
Lighting	1,425,080			3.2		
Receptacles	820,778			1.8		
Totals	8,666,768	124,195,200	16,550	100		

Table 7

When the design heating consumption is substituted for the TRACE calculated value in Table 7, the overall results are much more reasonable, and are shown in Figure 3.





The chart above provides an estimate of annual energy consumption according to load type. Primary heating loads and auxiliary equipment, including supply fans and pumps, consume most of the annual energy, followed by primary cooling, lighting and receptacle loads. While these results are acceptable, the receptacle load should account for a greater portion of the overall energy use given the amount of laboratory and computer equipment requiring power.

Monthly Energy Consumption

Figures 4 and 5 show the fluctuations in energy usage over the course of the design year. As expected for this climate, electricity use peaks in the summer months (Fig. 4), while gas usage peaks in the winter (Fig. 5). Figure 5 also indicates a summertime surge in natural gas consumption, the reason for the unexpectedly large annual heating load seen in Table 7. This spike is most likely due to the modeled interior and underground spaces requiring VAV reheat during the summer, and is most likely not a realistic estimate of this building's gas consumption. Table 8 shows the numerical values which were given by TRACE and used to produce these graphs.



Fig. 4

Fig. 5

Monthly Energy Consumption												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Electric - on peak (kWh)	196594	176785	217748	194321	342564	490203	483988	537002	333919	213753	204135	187979
Electric - off peak (kWh)	332773	299699	320868	334547	383614	486969	867202	663076	395704	336323	324621	342380
Electric - total (kWh)	529367	476484	538616	528868	726178	977172	1351190	1200078	729623	550076	528756	530359
Gas (therms)	136759	133524	136759	97817	29510	82032	86759	84266	26468	91261	110038	136759

Table 8

Annual Energy Cost Analysis

Monthly Energy Costs						
Month	Electricity (\$)	Natural Gas (\$)	Water (\$)	Total (\$)	% of Annual Total	
January	28,464	98,467	9,485	136,415	8.5	
February	26,422	88,938	8,510	123,869	8	
March	30,769	98,467	9,862	139,098	9.6	
April	28,516	70,428	10,001	108,945	6.6	
Мау	55,419	21,247	15,190	91,857	6	
June	71,003	66,263	22,573	159,839	10	
July	71,142	98,467	32,532	202,141	12.5	
August	76,423	89,472	28,723	194,618	12	
September	55,737	19,057	15,350	90,143	5.5	
October	31,561	65,708	10,450	107,719	6.5	
November	30,023	30,023	9,805	119,055	7.4	
December	27,748	27,748	9,570	135,785	8.4	
Totals	533,228	894,205	182,051	1,609,484	100	

Table 9

Table 9 provides a monthly summary of overall utility costs based on the rates in Table 6. Figure 6 provides a graphical representation of overall monthly utility costs. Energy costs will be at their peak in the summer months as a result of the cooling demand; an increase in natural gas consumption also contributes to this peak in overall energy costs. Natural gas usage constitutes the greatest economic cost, at 55% of the yearly total.

The building will cost approximately \$8.04/ft² to operate for a typical year. Comparisons of the costs according to type can be found in Figure 7 and Table 10.

Monthly Utility Costs







Fig. 7

Overall Cost Comparison						
Electricity Natural Gas Water Overall						
\$2.66/ft ²	\$4.47/ ft ²	\$0.91/ ft ²	\$8.04/ ft ²			

Table 10

Annual Energy Emissions

An emissions calculation was performed using the results of TRACE analysis and the 2007 NREL Regional Grid Emission Factors data. This project is located in the Eastern Interconnection of the North American Electrical Reliability Council electrical grid depicted in Figure 8.

Analysis shows that emissions are primarily the result of delivered electricity. This is the result of the large building electrical loads in combination with the poor efficiency of delivering the electricity itself. High efficiency on-site low-No_x boilers with sealed combustion effectively limit environmental impact from natural gas combustion. The TRACE model produced the summary of overall annual emissions found in Table 11.



Fig. 8

Computed Emissions Summary							
CO ₂	SO ₂	NO _x					
54,797,620 lb/yr	423,662 gm/yr	85,156 gm/yr					

Table 11

Tables 12 and 13 summarize emissions from delivered electricity and on-site combustion, respectively.

Annual Emissions from Delivered Electricity							
Pollutant	lb of Pollutant per kWh of	Annual lb of Pollutant					
	Electricity	Annual Electricity Consumption = 8,666,768 kWh					
CO2e	1.74E+00	15080174.58					
CO2	1.64E+00	14213497.88					
CH4	3.59E-03	31113.69					
N20	3.87E-05	335.40					
NOX	3.00E-03	26000.30					
SOX	8.57E-03	74274.19					
CO	8.54E-04	7401.42					
TNMOC	7.26E-05	629.21					
Lead	1.39E-07	1.20					
Mercury	3.36E-08	0.29					
PM10	9.26E-05	802.54					
Solid Waste	2.05E-01	1776687.24					
Total Annual Emis	31,210,917.95						

Table 12

Annual Emissions from Natural Gas Boilers							
Pollutant	lb of Pollutant per 1000 ft3 Natural Gas	Annual lb of Pollutant					
CO2e	1.23E+02	141690.096					
CO2	1.22E+02	140538.144					
CH4	2.50E-03	2.87988					
N20	2.50E-03	2.87988					
NOX	1.11E-01	127.866672					
SOX	6.32E-04	0.728033664					
СО	9.33E-02	107.4771216					
VOC	6.13E-03	7.06146576					
Lead	5.00E-07	0.000575976					
Mercury	2.60E-07	0.000299508					
PM10	8.40E-03	9.6763968					
Total Annual Emissi	ons (lb)	282,486.8103					

Table 13

REFERENCES

Deru, M., and P. Torcellini. *Source Energy and Emission Factors for Energy Use in Buildings*. Oak Ridge, TN: U.S. Department of Energy, 2007.

ASHRAE, 2009 Fundamentals.

Project documentation provided by Einhorn Yaffee Prescott Architecture and Engineering.

APPENDIX

nternal Lo	ad Temp	lates - Project					×
Alternative Description	Altern Classr	ative 1 com	•				Apply
People							
Туре	Classroo	m				•	New
Density	20	sq ft/person 💌	Schedule	People - Co	llege	•	Сору
Sensible	250	Btu/h	Latent	200 Bt	u/h		<u>D</u> elete
Workstation	s						Add <u>G</u> lobal
Density	1	workstation/person 💌					
Lighting							
Туре	Recesse	d fluorescent, not vented, 8	30% load to sp	ace		-	
Heat gain	1.25	W/sq.ft 💌	Schedule	Lights - Coll	ege	-	
Miscellaneou	us loads						
Туре	Std Scho	ool Equipment				-	
Energy	0.22	W/sq.ft 💌	Schedule	Misc - Colle	ge	•	
Energy meter	Electricity	y 🔽		,			
<u>I</u> nternal	Load	Airflow	<u>I</u> herm	iostat	<u>C</u> onstruction		<u>R</u> oom

Internal Load Template - Classroom

Internal Load Templates - Project		
Alternative Alternative 1 Description Laboratory	<u> </u>	Apply
People		
Type Laboratory		▼ <u>New</u>
Density 33.3 sq.ft/person	Schedule Cooling Only (Design)	▼ Copy
Sensible 250 Btu/h	Latent 250 Btu/h	<u>D</u> elete
Workstations Density 1 workstation/person	•	Add <u>G</u> lobal
Lighting		
Type Recessed fluorescent, not ven	ed, 80% load to space	•
Heat gain 1.25 W/sq ft	Schedule Cooling Only (Design)	•
Miscellaneous loads		
Type None		-
Energy 9 W/sq.ft	Schedule Cooling Only (Design)	•
Energy meter None	•	
Internal Load Airflow	Ihermostat Construction	<u>R</u> oom

Internal Load Template - Laboratory

Internal Loa	ad Temp	lates - Project					\mathbf{X}
Alternative Description	Alterna	ative 1 Suite	•				Apply Close
People							
Туре	General (Office Space				•	New
Density	143	sq ft/person 💌	Schedule	People	Office	•	С <u>о</u> ру
Sensible	250	Btu/h	Latent	200	Btu/h		<u>D</u> elete
Workstations	,						Add <u>G</u> lobal
Density	1	workstation/person 💌					
Lighting							
Туре	Recesse	d fluorescent, not vented, 80)% load to sp	ace		•	
Heat gain	1.25	W/sq.ft 📃 💌	Schedule	Lights -	Office	-	
Miscellaneou	ıs loads						
Туре	Std Office	e Equipment				•	
Energy	0.5	W/sq.ft 🗾 💌	Schedule	Misc - C	ollege	-	
Energy meter	Electricity	•					
<u>I</u> nternal	Load	Airflow	<u>T</u> herm	ostat	Construc	tion	<u>R</u> oom

Internal Load Template - Offices

Internal Loa	ad Temp	lates - Project					
Alternative Description	Alterna Vivariu	ative 1 m	•				Apply Close
People							
Туре	Laborato	ry .				•	New
Density	33.3	sq ft/person 💌	Schedule	Availab	le (100%)	•	Сору
Sensible	250	Btu/h	Latent	250	Btu/h		<u>D</u> elete
Workstations							Add <u>G</u> lobal
Density	1	workstation/person 💌					
Lighting							
Туре	Recesse	d fluorescent, not vented, {	30% load to sp	ace		-	
Heat gain	1.25	W/sq.ft 🔍	Schedule	Availab	le (100%)	•	
Miscellaneou	us loads						
Туре	None					-	
Energy	10	W/sq.ft 💌	Schedule	Availab	le (100%)	-	
Energy meter	None	•					
<u>I</u> nternal	Load	Airflow	<u> </u>	nostat	Construction		<u>R</u> oom

Internal Load Template - Vivarium

Airflow Temp	lates - I	Project				
Alternative Description	Alternat Vivariun	ive 1	•			Apply
Main supply Cooling Heating		To be calculated To be calculated	Auxiliary supply Cooling Heating	To be calculated To be calculated		<u>N</u> ew C <u>o</u> py
Ventilation Apply ASHR	AE Std62	2.1-2004/2007 No 💌	Std 62.1-2004/2007 Clg Ez Custom		%	Delete
Type Cooling Heating	100 Per 100 100	rcent Outdoor Air	Htg Ez Custom Er Default b DCV Min OA Inta	ased on system type	~ % ~ %	
Schedule	Availab	le (100%)	Room exhaust Rate 100	% Clg Airflow		
Туре	Neutral,	Average Const. 💌	Schedule Availa	able (100%)		
Cooling Heating	0.6	air changes/hr 💌	VAV minimum Rate	% Cla Airflow 🗨		
Schedule	, Availabl	e (100%)	Schedule Availa	able (100%)		
			Type Defau			
Internal Loa	ed	<u>A</u> irflo w	<u>I</u> hermostat	<u>C</u> onstruction		<u>R</u> oom

Airflow Template - Vivarium

Airflow Temp	lates -	Project				
Alternative	Alterna	tive 1	•			Apply
Description	Classro	om	•			<u>C</u> lose
Main supply			Auxiliary supply			
Cooling		To be calculated 💌	Cooling	To be calculated 💌		<u>N</u> ew
Heating		To be calculated 💌	Heating	To be calculated 💌		Copy
Ventilation			Std 62.1-2004/2007.			Delete
Apply ASHR	IAE Std6	2.1-2004/2007 No 💌	Clg Ez Custom	~	%	
Туре	100 Pe	rcent Outdoor Air 📃 💌	Htg Ez Custom	-	%	
Cooling	100	🛛 🗶 Clg Airflow 💽	Er Default I	based on system type 💌 🗾	%	
Heating	100	% Htg Airflow 🗨	DCV Min 0A Inte	ake None	-	
Schedule	Availab	ıle (100%) 🔹 💌	Room exhaust			
Infiltration			Rate 100	% Clg Airflow 💌		
Туре	Neutral	, Average Const. 📃 💌	Schedule Avail	able (100%) 🛛 💌		
Cooling	0.6	air changes/hr 💽	VAV minimum			
Heating	0.6	air changes/hr 🛛 💌	Rate	🛛 🖇 Clg Airflow 🛛 💌		
Schedule	Availab	le (100%) 🔹 💌	Schedule Avail	able (100%) 🛛 💌		
			Type Defa	ult 💌		
Internal Loa	ad .	<u>A</u> irflow	<u>I</u> hermostat	<u>C</u> onstruction		<u>R</u> oom

Airflow Template - typ.



Modeled System Diagram, all AHUs

Configuration
Ltdd Cooling plants
🖻 📲 Cooling plant - 001
🖻 🔩 Water-cooled chiller - 001
🕀 👻 Cooling tower
🖓 🖓 Primary chilled water pump
🖃 🕰 Water-cooled chiller - 002
😟 👻 Cooling tower
🖓 🖓 Primary chilled water pump
Heating plants
🖻 🏙 Heating plant - 002
🗄 💆 Boiler - 001
🖻 🚊 Boiler - 002
庄 💆 Boiler - 009
🖻 💆 Boiler - 010
🖻 🚊 Boiler - 011
🖻 🚊 Boiler - 012
🗄 💆 Boiler - 013
🗄 🚊 Boiler - 014

Modeled Cooling and Heating Plants

🗩 Create Plants							_ 🗆 🛛
Cooling Equipment - Alterr	native 1			Heat Reje	ction		
Cooling plant	Cooling plant -	001	-	Туре	Cooling tower for Cent.	Chillers 🔹	Apply
Equipment tag	Water-cooled	chiller - 001	•	Hourly ambient wet bulb offset F			<u>C</u> lose
Category	Water-cooled	chiller	-				
Equipment type	Centrifugal 2-Stage w/ Var Freq Dr			Thermal S	torage		<u>N</u> ew Equip
Sequencing type	Single		•	Туре	None	-	Copy Equip
Energy source			_	Capacity	0 Ito	n-hr	
		· .		Delete			<u>D</u> elete Equip
Reject condenser heat	Heat rejection	equipment	<u> </u>	Schedule	Storage		
Reject heat to plant			~				Controls
							<u>Controis</u>
Operating mod	le		Capacity		Energy r	ate	Packaged
Cooling		550	tons		0.548 kW/to	n	Energy
Heat recovery			tons		kW/to	n	breakout
Tank charging			tons		kW/to	n	
Tank charging & heat reco	very		tons		kW/to	n j	
Pumps			Туре		Full load cons	umption	
Primary chilled water	water Default water pump		P	95 ft water		:r	
Condenser water	Default water pump		P		65 ft wate	er	
Heat recovery or aux cond	enser	None			0 ft wate	er en	
<u>C</u> onfiguration		Cooling Equ	uipment		Heating Equipment	Base Utility / N	disc. Accessory

Modeled Chillers

💭 Create Plants								_ 🗆 🗙
Heating Equipmen Heating plant Equipment tag	it - Alternative 1 — Heating plant - 0 Boiler - 001	02	•	Thermal Sto Type Capacity	None	ton-hr	• •	Apply
Category Equipment type	Boiler Gas Fired Hot W	ater Boiler	•	Schedule	Storage		_	<u>N</u> ew Equip
Capacity Energy rate	1760 Mb 87 Pe	h 💌		Equipment schedule Demand lir	Available (10	0%)	•	<u>D</u> elete Equip
Hot Water Pump Type Full load consumption	Heating water ci	rc pump vater	T					
Configura	ation	Coojing Equipmen	nt	<u>H</u> eati	ng Equipmen	ıt 🗌	<u>B</u> ase Utility / N	lisc. Accessory

Modeled Boilers