The Eberly Campus Community Center
Uniontown, PA

Mechanical Systems | Existing Conditions Analysis

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Executive Summary

An evaluation of an existing building is incomplete without an evaluation of all of its existing systems and components. To provide a quality evaluation, all aspects of the given system should be known. In-depth research and several pertinent calculations about the building and its systems are required for a full analysis. The mechanical systems of the Eberly Campus Community Center are currently being analyzed through a series of reports. Therefore, an existing conditions analysis is a logical extension of the current studies of the community center. Within this report is a detailed overview of the mechanical systems and equipment included in the Eberly Campus Community Center.

Detailed within this overview are several analyses and large quantities of data sheets. The analyses have already been performed during previous reports on the center and are only presented here as pertinent information. Analyzed within are the utility sources and rates, the building base ventilation requirements, the building heating and cooling demand loads, as well as the building monthly and yearly energy consumption and costs. Data sheets include building base design goals, indoor and outdoor design conditions, schedules of the existing mechanical equipment, and the operating history of the current system. Each of these included calculations and information are key components of the existing building systems evaluation.

After the compilation of the analysis and the data, the current operating conditions and efficiency of the system become clear. The system meets the majority of its original design goals, though the energy efficiency of the system could be improved. Several outstanding conditions – problems within the operating history - must be addressed in future reports to provide a system operating at its optimum point of both interior environmental quality and energy efficiency. This report provides a definitive overview both of the existing mechanical systems within the Eberly Campus Community Center as well as the possible problems that must be resolved within the future of the building.

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1. Design Objectives and Requirements

The Eberly Campus Community Center is a building designed for economy. As the building has large disparate spaces and generic use types, complicated systems become unnecessary as well as uneconomical. To provide the best system type for the project, the owners and the engineering design team have compiled a set of design goals to reflect the economy and simplicity of the building design. The design goals are stated as follows:

DESIGN GOALS:

- Quality
- Simple Approach
- Maintainable
- Energy Efficient

To meet these goals, several options have been discussed in the schematic design phase. The options are included in Table 1 below along with their eventual use or exclusion within the project.

Table 1: Applied Design Goals per System

Applied Design Goals		
System	**Options Discussed**	**Used in Final Design**
Energy Efficient Measures	Cross Flow Heat Exchangers	No
Heating System	Cast Iron Boilers	Yes
	Hot Water Heating	Yes
Cooling System	Air Cooled Chiller	Yes
	Remote Evaporator in Mechanical Room	No – Attached to hermetic chiller.
	Individual DX Units	Yes
Water Heating System	Large (500 gal.) Water Storage Tank	Yes
	Side Arm Water Boiler	Yes

2. Energy Sources and Rates

Uniontown, located in Fayette County Pennsylvania, is a largely rural area with few available energy sources. While the community center is located on a Penn State Commonwealth Campus, the existing campus has no central heat or cooling plants. Therefore, each building on the campus has been treated as a stand alone system, forcing the current project to be dependant upon the available site energy sources. The preliminary site investigation has revealed the existing utilities as follows:

AVAILABLE UTILITIES:

- Sanitary and Storm Sewers
- Gas Energy
- Water
- Power and Communication

Of the available utilities, only two are potential energy sources, limiting the choice of energy sources to gas and electric power. The owner has chosen to employ the most cost efficient power provider as well as the local gas supplier to supply the building energy. The chosen utilities include Allegheny Power as well as Columbia Gas. Applicable rate structures for each energy source are included in Tables 2 and 3. Further details on the charges and sources of rate information are included in Appendix A of this report.

Table 2: Electric Utility Rates | Allegheny Power

Electric Demand on Peak			
Charge	**Minimum Charge**	**100 kW and under**	**Over 100 kW**
Distribution	$1.07	$0.98	$0.82
Total equals =	$1.07	$0.98	$0.82

Electric Consumption Energy Charges			
Charge	**Minimum Charge**	**0 - 40,000 kWh**	**Over 40,000 kWh**
Distribution	$0.00	$0.00704	$0.00630
Total equals =	$0.00	$0.00704	$0.00630

Table 3: Gas Utility Rates | Columbia Gas Company

Gas Demand on Peak			
Annual Use (Mcf)	**In Therms:**	**Total effective rate ($)**	**Charge per Therm**
<10k	102700	$72.09	
10k - 50k	513500	$264.48	
50k - 100k	1027000	$911.80	
100k - 300k	3081000	$1,620.97	
300k - 700k	7189000	$3,241.95	
700k +	7189000	6483.89	
Monthly Commodity Charge (Mcf)	**Convert to Therms**	**Rate: $/Mcf**	**Charge ($/Therm)**
1000	10270	$9.85750	$0.95983
4000	41080	$9.82730	$0.95689
5000	51350	$9.79310	$0.95356
10000	102700	$9.75840	$0.95019
20000	205400	$9.73080	$0.94750

3. Impact of Utility Cost on Design

While this project has been designed to a strictly economical first cost, system operating costs have had little to no impact upon the design. For an example, consider the building management of electric power on/off peak periods. Electric off peak operation is usually a good way to avoid higher utility rates. Yet currently, the building systems are set to run at 100% on demand with no regard towards the impact of electric demand charges. Other energy saving devices have been removed through value engineering, including the cross-flow heat exchangers originally considered in the preliminary schematic design phase. Therefore the utility costs have not had a significant effect upon the building mechanical systems design.

4. Impact of Site Factors on Design

Like the utility costs, site factors have also had very little influence upon the mechanical system design. The only recognizable impact the site has had upon the mechanical system is in the placement of the equipment. The building is located at the base of a grade that runs up toward the core of the commuter campus. Therefore, the roofs of the community center are clearly visible throughout the campus except from the parking lot directly behind the center. The architects as well as the owner have been adamant that large mechanical equipment should be placed in locations alternative to the roof. The finished design includes many small mezzanine mechanical rooms for the air handling units, with only one chiller condensing unit located upon the roof within a decorative enclosure. Though the site has forced the mechanical design team to remove the equipment from the roof, no other design considerations have been associated with the site. Therefore, the site has had only a minor role in the mechanical system design.

5. Indoor and Outdoor Design Conditions

Indoor design conditions and set points have been assembled from the various controls documents as well as the Building Automation System control logic. Applicable indoor design conditions are included in Table 4.

Outdoor design conditions have been taken from the ASHRAE Fundamentals Handbook 2005 at a 0.4% design condition as well as the Trane Trace weather data file for the closest site. These conditions have been used in building load calculations as well as the annual energy analysis calculations presented in sections 7 and 8 of this report, respectively. Applied outdoor design conditions can be found in Table 5 below.

Table 4: Indoor Design Conditions

Indoor Design Conditions				
Cooling DB (ºF)	Heating DB (ºF)	Relative Humidity (%)	Cooling Driftpoint (ºF)	Heating Driftpoint (ºF)
75	68	50	95	55

Table 5: Outdoor Design Conditions

Outdoor Design Conditions						
Summer		Winter	Clearness		Ground Reflectance	
DB (ºF)	WB (ºF)	DB (ºF)	Summer	Winter	Summer	Winter
89.1	75.1	4.5	0.97	0.97	0.2	0.2

6. Design Ventilation Requirements

As the source of oxygen and effluence control within the building, correct ventilation is a very important step in the design process. The calculation of this requirement requires a multitude of steps set forth in ASHRAE Standard 62.1-2004. Design ventilation requirements for the Eberly Campus Community Center have already been calculated in a previous report. Therefore, the results are presented here in Table 7, while the full calculations can be found in Appendix B of this document. As shown in Table 6, this building complies with the overall ventilation supplied, though some individual spaces are either over or under ventilated.

Table 6: Design Ventilation Requirements

Design Ventilation Requirements			
Zone (system)	Zones Served	Supplied OA (cfm)	V_ot Required (cfm)
AHU 1	Auxiliary Gym	2000	1906
AHU 2	Arena	2815	2694
AHU 3	Arena	2815	2694
AHU 4	Arena	2815	2694
AHU 5	Arena	2815	2694
AHU 6	Fitness	840	619
AHU 7A	Racquetball 115, 116	560	177
AHU 8	104, Q101, F104, Q107, Q103, 103	4440	4436
AHU 9	Auditorium, Stage	1800	1775
AHU 10	Auditorium, Stage, Control Rm	1800	1797
FC 2	Office 102B	20	10
FC 2	Office 113A	20	13
FC 2	Office 114A	20	12
FC 1	Multipurpose 106	40	74
FC 1	Multipurpose 106	40	74
FC 1	Office 107	40	17
FC 1	Office 108	40	14
FC 1	Office 109	40	15
FC 1	Office 111	40	18
FC 1	Office 112	40	19
UV1	Kitchen, dish wash	435	257
	Entire Building Totals	23475	22008

7. Design Heating and Cooling Loads

Heating and cooling loads for the buildings have been computed in the Trane Trace energy modeling program. The most applicable results have been summarized in Table 7, however, monthly heating and cooling load outputs are included in Appendix C.

Table 7: Design Heating and Cooling Loads

Design Heating and Cooling Loads		
System	Heating Load (Btuh)	Cooling Load (Btuh)
FCU1-107	5,269	9,092
AHU-1	151,534	162,169
AHU-10	79,137	125,198
AHU-2	115,798	160,084
AHU-3	91,935	164,536
AHU-4	130,094	160,084
AHU-5	130,094	160,084
AHU-6	122,242	167,165
AHU-7A	36,155	44,091
AHU-8	248,289	942,994
AHU-9	77,464	124,766
CH 102	11,532	0
CH 103	10,082	0
CH E104	4,911	0
CH aud. Lobby	8,614	0
CH main lobby E	13,244	0
CH main lobby W	13,244	0
FCU1-108	5,052	8,466
FCU1-109	5,052	8,466
FCU1-111	7,222	11,801
FCU1-112	8,006	11,844
FCU1-mp106E	4,554	9,087
FCU1-mp106W	3,887	9,508
FCU2-102B	2,315	3,336
FCU2-113A	1,425	3,358
FCU2-114A	1,421	3,324
SS-dry store	1,801	2,237
UV	30,272	119,016
Rad-113B	1,372	0
Rad-117	1,378	0
Rad-118	1,378	0
Rad-119	1,378	0
Rad-120	2,652	0
Rad-AV101B	780	0
RP-117A	1,174	0

Design Heating and Cooling Loads		
System	Heating Load (Btuh)	Cooling Load (Btuh)
RP-118A	1,174	0
RP-119A	1,174	0
RP-120A	1,174	0
RP-122	614	0
RP-123	614	0
RP-men108	4,840	0
RP-toilet102	816	0
RP-Training114	5,882	0
RP-W106	7,145	0
SS-122	1,114	1,619
Stage Back E	3,687	0
Stage Back W	3,687	0
Totals	**1,362,678**	**2,412,325**

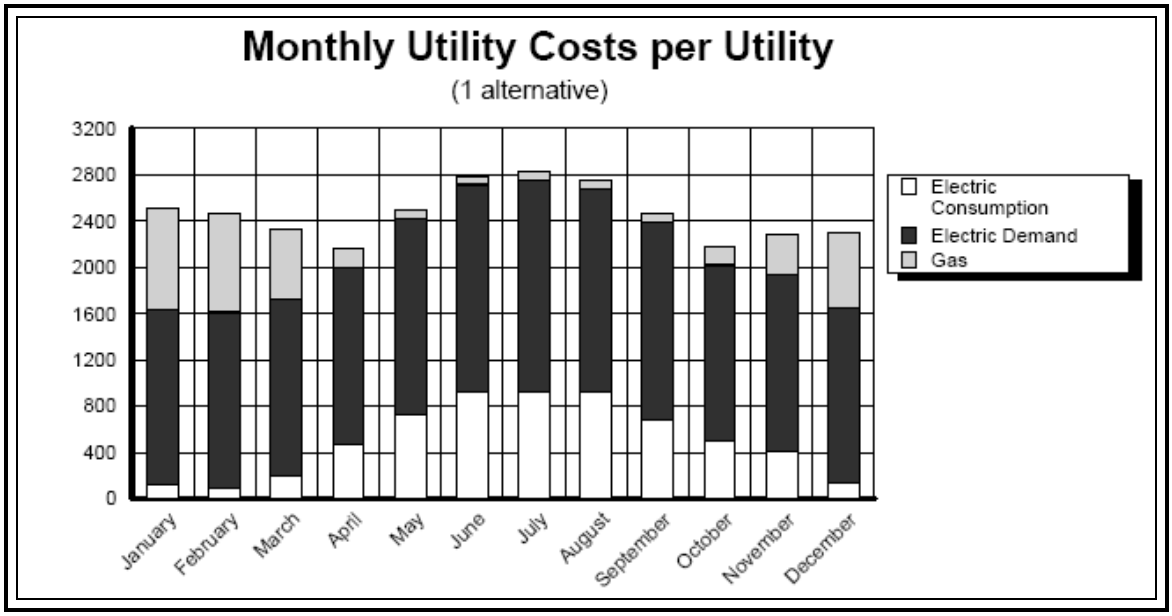
8. Annual Energy Use

Calculation of the building annual energy use has been completed in the Trane Trace program as well. A summary of the results can be found in Table 8. Figure 1 provides a graphical representation of the monthly energy use over the course of the year in dollars. Combining these two useful tools provides an overview of the building energy use as well as its associated energy costs. Appendix D holds more detailed Trace output on energy demands and consumption.

Table 8: Building Annual Energy Use

Annual Energy Consumption Summary				
Energy Useage Source	Electric Consumption (kWh)	Gas Consumption (Therms)	Percent of Total Energy	Total Source Energy (kBtu/yr)
Primary Heating	5177.6	3826.1	10.1%	4557.7
Primary Cooling	830268.7		71.5%	85019.7
Auxiliary	83290.6		7.2%	8529.0
Lighting	129253.9		11.1%	13235.6
Recepticles	2000.6		0.2%	204.9
Total (annual)	1049991.4	3826.1	100.0%	111546.8

Figure 1: Building Monthly Energy Costs | Dollars vs. Month



9. Existing Mechanical Systems: Schedules

Included below are schedules of the existing mechanical system equipment as well as its key characteristics and defining operating points. To reference any particular piece of equipment, please see the Index of Tables and Figures included at the beginning of this paper.

Table 9: Boiler Schedule

Boilers (2, typical of below)				
Mark	Type	Input MBH	Output MBH	Burner Electrical Characteristics
B (1&2)	Cast Iron Sectional	3172	2498	1 Hp - 480/1/60

Table 10: Pump Schedule

Pumps (typ.of type)						
Mark	Fluid	GPM	Head (ft. wg.)	RPM	HP	Electrical Characteristics
P (1&2)	Hot Water	347	70	1750	10	480/3/60
BP (1&2)	Hot Water	250	13	1150	1.5	480/3/60
P (3&4)	Chilled Water	411	80	1750	15	480/3/60

Table 11: Expansion Tank Schedule

Expansion Tanks									
Mark	Type	Service	Acceptance Volume (gal)	Pressure			Dimensions		
				fill	relief	prch	lngth	dia	inlet
ET 1	Bladder	Hot water system	317	15	30	12	88	36	1.5
ET 2	Bladder	Chilled water system	53	15	30	12	38	24	1

Table 12: Air Separator Schedule

Air Separators (Typ. of both)	
Mark	Description
AS 1&2	Centrifugal type air separator with 5" inlet and outlet connections tengential to the vessel shell.

Table 13: Water Meter Schedule

Water Meter Schedule					
Mark	Service	Size	Flow - GPM	Max. Pressure	Max. Temp.
WM 1	Hot water system	5/8"	2 - 20.	150 psi	250 F
WM 2	Chilled water system	5/8"	2 - 20.	150 psi	250 F

Table 14: Make-up Air Unit Schedule

Make-up Air Unit Schedule							
Mark	Service	Fan & Motor			Gas Fired		
		CFM	Max. RPM	HP	Type	EAT	LAT
MUA 1	Kitchen Exh. Hood	850	1020	0.5	Indirect gravity vent	0	85
MUA 2	Servery Exh. Hood	2010	960	1	Indirect gravity vent	0	85

Table 15: Fan Coil Unit Schedule

Fan Coil Unit Schedule											
Mark	Fan Nom. CFM	Min. OA	Cooling Coil					Heating Coil			
			Total MBH	Sen. MBH	GPM	EWT	P drop (ft. wg.)	MBH	GPM	EWT	P drop (ft. wg.)
FC 1	380	40	8.5	7.7	1.6	42	3.3	17	0.9	200	2.1
FC 2	180	20	4.5	3.8	0.8	42	4.1	9.2	0.5	200	0.6

Table 16: Split System | Condensing Unit (Paired) Schedules

Split System A/C Unit Schedule				Condensing Unit Schedule				
Mark	CFM	DX Cooling MBH	Elec. Heat MBH	Mark	EER	Cont. steps	TMBH min.	Sat. Suc. Temp
SS 1	340	12.6	N/A	CU 1	10.6	1	12.2	50
SS 2	340	9.8	1.5	CU 2	10	1	9	50

*Note: Split systems are paired with the above condensing units.

Table 17: Combustion Air Unit Schedule

Combustion Air Unit Schedule								
Mark	Service	Fan & Motor			Gas Fired			
		CFM	Max. RPM	HP	CFM	Type	EAT	LAT
CAU 1	Boiler room combustion air	3500	940	2	350	Indirect	0	80

Table 18: Cabinet Heater Schedule

Cabinet Heater Schedule					
Mark	Type	CFM	MBH	GPM	HP
CH 1	Vert. Recessed	660	56.8	3.8	1/8
CH 2	Hori. Recessed	660	56.8	3.8	1/8
CH 3	Hori. Recessed	340	29.4	2	1/20
CH 4	Hori. Cabinet	340	29.4	2	1/20

Table 19: Unit Heater Schedule

Unit Heater Schedule							
Mark	Type	MBH	GPM	P drop	Delta T	HP	EWT
UH 1	Hori. Throw	19.1	2	0.05'	20	1/20	200
UH 2	Hori. Throw	7.3	1	0.01'	15	1/20	200

Table 20: Radiation Schedule

Radiation Schedule		
Mark	Btu / sq.ft.	Avg. Wt.
RAD 1	687	190
RAD 2	1348	190

Table 21: Radiant Panel Schedule

Radiant Panel Schedule			
Mark	Btuh / sq.ft.	Width	Min. awt.
RP 1	290	24"	190 F
RP 2	290	12"	190 F

Table 22: Fan Schedule

Fan Schedule					
Mark	Service	CFM	S.P.	Max. RPM	HP
EF 1	Kitchen Exh. Hood	1700	1.9	1335	1 1/2
EF 2	Servery Exh. Hood	4025	2.7	1210	5
EF 3	Stone Hearth Oven Exh.	625	0.9	1600	1/2
EF 4	Dishwasher Hood	500	0.5	805	1/4
EF 5	General Exhaust	150	0.375	875	1/6
EF 6	Dressing Rooms	250	0.375	895	1/6
EF 7	Set Building	300	0.375	915	1/6
EF 8	Storage Room Exh.	75	0.375	1350	1/30
EF 9	Data	75	0.375	1350	1/12
EF 10	Mech. Room Exh.	250	0.25	1120	1/5
EF 11	Mech. Rm. Exh.	500	0.25	1240	1/12
EF 12	Storage Room Exh.	200	0.375	1190	1/5
EF 13	Electric Room Exh.	425	0.375	1290	1/7
EF 14	Storage Room Exh.	275	0.375	1200	1/4
EF 15	Faculty Locker Rm. Exh.	625	0.375	790	3/4
EF 16	Toilet Exh.	2350	0.625	770	1/4
EF 17	Training Rm. Exh.	865	0.5	950	1/4
EF 18	Locker Rm. Exh.	1500	0.375	840	1/4
EF 19	Electric Room Exh.	500	0.25	1240	1/5
EF 20	Refrigerant Exh.	1700	0.25	1230	1/2
EF 21	Coffee Bar Exh.	350	0.25	1170	1/7

Table 23: AHU Schedule

Air Handling Units Schedule							
	Mark	AHU 1	AHU 2-5	AHU 6	AHU 7A	AHU 8	AHU 9-10
	Service	Aux. Gym	Arena	Fitness	Racquetball	Food/Dining	Auditorium
Fan & Motor	CFM	6000	7500	3500	2250	12700	5500
	Min OA CFM	2000	2815	840	560	4440	1800
	Max. RPM	2010	1780	2910	2400	1280	2205
	HP	7.5	10	5	3	156	5
	Fan Type	Centrifugal - airfoil	Centrifugal - airfoil	Centrifugal - airfoil	Centrifugal - airfoil	Centrifugal - airfoil	Vaneaxial - airfoil
HW Heating Coil	MBH	347	457	178	184	791	336
	Air Temp,i	46.7	43.8	53.1	44.7	42.6	43.6
	Air Temp,o	100	100	100	100	100	100
	GPM	23	30	12	12	53	22
	EWT	200	200	200	200	200	200
	P drop, H2O (ft. wg.)	0.57	0.58	0.21	1	1.24	0.53
	P drop, air (ft. wg.)	0.23	0.16	0.37	0.55	0.2	0.2
CHW Cooling Coil	Tot. MBH	227	319	110	70	490	226
	Sen. MBH	173	219	98.2	64.8	357	162
	EAT DB	81.1	81.5	80.5	80.3	80.5	81.6
	EAT WB	68.8	68	65.2	63.4	66.8	67.8
	LAT DB	54.9	55	54.1	54.1	55	55
	LAT WB	54.5	54.4	54.8	52.7	54.3	54.6
	GPM	33	46	16	10	70	33
	P drop H2O (ft. wg.)	3.02	8.09	1.07	2.54	6.79	2.99
	P drop air (ft. wg.)	0.67	0.47	0.64	0.46	0.5	0.59

Table 24: Unit Ventilator Schedule

Unit Ventilator Schedule																				
Mark			Fan & Motor				HW Heating Coil					CHW Cooling Coil								
Type																				
Service			CFM	Max. RPM	HP	Min OA CFM	MBH	EAT	GPM	EWT	P drop H2O (ft.wg.)	Tot. MBH	Sen. MBH	EAT DB	EAT WB	LAT DB	LAT WB	GPM	EWT	P drop H2O (ft. hd.)
UV 1	Horizontal	Kitchen	1750	1140	0.75	435	149	54	6	200	3.4	54	44.3	82	65	55.5	53.3	9	42	6.3

Table 25: Air-cooled Chiller Schedule

Water Chiller - Air Cooled														
Mark	Nom. Tons	Evaporator Chilled Water				Capacity				Compressors			Condenser Fans	
		GPM	EWT	LWT	P drop	Tons	Amb.	EER	IPLV	No.	COP	Tons	No.	HP (Ea.)
AC 1	225	396	54.8	42	9.1	214.3	95 F	9.7	13.5	2	2.83	120/100	13	1.5

10. Existing Mechanical Systems: Schematics

Simplified schematics of the major mechanical systems have been included to facilitate comprehension within this analysis. The most significant systems have been selected and included: the hot water supply system has been shown in Figure 2 and the chilled water supply system has been represented shown in Figure 3.

Unfortunately, the air handling distribution has not been included below. This has been omitted because the project in question employs only small constant volume air handling units without duct risers, serving only a single zone. A ductwork schematic for a system of that type is unnecessary.

Figure 2: Hot Water Piping System Schematic

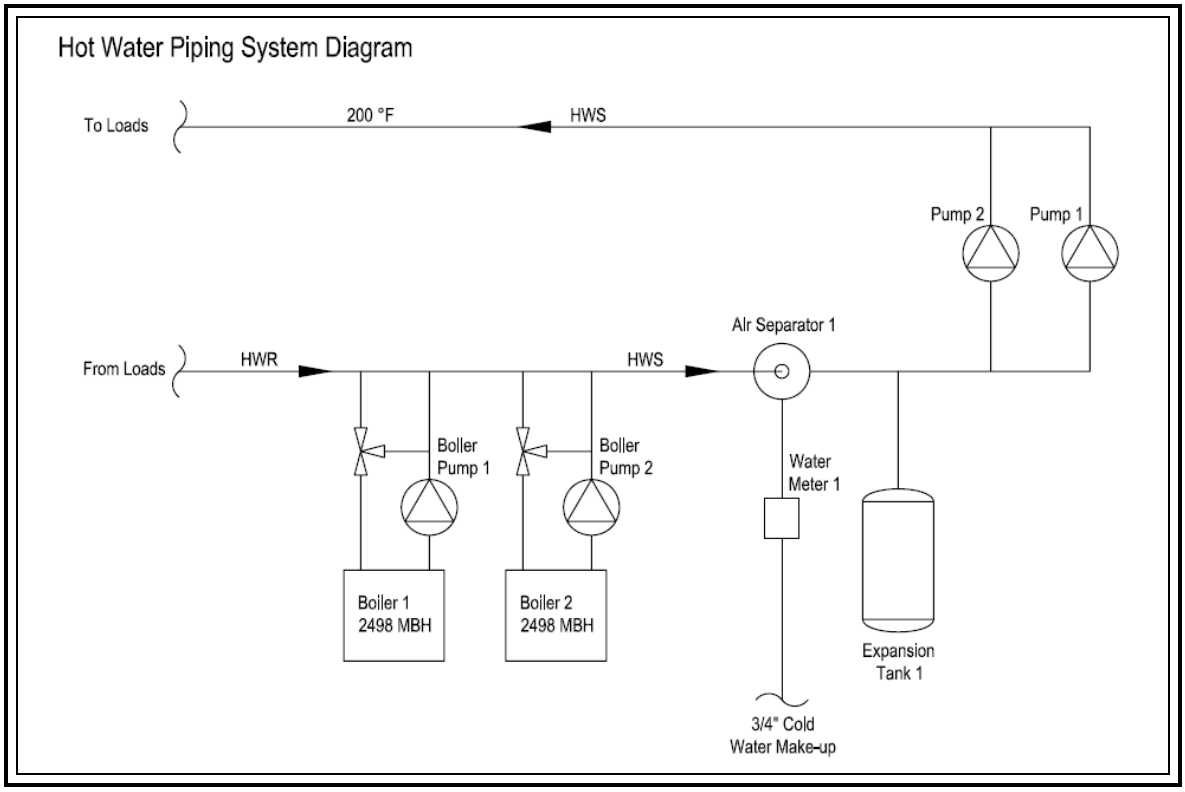
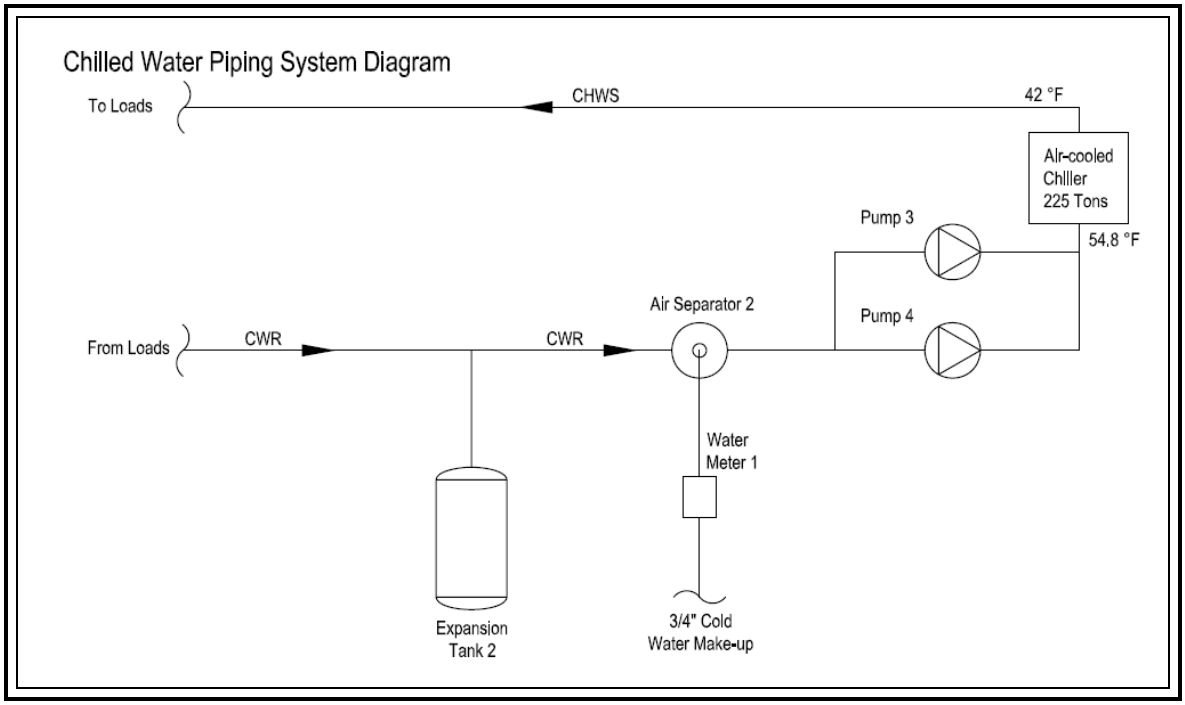


Figure 3: Chilled Water Piping System Schematic



11. Existing Mechanical Systems: System Operation

1. HOT WATER SYSTEM:

   The boilers are among the most important components within the hot water system. Boiler operation is controlled through a direct digital control system (DDC), as are all of the systems in the building. Certain conditions will trigger the DDC system to begin boiler operation. Boilers will cycle on from either a manual command from the operator or when outdoor air temperature falls below 65 °F. During the boiler start-up, a linked combustion air unit is also initialized to exhaust the byproducts from the boiler.

   The boilers are installed in a lead/lag relationship. Figure 2 shows the two boilers set up in series with a set of three way valves connecting to a boiler bypass and an individual boiler pump for each boiler. This configuration allows for different variations of boiler staging. Currently, the lag boiler is staged to initialize 15 minutes after the start of the lead boiler. As the building loads drop, the boilers will be de-energized in a sequential pattern. Gradual shutdown begins with the lag boiler and ends with the lead boiler. Each individual boiler pump will continue to run for 5 minutes after its boiler shutdown. This will remove any residual heat from the piping loop before closing the three-way valve and enabling the individual boiler bypass.

   Pumps 1 and 2, as shown on Figure 2, operate in parallel. Pump 2 has been arbitrarily designated as the lead pump. When either boiler is called to operate, the lead pump will be enabled. If the lead pump fails, the lag pump will then be called to operate.

   The minimum boiler supply temperature is 140 °F to prevent boiler shock and corrosion. The hot water supply temperature coming from the boilers is between 160 and 200 °F. If this setpoint is not attained and maintained within 5 minutes of the lead boiler startup, the lag boiler will be called to operation.

2. CHILLED WATER SYSTEM:

   Just as the boilers are the core of the hot water system, the chiller is the core of the cold water system. Figure 3 shows a simplified schematic of the chiller and its associated chilled water system. The DDC system has several programmed conditions that, when met, will start the chiller operation. Chiller operation begins during the following: when the outdoor air temperature is above 55 °F, at pre-programmed time schedules, or when building loads demand cooling from the air handling units/fan coil units.

   The chilled water system is supplied by a set of pumps: pumps 3 and 4. The duty pump has been arbitrarily selected as pump 3, while pump 4 acts as the standby

pump for a possible failure of the duty pump. To ensure proper functioning of the standby pump, the standby pump is exercised after every 750 hours of duty pump operation.

3. AIR HANDLING SYSTEMS:

   All air handling systems supplying outdoor air have been equipped with an economizer that will start functioning when the outdoor air in below 50 °F. The economizer begins to modulate from 100% outdoor air intake when the mixed supply air reaches 48 °F down to 20% outdoor air intake when the mixed supply air reaches 44 °F.

   Uniformly throughout the building, all air handling systems are constant volume, supplying primarily small single zone systems. Each unit comes equipped with a thermostat, providing direct temperature control within the zone served by the unit. Supply air temperature setpoint is 48 °F while the space setpoint temperature is 70 °F.

12. Existing Mechanical Systems: Operating History

The Eberly Campus Community Center has been in operation for roughly three years. This time period has seen continuous re-evaluations of the systems operations and controls, while project punchlisting and building commissioning is still underway.

Unfortunately, the community center is utilized to a maximum of 30% of the design condition for most of its spaces. The commuter students do not use the 250 seat dining facility due to its distance from the rest of the campus. Community members in the surrounding area avoid the fitness facilities due to the fees, and the theater is used perhaps once a month. Finally, the building closes throughout the summer, as the Penn State Fayette campus also closes for the summer. Therefore, the facility is most often used at 20 to 30% of its design capacity and only rarely sees usage approaching its original design estimation.

The under-utilization of the spaces leads to under-utilization of the equipment as well. While the extreme partial loading of the systems is an energy waste due to lost efficiencies and on/off cycling, the equipment has also not been designed to compensate for such reduced part load conditions. Therefore many of the spaces are facing humidity problems. The dampness within the theater is so pronounced that the theater curtain has shrunk 6” over the past three years and often feels wet, and several of the seats have already been re-upholstered to remove mold damage. Also, the dampness has had a large impact upon the main arena area: the finish on the hardwood basketball flooring never dried after its first application, causing warping of the floor itself as well as uncounted amounts of extra costs as the floor had to be repaired and refinished.

The extreme nature of the space moisture levels suggests several problems that should be examined in the future. First, the building could be under negative pressurization, causing excess infiltration, and adding to the moisture problem. A second cause of excess space humidity is the equipment controls. The equipment controls and staging could be properly adjusted so that the moisture and space humidity are removed from the air. Unfortunately, this is an extremely uneconomical use of the equipment and available energy, and should only be considered as a last resort. Finally, the problem could be caused through incorrect placement of the building envelope vapor barrier, causing condensation on the inside of the walls and trapping humidity within the space. All three of these problems are probable, and are worth investigation at a later date.

13. Critique of System

The mechanical systems of the Eberly Campus Community Center have been designed with four goals in mind. These goals are the following: quality, simplicity, maintainability, and energy efficiency. Certain tradeoffs between different goals have been employed to arrive at the existing system. For instance, a hermetic packaged chiller with inclusive condenser and evaporator components enhances the system simplicity but detracts from the system maintainability. Also, many of the selections have been made at the expense of the energy efficiency goal. Often, designing for energy efficiency and quality can increase system first costs. Therefore, energy efficiency and quality are often sacrificed to lower the system first costs. Here, higher efficiency filters have been eliminated to save costs. Also, though economizers have been employed to increase the building energy efficiency, building schedules and the actual people design loads have not been considered in the original controls scheme. Therefore, the system has some energy efficiency and quality control weak points that can be addressed in the future to provide a more sustainable, higher quality system. After an evaluation of this mechanical system, it is apparent that the system meets most of the design goals satisfactorily, while still having some problems that must be addressed.

14. Appendices Index

Appendix A

Detailed Energy Rates Breakdown

GENERAL POWER SERVICE
SCHEDULE 30

Available for any purpose for loads totaling over 100 kilowatts at an establishment when all service at the establishment is supplied under this Schedule. Connections made before October 14, 1966, shall be for loads greater than 50 kilowatts. Loads over 1,500 kilowatts connected after August 28, 1985, will be served at voltages greater than 1,000 volts. Service shall not be available for Standby or Maintenance Service such as that required for Alternative Generation Facilities. An Electric Service Agreement shall be executed.

Riders Available - Curtailable Service Rider and Experimental Shoulder-Peak Rider are available under this schedule.

MONTHLY RATE

DISTRIBUTION CHARGES (I)

Demand Charge (kW)

Minimum kilowatts	$1.07 per kilowatt
First Block kilowatts (0 to 100)	$0.98 per kilowatt
Second Block kilowatts (Over 100)	$0.82 per kilowatt

Voltage discount (kW)

1,000 to 15,000 volts	$0.20 per kilowatt
Over 15,000 volts	$0.40 per kilowatt

Reactive kilovolt-ampere charge

Reactive kilovolt-ampere charge is applied to the Customer's reactive kilovolt-ampere capacity requirement in excess of 35% of the Customer's kilowatt capacity.

Billing reactive kilovolt-amperes	$0.40 per reactive kilovolt-ampere

Energy Charges (kWh)

First Block (0 to 40,000)	$0.00704 per kilowatt-hour
Second Block (over 40,000)	$0.00630 per kilowatt-hour

TRANSMISSION CHARGES (I)

Demand Charge (kW)

Minimum kilowatts	$0.54 per kilowatt
First Block kilowatts (0 to 100)	$(0.09) per kilowatt
Second Block kilowatts (Over 100)	$(0.16) per kilowatt
Ancillary Services:	
Scheduling, System Control & Dispatch	$0.00 per kilowatt
Energy Imbalance	$0.00 per kilowatt
Reactive & Voltage Control	$0.08 per kilowatt
Regulation & Frequency Response	$0.08 per kilowatt
Spinning Reserve	$0.22 per kilowatt
Supplemental Reserve	$0.20 per kilowatt

(I) Indicates Increase

Continued on Page No. 11-2

GENERAL POWER SERVICE
SCHEDULE 30 (Continued)

Energy Charges (kWh)
First Block (0 to 40,000) ..... $0.00356 per kilowatt-hour
Second Block (over 40,000) ..... $0.00318 per kilowatt-hour

The transmission charges are based on PJM's Open Access Transmission Tariff which will change from time to time and is subject to Federal Energy Regulatory Commission (FERC) approval.

COMPETITIVE TRANSITION CHARGES

Demand Charge (kW)
Minimum kilowatts ..... $0.00 per kilowatt
First Block kilowatts (0 to 100) ..... $0.00 per kilowatt
Second Block kilowatts (Over 100) ..... $0.00 per kilowatt

Energy Charges (kWh)
First Block (0 to 40,000) ..... $0.00000 per kilowatt-hour
Second Block (over 40,000) ..... $0.00000 per kilowatt-hour

INTANGIBLE TRANSITION CHARGES (D)

Demand Charge (kW)
Minimum kilowatts ..... $0.60 per kilowatt
First Block kilowatts (0 to 100) ..... $0.55 per kilowatt
Second Block kilowatts (Over 100) ..... $0.48 per kilowatt

Energy Charges (kWh)
First Block (0 to 40,000) ..... $0.00394 per kilowatt-hour
Second Block (over 40,000) ..... $0.00356 per kilowatt-hour

GENERATION CHARGES (I)

Demand Charge (kW)
Minimum kilowatts ..... $4.52 per kilowatt
First Block kilowatts (0 to 100) ..... $4.09 per kilowatt
Second Block kilowatts (Over 100) ..... $3.51 per kilowatt

Energy Charges (kWh)
First Block (0 to 40,000) ..... $0.02973 per kilowatt-hour
Second Block (over 40,000) ..... $0.02679 per kilowatt-hour

The transmission and generation charge applies only to Customers receiving PLR service from Company. These charges do not apply to Customers obtaining Competitive Energy Supply.

(D) Indicates Decrease
(I) Indicates Increase

Continued on Page No. 11-3

GENERAL POWER SERVICE
SCHEDULE 30 (Continued)

Minimum Charge

Minimum charges from above per kilowatt of 50% Agreement Capacity but not less than 101 kilowatts. The Agreement Capacity shall not be less than the highest Customer's Kilowatt Demand during the term of the Agreement.

Tax Adjustment Surcharge

The Tax Adjustment Surcharge included in this Tariff applies to charges under this Schedule.

Late Payment Charge

The above net rates apply if the current bill is paid in full within 15 days of the date of such bill and if all previous undisputed bills have been paid in full. A late payment charge of 1.25% per month of the unpaid balance of a bill will be made for failure to make payment in full by the due date. These charges are to be calculated on the overdue portions of the bill only. Such interest rate, when annualized, shall not exceed 15% simple interest per annum.

DETERMINATION OF CUSTOMER'S DEMAND FOR INDIVIDUAL CONNECTIONS

300 Kilowatts or Less

The Customer's Kilowatt Demand for any month for an individual connection with a fifteen-minute demand of 300 kilowatts or less shall be the maximum fifteen-minute kilowatt demand, but shall not be less than one kilowatt for each meter. For Customers using weekly averaging, transferred from Rate Schedule 31 after December 15, 1990, weekly averaging availability is also transferred.

Over 300 Kilowatts

Customer's Kilowatt Demand

The Customer's Kilowatt Demand for any month for an individual connection with a fifteen-minute demand of more than 300 kilowatts shall be the average of the Weekly Demands established during the calendar weeks ending within the billing month but not less than 300 kilowatts. No Weekly Demand shall be taken at less than 25% of the highest Weekly Demand of the month.

Customer's Reactive Kilovolt-Ampere Demand

The Customer's Reactive Kilovolt-Ampere Demand for any month for an individual connection with a fifteen-minute demand of more than 300 kilowatts shall be the maximum fifteen-minute leading or lagging reactive kilovolt-ampere demand.

Weekly Demand

The weekly demand shall be the on-peak demand plus 20% of the amount the off-peak demand for the same week exceeds 150% of the on-peak demand. The on-peak demand for a week shall be the maximum fifteen-minute kilowatt-demand of the on-peak period. The off-peak demand for a week shall be determined for the off-peak period in the same manner as the on-peak demand.

Concluded on Page No. 11-4

GENERAL POWER SERVICE
SCHEDULE 30 (Concluded)

The on-peak/off-peak provisions are available only to Customers whose on-peak demand regularly exceeds 300 kilowatts and who regularly establish off-peak demands that are in excess of the on-peak demand in the same month. For Customers using off-peak service transferred from Rate Schedule 31 after March 15, 1990, off-peak service availability is also transferred.

The on-peak period shall be from 7 a.m. until 10 p.m., Monday through Saturday, provided, however, that the designated on-peak hours may be changed from time to time to conform to Company's system load upon 60 days written notice to Customers affected. The off-peak period shall include all other times.

GENERAL

Compensating for Transmission and Distribution Losses.

For service at less than 1,000 volts, multiplying Customers' on peak metered energy by 1.09333 and off-peak metered energy by 1.04808 produces the generation energy that must be delivered to the West Penn system. For service between 1,000 and 15,000 volts, the multipliers are 1.07447 and 1.04325, for service between 15,000 and 100,000 volts, the multipliers are 1.05091 and 1.04128 and for service at greater than 100,000 volts, the multipliers are 1.02354 and 1.01879 respectively. (C)

The demand and kilowatt-hours, respectively, of connections of different voltage and phase at an establishment being combined for billing purposes as of July 7, 1976, may continue to be so combined. All other connections shall be billed separately.

This Schedule may be applied when the maximum fifteen-minute demand normally exceeds 100 kilowatts at an establishment.

Service under this Schedule is subject to power service voltage regulation.

When Customer desires a recording kilowatt meter for an individual connection with a fifteen-minute demand of 300 kilowatts or less, a monthly charge as specified in Rule 19 shall be made for not less than 12 months.

When Company installs local transformer capacity to supply a highly fluctuating load, a facility charge of 2.1% net per month of the cost of additional transformer capacity required by the highly fluctuating load shall be made.

TERM

Minimum of one year, except as provided below under Monthly Service.

MONTHLY SERVICE

Monthly Service is supplied under this Schedule when Customer advances the net cost of connection and disconnection under the provisions of the applicable financing plan. Charges shall be increased 10% and the Minimum Charge based on 50% of the Agreement Capacity shall be waived.

Monthly Service shall not be available for standby or maintenance service such as that required for alternative generation facilities.

(C) Indicates Change

Rates per Mcf

Retail Service Rate Schedules		Distribution Charge	Gas Supply Charge	Gas Cost Adjustment	Total Effective Rate 1/
Rate LGSS - Large General Sales Service					
Monthly Customer Charge:					
Annual Throughput of < 10,000 Mcf	$	72.09	-	-	72.09
Annual Throughput >= 10,000 Mcf but <= 50,000 Mcf	$	264.48	-	-	264.48
Annual Throughput >= 50,000 Mcf but <= 100,000 Mcf	$	911.80	-	-	911.80
Annual Throughput >= 100,000 Mcf but <= 300,000 Mcf	$	1,620.97	-	-	1,620.97
Annual Throughput >= 300,000 Mcf but <= 700,000 Mcf	$	3,241.95	-	-	3,241.95
Annual Throughput > 700,000 Mcf	$	6,483.89	-	-	6,483.89
Commodity Charge:					
First 1,000 Mcf per Month	$	-	-	-	9.8575
Next 4,000 Mcf per Month	$	-	-	-	9.8273
Next 5,000 Mcf per Month	$	-	-	-	9.7931
Next 10,000 Mcf per Month	$	-	-	-	9.7584
All Mcf per Month Over 20,000	$	-	-	-	9.7308
Rate MLSS - Main Line Sales Service					
Monthly Customer Charge:					
Annual Throughput of < 50,000 Mcf	$	264.48	-	-	264.48
Annual Throughput >= 50,000 Mcf but < 100,000 Mcf	$	866.21	-	-	866.21
Annual Throughput >= 100,000 Mcf but < 300,000 Mcf	$	1,539.93	-	-	1,539.93
Annual Throughput >= 300,000 Mcf but < 700,000 Mcf	$	3,079.85	-	-	3,079.85
Annual Throughput >= 700,000	$	6,159.69	-	-	6,159.69
Administrative Charge	$	35.09	-	-	35.09
Commodity Charge for Distribution Service:					
MLS-I	$	0.1003	-	-	0.1003
MLS-II					
Annual Throughput of < 100,000 Mcf	$	0.5648	-	-	0.5648
Annual Throughput >= 100,000 Mcf but < 300,000 Mcf	$	0.4797	-	-	0.4797
Annual Throughput >= 300,000 Mcf but < 700,000 Mcf	$	0.4148	-	-	0.4148
Annual Throughput >= 700,000	$	0.3593	-	-	0.3593
Rate SS - Standby Service		$7.87 per Mcf based on a customer's Maximum Daily Firm Requirement. See Pages 110-112 herein for detail.			

1/ Does not reflect the State Tax Adjustment Surcharge. See Page 165 herein for detail.

Appendix B

Design Ventilation Rates Calculations

Spaces and Use Summary				
Room Number	Room Name	Use	Sq. Ft.	Design Occupancy
P121	Electrical Room	Equipment	448	0
M121	Mechanical Room	Equipment	1,760	0
126	Auxiliary Gym	Mixed use	6,760	200
F103	Entry	Corridor	544	0
Q105	Corridor	Corridor	357	0
Q106	Corridor	Corridor	322	0
T122	Data/Telecom	Equipment	112	0
J122	Janitor	Janitor	91	0
122	Faculty Locker	Locker	208	2
123	Faculty Locker	Locker	208	2
124	Storage	Storage	416	0
P125	Electrical Closet	Equipment	104	0
125	Storage	Storage	319	0
120	Locker Room	Locker	270	2
120A	Toilet	Toilet	208	0
119A	Toilet	Toilet	208	0
119	Locker Room	Locker	270	2
118	Locker Room	Locker	270	2
118A	Toilet	Toilet	208	0
117A	Toilet	Toilet	208	0
117	Locker Room	Locker	270	2
115	Racquetball Court	Gym	810	2
116	Racquetball Court	Gym	810	2
113A	Office	Office	126	1
113B	Equipment	Equipment	99	0
113	Fitness Center	Gym	2,652	23
Q104	Corridor	Corridor	952	0
F102	Entry	Corridor	475	0
J105	Janitor	Janitor	50	0
105	Main Arena	Gym	11,045	1200
114B	Closet	Closet	32	0
T114	Data/Telecom	Equipment	28	0
114	Training Room	Gym	424	5
114A	Office	Office	117	1
110	Toilet	Toilet	42	0
R108	Men	Toilet	540	0
R106	Women	Toilet	810	0
Q103	Corridor	Corridor	1,063	0
112	Office	Office	238	1
111	Office	Office	213	1
109	Office	Office	162	1
108	Office	Office	156	1
107	Office	Office	206	1
106	Multi-purpose Room	Conference	462	24
	Vestibule	Corridor	221	0
F104	Entry	Corridor	255	0
Q107	Corridor	Corridor	1401	0
104	Dining	Dining	2780	250

103	Servery	Cafeteria	2203	6
102	Kitchen	Kitchen	462	6
	Refrigerators	Refrigerators	192	0
R102	Toilet	Toilet	48	0
102A	Dry Storage	Storage	123	0
102B	Office	Office	90	1
J102	Janitor	Janitor	18	0
102C	Dish Wash	Dish Wash	520	2
Q102	Corridor	Corridor	637	0
101	Auditorium	Auditorium	5230	450
	Stage	Gym	1260	20
	Set Building	Gym	422	5
101B	A/V Storage	Storage	54	0
101C	Dressing Room	Toilet	96	1
101D	Dressing Room	Toilet	108	1
101E	Green Room	Gym	280	20
101A	Control Room	Office	128	2
T101	Data/Telecom	Equipment	32	0
F101	Lobby	Corridor	1630.5	5
Q101	Auditorium Lobby	Corridor	970.3	50
M105A	Mechanical Room	Equipment	276	0
M105B	Mechanical Room	Equipment	276	0
M105C	Mechanical Room	Equipment	276	0
M105D	Mechanical Room	Equipment	276	0
M113	Mechanical Room	Equipment	468	0
M101A	Mechanical Room	Equipment	462	0
M101B	Mechanical Room	Equipment	476	0
M101C	Mechanical Room	Equipment	1115	0
		Totals =	57,859	2294

Ventilation Requirement per Zone												
Room Number	Room Name	Sq. Ft.	Design Occ.	cfm/ person	cfm/ ft^2	RpPz	RaAz	V_bz	V_oz	V_pz	Z_p	
P121	Electrical Room	448	0			0	0	0	0	0		
M121	Mech. Rm	1,760	0			0	0	0	0	0		
126	Auxiliary Gym	6,760	200	7.5	0.06	1500	406	1906	1906	6000	0.32	
F103	Entry	544	0	5	0.06	0	32.6	33	33	0		
Q105	Corridor	357	0		0.06	0	21.4	21	21	0		
Q106	Corridor	322	0		0.06	0	19.3	19	19	0		
T122	Data/Telecom	112	0		0.12	0	13.4	13	13	0		
J122	Janitor	91	0			0	0	0	0	0		
122	Faculty Locker	208	2			0	0	0	0	0		
123	Faculty Locker	208	2			0	0	0	0	0		
124	Storage	416	0		0.12	0	49.9	50	50	0		
P125	Electrical Closet	104	0			0	0	0	0	0		
125	Storage	319	0		0.12	0	38.3	38	38	0		
120	Locker Room	270	2			0	0	0	0	0		
120A	Toilet	208	0			0	0	0	0	0		
119A	Toilet	208	0			0	0	0	0	0		
119	Locker Room	270	2			0	0	0	0	0		
118	Locker Room	270	2			0	0	0	0	0		
118A	Toilet	208	0			0	0	0	0	0		
117A	Toilet	208	0			0	0	0	0	0		
117	Locker Room	270	2			0	0	0	0	0		
115	Racquetball Court	810	2	20	0.06	40	48.6	89	89	1125	0.08	
116	Racquetball Court	810	2	20	0.06	40	48.6	89	89	1125	0.08	
113A	Office	126	1	5	0.06	5	7.56	13	13	180	0.07	
113B	Equipment	99	0			0	0	0	0	0		
113	Fitness Center	2,652	23	20	0.06	460	159	619	619	3500	0.18	
Q104	Corridor	952	0		0.06	0	57.1	57	57	0		
F102	Entry	475	0	5	0.06	0	28.5	29	29	0		
J105	Janitor	50	0			0	0	0	0	0		
105	Main Arena-seating	6,408	1200	7.5	0.06	9000	384	9384	9384	7500	0.36	**
	Main Arena-court	4,636	20		0.3	0	1391	1391	1391			
114B	Closet	32	0			0	0	0	0	0		
T114	Data/Telecom	28	0			0	0	0	0	0		
114	Training Room	424	5	10	0.03	50	12.7	63	63	0		
114A	Office	117	1	5	0.06	5	7.02	12	12	180	0.07	

110	Toilet	42	0			0	0	0	0	0		
R108	Men	540	0			0	0	0	0	0		
R106	Women	810	0			0	0	0	0	0		
Q103	Corridor	1,063	0		0.06	0	63.8	64	64	400	0.16	
112	Office	238	1	5	0.06	5	14.3	19	19	380	0.05	
111	Office	213	1	5	0.06	5	12.8	18	18	380	0.05	
109	Office	162	1	5	0.06	5	9.72	15	15	380	0.04	
108	Office	156	1	5	0.06	5	9.36	14	14	380	0.04	
107	Office	206	1	5	0.06	5	12.4	17	17	380	0.05	
106	Multi-purpose Room	462	24	5	0.06	120	27.7	148	148	380	0.39	
	Vestibule	221	0	5	0.06	0	13.3	13	13	0		
F104	Entry	255	0	5	0.06	0	15.3	15	15	250	0.06	
Q107	Corridor	1401	0		0.06	0	84.1	84	84	850	0.10	
104	Dining	2780	250	7.5	0.18	1875	500	2375	2375	5300	0.45	
103	Servery	2203	6	7.5	0.18	45	397	442	442	3600	0.12	
102	Kitchen	462	6	10	0.18	60	83.2	143	143	1275	0.11	
	Refrigerators	192	0			0	0	0	0	0		
R102	Toilet	48	0			0	0	0	0	0		
102A	Dry Storage	123	0		0.12	0	14.8	15	15	0		
102B	Office	90	1	5	0.06	5	5.4	10	10	180	0.06	
J102	Janitor	18	0			0	0	0	0	0		
102C	Dish Wash	520	2	10	0.18	20	93.6	114	114	475	0.24	
Q102	Corridor	637	0		0.06	0	38.2	38	38	0		
101	Auditorium	5230	450	5	0.06	2250	314	2564	2564	4600	0.28	*
	Stage	1260	20	10	0.06	200	75.6	276	276	900	0.15	*
	Set Building	422	5	10	0.18	50	76	126	126	0		
101B	A/V Storage	54	0		0.12	0	6.48	6	6	0		
101C	Dressing Room	96	1	7.5	0.12	7.5	11.5	19	19	0		
101D	Dressing Room	108	1	7.5	0.12	7.5	13	20	20	0		
101E	Green Room	280	10	5	0.06	50	16.8	67	67	0		
101A	Control Room	128	2	5	0.06	10	7.68	18	18	100	0.18	
T101	Data/Telecom	32	0			0	0	0	0	0		
F101	Lobby	1631	5	5	0.06	25	97.8	123	123	0		
Q101	Auditorium Lobby	970.3	50	5	0.06	250	58.2	308	308	1900	0.16	
M105A	Mechanical Room	276	0			0	0	0	0	0		
M105B	Mechanical Room	276	0			0	0	0	0	0		
M105C	Mechanical Room	276	0			0	0	0	0	0		
M105D	Mechanical Room	276	0			0	0	0	0	0		

M113	Mechanical Room	468	0			0	0	0	0	0	
M101A	Mechanical Room	462	0			0	0	0	0	0	
M101B	Mechanical Room	476	0			0	0	0	0	0	
M101C	Mechanical Room	1115	0			0	0	0	0	0	

NOTES:
1. The * Z_p of these spaces were calculated with one half of the V_oz, because there are two systems serving the space
2. The ** Z_p of this space was calculated with one fourth of the V_oz, as there are four systems serving the space

Zone and system information													
Zone (system)	Zones Served	V_bz, zone	Supplied OA	P_s	D	E_z	V_oz	Z_p max	RpPz	RaAz	V_ou	E_v	V_ot
AHU 1	Auxiliary Gym	1,906	2000	200	1	1	1906	N/A	1500	406	1906		1906
AHU 2	Arena	4,194	2815	500	1	1	2694	N/A	2250	444	2694		2694
AHU 3	Arena	4,194	2815	500	1	1	2694	N/A	2250	444	2694		2694
AHU 4	Arena	4,194	2815	500	1	1	2694	N/A	2250	444	2694		2694
AHU 5	Arena	4,194	2815	500	1	1	2694	N/A	2250	444	2694		2694
AHU 6	Fitness	619	840	23	1	1	619	N/A	460	159	619		619
AHU 7A	Racquetball 115, 116	177	560	4	1	1	177	0.08	80	97	177	1.00	177
AHU 8	104, Q101, F104, Q107, Q103, 103	3,236	4440	256	1	1	3236	0.45	1995	1110	3105	0.70	4436
AHU 9	Auditorium, Stage	1,420	1800	235	1	1	1420	0.28	1225	195	1420	0.80	1775
AHU 10	Auditorium, Stage, Control Rm	1,437	1800	237	1	1	1437	0.28	1235	202	1437	0.80	1797
FC 2	Office 102B	10	20	1	1	1	10	N/A	5	5	10		10
FC 2	Office 113A	13	20	1	1	1	13	N/A	5	8	13		13
FC 2	Office 114A	12	20	1	1	1	12	N/A	5	7	12		12
FC 1	Multipurpose 106	74	40	12	1	1	74	N/A	60	14	74		74
FC 1	Multipurpose 106	74	40	12	1	1	74	N/A	60	14	74		74
FC 1	Office 107	17	40	1	1	1	17	N/A	5	12	17		17
FC 1	Office 108	14	40	1	1	1	14	N/A	5	9	14		14
FC 1	Office 109	15	40	1	1	1	15	N/A	5	10	15		15
FC 1	Office 111	18	40	1	1	1	18	N/A	5	13	18		18
FC 1	Office 112	19	40	1	1	1	19	N/A	5	14	19		19
UV1	Kitchen, dish wash	257	435	8	1	1	257	N/A	80	177	257		257

V_oz, entire building (calculated)	20,094
V_ot, entire building (calculated)	22,008
Total supplied OA (design)	23,475

Appendix C

Monthly Heating and Cooling Load Outputs

BUILDING COOL HEAT DEMAND

By ae

January	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	24.9	21.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	24.0	20.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	23.7	20.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	23.9	20.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	24.6	21.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	25.6	22.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	27.0	24.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	28.6	25.7	-192,051	0.0	-154,487	0.0	-52,346	0.0	0	0.0	-283,485	0.1
9	30.3	27.6	-68,239	0.0	-90,633	0.0	-485	0.0	0	0.0	-217,305	0.1
10	32.1	29.3	-224,421	0.1	-448,012	0.1	-487	0.0	0	0.0	-731,376	0.5
11	33.9	30.7	-393,717	2.0	-451,197	0.6	-483	0.0	0	0.0	-698,441	0.9
12	35.5	32.0	-342,913	4.2	-283,889	1.3	-472	0.0	0	0.0	-469,666	1.6
13	36.9	32.8	-208,130	4.3	-215,308	1.5	-124,412	0.1	0	0.0	-358,424	1.7
14	37.9	33.6	-208,276	4.7	-192,259	2.4	-126,489	0.1	0	0.0	-343,173	2.7
15	38.5	33.7	-158,115	4.5	-138,409	2.7	-123,675	0.1	0	0.0	-240,621	3.0
16	38.7	33.8	-143,215	4.2	-126,572	2.8	-121,820	0.1	0	0.0	-210,702	3.0
17	38.4	33.6	-141,703	3.8	-127,811	2.7	-127,638	0.0	0	0.0	-212,173	2.9
18	37.6	33.0	-125,770	0.6	-94,005	0.5	-109,654	0.0	0	0.0	-117,611	0.5
19	36.2	32.0	-265,555	0.4	-205,846	0.1	-580,690	0.0	0	0.0	-266,914	0.2
20	34.4	30.5	-254,190	0.1	-199,851	0.1	-175,949	0.0	0	0.0	-256,424	0.1
21	32.3	28.6	0	0.1	-54,268	0.0	-167,556	0.0	0	0.0	-210,001	0.0
22	30.2	26.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	28.1	24.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	26.3	22.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

February	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	24.4	22.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	23.0	20.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	21.8	19.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	20.9	18.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	20.4	18.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	20.2	18.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	20.6	18.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	21.6	20.0	-152,805	0.1	-155,168	0.1	-39,373	0.0	0	0.0	-280,047	0.1
9	23.3	21.8	-61,081	0.1	-89,689	0.1	-494	0.0	0	0.0	-216,205	0.1
10	25.3	23.6	-329,007	0.1	-495,513	0.3	-498	0.0	0	0.0	-751,100	0.5
11	27.6	25.4	-524,334	0.4	-518,252	0.2	-497	0.0	0	0.0	-717,926	0.5
12	29.9	27.1	-460,027	1.9	-314,978	0.2	-489	0.0	0	0.0	-489,147	0.4
13	32.0	28.6	-336,399	2.4	-242,377	0.1	-127,292	0.0	0	0.0	-369,534	0.3
14	33.7	29.9	-301,174	3.0	-218,604	0.3	-130,041	0.0	0	0.0	-354,918	0.5
15	34.7	30.4	-254,553	3.0	-154,760	1.0	-126,878	0.1	0	0.0	-250,103	1.2
16	35.1	30.6	-234,158	2.7	-140,839	1.2	-124,664	0.1	0	0.0	-214,170	1.4
17	34.9	30.3	-222,846	2.2	-141,959	1.1	-137,540	0.0	0	0.0	-208,837	1.2
18	34.3	30.0	-194,543	0.1	-110,597	0.1	-118,755	0.0	0	0.0	-117,679	0.1
19	33.5	29.4	-370,562	0.1	-223,034	0.1	-685,478	0.0	0	0.0	-273,429	0.1
20	32.3	28.7	-346,883	0.1	-215,998	0.0	-190,790	0.0	0	0.0	-262,630	0.1
21	30.9	27.6	-116,619	0.1	-60,973	0.0	-177,684	0.0	0	0.0	-230,237	0.0
22	29.3	26.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	27.6	24.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	26.0	23.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

BUILDING COOL HEAT DEMAND

By ae

March	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	36.7	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	34.9	31.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	33.3	30.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	32.0	29.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	31.0	28.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	30.4	27.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	30.1	27.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	30.7	27.7	-103,640	0.4	-102,012	0.1	0	0.0	0	0.0	-188,164	0.1
9	32.4	29.1	-34,063	0.7	-37,321	0.1	-379	0.0	0	0.0	-96,298	0.1
10	34.9	31.4	-272,570	1.0	-364,141	1.2	-383	0.1	0	0.0	-513,485	1.4
11	38.0	33.7	-417,833	8.2	-346,511	2.7	-381	0.1	0	0.0	-507,705	2.9
12	41.4	36.5	-338,938	11.2	-223,588	4.2	0	0.4	0	0.0	-324,927	4.4
13	44.5	39.2	-243,743	26.5	-138,701	4.3	-62,445	0.6	0	0.0	-247,458	4.5
14	47.0	41.3	-209,055	33.8	-128,621	7.7	-57,139	0.8	0	0.0	-210,631	7.9
15	48.7	42.5	-157,038	36.9	-88,153	9.1	-55,023	0.9	0	0.0	-151,387	9.3
16	49.2	42.8	-133,652	37.7	-75,281	9.5	-45,587	0.9	0	0.0	-132,736	9.7
17	49.0	42.7	-140,292	35.0	-69,123	9.3	-90,902	0.0	0	0.0	-87,203	9.5
18	48.4	42.4	-122,464	1.8	-58,451	1.8	0	0.0	0	0.0	-65,277	1.8
19	47.4	42.1	-232,419	1.6	-149,481	1.7	-133,830	0.0	0	0.0	-189,136	1.7
20	46.1	41.3	-211,223	1.2	-145,894	1.6	-57,164	0.0	0	0.0	-180,440	1.6
21	44.5	40.4	0	0.9	-2,896	0.0	0	0.0	0	0.0	-53,513	0.0
22	42.6	39.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	40.7	37.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	38.7	35.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

April	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	47.9	43.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	45.7	41.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	43.8	39.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	42.4	38.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	41.5	37.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	41.2	37.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	41.6	38.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	42.8	39.0	-20,029	2.1	-22,708	1.1	0	0.6	0	0.0	-35,621	1.2
9	44.8	40.3	-13,536	20.4	-9,166	1.4	0	0.7	0	0.0	-17,633	1.4
10	47.2	41.7	-180,968	21.5	-142,021	8.2	0	0.8	0	0.0	-220,417	8.7
11	50.1	43.7	-234,572	30.7	-124,559	26.2	0	14.5	0	0.0	-199,561	26.6
12	53.1	45.9	-154,441	34.2	-57,067	30.7	0	14.3	0	0.0	-98,528	28.9
13	55.9	48.2	-115,983	37.8	-48,639	33.7	0	14.2	0	0.0	-70,827	34.1
14	58.4	50.2	-97,814	43.9	-39,810	37.2	0	14.0	0	0.0	-54,313	37.2
15	60.3	51.5	-62,602	42.9	-22,587	38.0	0	13.9	0	0.0	-38,219	38.1
16	61.6	52.6	-49,933	44.4	-19,019	38.9	0	13.7	0	0.0	-35,134	38.0
17	62.0	52.9	-58,213	44.7	-25,239	38.1	0	0.0	0	0.0	-20,467	37.9
18	61.7	52.9	-47,472	30.2	-18,279	27.5	0	0.0	0	0.0	-14,009	27.5
19	60.8	52.7	-68,243	29.3	-40,456	27.0	0	0.0	0	0.0	-64,926	26.3
20	59.4	52.0	-65,652	25.8	-36,963	26.2	0	0.0	0	0.0	-57,875	26.3
21	57.5	51.0	0	25.6	0	0.0	0	0.0	0	0.0	0	0.0
22	55.3	49.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	52.8	47.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	50.3	45.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

BUILDING COOL HEAT DEMAND

By ae

May	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	62.1	56.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	60.0	54.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	58.3	53.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	57.0	52.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	56.2	51.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	55.9	51.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	56.5	52.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	58.0	52.9	-78	26.0	0	27.8	0	12.8	0	0.0	0	20.6
9	60.4	54.0	0	27.2	0	29.0	0	13.0	0	0.0	0	22.3
10	63.5	55.3	-46,051	27.1	0	40.1	0	12.9	0	0.0	-25,141	47.2
11	66.9	57.5	-38,308	48.7	0	42.4	0	12.6	0	0.0	0	48.1
12	70.3	59.9	-26,479	55.9	0	44.6	0	12.5	0	0.0	0	45.8
13	73.4	61.8	-23,659	57.1	0	46.0	0	12.3	0	0.0	0	45.0
14	75.8	63.1	-20,263	58.2	0	50.0	0	12.2	0	0.0	0	49.6
15	77.3	64.5	0	63.5	0	49.3	0	12.1	0	0.0	0	49.4
16	77.9	64.2	0	62.2	0	50.7	0	11.9	0	0.0	0	49.1
17	77.6	63.9	0	55.4	0	48.8	0	0.0	0	0.0	0	51.9
18	76.8	63.0	0	40.1	0	38.3	0	0.0	0	0.0	0	38.3
19	75.5	62.5	0	56.1	0	40.6	0	0.0	0	0.0	0	40.6
20	73.7	62.3	0	57.6	0	41.1	0	0.0	0	0.0	0	41.0
21	71.7	62.2	0	58.8	0	0.0	0	0.0	0	0.0	0	0.0
22	69.3	61.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	66.9	59.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	64.5	58.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

June	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	67.2	62.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	65.0	60.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	63.2	59.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	61.8	58.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	61.0	58.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	60.7	58.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	61.3	58.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	62.9	59.1	0	27.4	0	33.1	0	14.2	0	0.0	0	25.4
9	65.4	60.3	0	29.5	0	33.5	0	14.4	0	0.0	0	26.2
10	68.6	62.2	0	38.7	0	59.4	0	14.3	0	0.0	0	65.7
11	72.1	63.9	0	61.1	0	66.3	0	14.1	0	0.0	0	70.7
12	75.7	66.0	0	69.9	0	61.0	0	13.9	0	0.0	0	63.7
13	78.9	67.7	0	76.4	0	60.7	0	13.7	0	0.0	0	63.9
14	81.4	69.1	0	78.4	0	62.3	0	13.5	0	0.0	0	64.7
15	83.0	70.0	0	75.7	0	57.8	0	13.4	0	0.0	0	60.8
16	83.6	70.3	0	75.8	0	57.8	0	13.2	0	0.0	0	59.9
17	83.3	70.4	0	74.0	0	58.0	0	0.0	0	0.0	0	59.3
18	82.4	70.1	0	59.1	0	44.4	0	0.0	0	0.0	0	45.2
19	81.1	69.9	0	81.5	0	54.8	0	0.0	0	0.0	0	55.5
20	79.3	69.7	0	76.1	0	54.1	0	0.0	0	0.0	0	54.8
21	77.1	69.2	0	73.2	0	0.0	0	0.0	0	0.0	0	0.0
22	74.7	68.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	72.1	66.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	69.6	64.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

BUILDING COOL HEAT DEMAND

By ae

July	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	69.8	64.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	67.9	63.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	66.5	62.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	65.7	61.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	65.4	61.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	65.8	62.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	67.0	63.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	68.9	64.9	0	33.6	0	35.7	0	15.5	0	0.0	0	28.8
9	71.3	65.5	0	33.3	0	35.2	0	15.5	0	0.0	0	29.1
10	74.1	66.4	0	56.4	0	70.5	0	15.3	0	0.0	0	73.4
11	77.1	67.3	0	77.4	0	75.8	0	15.1	0	0.0	0	79.0
12	79.8	68.4	0	78.5	0	65.8	0	14.9	0	0.0	0	68.2
13	82.3	69.7	0	79.5	0	65.4	0	14.7	0	0.0	0	68.1
14	84.2	70.8	0	81.3	0	66.5	0	14.5	0	0.0	0	69.2
15	85.4	71.6	0	79.2	0	62.2	0	14.3	0	0.0	0	64.1
16	85.8	71.6	0	79.2	0	61.5	0	14.2	0	0.0	0	63.7
17	85.5	71.9	0	77.6	0	60.5	0	0.0	0	0.0	0	62.7
18	84.7	71.8	0	63.7	0	46.7	0	0.0	0	0.0	0	48.7
19	83.3	71.4	0	88.6	0	59.5	0	0.0	0	0.0	0	63.5
20	81.4	70.8	0	84.1	0	57.8	0	0.0	0	0.0	0	59.5
21	79.2	70.2	0	79.1	0	0.0	0	0.0	0	0.0	0	0.0
22	76.8	69.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	74.4	67.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	72.0	66.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

August	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	67.7	63.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	65.7	61.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	63.9	60.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	62.4	58.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	61.3	57.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	60.7	57.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	60.4	57.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	61.1	57.4	0	33.1	0	33.5	0	14.4	0	0.0	0	25.0
9	62.9	57.8	0	33.6	0	33.7	0	14.6	0	0.0	0	25.7
10	65.7	58.7	0	51.7	0	58.6	0	14.4	0	0.0	0	57.7
11	69.1	60.6	0	73.0	0	62.9	0	14.1	0	0.0	0	64.9
12	72.7	62.6	0	74.6	0	58.3	0	13.9	0	0.0	0	61.1
13	76.1	64.8	0	75.6	0	58.1	0	13.7	0	0.0	0	61.3
14	78.9	67.7	0	77.9	0	60.3	0	13.6	0	0.0	0	62.8
15	80.7	69.0	0	76.7	0	56.8	0	13.5	0	0.0	0	57.4
16	81.3	68.9	0	75.8	0	56.6	0	13.4	0	0.0	0	57.4
17	81.1	69.0	0	73.9	0	56.9	0	0.0	0	0.0	0	57.7
18	80.4	68.5	0	58.4	0	42.7	0	0.0	0	0.0	0	43.1
19	79.3	68.2	0	78.8	0	51.9	0	0.0	0	0.0	0	52.4
20	77.9	68.7	0	74.4	0	51.9	0	0.0	0	0.0	0	52.4
21	76.1	68.8	0	72.8	0	0.0	0	0.0	0	0.0	0	0.0
22	74.1	67.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	72.0	66.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	69.8	65.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

BUILDING COOL HEAT DEMAND

By ae

September	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	62.2	56.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	60.0	55.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	58.2	53.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	56.9	52.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	56.1	52.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	55.8	52.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	56.3	53.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	57.9	54.8	0	29.2	0	23.3	0	14.0	0	0.0	0	22.2
9	60.4	55.5	0	30.5	0	28.7	0	14.3	0	0.0	0	23.1
10	63.6	56.7	0	37.6	0	42.6	0	14.2	0	0.0	0	47.7
11	67.1	57.8	0	56.9	0	48.4	0	13.9	0	0.0	0	49.5
12	70.6	59.4	0	62.1	0	47.7	0	13.6	0	0.0	0	49.1
13	73.8	61.3	0	66.4	0	47.0	0	13.3	0	0.0	0	47.4
14	76.3	62.9	0	69.7	0	50.2	0	13.2	0	0.0	0	51.3
15	77.9	64.0	0	66.7	0	50.0	0	13.0	0	0.0	0	49.9
16	78.4	64.4	0	66.3	0	50.8	0	12.9	0	0.0	0	51.7
17	78.2	64.2	0	64.5	0	52.3	0	0.0	0	0.0	0	53.0
18	77.3	64.0	0	49.5	0	38.3	0	0.0	0	0.0	0	38.5
19	76.0	64.5	0	65.3	0	43.9	0	0.0	0	0.0	0	41.8
20	74.2	64.4	0	65.1	0	45.0	0	0.0	0	0.0	0	42.8
21	72.0	63.8	0	63.4	0	0.0	0	0.0	0	0.0	0	0.0
22	69.6	62.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	67.1	60.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	64.6	58.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

October	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	45.7	40.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	43.7	38.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	42.0	37.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	40.5	36.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	39.4	35.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	38.8	35.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	38.6	35.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	39.4	36.2	-5,580	1.8	-55,855	0.7	0	0.1	0	0.0	-86,967	0.7
9	42.0	38.2	-5,445	3.0	-12,161	1.0	0	0.5	0	0.0	-25,580	1.0
10	45.7	40.6	-70,083	23.4	-134,477	7.1	0	0.7	0	0.0	-255,056	7.4
11	50.1	42.8	-55,490	30.4	-97,054	25.5	0	15.5	0	0.0	-221,316	25.9
12	54.6	45.4	-43,214	37.3	-30,668	28.1	0	15.3	0	0.0	-132,747	26.2
13	58.3	47.6	-35,986	40.9	-24,812	32.7	0	15.0	0	0.0	-87,797	29.3
14	60.8	48.9	-30,556	44.5	-22,055	35.3	0	14.8	0	0.0	-50,403	35.5
15	61.7	49.2	-23,131	45.3	-14,219	36.9	0	14.6	0	0.0	-34,353	36.7
16	61.5	48.8	-21,119	44.5	-13,944	36.4	0	14.4	0	0.0	-32,575	35.7
17	60.8	48.1	-4,884	36.9	-11,751	32.1	0	0.0	0	0.0	-14,944	32.0
18	59.8	48.0	0	27.2	-6,824	26.2	0	0.0	0	0.0	-9,690	26.1
19	58.3	48.3	-3,484	31.7	-30,949	26.6	0	0.0	0	0.0	-60,472	26.1
20	56.6	48.0	0	28.8	-27,948	26.0	0	0.0	0	0.0	-50,868	26.0
21	54.6	46.9	0	27.4	0	0.0	0	0.0	0	0.0	0	0.0
22	52.4	45.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	50.1	43.9	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	47.9	42.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

BUILDING COOL HEAT DEMAND

By ae

November	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	41.9	38.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	40.2	36.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	38.8	35.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	37.6	34.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	36.7	33.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	36.2	33.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	36.0	33.4	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	36.7	34.3	-76,771	1.4	-91,345	0.4	0	0.1	0	0.0	-168,260	0.5
9	38.8	36.1	-17,079	1.7	-34,374	0.6	0	0.1	0	0.0	-82,640	0.7
10	41.9	38.4	-153,392	2.6	-228,090	5.1	0	0.5	0	0.0	-391,134	5.3
11	45.5	40.7	-244,328	28.1	-254,026	7.2	0	0.7	0	0.0	-381,956	7.4
12	49.1	43.0	-165,434	27.9	-120,048	9.3	0	0.9	0	0.0	-220,159	9.5
13	52.2	44.8	-101,303	33.8	-74,409	27.2	0	14.1	0	0.0	-159,356	25.1
14	54.3	45.8	-82,084	39.5	-68,866	32.8	0	13.9	0	0.0	-144,473	28.3
15	55.0	46.1	-61,550	39.4	-41,711	33.1	0	13.8	0	0.0	-108,750	32.5
16	54.8	45.5	-53,361	35.7	-40,942	31.1	0	13.6	0	0.0	-77,908	31.0
17	54.3	45.1	-57,617	31.4	-36,005	30.0	0	0.0	0	0.0	-46,395	30.0
18	53.4	45.4	-51,799	25.5	-29,304	25.6	0	0.0	0	0.0	-36,274	25.6
19	52.2	45.5	-95,960	25.4	-79,187	25.6	0	0.0	0	0.0	-123,063	25.6
20	50.8	44.9	-81,803	2.1	-74,811	25.5	0	0.0	0	0.0	-117,133	25.5
21	49.1	43.6	0	1.8	0	0.0	0	0.0	0	0.0	0	0.0
22	47.4	42.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	45.5	40.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	43.7	39.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

December	Typical Weather (°F)		Design		Weekday		Saturday		Sunday		Monday	
Hour	OADB	OAWB	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)	Htg (Btuh)	Clg (Tons)
1	28.6	26.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	27.7	25.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
3	27.4	25.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4	27.6	25.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
5	28.2	26.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
6	29.2	27.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
7	30.5	28.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
8	32.1	30.2	-119,237	0.1	-137,548	0.1	-30,833	0.0	0	0.0	-207,640	0.1
9	33.7	31.9	-51,811	0.2	-79,264	0.1	-439	0.0	0	0.0	-171,181	0.1
10	35.5	33.5	-230,315	0.5	-399,689	1.5	-439	0.1	0	0.0	-621,805	1.7
11	37.2	34.9	-384,910	4.9	-376,270	2.3	-433	0.1	0	0.0	-595,851	2.5
12	38.7	35.9	-298,129	7.6	-246,604	2.9	-422	0.1	0	0.0	-400,118	3.2
13	40.0	36.7	-217,237	6.5	-162,619	2.7	-102,537	0.4	0	0.0	-303,506	2.9
14	41.0	37.4	-209,653	8.1	-155,379	4.1	-85,205	0.4	0	0.0	-281,326	4.3
15	41.6	37.8	-153,486	7.8	-103,891	4.4	-70,080	0.4	0	0.0	-182,521	4.5
16	41.8	38.0	-153,107	7.5	-95,801	4.6	-61,530	0.5	0	0.0	-176,782	4.8
17	41.5	37.9	-145,165	6.8	-84,335	4.5	-105,001	0.0	0	0.0	-158,474	4.7
18	40.7	37.4	-132,615	1.1	-81,299	0.8	0	0.0	0	0.0	-97,503	0.9
19	39.3	36.3	-267,694	0.9	-174,819	0.6	-176,244	0.0	0	0.0	-226,033	0.7
20	37.6	34.8	-249,810	0.6	-169,531	0.5	-152,676	0.0	0	0.0	-213,975	0.5
21	35.6	32.8	0	0.5	-45,828	0.0	-46,106	0.0	0	0.0	-59,089	0.0
22	33.6	31.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
23	31.6	29.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
24	29.9	27.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Appendix D

Energy Demands and Consumption

ENERGY CONSUMPTION SUMMARY

By ae

	Elect Cons. (kWh)	Gas Cons. (therms)	Percent of Total Energy	Total Source Energy* (kBtu/yr)
Primary heating				
Primary heating	5,177.6	3,826.1	10.1 %	4,557.7
Primary cooling				
Cooling Compressor	774,643.5		66.7 %	79,323.7
Tower/Cond Fans	37,805.9		3.3 %	3,871.3
Condenser Pump			0.0 %	0.0
Other CLG Accessories	17,819.3		1.5 %	1,824.7
Cooling Subtotal....	830,268.7		71.5 %	85,019.7
Auxiliary				
Supply Fans	48,281.1		4.2 %	4,944.0
Circ Pumps	35,009.5		3.0 %	3,585.0
Base Utilities			0.0 %	0.0
Aux Subtotal....	83,290.6		7.2 %	8,529.0
Lighting				
Lighting	129,253.9		11.1 %	13,235.6
Receptacle				
Receptacles	2,000.6		0.2 %	204.9
Heating plant load				
Base Utilities			0.0 %	0.0
Cogeneration				
Cogeneration			0.0 %	0.0
Totals				
Totals**	1,049,991.4	3,826.1	100.0 %	111,546.8

* Note: Resource Utilization factors are included in the Total Source Energy value.
** Note: This report can display a maximum of 6 utilities. If additional utilities are used, they will be included in the total.

MONTHLY ENERGY CONSUMPTION

By ae

Alternative: 1 Eberly Campus Community Center

------- Monthly Energy Consumption -------

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Electric													
On-Pk Cons. (kWh)	16,892	13,503	27,494	70,003	109,845	142,115	142,416	141,486	103,958	73,204	60,152	19,110	920,178
Off-Pk Cons. (kWh)	3,743	3,502	3,452	7,055	17,367	19,612	21,611	20,230	17,576	6,413	5,256	3,999	129,814
On-Pk Demand (kW)	1,828	1,827	1,838	1,845	2,059	2,161	2,203	2,123	2,067	1,842	1,840	1,828	2,203
Gas													
On-Pk Cons. (therms)	914	893	644	166	0	0	0	0	0	169	361	681	3,826
On-Pk Demand (therms/hr)	9	10	7	3	1	0	0	0	0	4	5	8	10

Building Energy Consumption =	83,718	Btu/(ft2-year)
Source Energy Consumption =	235,450	Btu/(ft2-year)
Floor Area =	47,376	ft2

TRACE® 700 Economic Summary

By ae

Project Information

Weather file	Pittsburgh, Pennsylvania
Project Name	Eberly Campus Community Center
Location	Uniontown, PA
Building Owner	Penn State
User	Heather Stapel
Company	Penn State
Comments	

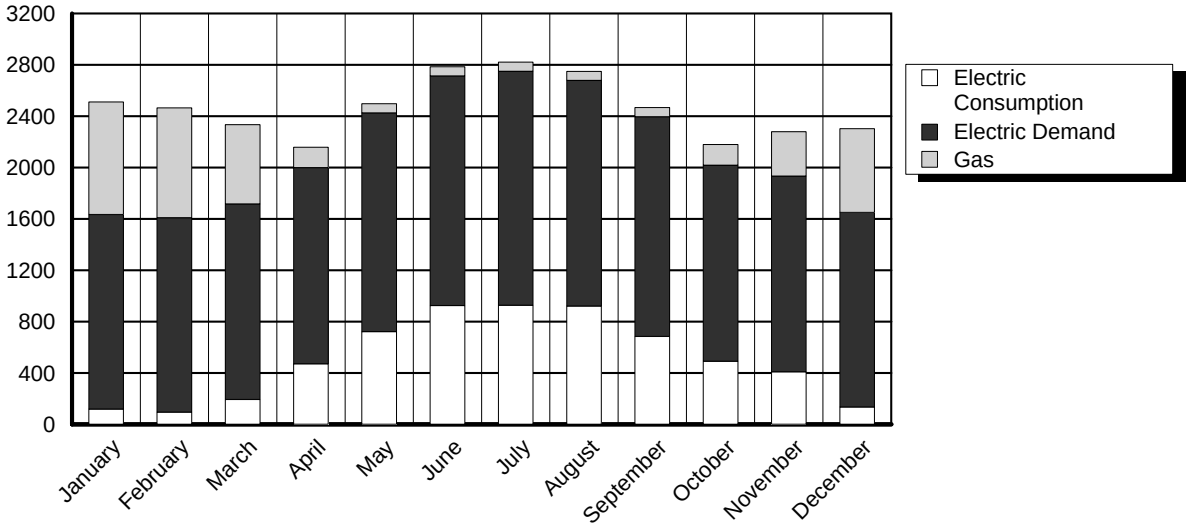
Alternative 1 - - Eberly Campus Community Center

Economic Summary

Alternative Number	Installed Cost	First Year Util.Cost	Final Year Util. Cost	First Year Maint. Cost	Final Year Maint. Cost	Life Cycle Cost
1	1650000.00	29553.74	29553.74	10000.00	10000.00	2009030.86

Monthly Utility Costs per Utility

(1 alternative)



Equipment Energy Consumption by Alternative

	Elect Cons. (kWh)	Gas Cons. (therms)	Percent of Total Energy	Total Source Energy* (kBtu/yr)
Alternative: 1 - Eberly Campus Community Center				
Primary heating	5,177.6	3,826.1	10.1%	4,557.7
Cooling Compressor	774,643.5		66.7%	79,323.7
Tower/Cond Fans	37,805.9		3.3%	3,871.3
Other CLG Accessories	17,819.3		1.5%	1,824.7
Supply Fans	48,281.1		4.2%	4,944.0
Circ Pumps	35,009.5		3.0%	3,585.0
Lighting	129,253.9		11.1%	13,235.6
Totals	**1,049,991.4**	**3,826.1**	**100.0%**	**111,546.8**

* *Note: Resource Utilization factors are included in the Total Source Energy value.*

MONTHLY UTILITY COSTS

By ae

Alternative: 1

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
					------- Monthly Utility Costs -------								
Electric													
On-Pk Cons. ($)	119	95	194	471	722	925	927	921	685	491	409	135	6,091
On-Pk Demand ($)	1,515	1,514	1,523	1,529	1,704	1,788	1,822	1,757	1,711	1,527	1,525	1,515	19,430
Total ($):	1,634	1,609	1,717	2,000	2,426	2,713	2,749	2,678	2,396	2,018	1,933	1,650	25,521
Gas													
On-Pk Cons. ($)	877	857	618	159	72	72	72	72	72	162	346	653	4,033
Monthly Total ($):	2,511	2,466	2,334	2,159	2,498	2,785	2,821	2,750	2,468	2,180	2,280	2,303	29,554