The Eberly Campus Community Center
Uniontown, PA

Building and Plant Energy Analysis

Performed by: Heather Stapel
BAE | MAE, Mechanical Building Systems Option
Advised by: Dr. William Bahnfleth
October 27, 2006

Executive Summary

Through the course of a year, a building consumes mass quantities of energy, much of which is often wasted through inefficiencies is design, use, and operating practices. While building use and operating practices can not be controlled by the building design team, limits on energy consumption are possible through careful planning and an attention to detail in the design process. To achieve an energy efficient project, the engineers, architects, and other team members must collaborate with all of the building systems and components to produce a functioning, coherent whole. In an effort to expedite this process, the building industry has created a series of design tools that will conscript energy saving components, monitor possible energy consumption, and provide a basis of comparison to the performance of other building projects.

As the building energy performance directly affects life cycle costs as well as the environment, an analysis of building energy performance is a key component of the evaluation of any building project. Therefore, the Eberly Campus Community Center has been subjected to an in-depth energy performance analysis incorporating several rigorous proscriptive codes, a comparison and rating tool, and an entire building energy simulation program. These tools are industry standard and include the LEED New Construction rating system, ASHRAE Standard 90.1-2004, and the Trane Trace 700 energy modeling program. After an extended use of the above tools, a comprehensive snapshot of the energy use of the community center has been constructed.

Applying the analysis of the project energy use, there are several glaring comparisons to be drawn. While the energy model has dutifully computed the building loads and has ejected the building energy use, the energy standards and the LEED rating system reflect unfavorably upon the energy usage of this campus building. Unfortunately, the study of the Standard 90.1-2004 in reference to the Eberly Campus Community Center proves that the building design is not code compliant in nearly every examined system. As well as the code compliance results, LEED rating system has the project performing at a substandard level: about 15% of the idealized building comparison case. After this rigorous study of the project energy performance, it becomes painfully obvious that the community center is performing below the level of the current industry standard. Energy saving measures should be considered in future modifications and be applied whenever the design permits.

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1. LEED-NC Version 2.2:

There is a new byword in the building industry, a snappy new catchphrase that has managed to permeate even the lofty sights of the U.S. General Services Administration. This upcoming new procedure is termed LEED – Leadership in Energy and Environmental Design. The LEED Rating Certification process is a rigorous set of engineering, construction, and design practices that must be met and verified to achieve a certain level of energy and environmental savings. Depending upon the number of required steps adopted by the project team, the U.S. Green Building Council and LEED will award the project a certain level of certification: Certified, Silver, Gold, or Platinum. The acquisition of a certification gives the project a certain amount of prestige as well as the attendant energy and sustainability savings that come along with the requirements of LEED certification. In view of the importance of this trend, the Eberly Campus Community Center has been evaluated with respect to a LEED rating certification.

A quick glance at the Penn State Fayette Eberly Campus Community Center gives a doubtful forecast to its future as a sustainable, energy efficient building. Completed a little over two years ago, the project has been designed with an eye for economy. Its site is not conducive to green design, and its large, sparsely populated spaces are a challenge to control in an energy efficient manner. However, for the sake of formality, an attempt at a LEED certification application has been attempted.

After a comprehensive review of the point possibilities, the response has been overwhelming. Nearly every point listed has met with some obstruction or design flaw that would prevent the passing of that point. See Appendix 1.1, for the LEED – NC Version 2.2 Checklist of spaces that could or could not make the LEED points. As the list is predominantly comprised of “No” answers, a review the calculations and thought processes involved has been included for only the definite “Yes” answers. The list of passing credits is included below:

- SS Prerequisite 1: Construction Activity Pollution Prevention
- SS Credit 1: Site Selection
- WE Credit 3.1: 20% Water Use Reduction
- EA Prerequisite 3: Fundamental Refrigerant Management
- EA Credit 4: Enhanced Refrigerant Management
- IEQ Prerequisite 1: Minimum IAQ Performance
- IEQ Prerequisite 2: Environmental Tobacco Smoke Control
- IEQ Credit 6.2: Controllability of Systems, Thermal Comfort
- IEQ Credit 7.1: Thermal Comfort, Design
- ID Credit 2: LEED Accredited Professional

While this list seems extensive, consider that these points are only 10 out of a possible 69 credits, and only make a small dent in the LEED Certification Process.

The points listed above can be proven with simple means. For instance, the first point - Construction Activity Pollution Prevention - requires the formation of and adherence to an erosion and sedimentation control plan (ESC) for a construction completed upon the project. The landscaping drawings go into great detail over the ESC Plan for this project, and the credit is easily verified. With the second SS Credit, Site Selection, the site must be selected with as little environmental impact as possible. The site selected has been adjacent to the Penn State Fayette Campus for years, and is not prime farmland. It is situated on a plateau overlooking a valley with no running water or lakes in the vicinity and therefore is above the flood plain, away from certified wetlands, and is consistent with the distances required by the Clean Water Act. Finally, as agriculturally designated land facing a commercial district and the side of a Penn State Commuter campus, there would be no endangered species or public parkland in the area to interfere with the environmental sustainability of the site.

Further down the list, the water efficiency credit is documented using a spreadsheet with input occupancies, plumbing fixture use, and plumbing fixture flow rates to calculate the potable water savings in comparison with a standardized baseline case. The spreadsheet, attached in Appendix 1.2, output a water savings of 24%. This reduction in water use is enough to earn the 20% water efficiency credit, though unfortunately low to attain the 30% water efficiency standard. The energy and atmosphere credit in fundamental refrigerant management merely requires the use of non-CFC based refrigerant or the use of an HCFC with a phase out plan. Fortunately, this project has incorporated chilled water equipment that uses R-134a, a chemical that is neither a CFC nor a HCFC. Therefore the EA Prerequisite 3 is attained. A similar credit, Energy and Atmosphere's Enhanced Refrigerant Management, requires the calculation of the combined effects of the refrigerant's ozone depletion potential and global warming potential. Assuming a chiller life of 25 years, the combined effects of these two are far below the allowable limit, therefore gaining yet another LEED credit in the area of refrigerant management. Calculations for the enhanced refrigerant management credit are catalogued in Appendix 1.3.

The indoor environmental quality credits are the credits most closely tied to the mechanical building systems specialty with which this entire project is being viewed. Surprisingly, the community center has earned itself four of these credits. The first credit, minimum IAQ performance, calls for the ventilation rates provided to meet or exceed the ASHRAE Standard 62.1-2004. Several spreadsheets proving compliance with Standard 62.1-2004 are included and can be referenced in Appendix 1.4. With the completion of the first prerequisite, completion of the second prerequisite seems almost easy. Environmental Tobacco Smoke Control is achieved through the establishment of a smoke-free building, as well as the provision of a smoking area at least 25 feet away from building openings and outdoor air intakes. As the project is a Penn State building, it is required to be smoke-free, and tables are provided for smokers along a veranda that runs away from operable windows, doors, and intake louvers. Thus the first two of the four attainable IEQ credits have been achieved.

Verification of the final two IEQ credits has been a relatively painless procedure as well. Credit 6.2 - Controllability of Systems, Thermal Comfort – requires that at least 50% of the full time building occupants have individual controls of their workstations and that large gathering spaces have access to a thermal control to share among the occupants as well. As the systems within the Eberly Campus Community Center are mostly single zone systems with individual thermostats provided for each space, this credit is easily obtained. The full time occupants of the center are all either office workers or workers within the dining establishment. The offices each have internal controls per space, while the Servery and Kitchen area have each their own thermostats. Finally, the IEQ Credit 7.1 – Thermal Comfort, Design – requires that the design team comply with ASHRAE Standard 55, thermal comfort. When designed, the system has been controlled to operate within the specified temperatures and relative humidity called for within the Standard 55. Therefore, the IEQ Credit 7.1 has also been passed.

Finally, the last LEED credit that can be obtained by this project is the use of a LEED Accredited Professional by the design team. If this project is hypothetically going to apply for LEED Accreditation, then the design team would certainly include a LEED Accredited Professional. The architect, engineer, site designer, interior designer are all included in one company, Burt Hill. This company provides integrated services for a fully developed product, and certainly has several LEED Accredited Professionals on staff. Therefore, if this project has decided to try for LEED Accreditation, then the design staff has direct access to a LEED Accredited Professional, and the credit becomes an effortless bonus credit.

Through the steps described above, as well as some hard work, dedication, and extra budgeting funds, it could be possible to gain a LEED Rated Certification for the Eberly Campus Community Center. Those credits under review above have been verified with no adjustments to the existing building plans and design. With fairly little effort and some expense, several more credits could be obtained. Many buildings have the potential to pass a LEED Accreditation. The limiting factor is the owner. The owner’s preferences and the owner’s budget are directly responsible for the resulting environmental practices by the project’s design team. Therefore, though this project is not going to qualify for a LEED rating as it has been designed, a dedicated owner and design team with enough funding could practice energy saving and environmentally sound methods to achieve a LEED rating.

2. ASHRAE Standard 90.1-2004 Compliance

As is evident by the building industry's recent fascination with LEED rated design and accreditation, energy efficiency and energy savings are very important to the industry of today. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) publishes industry standards that address the performance and best design practices for operating mechanical building systems in buildings. While there are many standards in circulation today, the most basic and commonly used for non-residential construction is the ASHRAE Standard 90.1-2004: Energy Standard for Buildings Except Low-Rise Residential Buildings. This prescriptive set of practices involves breakdowns of energy use for all of the features of the mechanical building system and mandates the minimum possible measures to be taken to design a project. A review of the Standard 90.1-2004 for the Eberly Campus Community Center has unfortunately produced failing results.

At the beginning of the energy analysis, the building envelope is the first system to be considered. Wall, roof, and fenestration systems are to be designed to meet certain requirements of heat transmission. The results of these analyses are included in a table entitled Section 5.5 in Appendix 2.2, and the calculation for the component U-values can be found in Appendix 2.1. Curtain wall U-values have been computed using the Lawrence Berkley National Laboratory's WINDOW 6 program. These outputs are also included in Appendix 2.1 with the other thermal transmission calculations. After calculations and documentations, it has been found that the wall systems, roof systems, and curtain wall system are compliant, while the basic window assemblies are not compliant with their solar heat gain coefficient. Therefore, the envelope analysis has proven that the Eberly Campus Community Center must be given more energy efficient window systems to pass the requirements of ASHRAE Standard 901.-2004.

As the compliance check continues, the next input under evaluation is the fan power per 1000 cfm ratio. The standard calls for a maximum limit of 1.2 fan horsepower per 1000 cfm of air supplied. Unfortunately, very few of the fans passed this test, with limits far over the baseline requirement. This may be accounted for by the fact that most of the design work for this project has occurred around 2002 and 2003 and would therefore have not been designed to the 90.1 2004 version standards. Calculations and fan information can be found in Table 6.5.3.1 of Appendix 2.2.

After the fan power evaluation, the equipment efficiency requirements are brought under review. Here, finally, the project is beginning to show a more energy efficient design. The chiller, boilers, duct insulation, and pipe insulation have been evaluated and all, except the boilers, have been found compliant with the standards of ASHRAE 90.1. Referenced tables include Table 6.8.1 in Appendix 2.2. No calculations have been performed for this check, as the information necessary has been included within the project drawing set.

Moving on down the list, the electricity required to operate the building systems is also evaluated. First, the building voltage drop for the feeders and the branch circuits has been examined to assure that the wire sizing is not wasting any possible energy in its transfer of the voltage. Two calculations have been included for this check: a typical feeder, and the longest run for a branch circuit. This generalization is possible because all of the panel boards are located within either the mechanical or the electrical rooms within a small distance of one another. Therefore, all of the feeder runs are about the same length, and if one feeder has been appropriately sized, chances are that they all have been. Also, the longest run branch circuit has been considered as a worst case scenario. As long as the voltage drop across the longest run with the smallest wire size is within the allowable limit, there should be no problem with the rest of the branch circuits within the building. After running the calculations, it has become evident that the base case feeder and the longest branch circuit run are compliant, and therefore the voltage drops within the building are satisfactory. Voltage drop calculation results can be found in Appendix 2.2, Table 8.4.1, and an example voltage drop calculation is included in Appendix 2.1.

The final electrical compliance check and the final Standard 90.1-2004 energy efficiency check is the lighting power density. This calculation involves the summing of the building lighting power loads and then dividing by the total lighted square feet to find the average density of power provided to the lighting system. For a building typical of the Eberly Campus Community Center, the maximum allowable power density has been chosen at 1.1 watts per square foot. Because the community center is a mix of widely varying use groups, several different power densities could apply to the different spaces. However, the median as well as the most commonly found power density for the building has been found to be 1.1 watts per square foot. A takeoff of the building lights and their wattages in included in Appendix 2.1, while the actual compliance check and power density comparison is included in Appendix 2.2, Table 9.5. Unsurprisingly, given the building performance throughout this evaluation, the lighting power density was higher than even the highest space allowable limit and far above the chosen average limit of 1.1 watts per square foot. Therefore, from a lighting standpoint, this building could stand to employ more energy efficient measures.

Throughout this analysis, the Eberly Campus Community Center has been evaluated for energy efficiency compliance with the ASHRAE Standard 90.1-2004. While several of the systems have passed the requirements, many other systems and design ideas have not. This lack of energy efficient design may or may not be due to the fact that the building has been designed before the application of the new version of Standard 90.1. However, these measures are still a cause of energy waste and should be addressed if possible.

3. Mechanical System: Lost Rentable Space

While the Eberly Campus Community Center has not been designed for energy efficiency, its use of space for the mechanical system is extremely economical. The entire building is only a single story, so there are no vertical duct shafts or risers to accommodate within the inhabited spaces. Most of the zones are single zone systems, and all of the mechanical equipment is located either on the roof, in a mezzanine level, or in the main mechanical room. As the main mechanical room has been specifically designed to its purpose, its space is excluded from the lost rentable space calculation. Therefore, the only space in the building where the mechanical system interferes with the function of its occupants is in the main gymnasium.

Within the gymnasium, there are telescoping bleachers and regular bleachers to seat about 1200 people. The four air handling units are located in mezzanine spaces at the four corners of the room, accessible through the bleachers. Removing the air handling units would provide more space for bleachers and therefore provide the owner with that much more revenue from the main gymnasium space.

Included below in Table 1 are the calculations for the lost rentable space due to the mechanical system. It is quickly visible that the mechanical systems in this project have remained unobtrusive within the environment, and excellent layout with a view to maximize the use of all of the building spaces.

Table 1: Lost Rentable Space

Area Lost	Space	Reason
276	M105A	The mechanical room is taking up possible bleacher seat space.
276	M105B	The mechanical room is taking up possible bleacher seat space.
276	M105C	The mechanical room is taking up possible bleacher seat space.
276	M105D	The mechanical room is taking up possible bleacher seat space.
Total lost rentable space = 1104 ft^2		

From Table 1, the total lost rentable space includes 1104 square feet. Taken in consideration of the entire building area, 52,000 square feet, the lost rentable space is only 2% of the building whole. Due to the relatively small percentage of lost rentable space, it is obvious that the space layout of the mechanical system of this project is well coordinated and efficient.

4. Mechanical System First Cost

As this project is a design – bid – build project, the mechanical contractor has been responsible for a comprehensive cost breakdown of the mechanical system equipment costs. Unfortunately, for the duration of this analysis the bid documents from the mechanical contractor have been in transit, so an estimate of the mechanical system first cost has been generated to establish a working base cost comparison. An estimate of the mechanical system first costs, from an overview of percentages of first costs from other projects, involves a price of 15% of the total building first costs. Therefore, the estimated mechanical system first cost is 15% of $10.8 million, or about $1.6 million. Broken down into a cost per square foot basis, the estimated mechanical system first cost estimate is about $31.25 per square foot. This estimate provides an interesting look at some very loose rules of thumb and their applications.

While rules of thumb and estimates are acceptable when no other information is available, the actual cost breakdown is a valuable source of information in and of itself. The mechanical contractor has proven cooperative and has sent a cost breakdown of the mechanical system as well as the lump sum number of the mechanical construction contract. Total cost breakdown information can be found in Appendix 3. General costs are provided below in Table 2.

Table 2: Preliminary Cost Breakdown

Cost	**Amount**
Original Contract Sum	$2 Million
Cost per Square Foot	$38.46 / ft^2

5. Yearly Energy Utilization Data

While actual yearly energy utilization data is also not obtainable at this time, the annual energy use per power source has been created through the use of an energy modeling program. For this application, Trane's Trace 700 program has been used. This program utilizes a wide multitude of inputs to create a complicated simulation model of the building and outputs any number of calculation and analysis reports. Directly from the outputs of the energy model, the annual energy loads are broken down in Table 2 below. The results of the energy consumption summary are included in Appendix 4.1, the Trace 700 Energy Outputs appendix.

Table 3: Annual Energy Use

Type of Energy Use	Units of Amount	Annual Energy Consumption
Electricity	kWh	424,543,560.0
Natural Gas	therms	1,204.4
Total	kBtu/hr	43,474,612.0

6. Energy Modeling: Inputs

As described above, the Trane Trace program is an energy modeling program capable of complex analysis and design calculations. To properly harness the full power of the program, a variety of intimate details are required about the project in question. The inputs for the Trane Trace program fall into the following categories:

- Project Information
- Weather Information
- Template Information
- Schedules
- Room Information
- Airside Systems
- Plants
- Economics Information.

Only with the provision of all of the details mentioned above will the energy model work as desired.

6.1: Project Information

The only inputs required in this section are self-imposed inputs for clarification purposes and have no bearing upon the actual calculations within the energy model. For this project, data includes the project name, its actual location, and other identifying information to help clarify the basics of the project for a quick snapshot of the building under review.

6.2: Weather Information

Within the weather information tab of the Trane Trace program is a map of the United States with which the designer can locate the closest weather station and pull up weather data with a few clicks of the mouse. However, the weather stations included in the program library have gaps in the area of information. The location of this project, Uniontown, Pennsylvania, is not included in the model preset file. Therefore, weather information has been obtained from 2005 edition of the ASHRAE Handbook of Fundamentals. The handbook provides several tiers of weather information depending upon how conservatively the designer wishes to use weather calculations. Weather data for this project has been found for the 0.4% worst case scenario – meaning that only 0.4% of the time will weather conditions be worse than the design conditions chosen. The temperature and wet bulb temperature set points included are written in Table 3 below.

Table 4: Weather Data

Type of Information	Heating Design	Cooling Design
Dry Bulb (ºF)	4.5	89.8
Dew Point (ºF)	-4.4	-
Wet Bulb (ºF)	-	75.1

All weather data has been chosen from the closest approximation to Uniontown, PA: in this case, the weather location is at the Pittsburgh Allegheny County Airport.

6.3: Template Information

To increase the ease of use of the program, universal templates are often created. These templates apply set, repetitive information and can be called when building rooms to greatly facilitate the room load, airflow, thermostat, and construction inputs. Assumptions and inputs used in this project's energy include the following:

- Lighting power density, found above, is 1.9 W / ft^2
- Schedules are set to the PSU Schedule developed for this project
- Cooling dry bulb = 75 ºF, heating dry bulb = 68 ºF, relative humidity = 50%, cooling drift point = 95 ºF, and heating drift point = 55 ºF
- U-values for the various floors, walls, roof, and window system are input at the values found in Appendix 2.1
- Occupant numbers for typical spaces: office -1, locker rooms – 2, unoccupied space – 0, and racquetball courts - 2
- Typical loads: office – 0.5 W / ft^2

This template information, paired with more tailored templates, creates a powerful tool to quickly and easily build the rooms within the model.

6.4: Schedules

Naturally, when modeling a building with variable occupancies and equipment loading, a schedule is necessary to correctly estimate building energy use and load profiles for any length of time. To achieve a correct schedule, a calendar has been set up with holidays and other day definitions so that the schedule can call out the correct days throughout the year. The Eberly Campus Community Center is sadly underused for its purpose, and the calendar reflects this lack. Operation of the building only occurs when Penn State is in session. Therefore, as the Fayette Campus is a small commuter campus, the building sits idle all summer from May graduation until the last week of August when classes resume. Other input holidays include about 2.5 weeks off near Christmas time, the fall "study" day, and the few days off for Thanksgiving break. The schedule itself has been created for design heating days, design cooling days, weekdays, Saturdays, and Sundays. The design heating and cooling days are simply set at 100% available, because it is safe to assume that the systems and equipment will need to work constantly to counteract these more extreme loads. Weekday, Saturday, and Sunday schedules follow the following pattern:

Table 5: Weekday Schedule

Start time	End time	Percentage
Midnight	5 a.m.	0
5 a.m.	7 a.m.	20
7 a.m.	7 p.m.	100
7 p.m.	11 p.m.	20
11 p.m.	Midnight	0

Table 6: Saturday Schedule

Start time	End time	Percentage
Midnight	8 a.m.	0
8 a.m.	10 a.m.	30
10 a.m.	8 p.m.	100
8 p.m.	10 p.m.	30
10 p.m.	Midnight	0

Table 7: Sunday Schedule

Start time	End time	Percentage
Midnight	5 a.m.	0
5 a.m.	7 a.m.	20
7 a.m.	7 p.m.	100
7 p.m.	11 p.m.	20
11 p.m.	Midnight	0

Through the use of these schedules, a maximum of accuracy is preserved in finding the building annual energy loads as well as the heating and cooling loads on a day-to-day basis.

6.5: Room Information

Under this information tab, the various non-uniform characteristics of the different rooms are located. Here, the airflows, room heights, exterior walls, glazing areas, extra internal loads, and the floor covering are specified. Load sources are also necessary in this portion, and can be found in Appendix 4.2. This is perhaps the most time consuming step in the input process, as the information changes for each space, and the time required to simply find and process the necessary information becomes a lengthy ordeal.

6.6: Airside Systems

Thankfully, the time required to input the airside systems for this project is much less than that required for the rooms and templates. While a great number of systems must be individually modeled, most of the systems are repetitive systems that can be copied to use for space after space. Inputs for the air handling units, split systems, unit ventilator, fan coil units, radiant panels, and radiation equipment remain the same for each type of unit. Air handlers each are built with a dry bulb sensitive economizer set to operate once the outdoor air reaches 50 ºF. The unit ventilator is also designed with a similar economizer. Split systems include two different types of MBH supply loads, as do the radiant panels and the radiation equipment. Finally, the two separate sized fan coil units simply have wide differences in the input fan power and the output loads.

6.7: Plants

Only two plants are available within this building. The cooling plant consists of an air-cooled helical rotary chiller with single sequencing and a condenser fan. Operating at 214.3 tons and a COP of 2.83, the chiller plant requires two constant volume chilled water pumps moving 80 feet of water apiece to serve the loads. The second plant consists of two cast iron sectional gas fired hot water boilers, each 78.8% efficient and producing 2498 MBH. To serve the hot water supply system, each boiler is equipped with a hot water circulating pump capable of producing 83 feet of water.

6.8: Economics Information

Through careful perusal of the contract documents, it is apparent that the electric utility for the campus is Allegheny Power, while the natural gas utility is Columbia Gas of Pennsylvania, Inc. Rates have been taken directly off of the utility websites and are included in Appendix 4.3, the energy inputs appendix. Final rate calculations are included in Tables 4-6 below. Assumptions have been made as to the rate package provided to Penn State Fayette campus. Allegheny Power is assumed to have a Schedule 30, General Power Service agreement with Penn State, as the building loads are too low to qualify the building for some of the larger power agreements. The gas utility has been assumed to provide a large general sales service rate to the project.

Table 8

Electric Demand on Peak			
Charge	**Minimum Charge**	**100 kW and under**	**Over 100 kW**
Distribution	$1.07	$0.98	$0.82
Transmission	$0.54	$0.09	$0.16
Intangible Transition	$0.60	$0.55	$0.48
Generation	$4.52	$4.09	$3.15
Ancillary Services	$0.58		
Total equals =	**$7.31**	**$5.71**	**$4.61**

Table 9

Electric Consumption Energy Charges			
Charge	**Minimum Charge**	**0 - 40,000 kWh**	**Over 40,000 kWh**
Distribution	$0.00	$0.00704	$0.00630
Transmission	$0.00	$0.00356	$0.00318
Intangible Transition	$0.00	$0.00394	$0.00356
Generation	$0.00	$0.02973	$0.02679
Ancillary Services	$0.00	$0.00000	$0.00000
Total equals =	**$0.00**	**$0.04427**	**$0.03983**

Table 10

Gas Demand on Peak				
Annual Throughput (Mcf)	**In Therms:**	**Distribution charge**	**Total effective rate**	**Charge per Therm**
<10k	102700	$72.09	$72.09	$0.000702
10k - 50k	513500	$264.48	$264.48	$0.000515
50k - 100k	1027000	$911.80	$911.80	$0.000888
100k - 300k	3081000	$1,620.97	$1,620.97	$0.000526
300k - 700k	7189000	$3,241.95	$3,241.95	$0.000451
700k +	7189000	6483.89	6483.89	$0.000902
Total equals =		**$12,595.18**	**$12,595.18**	

7. Energy Modeling: Design Load Outputs

Among the most useful of the energy model attributes is the ability to generate design data in a comparison format. A practical set of engineering checks includes the cooling (square foot per ton), the total supply air (cfm / square foot), and the ventilation supply air (cfm / square foot). This information is included in Appendix 4.4. Unfortunately, the engineering design documents have not included this information and the engineer of record has elected not to use an energy model, so there is no basis of comparison beyond what is included here. The original design team has avoided an energy model because Burt Hill, the AE firm responsible, already uses a comprehensive Excel spreadsheet that calculates all of the building loads, R-values, and other energy use problems that would be solved by the energy model. Unfortunately, the spreadsheet still resides with the mechanical engineer at this point, though there has been progress in obtaining a copy of that information.

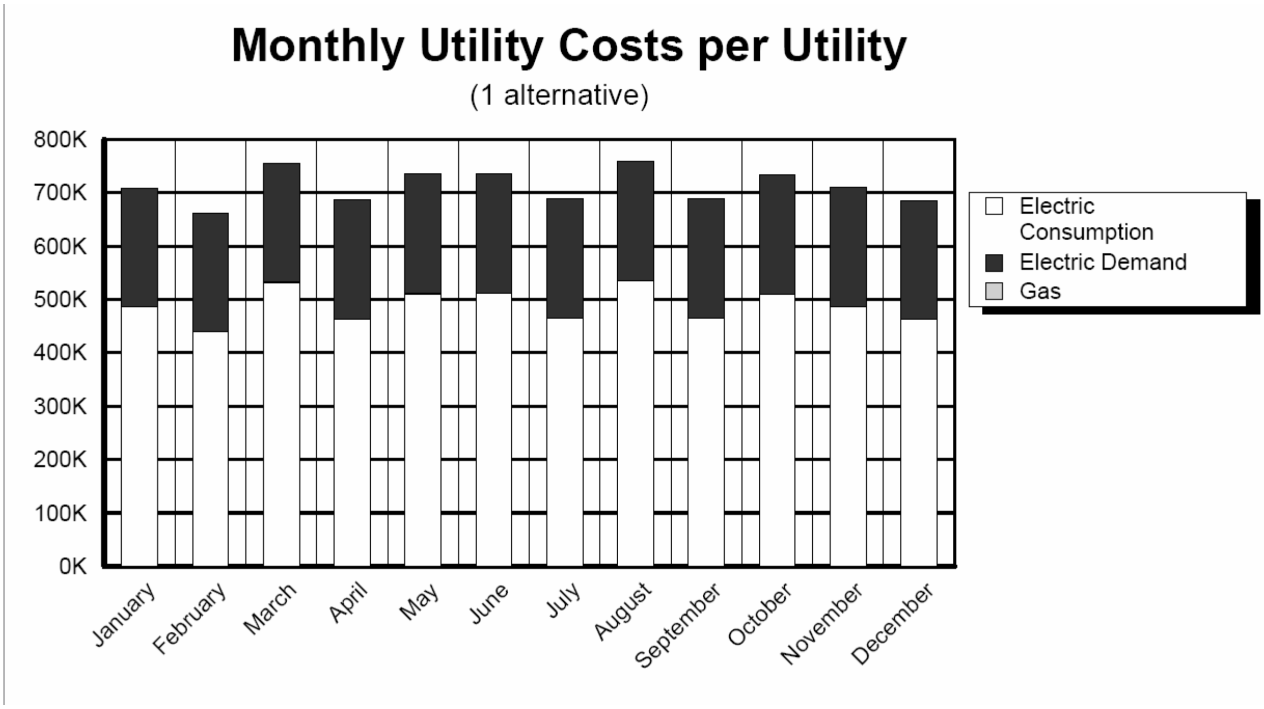
A careful review of the system engineering checks mentioned above for this project provides useful information on a zone-by-zone basis. Though the program does calculate this information, the results are provided per system. As this building is composed of a multitude of small, single zone systems with some larger multi-zone systems, there is a wide variety of information output from the Trace program to consider. Included below in Table 7 are the ranges for the project outputs mentioned below.

Table 11

Heating (cfm / ft^2)	**Cooling (ft^2 / ton)**	**Supply Air (cfm / ft^2)**	**Ventilation Air (% SA)**
0.38 – 5.52	57.4 – 830.2	0.89 – 2.72	10.5 – 37.5

8. Energy Modeling: Consumption and Operating Costs

Finally, the most beneficial aspect of the energy model is its output on energy consumption and operating costs. For this segment, the same schedules have been used that are represented in Section 6.4, as well as the same fuel costs, air and water flow rates, and equipment performance characteristics that are specified in Section 6.8, the design documents, and Section 6.7 respectively. The annual energy consumption has been found and is represented in Section 5, Appendix 4.1. The operating costs have also been calculated within the energy model and are located in Appendix 4.1.



9. Appendices Index

Appendix 1

Appendix 1.1

LEED-NC Version 2.2: Checklist

LEED-NC Version 2.2 Registered Project Checklist

<< enter project name >>

<< enter city, state, other details >>

Yes	?	No			
			Sustainable Sites		**14** Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
x			Credit 1	**Site Selection**	1
		x	Credit 2	**Development Density & Community Connectivity**	1
		x	Credit 3	**Brownfield Redevelopment**	1
		x	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
	x		Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		x	Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1
		x	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
	x		Credit 5.1	**Site Development,** Protect of Restore Habitat	1
	x		Credit 5.2	**Site Development,** Maximize Open Space	1
	x		Credit 6.1	**Stormwater Design,** Quantity Control	1
	x		Credit 6.2	**Stormwater Design,** Quality Control	1
		x	Credit 7.1	**Heat Island Effect,** Non-Roof	1
		x	Credit 7.2	**Heat Island Effect,** Roof	1
	x		Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
2	6	7	**Water Efficiency**		**5** Points
	x		Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
	x		Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		x	Credit 2	**Innovative Wastewater Technologies**	1
x			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		x	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
1	2	2	**Energy & Atmosphere**		**17** Points
Y		x	Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y		x	Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
	x		Credit 1	**Optimize Energy Performance**	1 to 10
		x	Credit 2	**On-Site Renewable Energy**	1 to 3
		x	Credit 3	**Enhanced Commissioning**	1
x			Credit 4	**Enhanced Refrigerant Management**	1
		x	Credit 5	**Measurement & Verification**	1
		x	Credit 6	**Green Power**	1

continued…

Yes	?	No			
2	1	6	**Materials & Resources**		**13** Points
Y		x	Prereq 1	**Storage & Collection of Recyclables**	Required
		x	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
		x	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
		x	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
		x	Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
		x	Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
		x	Credit 3.1	**Materials Reuse**, 5%	1
		x	Credit 3.2	**Materials Reuse**,10%	1
	x		Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
	x		Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
	x		Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regic	1
	x		Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regic	1
		x	Credit 6	**Rapidly Renewable Materials**	1
		x	Credit 7	**Certified Wood**	1

Yes	?	No			
	4	10	**Indoor Environmental Quality**		**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
	x		Credit 1	**Outdoor Air Delivery Monitoring**	1
		x	Credit 2	**Increased Ventilation**	1
		x	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
		x	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
		x	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
		x	Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
		x	Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
		x	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
	x		Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		x	Credit 6.1	**Controllability of Systems**, Lighting	1
x			Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
x			Credit 7.1	**Thermal Comfort**, Design	1
		x	Credit 7.2	**Thermal Comfort**, Verification	1
	x		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		x	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Yes	?	No			
4	3	10	**Innovation & Design Process**		**5** Points
		x	Credit 1.1	**Innovation in Design**: Provide Specific Title	1
		x	Credit 1.2	**Innovation in Design**: Provide Specific Title	1
		x	Credit 1.3	**Innovation in Design**: Provide Specific Title	1
		x	Credit 1.4	**Innovation in Design**: Provide Specific Title	1
x			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No		
9	16		**Project Totals (pre-certification estimates)**	**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Appendix 1.2

Water Use Management Spreadsheet

(Responsible Individual) (Company Name)

I, Heather Stapel , from Penn State

verify that the information provided below is accurate, to the best of my knowledge.

GENERAL INFORMATION

Please enter the following general project information:

(•) Use Default Male / Female Occupancy Breakdown (50% / 50%).
ENTER THE TOTAL OCCUPANCY FOR EACH OCCUPANCY TYPE IN TABLE 1.01 BELOW

( ) Special Male/Female Occupancy Breakdown
ENTER THE MALE AND FEMALE OCCUPANCY FOR EACH OCCUPANCY TYPE IN TABLE 1.02 BELOW. PROVIDE A NARRATIVE DESCRIPTION AT THE END OF THIS FORM TO EXPLAIN THE UNIQUE MALE/FEMALE OCCUPANCY BREAKDOWN.

Table 1.01 - Occupancy Breakdown (Default Male / Female Occupancy)
Enter the values as whole numbers without any commas

	Full Time Equivalent (FTE):	Student/Visitor:	Retail Customer:	Residential:	Other: spectators/events
Total	11	280			1,650
Male	5	140			825
Female	6	140			825

Table 1.02 - Occupancy Breakdown (Special Male / Female Occupancy Breakdown)
Enter the values as whole numbers without any commas

	Full Time Equivalent (FTE):	Student/Visitor:	Retail Customer:	Residential:	Other:
Total					
Male					
Female					

Percent of male restrooms with urinals: 100 %

Annual Days of Operation (1-365): 250

WATER SAVINGS CALCULATION

1 - Baseline Case

Tables 1.1 and 1.2 reflect the default baseline flush and flow fixtures for the project.

To edit the baseline, deselect the "Included in Project?" checkbox for any baseline fixtures that don't apply to your project. The default flush and flow rates, and daily uses per person match those in the reference guide, and should nc be altered unless justification for these changes is provided in the narrative at the end of this form. Provide daily use per person input for "other" occupants (if applicable), and justify these values in the required narrative

Table 1.1 - Flush Fixture Data - Baseline Case

Fixture Reference	Baseline Fixture Type	Gender	Flush Rate (GPF)	Daily Uses Per Person					Included in Project?
				FTE	Student / Visitor	Retail Customer	Residential	spectators/event	
1	Conventional Water Closet	Female	1.6	3.0	0.5			0.5	☒
2	Conventional Water Closet	Male	1.6	1.0	0.1			0.1	☒
3	Conventional Urinal	Male	1.0	2.0	0.4			0.4	☒

Annual Baseline Flush Fixture Water Usage:	**339,800**	**gallons/year**

Table 1.2 - Flow Fixture Data - Baseline Case

Fixture Reference	Baseline Fixture Type	Flow Rate (GPM)	Duration (seconds)	Daily Uses Per Person					Included in Project?
				FTE	Student / Visitor	Retail Customer	Residential	spectators/event	
A	Conventional Lavatory	2.5	15	3.0	0.5			0.5	☒
B	Conventional Shower	2.5	300	0.1	0.1				☒
C	Kitchen Sink	2.5	15	1.0					☒
D	Janitor Sink	2.5	15	0.1					☒
E									☐

TOTAL ANNUAL BASELINE WATER USAGE:	**623,565**	**gallons/year**
Annual Baseline Flow Fixture Water Usage:	**283,765**	**gallons/year**

2 - Design Case

Document the Design Case flush and flow fixtures in Tables 2.1 and 2.2 respectively. The daily uses per person, and duration of use for each fixture type should equal those listed for the comparable fixture type in the Baseline case. If the design case fixture type is not listed in the dropdownlist, simply type in the appropriate fixture type.

Provide the fixture manufacturer and model number , and the flush or flow rate for each fixture type.

Multiple corresponding fixture types: If the project has multiple design case fixtures that correspond to a single Baseline comparison system fixture type , enter the "Percent of Occupants" field to reflect the percentage of each fixture (e.g. for a project with 25% non-water urinals and 75% low-flow urinals corresponding to Fixture Reference # 3 - "Conventional Urinals" in the Baseline design, enter the "Percent of Occupants" as 25% for non-water urinals. Then, in a blank line, select Fixture Reference #3, and enter the "Percent of Occupants" as 75% for low-flow urinals).

Dual-Flush Water Closets: If the project has dual-flush water closets , utilize the "Percent of Occupants" field to enter 33% for "Dual-Flush Water Closets, Full-Flush" (for solid waste use). Then, in a blank line, select Fixture Reference #1, and enter the "Percent of Occupants" as 67% for "Dual-Flush Water Closets, Low-Flush" (for liquid waste). Note: This clarification is not applicable for males when urinals are used.

Automatic Controls: If the flow fixutres include automatic faucet controls, you may adjust the Duration in Table 2.2 to reflect the impact of the automated controls. Justification for these input values, along with the identification of the faucet control manufacturer and model number must be provided in the required narrative.

Table 2.1 - Flush Fixture Data - Design Case

Fixture Reference	Design Case Fixture Type	Gender	Fixture Manufacturer	Fixture Model	Flush Rate (GPF)	Percent of Occupants	Daily Uses Per Person				
							FTE	Student / Visitor	Retail Customer	Residential	spectators/e
1	Water Closet	Female	American Std.	Afwall Siphon Jet	1.6	100 %	3.0	0.5			0.5
2	Water Closet	Male	American Std.	Afwall Siphon Jet	1.6	100 %	1.0	0.1			0.1
3	Urinal	Male	American Std.	Trimbock	1.0	100 %	2.0	0.4			0.4
						%					
						%					
						%					

Annual Design Case Flush Fixture Water Usage:	**339,800**	**gallons/year**

Table 2.2 - Flow Fixture Data - Design Case

Fixture Reference	Design Case Fixture Type	Fixture Manufacturer	Fixture Model	Flow Rate (GPF)	Percent of Occupants	Duration (seconds)	Daily Uses Per Person				
							FTE	Student / Visitor	Retail Customer	Residential	spectators/e
A	Lav	American Std.	Cadet model	0.5	100 %	15	3.0	0.5			0.5
B	shower	Bradley	1K	2.0	100 %	300	0.1	0.1			
C	kit sink	Elkay	Type 302	2.5	100 %	15	1.0				
D	jan sink	Fiat Products	Model L-5	2.5	100 %	15	0.1				
					%						
					%						
					%						
					%						

Annual Design Case Flow Fixture Water Usage:	**133,828**	**gallons/year**
Annual Design Case Flush and Flow Fixture Water Usage:	**473,628**	**gallons/year**

Non-Potable Source Water

Enter the annual amount of on-site collected / treated water used for flush or flow fixtures. (Click "CLEAR" to clear a row of data. Enter the Annual Quantity as a whole number without commas.)

Water Source	Annual Quantity (gal)	
Grey Water Re-Use	0	CLEAR
Rainwater Re-Use	0	CLEAR
		CLEAR
		CLEAR
Total on-site nonpotable water:	0	

WATER USE SUMMARY

Baseline Case - Annual Water Consumption (gal):	623,565	gallons/year
Design Case - Annual Water Consumption (gal):	473,628	gallons/year
Total Annual Non-Potable Water Consumption (gal):	0	gallons/year
Total Water Savings:	24	**%**

For credit compliance, a water savings of at least 20% earns 1 LEED point, and a water savings of at least 30% earns 2 LEED points.

NARRATIVE (Required)

Please provide any additional comments or notes regarding special circumstances or considerations regarding the project's credit approach. Describe the water savings features of this project, and include specific data regarding any water saving fixtures and/or reclaimed water usage (greywater re-use / rainwater reuse).

There was no attempt at grey-water reuse. This was a very small, exceptionally economically designed project.

NARRATIVE (Optional)

Please provide any additional comments or notes regarding special circumstances or considerations regarding the project's credit approach.

I am very surprised that the water use savings came out as they did. The number remains above 20% whether or not the additional spectators are considered, therefore any miscalculations upon my part about the average spectators and their annual availability does not matter in consideration of the number of daily visits by students. Actually, this calculation should include a yearly schedule, as the building practically sits idle throughout much of the summer session and is only in use during the Penn State fall and spring semesters.

☐ The project is seeking point(s) for this credit using an alternate compliance approach. The compliance approach, including references to any applicable Credit Interpretation Rulings is fully documented in the narrative above. *(Indicate the number of points documented in the Alternate Compliance Points Documented field below).*

Alternative Compliance Points Documented

Project Name:

Credit: WE Credit 3: Water Use Reduction

Points Documented: 1

READY TO SAVE THIS TEMPLATE TO LEED-ONLINE? Please enter your first name, last name and today's date below, followed by your LEED-Online Username and Password associated with the Project listed above to confirm submission of this template.

First Name	Last Name	Date	Username (Email Address)	Password
Heather	Stapel	10/24/2006	hms179@psu.edu	

SAVE TEMPLATE TO LEED-ONLINE

PRINT TEMPLATE

T0000504

Letter Template Version A1 .

Appendix 1.3

Refrigerant Management Calculation

Enhanced Refrigerant Management Checksheet									
GWPr	ODPr	Lr	Life	Mr	Rc	LCGWP	LCODP	Combined	<100?
1300	0	0.02	25	0.1	1	31.2	0	31.2	Y

Appendix 1.4

Standard 62.1-2004 Compliance

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 2

Appendix 2.1

Standard 90.1-2004 Calculations

Lighting Power Density Calculations			
Fixture	**Number**	**Watts**	**Total Watts**
A	43	64	2752
B	29	107	3103
C	1	64	64
D	91	64	5824
F	5	194	970
G	66	64	4224
H	18	35	630
J	35	35	1225
K	23	475	10925
KI	17	455	7735
L	24	128	3072
M	11	455	5005
M1	7	750	5250
M2	4	295	1180
M3	4	295	1180
M4	6	750	4500
N	8	295	2360
N1	4	590	2360
N2	4	590	2360
P	4	295	1180
R	2	85	170
S		455	0
S1	5	455	2275
S2	19	95	1805
S3	12	315	3780
T			0
T1	23	250	5750
U	29	75	2175
V	76	90	6840
W	6	28	168
X	10		0
Y	10		0
BB	6	45	270
CC		18	0
DD	9	32	288
FF	4	95	380
GG	8	70	560
EX	37	5	185
Stage lighting			3000
Racquetball		5460	5460
		Total W =	99005
		Power Density =	1.9

*Stage lighting assumed at 3000 W
*Racquetball court lighting assumed at 2730 W apiece

R-value calculation sheet								
Surface	**Layer**	**Material**	**R-value, material**	**R-value per in.**	**Thick (in.)**	**Overall R**	**Overall U-value**	**SHGC**
Wall								
12" CMU, Brick Veneer	inside	inside	0.68		0	0.68		
	CMU	CMU	2.45		12	2.45		
	Rigid Insul.	Rigid Insul.		5.6	2	11.20		
	Air space	Air space	2.29		2	2.29		
	face brick	face brick		0.16	4	0.64		
	outside	outside	0.17		0	0.17		
						17.43		
							0.057	
8" CMU, Brick Veneer	Inside	Inside	0.68			0.68		
	Gyp. Bd.	Gyp. Bd.	0.56		0.63	0.56		
	Air	Air Space	2.29		2	2.29		
	CMU	CMU	2.45		8	2.45		
	Rigid Insul.	Rigid Insul.		5.6	2	11.20		
	Air	Air Space	2.29		2	2.29		
	Face brick	Face Brick		0.16	4	0.64		
	Outside	Outside	0.17			0.17		
						20.28		
							0.049	
Floor								
4" Slab on Grade	inside	inside	0.68		0	0.68		
	Concrete	150 pcf		0.075	4	0.30		
	Rigid Insul.	Rigid Insul.		5.6	2	11.20		
						12.18		
							0.082	
4" SOG, wood flooring	inside	inside	0.68		0	0.68		
	wood	wood		0.85	1	0.85		
	Concrete	150 pcf		0.075	4	0.30		
	Rigid Insul	Rigid Insul		5.6	2	11.20		
						13.03		
							0.077	
5" SOG	inside	inside	0.68		0	0.68		
	Concrete	150 pcf		0.075	5	0.38		
	Rigid Insul.	Rigid Insul.		5.6	2	11.20		
						12.26		
							0.082	

6" SOG	inside	inside	0.68		0	0.68		
	Concrete	150 pcf		0.075	6	0.45		
	Rigid Insul.	Rigid Insul.		5.6	2	11.20		
						12.33		
							0.081	
Built up coal tar roof	Inside	Inside	0.68			0.68		
	Metal	Batt Insul	10			10.00		
	EPDM	EPDM	20			20.00		
						30.68		
							0.033	
Metal panels				5.83	2	11.66		
					Panel U		0.086	
Curtainwall System	1'x5'	Solarban 60					0.528	0.346
	4'x5'	Solarban 60					0.438	0.359
	6'x5'	Solarban 60					0.408	0.363

*Note:
1. R-values for building materials taken from ASHRAE Fundamentals Handbook
2. U-values and SHGC of curtainwall calculated in the WINDOW 6 Program, data ouput sheets provided in Appendix 2.1

ID: 5
Name: ec3
EnvCond: 1 NFRC 100-2001

Type: Casement, custom
Tilt: 90
Width: 63.0 inches
Height: 22.0 inches
Area: 9.62 ft2

U-value: 0.528 Btu/h-ft2-F
SHGC: 0.346
Vt: 0.518
CI: N/A

Data for Glazing Systems

ID	Name	COG Area ft2	#Lay	Tilt	Uc Btu/h-ft2	SCc	SHGCc	Vtc	RHG
16	ec3	4.64	2	90	0.298	0.438	0.381	0.701	91

Layer Data for Glazing System '16 ec3'

ID	Name	D(")	Tsol	1 Rsol	2 Rsol	Tvis	1 Rvis	2 Rvis	Tir	1 Emis	2 Emis	Keff
Outside												
5284	SB60 Clear-6.PP	#0.223	.386	.272	.455	.790	.059	.049	.000	.840	.035	.578
1	Air	0.552										.020
103	CLEAR_6.DAT	#0.225	.771	.070	.070	.884	.080	.080	.000	.840	.840	.578
Inside												

Frame Data

Location	ID	Name	Source	Frame Area ft2	Edge Area ft2	Uframe Btu/h-ft2-F	Uedge
Header	1	Al w/break	ASHRAE/LBL	0.949	0.972	1.0003	0.4752
Left Jamb	1	Al w/break	ASHRAE/LBL	0.309	0.260	1.0003	0.4752
Right Jamb	1	Al w/break	ASHRAE/LBL	0.309	0.260	1.0003	0.4752
Sill	1	Al w/break	ASHRAE/LBL	0.949	0.972	1.0003	0.4752

Gas Data

ID	Name	Type	Cond Btu/h-ft-F	Visc lb/ft-s x e-6	Cp Btu/lb-F	Dens lb/ft3	Pran
1	Air	Pure	0.0139	11.57	0.24	0.0807	0.7197

Environmental Conditions: 1 NFRC 100-2001

	Tout (F)	Tin (F)	WndSpd (mph)	Wnd Dir	Solar (Btu/h-ft2)	Tsky (F)	Esky
Uvalue	-0.4	69.8	12.30	Windward	0.0	-0.4	1.00
Solar	89.6	75.2	6.26	Windward	248.2	89.6	1.00

Frame Library Data

ID	Name	Source	U-value Frame Btu/h-ft2-F	U-value Edge Btu/h-ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h-ft2-F	Width (PFD)	Abs
1	Al w/break	ASHRAE/LBL	1.0003	N/A	1	N/A	N/A	2.25	0.90

Divider Library Data

ID	Name	Source	U-value Div Btu/h-ft2-F	U-value Edge Btu/h-ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h-ft2-F	Width (PFD)	Abs

No Dividers for this Glazing System

Optical Properties for Glazing System '16 ec3'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc :	0.701	0.705	0.696	0.683	0.665	0.629	0.549	0.398	0.184	0.000	0.584
Rf :	0.109	0.102	0.099	0.102	0.114	0.139	0.186	0.291	0.524	0.999	0.168
Rb :	0.119	0.113	0.112	0.116	0.130	0.159	0.223	0.367	0.634	1.000	0.199
Tsol :	0.327	0.329	0.324	0.318	0.309	0.292	0.255	0.184	0.085	0.000	0.271
Rf :	0.292	0.286	0.285	0.287	0.296	0.312	0.344	0.420	0.604	0.999	0.332
Rb :	0.311	0.307	0.304	0.302	0.304	0.314	0.343	0.423	0.599	1.000	0.339
Abs1 :	0.348	0.352	0.358	0.362	0.362	0.362	0.368	0.366	0.291	0.001	0.354
Abs2 :	0.032	0.032	0.033	0.033	0.034	0.034	0.033	0.029	0.021	0.000	0.032
SHGCc:	0.381	0.384	0.379	0.374	0.365	0.348	0.311	0.237	0.125	0.000	0.326

Tdw-K : 0.330
Tdw-ISO: 0.536
Tuv   : 0.180

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Temperature Distribution (degrees F)

	Winter		Summer	
	Out	In	Out	In
	----	----	----	----
Lay1	3.7	4.3	110.6	111.7
Lay2	53.3	54.0	88.0	87.5

ID: 6
Name: ec3
EnvCond: 1 NFRC 100-2001

Type: Casement, custom
Tilt: 90
Width: 63.0 inches
Height: 46.0 inches
Area: 20.12 ft2

U-value: 0.438 Btu/h-ft2-F
SHGC: 0.359
Vt: 0.588
CI: N/A

Data for Glazing Systems

ID	Name	COG Area ft2	#Lay	Tilt	Uc Btu/h-ft2	SCc	SHGCc	Vtc	RHG
17	ec3.1	13.56	2	90	0.293	0.438	0.381	0.701	91

Layer Data for Glazing System '17 ec3.1'

ID	Name	D(")	Tsol	1 Rsol	2 Tvis	1 Rvis	2 Tir	1 Emis	2 Keff			
Outside												
5284	SB60 Clear-6.PP	#0.223	.386	.272	.455	.790	.059	.049	.000	.840	.035	.578
	1 Air	0.552										.020
103	CLEAR_6.DAT	#0.225	.771	.070	.070	.884	.080	.080	.000	.840	.840	.578
Inside												

Frame Data

Location	ID	Name	Source	Frame Area ft2	Edge Area ft2	Uframe Btu/h-ft2-F	Uedge
Header	1	Al w/break	ASHRAE/LBL	0.949	0.972	1.0003	0.4752
Left Jamb	1	Al w/break	ASHRAE/LBL	0.684	0.677	1.0003	0.4752
Right Jamb	1	Al w/break	ASHRAE/LBL	0.684	0.677	1.0003	0.4752
Sill	1	Al w/break	ASHRAE/LBL	0.949	0.972	1.0003	0.4752

Gas Data

ID	Name	Type	Cond Btu/h-ft-F	Visc lb/ft-s x e-6	Cp Btu/lb-F	Dens lb/ft3	Pran
1	Air	Pure	0.0139	11.57	0.24	0.0807	0.7197

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Environmental Conditions: 1 NFRC 100-2001

	Tout (F)	Tin (F)	WndSpd (mph)	Wnd Dir	Solar (Btu/h-ft2)	Tsky (F)	Esky
Uvalue	-0.4	69.8	12.30	Windward	0.0	-0.4	1.00
Solar	89.6	75.2	6.26	Windward	248.2	89.6	1.00

Frame Library Data

ID	Name	Source	U-value Frame Btu/h-ft2-F	U-value Edge Btu/h-ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h-ft2-F	Width (PFD)	Abs
1	Al w/break	ASHRAE/LBL	1.0003	N/A	1	N/A	N/A	2.25	0.90

Divider Library Data

ID	Name	Source	U-value Div Btu/h-ft2-F	U-value Edge Btu/h-ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h-ft2-F	Width (PFD)	Abs

No Dividers for this Glazing System

Optical Properties for Glazing System '17 ec3.1'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc :	0.701	0.705	0.696	0.683	0.665	0.629	0.549	0.398	0.184	0.000	0.584
Rf :	0.109	0.102	0.099	0.102	0.114	0.139	0.186	0.291	0.524	0.999	0.168
Rb :	0.119	0.113	0.112	0.116	0.130	0.159	0.223	0.367	0.634	1.000	0.199
Tsol :	0.327	0.329	0.324	0.318	0.309	0.292	0.255	0.184	0.085	0.000	0.271
Rf :	0.292	0.286	0.285	0.287	0.296	0.312	0.344	0.420	0.604	0.999	0.332
Rb :	0.311	0.307	0.304	0.302	0.304	0.314	0.343	0.423	0.599	1.000	0.339
Abs1 :	0.348	0.352	0.358	0.362	0.362	0.362	0.368	0.366	0.291	0.001	0.354
Abs2 :	0.032	0.032	0.033	0.033	0.034	0.034	0.033	0.029	0.021	0.000	0.032
SHGCc:	0.381	0.383	0.379	0.373	0.364	0.348	0.310	0.237	0.124	0.000	0.325

Tdw-K : 0.330
Tdw-ISO: 0.536
Tuv   : 0.180

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Temperature Distribution (degrees F)

	Winter		Summer	
	Out	In	Out	In
Lay1	3.6	4.3	110.6	111.7
Lay2	52.6	53.3	88.5	88.1

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ID: 7
Name: ec3.2
EnvCond: 1 NFRC 100-2001

Type: Casement, custom
Tilt: 90
Width: 63.0 inches
Height: 70.0 inches
Area: 30.62 ft2

U-value: 0.408 Btu/h-ft2-F
SHGC: 0.363
Vt: 0.609
CI: N/A

Data for Glazing Systems

ID	Name	COG Area ft2	#Lay	Tilt	Uc Btu/h-ft2	SCc	SHGCc	Vtc	RHG
19	ec3.2	22.48	2	90	0.290	0.437	0.380	0.701	91

Layer Data for Glazing System '19 ec3.2'

ID	Name	D(")	Tsol	1 Rsol	2	Tvis	1 Rvis	2	Tir	1 Emis	2	Keff
Outside												
5284	SB60 Clear-6.PP	#0.223	.386	.272	.455	.790	.059	.049	.000	.840	.035	.578
	1 Air	0.552										.020
103	CLEAR_6.DAT	#0.225	.771	.070	.070	.884	.080	.080	.000	.840	.840	.578
Inside												

Frame Data

Location	ID	Name	Source	Frame Area ft2	Edge Area ft2	Uframe Btu/h-ft2-F	Uedge
Header	1	Al w/break	ASHRAE/LBL	0.949	0.972	1.0003	0.4752
Left Jamb	1	Al w/break	ASHRAE/LBL	1.059	1.094	1.0003	0.4752
Right Jamb	1	Al w/break	ASHRAE/LBL	1.059	1.094	1.0003	0.4752
Sill	1	Al w/break	ASHRAE/LBL	0.949	0.972	1.0003	0.4752

Gas Data

ID	Name	Type	Cond Btu/h-ft-F	Visc lb/ft-s x e-6	Cp Btu/lb-F	Dens lb/ft3	Pran
1	Air	Pure	0.0139	11.57	0.24	0.0807	0.7197

Window 6.0 Research v 6.0.30 Report Page 2 10/25/06 04:14:13
Environmental Conditions: 1 NFRC 100-2001

	Tout (F)	Tin (F)	WndSpd (mph)	Wnd Dir	Solar (Btu/h-ft2)	Tsky (F)	Esky
Uvalue	-0.4	69.8	12.30	Windward	0.0	-0.4	1.00
Solar	89.6	75.2	6.26	Windward	248.2	89.6	1.00

Frame Library Data

ID	Name	Source	U-value Frame Btu/h-ft2-F	U-value Edge Btu/h-ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h-ft2-F	Width (PFD)	Abs
1	Al w/break	ASHRAE/LBL	1.0003	N/A	1	N/A	N/A	2.25	0.90

Divider Library Data

ID	Name	Source	U-value Div Btu/h-ft2-F	U-value Edge Btu/h-ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h-ft2-F	Width (PFD)	Abs

No Dividers for this Glazing System

Optical Properties for Glazing System '19 ec3.2'

Angle	0	10	20	30	40	50	60	70	80	90	Hemis
Vtc :	0.701	0.705	0.696	0.683	0.665	0.629	0.549	0.398	0.184	0.000	0.584
Rf :	0.109	0.102	0.099	0.102	0.114	0.139	0.186	0.291	0.524	0.999	0.168
Rb :	0.119	0.113	0.112	0.116	0.130	0.159	0.223	0.367	0.634	1.000	0.199
Tsol :	0.327	0.329	0.324	0.318	0.309	0.292	0.255	0.184	0.085	0.000	0.271
Rf :	0.292	0.286	0.285	0.287	0.296	0.312	0.344	0.420	0.604	0.999	0.332
Rb :	0.311	0.307	0.304	0.302	0.304	0.314	0.343	0.423	0.599	1.000	0.339
Abs1 :	0.348	0.352	0.358	0.362	0.362	0.362	0.368	0.366	0.291	0.001	0.354
Abs2 :	0.032	0.032	0.033	0.033	0.034	0.034	0.033	0.029	0.021	0.000	0.032
SHGCc:	0.380	0.383	0.378	0.373	0.364	0.347	0.310	0.236	0.124	0.000	0.325

Tdw-K : 0.330
Tdw-ISO: 0.536
Tuv : 0.180

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Temperature Distribution (degrees F)

	Winter		Summer	
	Out	In	Out	In
Lay1	3.6	4.2	110.7	111.8
Lay2	52.2	52.8	88.8	88.4

Appendix 2.2

Standard 90.1-2004 Compliance

ASHRAE 90.1 Compliance Checks

Table 5.5: Building Envelope Compliance								
Section of envelope	**Type**	**Required Max U**	**Req. min Insulation R**	**Req. Max SHGC**	**Actual U**	**Actual Insulation R**	**Actual SHGC**	**Complies?**
Roof	Insulation entirely above deck	0.063	R - 15 ci		0.033	R - 20		Y
Above Grade Walls	Mass Wall	0.123	R - 7.6 ci		0.057	11.2		Y
					0.049	11.2		Y
Slab-on-grade Floors	Unheated	F-0.730	NR		F-0.54			Y
Opaque Doors	Swinging	0.7			0.25			Y
Fenestration	20-30% Glazing	0.57		0.39	0.438		0.359	Y
					0.3		0.469	N

Table 6.5.3.1: Fan Power Limitation					
Air Handler	**Hp**	**1000 cfm SA**	**hp / 1000 cfm**	**Allowable**	**Complies?**
1	7.5	6	1.25	1.2	N
2	10	7.5	1.33	1.2	N
3	10	7.5	1.33	1.2	N
4	10	7.5	1.33	1.2	N
5	10	7.5	1.33	1.2	N
6	5	3.5	1.43	1.2	Y
7a	3	2.25	1.33	1.2	Y
8	15	12.7	1.18	1.2	N
9	5	5.5	0.91	1.2	Y
10	5	5.5	0.91	1.2	Y

* For fan system power of greater than 5 Hp.

Table 6.8.1: Equipment Efficiency			
Equipment	**Required Minimum**	**Actual**	**Complies?**
Air cooled chiller with condenser, electrically operated	2.8 COP, 3.05 IPLV	2.83 COP, 13.5 IPLV	Y
Boilers, gas fired	80% Ec	78.8% Ec	Close, but N
Supply Duct Insulation	R-6	R-8	Y
Return Duct Insulation	R-3.5	R-4	Y
Heating pipe insulation thickness	1" for up to 4" pipe dia., 1.5" for larger than 4" pipe dia.	1.5" for up to 2" pipe dia., 2" for larger	Y
Cooling pipe insulation thickness	0.5" for 1" pipe dia., 1" for 1.25" pipe dia.	0.5" for 1" pipe dia., 1" for 1.25" pipe dia.	Y
Domestic hot water insulation thickness	0.5" for up to 1" pipe dia., 1" for 1.5" pipe dia. and larger	0.5" for up to 1" pipe, 1" for 1.5" and larger	Y

Tabel 8.4.1: Voltage Drop Calculations								
Feeders	**Size**	**Circ. Mils**	**Length of run (ft)**	**I (Amps)**	**V_drop**	**Initial V**	**% V_drop**	**Complies?**
52	600 kcmil	600000	8	133.333	0.0383999	480	0.008	Y
Branch Ckt								
Panel to stage receptacles - farthest power run check	12	6530	368	3	3.6518224	120	3.043	Y

*Only the farthest or the most typical runs have been checked

Table 9.5: Lighting Power Density, Building Area Method				
Space lighted area	**Total lighting watts**	**Space Power Density**	**Allowable power density**	**Complies?**
52000	99005	1.9	1.1	N

Appendix 3

Mechanical Cost Breakdown

Mechanical Contractor, Contract Cost Breakdown

Description of work	Scheduled Value
Mobilization HVAC	$10,020.00
Mobilization Plumbing	$4,980.00
Demobilization HVAC	$4,140.00
Demobilization Plumbing	$1,840.00
Piping HVAC	
5" Steel	$23,256.00
4" Steel	$43,808.00
3" Steel	$26,915.00
2.5" Steel	$23,278.00
2" Copper	$57,158.00
1.5" Copper	$20,130.00
1.25" Copper	$31,345.00
1" copper	$18,601.00
3/4" Copper	$37,709.00
Refrigerant Pipe	$16,363.00
Boiler B-1	$32,000.00
Boiler B-2	$32,000.00
Pumps	$7,700.00
Pump Specialies	$6,800.00
C.W. air sparator	$1,900.00
H.W. air sparator	$1,900.00
ET-1 Tank	$3,000.00
ET-2 Tank	$900.00
By-pass filters	$2,600.00
Chemical Feeders	$4,200.00
Generator Exhaust	$5,800.00
Duct Fabrication	$62,400.00
Duct Installation	$104,000.00
Spiral Duct	$101,000.00
Flues	$20,500.00
GRDs	$20,600.00
Exhaust fans/vents	$17,900.00
Dampers	$7,400.00
Sound Attenuators	$3,500.00
AHU 1 through 10	$107,800.00
Chiller	$73,700.00
Air cooled condenser	$13,500.00
Generator Exhaust	$11,637.00
Ref. monitor	$6,200.00
Fan Coils	$4,600.00
Cabinet Heaters	$7,200.00
Unit Heaters	$1,900.00
Unit ventilator	$3,300.00
MUA 1&2	$7,200.00
CAU 1	$3,600.00
Mini-splits	$5,800.00
Radiant Heaters	$4,300.00
Pipe Insulation HVAC	$53,170.00
Ductwrap	$8,770.00

External ductboard insulation	$30,200.00
Equipment insulation	$1,500.00
Pump covers	$2,200.00
Gen. Exh. Insul.	$1,800.00
SS Insul Jacket	$8,400.00
Finned tube	$9,800.00
Tags/markers/paint	$11,050.00
Mech. Starters Disk	$18,300.00
Balancing	$13,600.00
Commissioning Coordination	$7,400.00
HVAC Coordination	$8,580.00
Site work/natural gas system	
6" piping	$48,000.00
2" piping	$1,500.00
Seeding	$2,000.00
Conc. Repair/patch	$2,000.00
Blacktop Repair/patch	$2,500.00
Site work dom./water system	
8" piping	$37,000.00
6" piping	$3,500.00
Fire Hydrants	$5,000.00
Tap-in to existing	$1,400.00
Site work san. Sewer system	
6" piping	$20,000.00
Sanitary Manholes	$12,000.00
Tap-in to existing manhole	$1,000.00
4" ductile iron piping	$20,000.00
San lift station	$25,500.00
New manholes/tap-in	$2,500.00
Int. stm. Below grades	
12" PVC Sch. 40	$5,000.00
10" PVC Sch. 40	$5,500.00
8" PVC Sch. 40	$1,350.00
6" PVC Sch. 40	$10,000.00
4" PVC Sch. 40	$5,000.00
Int. san. Below grade	
6" PVC Sch. 40	$15,500.00
4" PVC Sch. 40	$37,000.00
Above grade storm system	
Roof drains	$12,500.00
Piping	
6" no hub cast iron	$7,500.00
5" no hub cast iron	$8,500.00
4" no hub cast iron	$9,000.00
Above grade waste/vent sys.	
Carriers (Plbg fixtures)	$11,500.00
Grease interceptor	$5,500.00
Piping	
4" no hub cast iron	$13,000.00
3" no hub cast iron	$2,600.00
2" no hub cast iron	$9,100.00
1.5" copper	$1,300.00
Int nat. gas sys	$16,800.00

Abc. Grd. Int. Dom. Water syst.	
Water service	
Meter	$9,200.00
Backflow	$6,400.00
Piping	
4" copper	$5,500.00
3" copper	$11,000.00
2" copper	$13,750.00
1.25" and 1.5" copper	$8,250.00
1" copper	$2,750.00
.75" copper	$8,250.00
.5" copper	$5,500.00
pipe covering (Plbg)	
Storm system-above grade	$6,800.00
dom. Water above grade	$15,200.00
Dom hot water gen equip	$18,000.00
Plumging Fixtures	$90,000.00
F.dr./fo.sinks/Cos/plbg.spec.	$12,000.00
Fire protection system	$17,300.00
Final hook-up, kitchen	$5,000.00
General conditions	
Submittals	
Submittals HVAC	$6,000.00
Submittals Plumbing	$3,000.00
Duct Drawings	$6,700.00
ATC Engineering	$18,250.00
ATC controls/equip	$61,078.00
ATC proj. management	$7,152.00
ATC installation	$94,605.00
ATC commissioning	$16,615.00
Total	$1,990,000.00
Contract	$2,000,000.00

Appendix 4

Appendix 4.1

Trace Energy and Cost Output

ENERGY CONSUMPTION SUMMARY

By ae

	Elect Cons. (kWh)	Gas Cons. (therms)	Percent of Total Energy	Total Source Energy* (kBtu/yr)
Primary heating				
Primary heating	2,566.3	1,061.4	0.0 %	1,380.0
Primary cooling				
Cooling Compressor	616,106.8		0.2 %	63,089.5
Tower/Cond Fans	71,633.8		0.0 %	7,335.3
Condenser Pump	86,619.3		0.0 %	8,869.8
Other CLG Accessories	745.2		0.0 %	76.3
Cooling Subtotal....	775,105.1		0.2 %	79,371.0
Auxiliary				
Supply Fans	530,280.9		0.1 %	54,300.9
Circ Pumps	76,009.2		0.0 %	7,783.4
Base Utilities			0.0 %	0.0
Aux Subtotal....	606,290.2		0.1 %	62,084.3
Lighting				
Lighting	423,151,648.0		99.7 %	43,330,828.0
Receptacle				
Receptacles	7,752.6		0.0 %	793.9
Heating plant load				
Base Utilities		143.0	0.0 %	150.5
Cogeneration				
Cogeneration			0.0 %	0.0
Totals				
Totals**	424,543,360.0	1,204.4	100.0 %	43,474,612.0

* 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.

TRACE® 700 Economic Summary

By ae

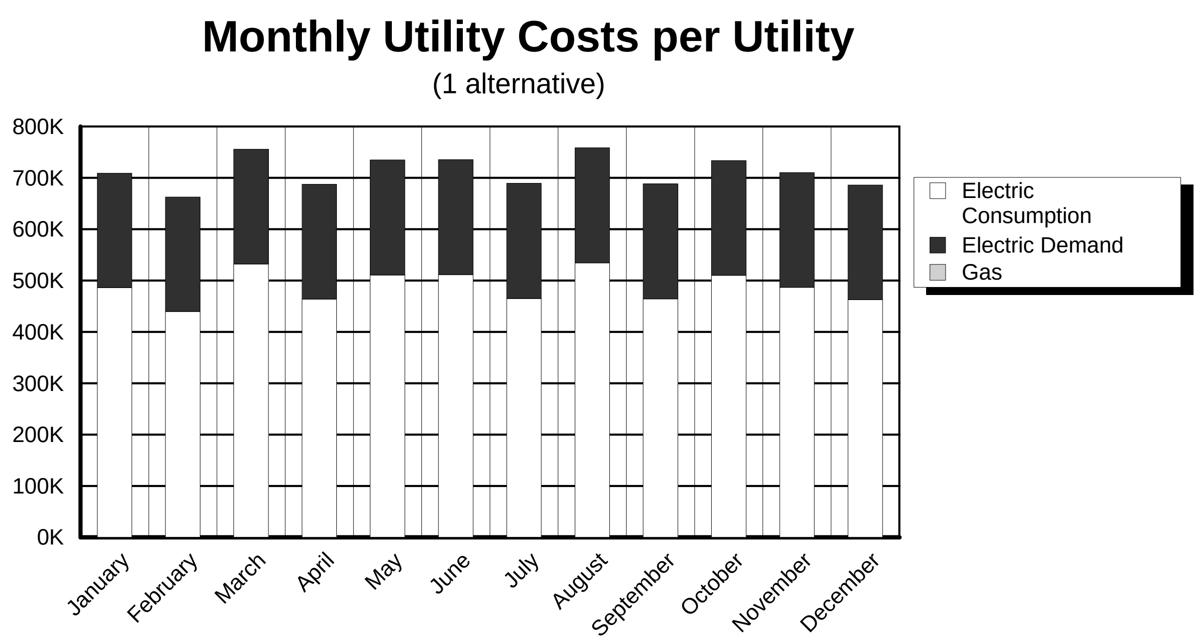
Project Information

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	8552854.51	8552854.51	10000.00	10000.00	79375376.62



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	2,566.3	1,061.4	0.0%	1,380.0
Cooling Compressor	616,106.8		0.2%	63,089.5
Tower/Cond Fans	71,633.8		0.0%	7,335.3
Condenser Pump	86,619.3		0.0%	8,869.8
Other CLG Accessories	745.2		0.0%	76.3
Supply Fans	530,280.9		0.1%	54,300.9
Circ Pumps	76,009.2		0.0%	7,783.4
Lighting	423,151,648.0		99.7%	43,330,828.0
Base Utilities		143.0	0.0%	150.5
Totals	**424,543,360.0**	**1,204.4**	**100.0%**	**43,474,612.0**

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

Appendix 4.2

Load Source Calculations

Refrigerator Loads Takeoff						
Item (k-)	V	Phase	Hp	A	W	Total W
3a	120	1		2		240
3b	208	1		7.8		1622.4
					Load Watts	1862.4

Dishwash Loads Takeoff						
Item (k-)	V	Phase	Hp	A	W	Total W
36	208	3	3			269077
37a	208	3		23.9		8610
37b	208	3			13000	7514
37c	120	1			1000	1000
					Load Watts	286202

Kitchen Loads Takeoff						
Item (k-)	V	Phase	Hp	A	W	Total W
1	120	1			1000	1000
2	120	1			1000	1000
12	120	1	0.5			44760
14	120	1	0.5			44760
16	208	3	1.5			134538.7
18a	208	3		8.9		1851.2
18b	120	1		0.3		36
21	120	1		9.8		1176
22	120	1		6		720
23	120	1		6		720
24	120	1			500	500
25a	120	1		20		2400
25b	-	1				
27	120	1		12		1440
78a	120	1		20		2400
78b	-	1				
					Load Watts	237301.9

Servery Loads Takeoff						
Item (k-)	**Number**	**V**	**Phase**	**A**	**W**	**Total W**
7b	1	-	1	-	-	-
43	1	120	1	7.1		852
44	2	208	3		620	358
48	1	120	1	7.1		852
52a	1	120	1	1.1		132
52b	1	120	1		300	300
54	1	120	1	7.1		852
55	1	120	1	1230		147600
60	1	120	1	7.1		852
62	1	120	1		500	500
66	1	120	1		4300	4300
67	4	120	1		1725	1725
68	1	120	1	9.1		1092
69	1	120	1	9		1080
73	1	120	1	9.3		1116
74	1	120	1	1		120
75a	1	120	1	9		1080
75b	1	120	1	6.9		828
76	1	120	1		500	500
80	1	208	3		3300	1908
81	1	120	1		1700	1700
82	1	120	1	7.6		912
83	1	120	1	9.1		1092
85	2	120	1	14.2		1704
91a	3	120	1	5		600
91b	3	-				
98	1	208	3	30		3607
99	1	120	1	9		1080
100	1	120	1	9		1080
102	1	120	1	14.2		1704
103a	1	120	1	3.2		384
103b	1	120	1	3.3		396
104	1	120	1	4.5		540
105	1	120	1	2.5		300
106	1	120	1	6.1		732
					Room Watts	181878

Appendix 4.3

Energy Input Information

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 4.4

Design Load Output

System Airflows and Outdoor Air Output From: Trace 700 System Checksums Files		
System	**Airflow (cfm / sq. ft.)**	**% Outdoor Air**
AHU 1	0.89	33.3
AHU 2-6	2.72	37.5
AHU 7A	1.39	24.9
AHU 8	1.89	23.3
AHU 9	1.74	32.7
AHU 10	1.67	32.7
FCU-1	1.6 - 2.39	10.5
FCU-2	1.43 - 2.00	11.1
Unit Ventilator	1.78	24.9

ENGINEERING CHECKS

By ae

Description	Type	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²	Floor Area ft²
Auxiliary Gym	Zone	33.33	0.89	142.0	160.0	75.00	33.33	0.89	-44.31	6,760
AHU 1	System - Single Zone	33.33	0.89	316.8	356.9	33.62	33.33	0.89	-51.29	6,760
Arena NW	Zone	37.53	2.72	262.1	96.5	124.37	37.53	2.72	-91.77	2,761
AHU 2	System - Single Zone	37.53	2.72	282.2	103.9	115.49	37.53	2.72	-165.58	2,761
Arena NE	Zone	37.53	2.72	246.4	90.7	132.28	37.53	2.72	-103.44	2,761
AHU 3	System - Single Zone	37.53	2.72	282.2	103.9	115.49	37.53	2.72	-165.58	2,761
Arena SE	Zone	37.53	2.72	252.0	92.8	129.33	37.53	2.72	-103.44	2,761
AHU 4	System - Single Zone	37.53	2.72	282.2	103.9	115.49	37.53	2.72	-165.58	2,761
Arena SW	Zone	37.53	2.72	263.1	96.9	123.86	37.53	2.72	-98.26	2,761
AHU 5	System - Single Zone	37.53	2.72	282.2	103.9	115.49	37.53	2.72	-165.58	2,761
Fitness Center	Zone	24.00	1.32	251.2	190.4	63.03	24.00	1.32	-56.20	2,652
AHU 6	System - Single Zone	24.00	1.32	381.8	289.3	41.48	24.00	1.32	-67.12	2,652
Racquetball 115	Zone	24.89	1.39	441.9	318.2	37.72	24.89	1.39	-44.21	810
Racquetball 116	Zone	24.89	1.39	446.4	321.4	37.34	24.89	1.39	-44.21	810
AHU 7A	System - Single Zone	24.89	1.39	385.7	277.7	43.21	24.89	1.39	-113.40	1,620
Dining	Zone	34.96	1.91	201.6	105.7	113.49	34.96	1.91	-58.21	2,780
Servery	Zone	34.97	1.63	93.8	57.4	209.14	34.97	1.63	-52.13	2,203
Corr 103	Zone	35.00	0.38	206.6	549.1	21.85	35.00	0.38	-19.77	1,063
Corr 107	Zone	34.94	0.87	231.2	264.4	45.38	34.94	0.87	-40.87	1,401
Aud Lobby	Zone	0.37	5.52	650.4	117.8	101.87	0.37	5.52	-48.24	970
AHU 8	System - Single Zone	23.30	1.89	388.8	206.0	58.24	23.30	1.89	-93.93	8,417
auditorium and stage	Zone	32.73	1.74	200.6	115.3	104.07	32.73	1.74	-57.22	3,161
AHU 9	System - Single Zone	32.73	1.74	291.9	167.8	71.53	32.73	1.74	-106.42	3,161
Aud Stage and Cntl	Zone	32.73	1.67	200.0	119.6	100.36	32.73	1.67	-55.65	3,289
AHU 10	System - Single Zone	32.73	1.67	291.9	174.6	68.74	32.73	1.67	-102.28	3,289
e half of multipurpose 106	Zone	10.53	1.65	108.3	65.8	182.26	10.53	1.65	-34.07	231
FCU 1 - mp 106 e	System - Fan Coil	10.53	1.65	536.5	326.1	36.80	10.53	1.65	-73.59	231
Office 102B	Zone	11.11	2.00	647.6	323.8	37.06	11.11	2.00	-36.48	90
FCU 2 - 102B	System - Fan Coil	11.11	2.00	480.0	240.0	50.00	11.11	2.00	-102.22	90
Kitchen	Zone	24.86	2.76	180.6	65.5	183.34	24.86	2.76	-57.15	462
Dishwash	Zone	24.84	0.91	166.1	181.9	65.98	24.84	0.91	-25.75	520
Unit Ventilator	System - Unit Ventilator	24.86	1.78	388.9	218.2	54.99	24.86	1.78	-151.73	982
Office 113a	Zone	11.11	1.43	643.2	450.2	26.65	11.11	1.43	-20.45	126
FCU 2 - 113A	System - Fan Coil	11.11	1.43	480.0	336.0	35.71	11.11	1.43	-73.02	126
Office 114a	Zone	11.11	1.54	649.8	422.4	28.41	11.11	1.54	-21.43	117
FCU 2 - 114A	System - Fan Coil	11.11	1.54	480.0	312.0	38.46	11.11	1.54	-78.63	117
w half of multi 106	Zone	10.53	1.65	114.1	69.4	172.93	10.53	1.65	-31.19	231
FCU 1 - mp 106 w	System - Fan Coil	10.53	1.65	536.5	326.1	36.80	10.53	1.65	-73.59	231
Office 107	Zone	10.53	1.84	436.3	236.5	50.74	10.53	1.84	-34.79	206
FCU 1 - 107	System - Fan Coil	10.53	1.84	536.5	290.8	41.26	10.53	1.84	-82.52	206

ENGINEERING CHECKS

By ae

Description	Type	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²	Floor Area ft²
office 108	Zone	10.53	2.39	494.6	207.0	57.98	10.53	2.39	-41.36	159
FCU 1 - 108	System - Fan Coil	10.53	2.39	536.5	224.5	53.46	10.53	2.39	-106.92	159
Office 109	Zone	10.53	2.39	494.6	207.0	57.98	10.53	2.39	-41.36	159
FCU 1 - 109	System - Fan Coil	10.53	2.39	536.5	224.5	53.46	10.53	2.39	-106.92	159
Office111	Zone	10.53	1.78	396.6	222.3	53.98	10.53	1.78	-43.08	213
FCU 1 - 111	System - Fan Coil	10.53	1.78	536.5	300.7	39.91	10.53	1.78	-79.81	213
office 112	Zone	10.53	1.60	393.5	246.4	48.70	10.53	1.60	-42.68	238
FCU 1 - 112	System - Fan Coil	10.53	1.60	536.5	336.0	35.71	10.53	1.60	-71.43	238
Entry 103	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.64	-18.53	544
CH 103	System - Unit Heaters	0.00	0.00	0.0	0.0	0.00	0.00	0.64	-54.04	544
Locker 120 (end)	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-15.92	270
rad 120	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-119.81	270
Locker 119	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.20	270
rad 119	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-99.85	270
Locker 118	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.20	270
rad 118	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-99.85	270
Locker 117	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.20	270
rad 117	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-99.85	270
Toilet 120A	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.74	208
rp 120A	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-22.31	208
Toilet 119A	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.74	208
rp 119a	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-22.31	208
Toilet 118A	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.74	208
rp 118a	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-22.31	208
Toilet 117A	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.74	208
rp 117a	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-22.31	208
Faculty Locker 122	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-9.05	208
rp 122	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-8.37	208
Faculty Locker 123	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-9.05	208
rp 123	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-8.37	208
Women 106	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-8.82	810
rp women 106	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-11.46	810
men 108	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-8.96	540
rp men 108	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-8.59	540
Training 114	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-13.87	424
rp training 114	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-10.94	424
Entry 102	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.84	-24.28	475
CH 102	System - Unit Heaters	0.00	0.00	0.0	0.0	0.00	0.00	0.84	-119.58	475
Equip 113B	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-13.86	99
rad 113B	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-20.42	99

ENGINEERING CHECKS

By ae

Description	Type	COOLING % OA	COOLING cfm/ft²	COOLING cfm/ton	COOLING ft²/ton	COOLING Btu/hr·ft²	HEATING % OA	HEATING cfm/ft²	HEATING Btu/hr·ft²	Floor Area ft²
AV Storage	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-14.44	54
rad AV stor 101B	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-37.44	54
Aud lobby doors	Zone	0.00	0.00	0.0	0.0	0.00	7.94	3.60	-123.06	70
CH aud lobby	System - Unit Heaters	0.00	0.00	0.0	0.0	0.00	7.94	3.60	-420.00	70
Entry 104	Zone	0.00	0.00	0.0	0.0	0.00	34.96	0.49	-25.74	255
CH Entry 104	System - Unit Heaters	0.00	0.00	0.0	0.0	0.00	34.96	0.49	-222.75	255
Main lobby e	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.56	-16.25	815
CH main lobby e	System - Unit Heaters	0.00	0.00	0.0	0.0	0.00	0.00	0.56	-69.69	815
Main lobby w	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.56	-16.25	815
CH main lobby w	System - Unit Heaters	0.00	0.00	0.0	0.0	0.00	0.00	0.56	-69.69	815
stage back w	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-43.89	84
stage back w	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-175.83	84
stage back e	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-43.89	84
stage back e	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-175.83	84
Dry goods storage	Zone	0.00	0.62	410.8	659.8	18.19	0.00	0.62	0.00	123
Split system, dry storage	System - Incremental Heat Pump	0.00	0.62	93.8	150.6	79.67	0.00	0.62	0.00	123
Toilet 102	Zone	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-17.01	48
rp toilet 102	System - Radiation (Heating Only)	0.00	0.00	0.0	0.0	0.00	0.00	0.00	-24.17	48
Data Tele 122	Zone	0.00	0.45	375.8	830.2	14.45	0.00	0.45	0.00	112
split system data tel 122	System - Incremental Heat Pump	0.00	0.45	48.3	106.7	112.50	0.00	0.45	0.00	112