Submission Category: Mechanical Systems

Date: 12 November 2012

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Summary Narrative

In designing a mechanical system for the Reading Elementary School many socioeconomic, constructability, and feasibility factors were taken into consideration. Our preliminary calculations presented us with a 70,000 cfm and 190 ton load requirement for the building. As such, it was determined that an Ethylene-Glycol recovery system be implemented to design the most cost effective system in terms of upfront and lifecycle costs. The recovery system manufactured by Konvekta was used in the determining the efficiency and cost analysis of this system as it was found to be the most energy efficient and sustainable in comparison with the products of other manufacturers. The system too will be a 100% outdoor air system to allow for high maximized ventilation rates and an overall improved internal environment. Because the building functioning as a nexus for education of students and giving back to the community it was clear that the system design must provide a valuable product to the owner in terms of its cost effectiveness, efficiency, and flexibility.

The first consideration in choosing this system was to be able to recover and reuse the energy lost by exhaust air during both the heating and cooling seasons. It was determined, however, that the recovery of energy during the heating season be the most crucial as it primarily when the school will be in full-fledged use. The Ethylene-glycol recovery system is much more efficient in terms of energy recovery than a typical recovery system. It is a packaged system that allows for Outdoor air inlets to be at different locations for the Exhaust air outlets. The Ethylene-Glycol will be piped in a traditional run-around system manner to capture the thermal energy leaving in the exhaust air, and implement that energy to precondition the incoming outdoor air. This will save on heating and cooling costs by reducing the temperature difference required by the system to achieve the optimal conditioning settings.

As this is a 100% outdoor air system, there will also be a large number of control factors implemented into the design to monitor the levels of carbon dioxide in the building to allow for the variable flow of conditioned air to each space. This will not only save on operation energy costs but ensure a quality indoor air environment for the students. Research shows that improving outdoor air ventilation to education environments improves the performance of the students and teachers. Certain studies have shown there is growing evidence that improving this indoor air quality via increased ventilation rates can even improve test scores. As such, this component of our design is a key factor in providing Reading with a building that not only looks nice, but facilitates a better learning environment.

The largest design consideration for the mechanical system has been the alternative addition of the indoor pool to the west of end of the building. As such, the mechanical system needed to be capable of capturing a significant amount of the high sensible loads leaving the pool so that they can be reintroduced to the incoming outdoor air. The system also needed to be able to eliminate the high latent loads and allow for serious dehumidification of this space. There is a dehumidification loop that runs concurrently with the ethylene glycol loop to fulfill this requirement. One of the other considerations the pool presented with selected a mechanical system was the need for flexibility. The construction of the pool is being presented as an alternate that can be built at the same time as the rest of the building or in a separate phase at a later date. As such the mechanical system needed to be able to accommodate this requirement by providing the flexibility to add zones (a very complex and demanding zone at that) while maintaining the same energy efficiency.

In terms of cost to the owner we found that the implementation of this system will have some initial upfront costs but drastically lower lifecycle costs than systems typical for this application. The ethylene-glycol runaround loop is about 30% more expensive than that of a traditional heat recovery system (enthalpy wheels, flat plate heat exchangers, etc.) but has a payback period of around 3 years. This payback period is really nothing in comparison to the longevity and lifecycle of the building and is much less than some of the other systems investigated by the design team. There are some initial costs associated with piping the Ethylene-Glycol from exhaust to outdoor air intake, however, these costs are offset by the reduction of return duct runs as the installation and initial cost of piping is much less expensive and intensive than that of running duct. In terms of duct runs, the design of the system utilizes round duct throughout this vast majority of the building. Round duct is much less expensive to install and run. It can also be seen that through the implementation of a round duct design, Team Nexus has be able to omit initial costs associated with interior finishes by allowing these runs to be visible in places to add to the interior aesthetic and experience. This system too offsets initial cost by allowing for the boiler to be downsized by more than 50%. This is a result of the system efficiency which results in a decrease of overall system loads. This reduction will allow for higher efficiency of the boiler and a lower operation cost associated with it.

Maintenance costs were also taken into consideration when implementing this system. The manufacturer, Konvekta, has never had a system that leaks to date in the lifecycle analysis of the system. The system too has very little need for maintenance and calibration as it works in cohesion with a specifically designed control system that maximizes the operation and efficiency of the system. This will hold very valuable to the owner as the system will continue to operate under the same conditions and efficiencies as it did on day one. It will continue to be optimized through the control system and will vary its conditioning requirements based on the day to day needs of each required zone.

Through the implementation of the incredible heat recovery capabilities of an ethylene glycol solution in cohesion with the advanced control system, it was calculated that the entire building will save and reintroduce 60% of the annual energy lost through exhaust air. This calculation does take into consideration the demanding loads of the pool which decrease the efficiency of the system. It was found that, should the pool not be included in the construction of the building that the system would save a minimum of 78% on energy cost annually. These energy savings additionally are guaranteed by Konvekta for the first year such that they are so confident that the system will perform to this level efficiency they will match the difference in energy costs to the owner should it not.

The Ethylene-Glycol system is a unique system for and proves to be a very effective and efficient solution to the challenges presented by the Reading Elementary School. The system will have an ease of constructability being a packaged unit that will not inhibit the construction schedule. The system has a relatively low initial cost with an overall payback of 3-5 years. Other equipment can be downsized by the resulting load reduction as an outcome of the 60-80% recovery efficiency of the system. This system too will enhance the learning potential of the students through the implementation of a 100% outdoor air system. The product has a guaranteed success rate of implementation as well, which proves to the owner that the investment in this technology will provide to be beneficial over the building's lifecycle. Overall, the system does a great job of fulfilling all of the owner requirements for the building, while adding value, in terms of the aforementioned components to the project as well.

Project Goals / Requirements

In calculating the socioeconomic barriers presented by the Reading School District it was determined that the mechanical system be both cost effective and efficient in terms of upfront and lifecycle cost. It is important that the final building not be a source of energy waste and a continually costly component of the community's tax base. It is thus felt, that the mechanical system design be as low cost and sustainable as physically possible. As such, Team Nexus developed three main goals to be achieved through the mechanical design.

The first of these goals is to **Reduce**. The primary aspect of this goal is derived from project cost. It was decided that the mechanical system be as economical as possible and as such reduction plays a key part in this objective of the design. To reduce initial and lifecycle costs it was determined that there first must be a reduction in system load. By reducing system loads the system equipment can be downsized which will save money in both energy consumption and upfront costs. In order for this to happen, it was also determined that there be a reduction in energy that is escaping from the building's envelope. Several static design considerations will also be developed to allow for more control with the dynamic loads of the building. One such example of this will be the building's envelope design. Nexus feels it is crucial to develop an envelope that meets the goals and requirements of all the design disciplines. It too was determined that a key aspect of system design was selecting an application that would not increase and could possibly decrease the overall construction schedule. By developing a system with ease of constructability will save on owner costs by reducing construction man hours and preventing a delay in the operation of the school. Finally, in terms of the integrity of the building's lifecycle, design considerations will be made to reduce operation and maintenance costs while considering the impacts of the system on the building's surrounding environment.

The second goal for the mechanical system is to **Recover.** This refers to capturing the energy that we cannot reduce in our system design to prevent it from going to waste. The building contains specific zones with very different conditioning considerations; two of which being the pool and the kitchen. It is crucial that the mechanical system design takes into consideration these high heat spaces and develops a way to capture that heat from dissipating to the surrounding environment. This holds true for not only the conditioning aspects of the mechanical system but also for the plumbing design as well. Through the recovery of white water and storm water it is possible to reduce the costs of water consumption in the building.

The third and final goal for the mechanical system design is to **Reuse.** This obviously plays directly into the aforementioned goal of recovery. By recovering the excess energy that is being lost by the system and implementing it into the mechanical system will greatly impact the buildings lifecycle sustainability. This can be achieved through the use of heat recovery devices and mechanical systems that use different methods of absorbing and rejecting heat to precondition outdoor air. As such, Nexus will investigate several opportunities to reintroduce recovered energy to the building in order to allow for a more cost effective system. This objective will also be applied to plumbing systems within the building as well. This can be achieved through the implementation of grey-water reuse for example.

As an integrated design team, Nexus feels that these three goals are crucial to the success of our design in terms of meeting the owner's needs. It too is felt that the implementation of a thoroughly designed system will add value to the overall building. As a design team it is our goal to meet, as well as to go above and beyond these requirements. As such, through these Reduction, Recovery, and Reuse objectives, the mechanical system design will save money for the community both in the initial upfront costs of construction in addition to the lifecycle energy consumption and maintenance costs. This will therefore play a significant role in the overall packaged product of our building. These objectives are derived from the overall Team Nexus goals which were developed to achieve the owner requirements and goals. As Team Nexus, the design of the Reading Elementary School will fully integrate these sustainable mechanical objectives with the overall objectives of the other disciplines and building.

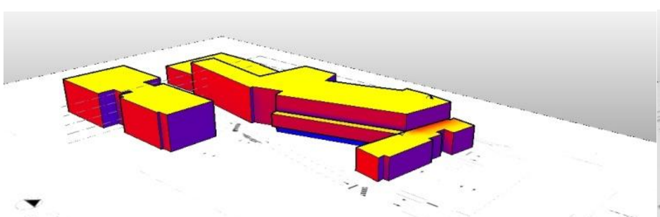
Narrative Description of Systems / Solutions

In initiating the design sequence for the mechanical system a conceptual mass energy model calculated using project Vasari. The model generated very basic annual energy use values based off a typical elementary school schedule. It too provided a thorough analysis of wind conditions on site and solar radiation conditions on each façade of the building. From this preliminary energy model a Trane Trace700 energy model was created as the design moved into more developed and advanced stages of mechanics. These outputs were used to develop both the static and dynamic considerations of the building's mechanics. The following will be based off the outputs created by utilizing these components. It should also be noted that much some of the referenced figures and analyses will be in included in the attached "Supporting Documentation Package."

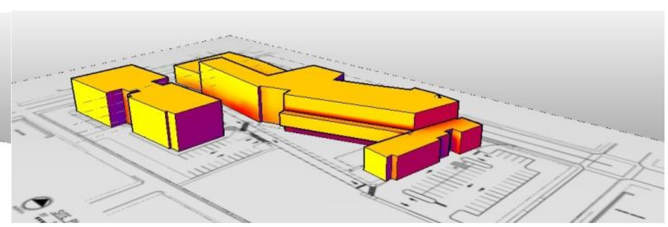
Thermal Envelope

The outputs generated by the preliminary Vasari energy model were primarily used to develop the exterior architectural components to enhance interior day lighting while maintaining the integrity of the thermal envelope of the building. It was found in our preliminary model that the southern façade experienced a vast amount of solar radiation. (See below)

Summer Solar Radiation



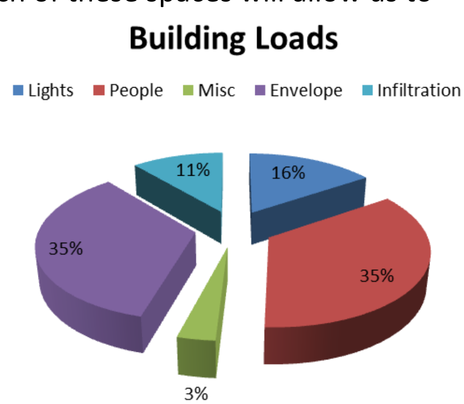
Winter Solar Radiation



To fulfill the requirements of each discipline (daylighting, structure, & constructability) the mechanical considerations of the envelope will be integrated into the each of the discipline specific components. As such an ICF (Insulated Concrete Form) wall system will be utilized. This system has an R-value of 24 which immensely helps the building retain the thermal energy being supplied in each season. This system too allows for enhanced daylighting which will reduce the heat being created in each zone due to the electrical heat dissipation from the luminaires. Light shelves and overhangs are also being utilized to reduce the amount of solar heat gain from the southern façade during the summer cooling season.

System Loads & Sizing:

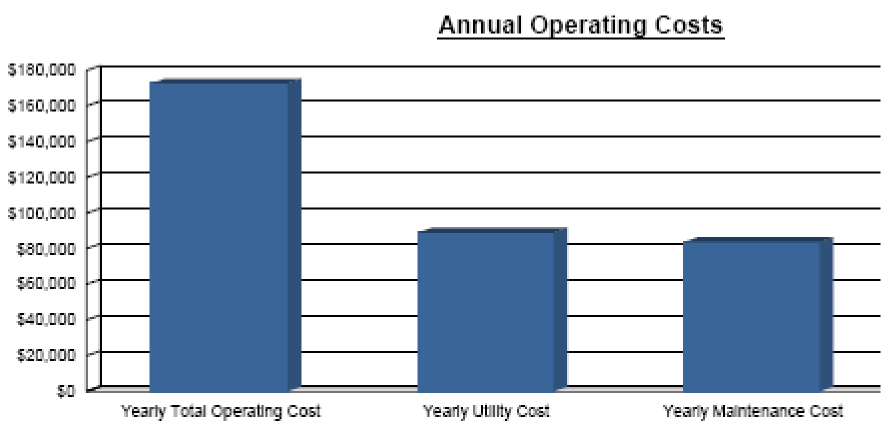
To more accurately analyze the loads in our building, an in-depth energy model was done using Trane Trace 700. Trane Trace 700 software is a complete load, system, energy, and economic analysis program. To easily model the building, Nexus has decided to divide the building into 5 large zones. This building was zoned vertically because all three floor plans are practically identical. The zones effectively divide the building into public and private spaces. The public spaces consist of the lobby zone, the multi-purpose space, and the pool. The private spaces are the two classroom zones. These zones were derived with the thought that each zone would have its own air handler. This will allow the mechanical system to condition the zones separately. This is important during the summer months when students will not be in the building. Zones 1-3 are considered the "public" spaces and will be occupied during the summer months. However, zones 4 and 5 primarily consist of classrooms. Having separate air handlers for each of these spaces will allow us to condition these public spaces while not wasting energy conditioning the classrooms when no students are present.



The energy model analyzed the building loads and calculated the total peak building load to be approximately 160 tons. The majority of this is due to the amount of people in the building, as can be seen in the load breakdown. Other factors that contribute to the building loads are the lights, infiltration, and heat loss or gain through the envelope. Our envelope primarily consists of ICF, or insulated concrete forms. For more information on the envelope structure, please refer to the Structural Systems Report. However, it is important to note that the exterior walls have an R-value of 24, which is higher than the ASHRAE baseline exterior wall value for climate zone 5, in which Reading, PA resides.

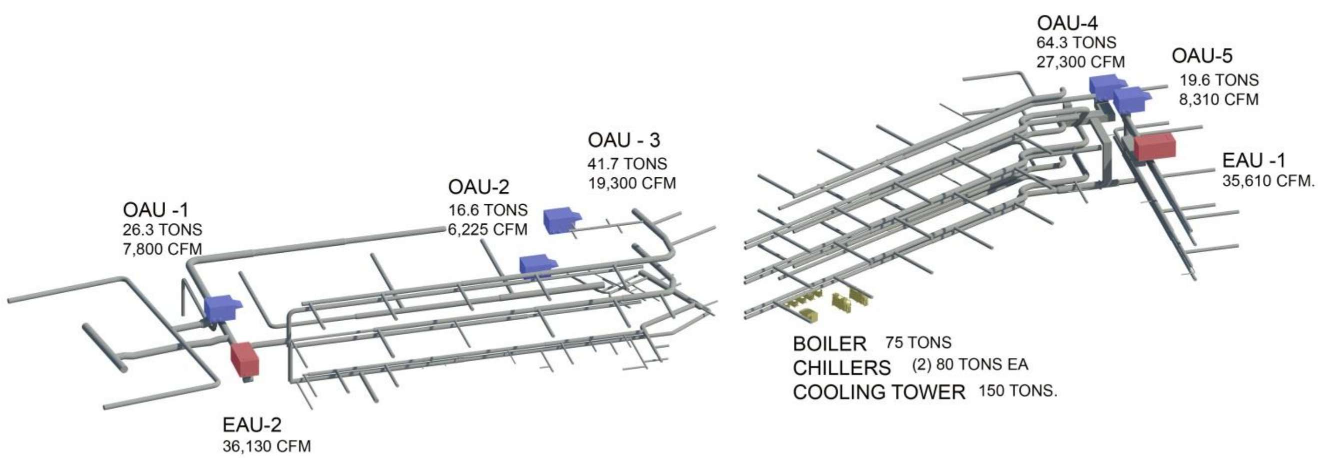
Here is a simple breakdown of the Trane Trace 700 analysis. This chart highlights the peak cooling and heating loads for each zone. The airflow rates listed here have been calculated using the ASHRAE 62.1-2007 Minimum Ventilation equation. The airflow values reported in the Trace outputs were not high enough for ASHRAE standards and were certainly not 30% above the calculated ASHRAE airflow minimum, which is required to achieve LEED NC-2009 IEQ Credit 2: Increased Ventilation. Using the spreadsheets attached in the supporting documentation, higher airflow rates were calculated and reported here.

Zone		Cooling Capacity [TONS]	Heating Capacity [TONS]	Airflow [CFM]
1	Pool	15.6	26.3	7800
2	Multi-Purpose Room	16.6	7.6	6225
3	Lobby/Admin Wing	41.7	33.0	19300
4	Central Wing	64.3	71.1	27300
5	Right Wing	19.6	10.8	8310
	TOTAL	157.8	148.7	68935



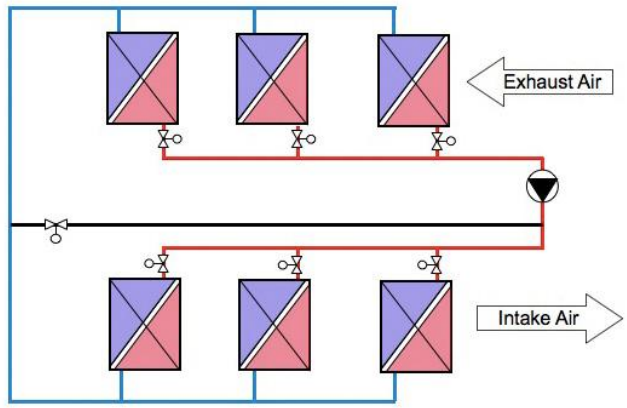
The energy model also calculated cost information for our mechanical system, in terms of yearly operational cost, utility cost, and maintenance cost. One of our goals from the beginning was to reduce, which was implemented in terms of up-front cost, building loads, and maintenance costs. Reducing the building loads lead to a reduced utility cost and operating cost. The full economic summary can be seen in the attached supporting documentation.

The loads calculated through the energy model will be used to determine equipment size for all mechanical components. This includes the five outdoor air units, two exhaust units, a boiler, two chillers, and a cooling tower. Each outdoor air unit was sized according to the peak tonnage and the airflow rate mentioned above. These five zones were consolidated into two exhaust units—one for the public spaces and one for the private. The public exhaust unit will exhaust air from the pool, kitchen, and gymnasium, which means this unit will have to be coated due to the corrosive elements in the air. These spaces will also have a slightly negative pressurization in relation to the rest of the building to stop the spread of odors from permeating to the other zones.



Our other mechanical components consist of more typical HVAC equipment. There will be one 75 ton boiler in the basement. Because of the high efficiency of the ethylene glycol loop, our boiler was able to be downsized by approximately 50%, which will save first costs as well as energy costs. There will be 2 chillers, each at 80 tons. There will also be a cooling tower on the roof which was sized for the peak cooling load, 150 tons. During the winter months, the condenser water from the chillers will be used for heat recovery. This will allow us to effectively not run the cooling tower during this time. This will save maintenance costs and utility costs. The cooling tower will be drained during the winter, preventing freezing and other maintenance issues.

Ethylene Glycol Run-around System



As previously mentioned the Ethylene-Glycol Run-around system is our key component of energy recovery and reuse that makes the building sustainable and energy efficient. The system specified is manufactured by Konvekta Inc. This system was chosen over alternate systems for its maximized efficiency and reliability in comparison to other runaround systems. There are three components of the Konvekta run-around system that make it more 20-30 % more efficient than a typical run-around recovery system. This allows Konvekta's system to recover 60 – 90% of energy that escapes the building in exhaust. This differs greatly from the 40-60% of energy recovered via a traditional runaround system. These three differentiating components are as follows:

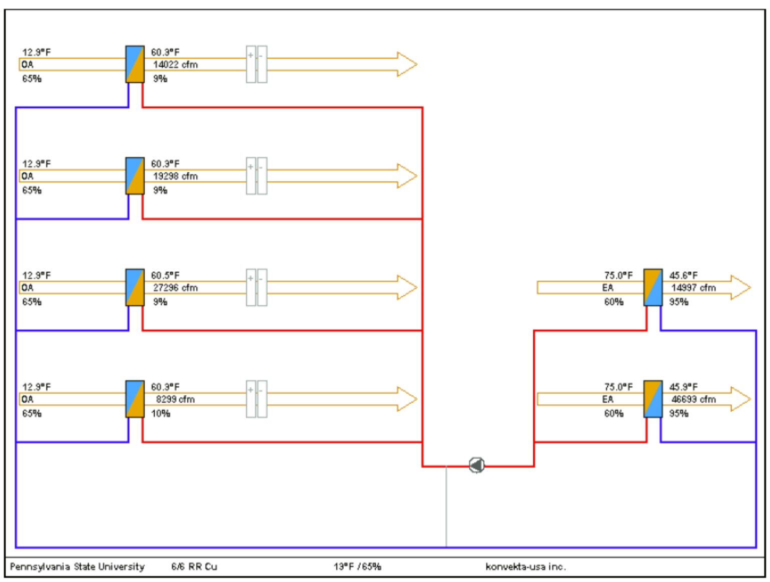
1) Konvekta's Coil Array:
    - Traditional systems use water with some form of an anti-freezing agent as the medium in which they transfer the thermal energy from exhaust air to precondition the outdoor air. These additives to the water diminish it's heat transfer capabilities to around 40-50%. Konvekta utilizes the glycol solution, in this application, one paired with ethylene, which is better than these typical solutions by about 20%.
    - In addition Konvekta's coil array is 10% more efficient than a typical flat plate heat exchanger. The array utilizes a double header, thick, wide-spaced, fin design that maximizes counter flow. It also offers a small air-glycol approach temperature to maximize heat transfer.
    - From a maintenance perspective the entire depth of the coil is accessible for ease of cleaning.

2) Piping/Flow Configuration
    - traditional runaround uses 1 or two units on the loop with constant flow of heat transfer fluid

- Konvekta utilizes a **Gang system** that allows multiple exhaust units on one loop with control valves at each unit. This allows for variable flow to optimize heat transfer between exhaust and glycol solution. This then feeds into the centralized pumping system that takes all of this pretreated solution and distributes it to the OA units for preheating/cooling in the same manner.

3) Control System
   - These controls match delta T between OA and EA with the variable flow valves at each unit in order to optimize heat transfer performance with glycol solution.
   - Integrates with air handler controls for variable air flow across coils as well in order to match ventilation requirements.
   - Also assesses energy savings in addition to having pressure drop alert systems for potential leakages etc. (Ethylene glycol has less chances of leaking due to its viscosity and surface tension)

100% Air Volumes



The image above shows a schematic design of the Konvekta ethylene glycol system. This schematic was created specifically for the design of the system we are going to implement. The system utilizes a hydronic unit that helps is where many of the controlling takes place for the overall system. (A schematic diagram for this unit is located in the Supplementary Material. NOTE: The schematic shown is that of another project utilizing the same system. The only similarities between the two projects are shown in the methodology of which the hydronic system controls are configured.)

In terms of constructability and maintenance the system has a very low initial cost in comparison to other forms of heat recovery. In comparison to typical heat recovery (i.e. enthalpy wheels and flat plate heat exchangers) this system is about 30% more expensive. Although this is a considerable amount, in comparison with other projects similar in size, the payback period for the system has been about three years. In the grand scheme of the overall building's lifecycle this is almost nothing. In terms of initial costs we too were able to downsize the boiler for the system to 50% of the building peak load. For constructability considerations there will be no impact to the current schedule as is designed. The Konvekta coil will take about 12 weeks to manufacture that will be specifically catered to the needs of each individual air handling unit. These coils will then be sent to the air handling manufacturer and will be installed in the units in about 10 weeks. This overall 22 week schedule works well with that on our construction process as it takes about 30 weeks for the roofs to be ready to place the units. Konvekta too will have an engineer on site at the first system start up and during installation to ensure that the contractor takes every measure possible in preventing leaks and allowing the system to operate at its designed efficiency. This too will ensure that the owner receives the results that were promised in the overall guaranteed energy simulation.

In designing our system and speaking with industry professionals we found that the high humidity in the exhaust air allows a high heat recovery rate without cooling the exhaust air too far down. This will cause some condensation in the exhaust air coils so they will implement an epoxy coating. The coils too for the pool exhaust will also be coated to prevent corrosion from the tri-chloramine vapors being exhausted from the building. The other aspect that makes this system very efficient is its efficiency at partial load supply. This is a result of the reduced airflow which allows the maximum transfer of thermal energy to precondition the outdoor air. In continuing with the pool the Konvekta system also utilizes a dehumidification circuit that will allow the system to handle the high latent loads being produced by the evaporative effects of the pool.

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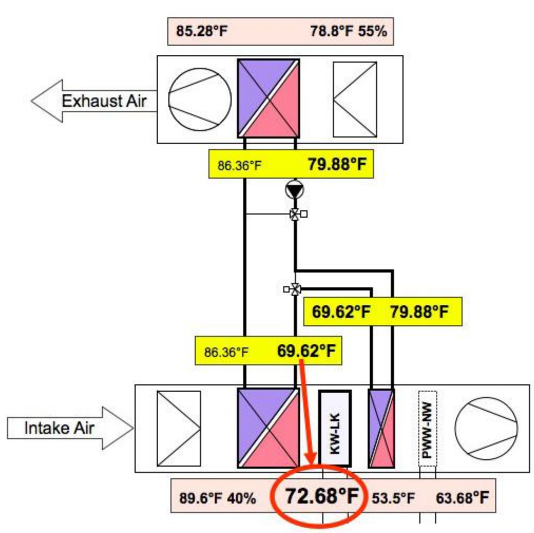


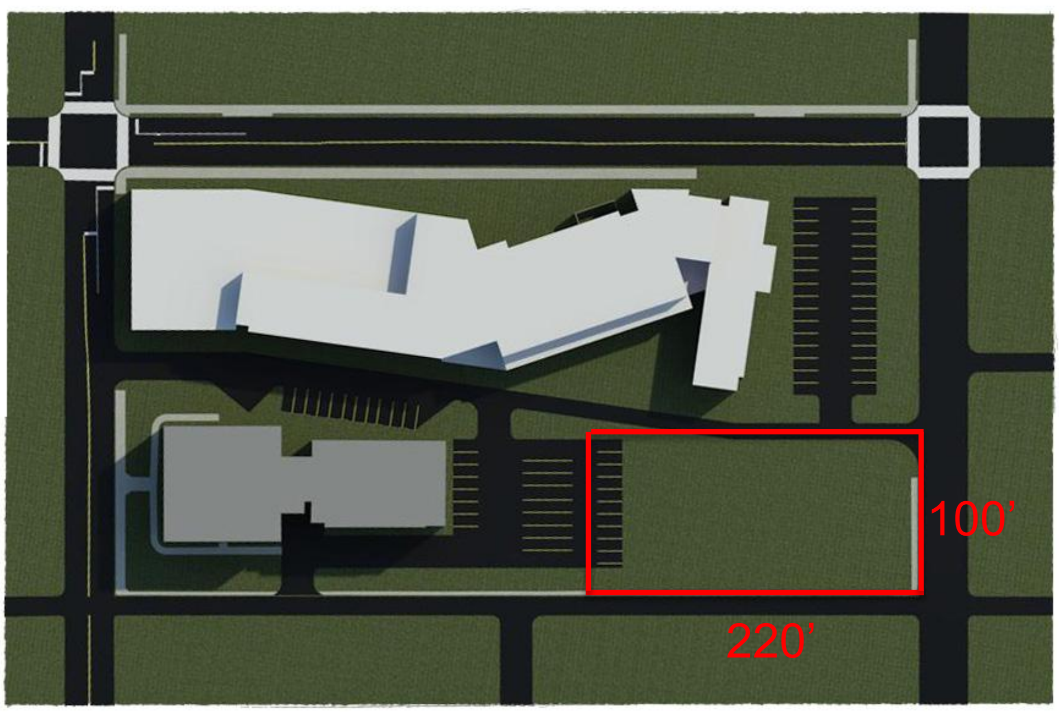
The heat exchanger on the intake side has two parts, the first will cool the intake air, thus dehumidifying it and the second part will be reheated using the runaround loop to bring it up to the required supply temperature. This allows for a reduction in the peak cooling load of the chiller and will require smaller chillers that will consume less energy as they will operate at a higher level of efficiency.

Utilizing this system allows us to use a 100% outdoor air system. This is great for an academic environment as it has been shown that larger percentages of outdoor air ventilation facilitates better performance by students and teachers. It has even been shown to increase test scores of the students in some studies. We felt that this aspect of our design was very important as the students of Reading need to have an environment that will help them learn and be conducive to success. As this is a region with socioeconomic challenges, we feel that these academic environments should be as accommodating as possible.

Rationale for System Selections and Solutions

In our schematic design phase a hybrid geothermal system was also considered. This system has been utilized in many school projects and has been used in some new projects in the Reading area. The reasons we veered away from using this system are as follows: Constructability, Cost, Project Exhaust Requirements, Flexibility, and Energy Efficiency.

In terms of constructability the hybrid geothermal system required a lot of front ended schedule time. The required well field (as shown below) would have taken up the vast majority



of the existing field area on site and would have caused complications with the construction phasing.

Additionally, the system requires a very high upfront cost for digging the numerous wells and piping the heat transfer fluid throughout them. We felt as though this money could be better spent on enhancing the actual experience and other systems within the school. Being an area with so many socioeconomic factors, Nexus has continually taken every endeavor to ensure that the money is well spent to minimize the financial burden it would create to the community.

It was also determined that the inclusion of the pool would require special mechanical considerations. There are going to be many exhausting issues due to the chemicals that are absorbed into the exhaust air via evaporation from the pool. The geothermal system would not be able to help in conditioning this space as it only preheats air with the 55 degree solution being brought from the ground temperature. The pool will be constantly a heated zone due to the high load requirements of the pool and indoor air quality. It was found that this zone will very seldom, if ever; receive cooling except for dehumidification purposes. The exhaust from this area too is very corrosive and would require other considerations be taken into account with the piping for the hybrid geothermal.

In continuing with the pool, the system for this project needs to have the flexibility required to add zones to it as the pool is being specified as an alternate to the owner. If the pool is added onto the system, more wells would need to be created to accommodate the large loads and more extensive construction would need to be done to incorporate it into the system. This differs greatly with the Ethylene- Glycol runaround system as the pool can be added directly into the system by adding it to the runaround loop piping.

Lastly and most importantly, the reason we went with the Ethylene-Glycol Recovery System was for its energy efficiency that greatly out performed that of the hybrid-geothermal. Hybrid geothermal systems have an efficiency of about 40-60%. It was determined however that with the implementation of the pool, it would only be possible to achieve the lower end of that spectrum in terms of energy recovery (mainly because of the pool for reasons mentioned earlier). The use of the Ethylene Glycol system allows for energy recovery of 60-90%. In our calculations thus far, it has been determined that over an annual analysis the system will save 60% of conditioning energy costs with the pool. If the pool were not to be implemented to the building design, it is expected that the system would recover 78% percent of the conditioning energy required.

Look-ahead

As we have made many decisions in regards to system selection and optimizing the energy performance of our building. The design team is in the next step of working with HVAC manufacturers to see if it is possible to increase the percentage of heat recovered even with the addition of the pool. System investigations are being made to see if the system specified can be paired with a form of energy storage to allow for free heating during the winter in off hours of the schedule. The design team too, is investigating ways of altering the configuration of the air handlers and exhaust components to see if we can maximize the heat transferred from pool exhaust air while being able to reintroduce it to precondition the incoming outdoor air for that space.

The energy models are also being updated to generate more concrete numbers in terms of annual costs and to investigate opportunities for more advanced energy savings.

System Checksums

By ACADEMIC

System - 001 **Packaged Terminal Air Conditioner**

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 7 / 13; Outside Air: OADB/WB/HR: 86 / 71 / 93

Clg Space Peak — Mo/Hr: Sum of; OADB: Peaks

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	56,277	0	56,277	3	44,689	4
Glass Solar	501,066	0	501,066	29	620,466	49
Glass/Door Cond	12,435	0	12,435	1	-11,323	-1
Wall Cond	9,306	0	9,306	1	3,667	0
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	28,873		28,873	2	-3,726	0
Sub Total ==>	607,958	0	607,958	36	653,773	51
Internal Loads						
Lights	259,786	9,798	269,584	16	259,786	20
People	588,860	0	588,860	35	306,300	24
Misc	54,603	0	54,603	3	54,603	4
Sub Total ==>	903,248	9,798	913,047	54	620,688	49
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	183,578	11	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	1,875		1,875	0	1,875	0
Exhaust Heat		-2,025	-2,025	0		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	1,513,081	7,774	1,704,433	100.00	1,276,336	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-78,881	-78,881	4.09
Glass Solar	0	0	0.00
Glass/Door Cond	-140,969	-140,969	7.31
Wall Cond	-51,246	-51,246	2.66
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-87,047	-87,047	4.51
Sub Total ==>	-358,143	-358,143	18.57
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	2	2	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		-1,231,301	63.85
RA Preheat Diff.		-339,134	17.58
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-358,141	-1,928,577	100.00

TEMPERATURES

	Cooling	Heating
SADB	54.8	75.8
Ra Plenum	75.0	70.0
Return	75.2	70.0
Ret/OA	76.2	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	57,552	53,438
Terminal	57,552	53,438
Main Fan	57,552	53,438
Sec Fan	0	0
Nom Vent	13,596	0
AHU Vent	13,596	0
Infil	1,298	1,298
MinStop/Rh	0	0
Return	58,738	54,703
Exhaust	14,782	1,266
Rm Exh	112	32
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	24.6	0.0
cfm/ft²	0.84	0.78
cfm/ton	405.19	
ft²/ton	484.10	
Btu/hr·ft²	24.79	-18.47
No. People	1,323	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	142.0	1,704.4	1,265.2	57,552	75.9	62.9	66.6	54.8	52.8	57.2
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	142.0	1,704.4								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	68,760		
Part	0		
Int Door	0		
ExFlr	0		
Roof	27,160	0	0
Wall	30,492	8,136	27
Ext Door	126	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-1,269.8	53,438	54.5	76.1
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1,269.8			

System Checksums

By ACADEMIC

System - 002 | **Computer Room Unit**

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 2 / 5; Outside Air: OADB/WB/HR: 25 / 21 / 12

Clg Space Peak — Mo/Hr: Sum of; OADB: Peaks

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	-18,934	0	-18,934	-10	14,409	17
Glass Solar	0	0	0	0	3,143	4
Glass/Door Cond	-3,008	0	-3,008	-2	227	0
Wall Cond	-9,150	0	-9,150	-5	1,691	2
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	-171,919		-171,919	-92	10,170	12
Sub Total ==>	-203,011	0	-203,011	-108	29,641	35
Internal Loads						
Lights	28,387	426	28,813	15	28,387	33
People	35,250	0	35,250	19	16,650	19
Misc	11,118	0	11,118	6	11,118	13
Sub Total ==>	74,754	426	75,180	40	56,154	65
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	0	0	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			6,383	3		
Ov/Undr Sizing	0		0	0	0	0
Exhaust Heat		304,385	304,385	163		
Sup. Fan Heat			4,310	2		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	-128,257	304,811	187,248	100.00	85,796	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-22,644	-22,644	54.31
Glass Solar	0	0	0.00
Glass/Door Cond	-3,938	-3,938	9.44
Wall Cond	-17,826	-17,826	42.75
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-122,658	-122,658	294.18
Sub Total ==>	-167,066	-167,066	400.69
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		218,627	-524.35
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		-93,256	223.66
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-167,066	-41,695	100.00

TEMPERATURES

	Cooling	Heating
SADB	61.9	118.5
Ra Plenum	75.0	70.0
Return	55.8	48.4
Ret/OA	55.6	48.4
Fn MtrTD	0.1	0.0
Fn BldTD	0.2	0.0
Fn Frict	0.7	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	4,040	4,040
Terminal	4,040	4,040
Main Fan	4,040	4,040
Sec Fan	0	0
Nom Vent	1,378	0
AHU Vent	1,378	0
Infil	1,530	1,530
MinStop/Rh	4,040	4,040
Return	9,995	10,153
Exhaust	5,954	6,112
Rm Exh	168	10
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.55	0.55
cfm/ton	258.94	
ft²/ton	467.51	
Btu/hr·ft²	25.67	-50.76
No. People	54	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR °F	°F	gr/lb	Leave DB/WB/HR °F	°F	gr/lb
Main Clg	15.6	187.3	108.2	4,040	55.8	55.8	81.8	60.2	41.1	8.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	15.6	187.3								

AREAS

	Gross Total	Glass ft²	(%)
Floor	7,295		
Part	0		
Int Door	0		
ExFlr	0		
Roof	6,515	0	0
Wall	6,734	192	3
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-314.9	4,040	47.6	118.5
Aux Htg	0.0	0	0.0	0.0
Preheat	-55.4	4,040	48.4	60.9
Reheat	-149.1	4,040	47.6	81.2
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-370.3			

Zone Checksums

By ACADEMIC

Zone - 001 PooL

COOLING COIL PEAK / CLG SPACE PEAK

	COOLING COIL PEAK				CLG SPACE PEAK	
Peaked at Time:	Mo/Hr: 2 / 5				Mo/Hr: 7 / 15	
Outside Air:	OADB/WB/HR: 25 / 21 / 12				OADB: 88	
	Space Sens. + Lat. Btu/h	**Plenum Sens. + Lat** Btu/h	**Net Total** Btu/h	**Percent Of Total** (%)	**Space Sensible** Btu/h	**Percent Of Total** (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	-18,934	0	-18,934	-10	14,409	17
Glass Solar	0	0	0	0	3,143	4
Glass/Door Cond	-3,008	0	-3,008	-2	227	0
Wall Cond	-9,150	0	-9,150	-5	1,691	2
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	-171,919		-171,919	-92	10,170	12
Sub Total ==>	-203,011	0	-203,011	-108	29,641	35
Internal Loads						
Lights	28,387	426	28,813	15	28,387	33
People	35,250	0	35,250	19	16,650	19
Misc	11,118	0	11,118	6	11,118	13
Sub Total ==>	74,754	426	75,180	40	56,154	65
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	0	0	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			6,383	3		
Ov/Undr Sizing	0		0	0	0	0
Exhaust Heat		304,385	304,385	163		
Sup. Fan Heat			4,310	2		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	-128,257	304,811	187,248	100.00	85,796	100.00

HEATING COIL PEAK

	Mo/Hr: Heating Design		
	OADB: 9		
	Space Peak Space Sens Btu/h	**Coil Peak Tot Sens** Btu/h	**Percent Of Total** (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-22,644	-22,644	54.31
Glass Solar	0	0	0.00
Glass/Door Cond	-3,938	-3,938	9.44
Wall Cond	-17,826	-17,826	42.75
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-122,658	-122,658	294.18
Sub Total ==>	-167,066	-167,066	400.69
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		218,627	-524.35
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		-93,256	223.66
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-167,066	-41,695	100.00

TEMPERATURES

	Cooling	Heating
SADB	61.9	118.5
Ra Plenum	75.0	70.0
Return	55.8	48.4
Ret/OA	55.6	48.4
Fn MtrTD	0.1	0.0
Fn BldTD	0.2	0.0
Fn Frict	0.7	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	4,040	4,040
Terminal	4,040	4,040
Main Fan	4,040	4,040
Sec Fan	0	0
Nom Vent	1,378	0
AHU Vent	1,378	0
Infil	1,530	1,530
MinStop/Rh	4,040	4,040
Return	9,995	10,153
Exhaust	5,954	6,112
Rm Exh	168	10
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.55	0.55
cfm/ton	258.94	
ft²/ton	467.51	
Btu/hr·ft²	25.67	-50.76
No. People	54	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	15.6	187.3	108.2	4,040	55.8	55.8	81.8	60.2	41.1	8.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	15.6	187.3								

AREAS

	Gross Total	Glass ft²	(%)
Floor	7,295		
Part	0		
Int Door	0		
ExFlr	0		
Roof	6,515	0	0
Wall	6,734	192	3
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-314.9	4,040	47.6	118.5
Aux Htg	0.0	0	0.0	0.0
Preheat	-55.4	4,040	48.4	60.9
Reheat	-149.1	4,040	47.6	81.2
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-370.3			

Zone Checksums

By ACADEMIC

Zone - 002 Multi-Purpose Room

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 7 / 15; Outside Air: OADB/WB/HR: 88 / 72 / 94

Clg Space Peak — Mo/Hr: 7 / 15; OADB: 88

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	15,632	0	15,632	8	15,632	14
Glass Solar	4,895	0	4,895	2	4,895	4
Glass/Door Cond	990	0	990	0	990	1
Wall Cond	1,017	0	1,017	1	1,052	1
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	2,228		2,228	1	1,520	1
Sub Total ==>	24,761	0	24,761	12	24,088	22
Internal Loads						
Lights	19,516	287	19,802	10	19,516	18
People	143,000	0	143,000	72	66,000	60
Misc	0	0	0	0	0	0
Sub Total ==>	162,516	287	162,802	82	85,516	78
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	10,945	6	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	150		150	0	150	0
Exhaust Heat		-71	-71	0		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	187,426	216	198,587	100.00	109,754	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-17,368	-17,368	16.71
Glass Solar	0	0	0.00
Glass/Door Cond	-5,141	-5,141	4.95
Wall Cond	-6,469	-6,469	6.22
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-7,134	-7,134	6.86
Sub Total ==>	-36,112	-36,112	34.75
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		-51,140	49.21
RA Preheat Diff.		-16,676	16.05
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-36,112	-103,928	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	76.6
Ra Plenum	75.0	70.0
Return	75.1	70.0
Ret/OA	76.0	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	4,992	4,992
Terminal	4,992	4,992
Main Fan	4,992	4,992
Sec Fan	0	0
Nom Vent	829	0
AHU Vent	829	0
Infil	106	106
MinStop/Rh	0	0
Return	5,099	5,099
Exhaust	935	106
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	16.7	0.0
cfm/ft²	0.76	0.76
cfm/ton	301.68	
ft²/ton	397.61	
Btu/hr·ft²	30.18	-13.93
No. People	220	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	16.6	198.6	115.1	4,992	76.0	63.8	70.5	55.0	50.0	46.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	16.6	198.6								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	6,580		
Part	0		
Int Door	0		
ExFlr	0		
Roof	5,980	0	0
Wall	3,122	300	10
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-91.7	4,992	59.9	76.6
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-91.7			

Zone Checksums

By ACADEMIC

Zone - 003 Lobby/Admin Wing

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 9 / 14; Outside Air: OADB/WB/HR: 81 / 63 / 58

Clg Space Peak — Mo/Hr: 11 / 14; OADB: 60

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	15,239	0	15,239	3	10,859	3
Glass Solar	197,362	0	197,362	39	236,442	57
Glass/Door Cond	2,619	0	2,619	1	-7,752	-2
Wall Cond	1,915	0	1,915	0	-308	0
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	7,655		7,655	2	-4,167	-1
Sub Total ==>	224,789	0	224,789	45	235,074	57
Internal Loads						
Lights	92,117	6,197	98,313	20	92,117	22
People	96,060	0	96,060	19	52,410	13
Misc	32,812	0	32,812	7	32,812	8
Sub Total ==>	220,988	6,197	227,185	45	177,338	43
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	48,415	10	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	781		781	0	781	0
Exhaust Heat		-1,260	-1,260	0		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	446,559	4,936	499,910	100.00	413,194	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-23,757	-23,757	23.21
Glass Solar	0	0	0.00
Glass/Door Cond	-41,118	-41,118	40.17
Wall Cond	-12,561	-12,561	12.27
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-25,234	-25,234	24.65
Sub Total ==>	-102,669	-102,669	100.30
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	1	1	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		-51,072	49.89
RA Preheat Diff.		51,374	-50.19
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-102,668	-102,366	100.00

TEMPERATURES

	Cooling	Heating
SADB	54.9	75.2
Ra Plenum	75.0	70.0
Return	75.3	70.0
Ret/OA	75.9	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	18,738	14,623
Terminal	18,738	14,623
Main Fan	18,738	14,623
Sec Fan	0	0
Nom Vent	4,376	0
AHU Vent	4,376	0
Infil	376	376
MinStop/Rh	0	0
Return	19,002	14,967
Exhaust	4,640	344
Rm Exh	112	32
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	23.6	0.0
cfm/ft²	0.74	0.58
cfm/ton	449.79	
ft²/ton	610.07	
Btu/hr·ft²	19.67	-15.58
No. People	231	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	41.7	499.9	417.2	18,738	76.0	62.6	64.9	54.9	53.5	59.7
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	41.7	499.9								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	25,415		
Part	0		
Int Door	0		
ExFlr	0		
Roof	8,180	0	0
Wall	7,819	2,339	30
Ext Door	84	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-396.1	14,623	51.8	76.4
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-396.1			

Zone Checksums

By ACADEMIC

Zone - 004 Central Wing

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 7 / 13; Outside Air: OADB/WB/HR: 86 / 71 / 93

Clg Space Peak — Mo/Hr: 9 / 12; OADB: 77

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	18,776	0	18,776	2	11,567	2
Glass Solar	206,068	0	206,068	27	284,756	49
Glass/Door Cond	8,198	0	8,198	1	-4,671	-1
Wall Cond	4,092	0	4,092	1	763	0
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	12,604		12,604	2	-1,830	0
Sub Total ==>	249,738	0	249,738	32	290,586	50
Internal Loads						
Lights	118,843	2,390	121,233	16	118,843	21
People	277,000	0	277,000	36	148,760	26
Misc	17,766	0	17,766	2	17,766	3
Sub Total ==>	413,609	2,390	415,999	54	285,369	50
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	105,777	14	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	0		0	0	0	0
Exhaust Heat		-494	-494	0		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	663,347	1,896	771,021	100.00	575,955	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-25,834	-25,834	11.45
Glass Solar	0	0	0.00
Glass/Door Cond	-71,979	-71,979	31.90
Wall Cond	-23,363	-23,363	10.35
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-36,670	-36,670	16.25
Sub Total ==>	-157,846	-157,846	69.95
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		-50,771	22.50
RA Preheat Diff.		-17,046	7.55
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-157,845	-225,661	100.00

TEMPERATURES

	Cooling	Heating
SADB	54.7	75.6
Ra Plenum	75.0	70.0
Return	75.1	70.0
Ret/OA	76.4	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	25,771	25,771
Terminal	25,771	25,771
Main Fan	25,771	25,771
Sec Fan	0	0
Nom Vent	7,380	0
AHU Vent	7,380	0
Infil	547	547
MinStop/Rh	0	0
Return	26,318	26,318
Exhaust	7,927	547
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	30.6	0.0
cfm/ft²	0.89	0.89
cfm/ton	401.09	
ft²/ton	449.17	
Btu/hr·ft²	26.72	-22.61
No. People	690	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	64.3	771.0	553.4	25,771	75.9	62.9	66.4	54.7	52.7	56.9
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	64.3	771.0								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	28,860		
Part	0		
Int Door	0		
ExFlr	0		
Roof	8,895	0	0
Wall	14,392	4,200	29
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-652.7	25,771	52.5	75.6
Aux Htg	0.0	0	0.0	0.0
Preheat	-60.5	25,771	52.5	54.7
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-652.7			

Zone Checksums

By ACADEMIC

Zone - 005 Right Wing

COOLING COIL PEAK / CLG SPACE PEAK

Cooling Coil Peak — Peaked at Time: Mo/Hr: 7 / 10; Outside Air: OADB/WB/HR: 78 / 68 / 89

Clg Space Peak — Mo/Hr: 7 / 10; OADB: 78

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	6,631	0	6,631	3	6,631	4
Glass Solar	92,741	0	92,741	39	94,373	53
Glass/Door Cond	627	0	627	0	110	0
Wall Cond	2,283	0	2,283	1	2,160	1
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	6,387		6,387	3	750	0
Sub Total ==>	108,670	0	108,670	46	104,025	59
Internal Loads						
Lights	29,311	925	30,236	13	29,311	17
People	72,800	0	72,800	31	39,130	22
Misc	4,025	0	4,025	2	4,025	2
Sub Total ==>	106,135	925	107,060	46	72,465	41
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	18,441	8	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	944		944	0	944	1
Exhaust Heat		-199	-199	0		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	215,749	726	234,916	100.00	177,434	100.00

HEATING COIL PEAK

Mo/Hr: Heating Design; OADB: 9

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	-11,922	-11,922	9.22
Glass Solar	0	0	0.00
Glass/Door Cond	-22,730	-22,730	17.58
Wall Cond	-8,854	-8,854	6.85
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0.00
Infiltration	-18,009	-18,009	13.92
Sub Total ==>	-61,516	-61,516	47.56
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		-51,085	39.50
RA Preheat Diff.		-16,731	12.94
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-61,516	-129,332	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	77.0
Ra Plenum	75.0	70.0
Return	75.1	70.0
Ret/OA	75.2	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	8,051	8,051
Terminal	8,051	8,051
Main Fan	8,051	8,051
Sec Fan	0	0
Nom Vent	1,011	0
AHU Vent	1,011	0
Infil	269	269
MinStop/Rh	0	0
Return	8,320	8,320
Exhaust	1,280	269
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	12.6	0.0
cfm/ft²	1.02	1.02
cfm/ton	411.27	
ft²/ton	403.80	
Btu/hr·ft²	29.72	-16.36
No. People	182	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	19.6	234.9	179.5	8,051	75.3	63.2	68.8	55.0	53.3	59.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	19.6	234.9								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	7,905		
Part	0		
Int Door	0		
ExFlr	0		
Roof	4,105	0	0
Wall	5,159	1,296	25
Ext Door	42	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-129.3	8,051	62.3	77.0
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-129.3			

ENERGY CONSUMPTION SUMMARY

By ACADEMIC

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 1						
Primary heating						
Primary heating		177,733		3.8 %	177,733	187,087
Other Htg Accessories	10,615			0.8 %	36,229	108,698
Heating Subtotal	**10,615**	**177,733**		**4.6** %	**213,961**	**295,785**
Primary cooling						
Cooling Compressor	280,811			20.5 %	958,408	2,875,511
Tower/Cond Fans	86,196		1,762	6.3 %	294,188	882,652
Condenser Pump				0.0 %	0	0
Other Clg Accessories	8,760			0.6 %	29,898	89,703
Cooling Subtotal....	**375,767**		**1,762**	**27.4** %	**1,282,494**	**3,847,866**
Auxiliary						
Supply Fans	16,989			1.2 %	57,984	173,970
Pumps				0.0 %	0	0
Stand-alone Base Utilities				0.0 %	0	0
Aux Subtotal....	16,989			1.2 %	57,984	173,970
Lighting						
Lighting	765,883			55.9 %	2,613,959	7,842,662
Receptacle						
Receptacles	149,935			10.9 %	511,729	1,535,341
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	**1,319,190**	**177,733**	**1,762**	**100.0** %	**4,680,128**	**13,695,622**

* Note: Resource Utilization factors are included in the Total Source Energy value .
** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

Economic Summary

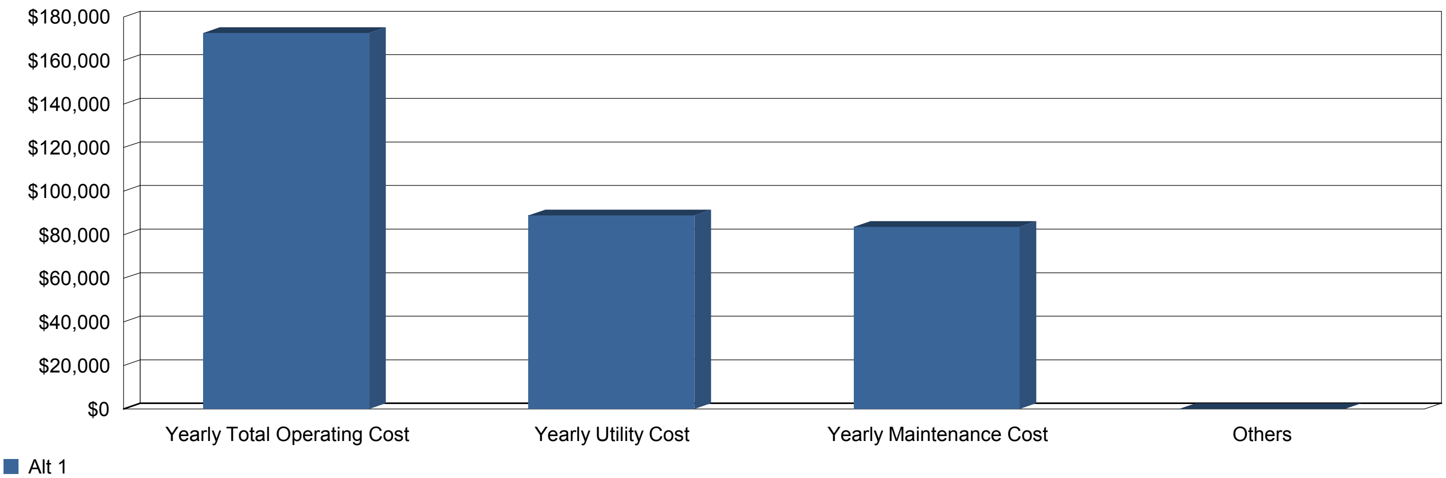
Project Information

Location	Reading, PA	Study Life:	20 years
Project Name	Elementary School	Cost of Capital:	10 %
User		Alternative 1:	Reading Elementary School
Company			
Comments			

Economic Comparison of Alternatives

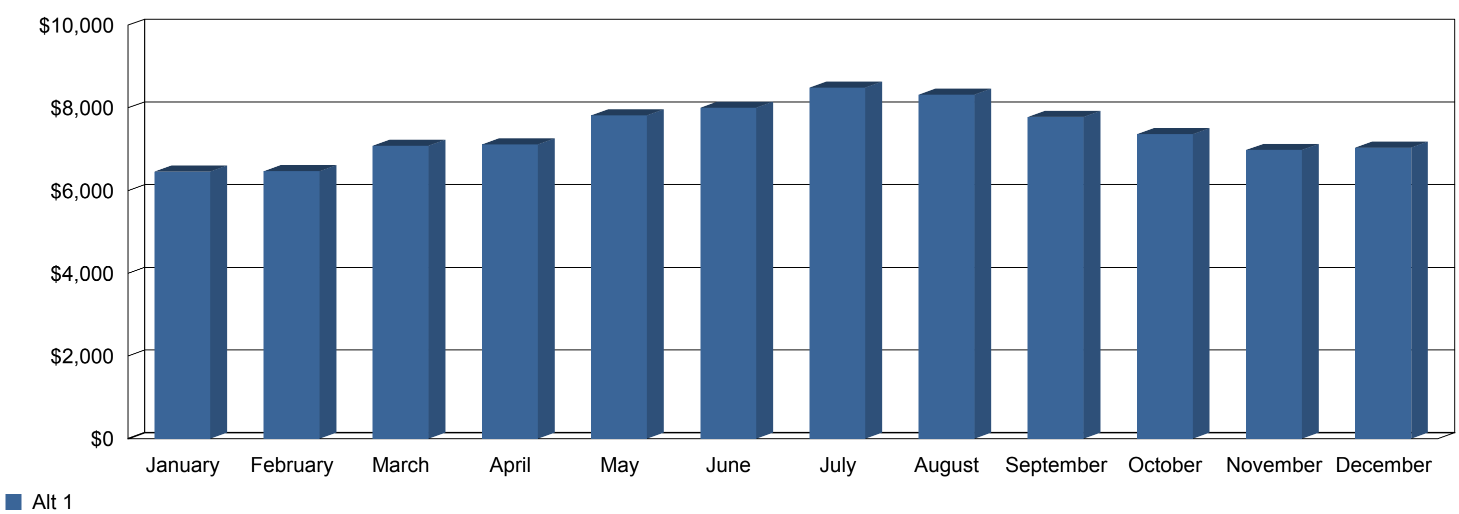
Yearly Savings ($)	First Cost Difference ($)	Cumulative Cash Flow Difference ($)	Simple Payback (yrs.)	Net Present Value ($)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost

Annual Operating Costs



Yearly Total Operating Cost ($)	Yearly Utility Cost ($)	Yearly Maintenance Cost ($)	Plant kWh/ton-hr

Monthly Utility Costs



Reading Elementary School - Reading, PA
ASHRAE 62.1 2007 Minimum Ventilation Calculations
AEI Team 5

AHU	Capacity cfm	Percent OA	OA cfm
RTU-1	7800	100.0%	7800

System Population, Ps	50
Zone Population, Pz	26
Occupant Diversity, D = (Pz-Ps)/Pz	52%

b a =a/b

Room Name	Room Number	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Occupant Density	Breathing Zone O.A. Flow Required Vbz	Table 6-2 Zone Air Dist. Eff.	Zone outdoor airflow	Primary O.A. fraction	Table 6.3 System Vent. Eff.	Uncorrected O.A. Intake	Design O.A. Intake	Zone Primary Air Flow Set Point (cfm)	Percent OA	Actual O.A. Flow	% Above Min OA	Meets Standard?	Meets LEED 30%?
			Az	Rp	Ra	Pz,f		Vbz = Rp*Pz + Ra*Az	Ez	Voz = Vbz / Ez	Zp = Voz / Vpz	Ev	Vou = D*∑(Rp*Pz) + ∑(Ra*Az)	Vot = Vou / Ev	Vpz		OA = % * Vpz	=(OA/Vot) -1		
RTU-1										**3654.0**	**0.47**	**0.6**	**3424**	**5706**	**7800**	**100.0%**	**7800**	**37%**	**Yes**	**Yes**
Pool	162	Pool	6515	0	0.48	26	3.99	3127.2	1.0	3127.2	0.46	0.6	3127.2	5212.0	6800		6800.0	30%	Yes	Yes
Girl's Locker Room	163	Locker Room	440	20	0.06	12	27.27	266.4	1.0	266.4	0.53	0.6	151.2	252.0	500		500.0	98%	Yes	Yes
Boy's Locker Room	164	Locker Room	340	20	0.06	12	35.29	260.4	1.0	260.4	0.52	0.6	145.2	242.0	500		500.0	107%	Yes	Yes

Maximum Zp	0.53

Reading Elementary School - Reading, PA
ASHRAE 62.1 2007 Minimum Ventilation Calculations
AEI Team 5

AHU	Capacity cfm	Percent OA	OA cfm
RTU-2	18533	100.0%	18533

System Population, Ps	220
Zone Population, Pz	220
Occupant Diversity, D = (Pz-Ps)/Pz	100%

b a =a/b

Room Name	Room Number	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Occupant Density	Breathing Zone O.A. Flow Required Vbz (cfm)	Table 6-2 Zone Air Dist. Eff.	Zone outdoor airflow	Primary O.A. fraction	Table 6.3 System Vent. Eff.	Uncorrected O.A. Intake	Design O.A. Intake	Zone Primary Air Flow Set Point (cfm)	Percent OA	Actual O.A. Flow	% Above Min OA	Meets Standard?	Meets LEED 30%?
			Az	Rp	Ra	Pz,f		Vbz = Rp*Pz + Ra*Az	Ez	Voz = Vbz / Ez	Zp = Voz / Vpz	Ev	Vou = D*∑(Rp*Pz) + ∑(Ra*Az)	Vot = Vou / Ev	Vpz		OA = % * Vpz	=(OA/Vot) -1		
RTU-2										**2823.6**	**0.15**	**0.7**	**2032**	**3386**	**18533**	**100.0%**	**18533**	**447%**	**Yes**	**Yes**
Vestibule	100	Vestibule	140	0	0.06	0	0.00	8.4	1.0	8.4	0.01	0.6	8.4	14.0	850		850.0	5971%	Yes	Yes
Multi-Purpose Room	104	Gym/Cafeteria	5980	7.5	0.18	220	36.79	2726.4	1.0	2726.4	0.15	0.6	1934.4	3224.0	18308		18308.0	468%	Yes	Yes
Stage	105	Stage	1020	10	0.06	0	0.00	61.2	1.0	61.2	0.44	0.6	61.2	102.0	140		140.0	37%	Yes	Yes
Storage	106	Storage	200	0	0.12	0	0.00	24.0	1.0	24.0	0.44	0.6	24.0	40.0	55		55.0	38%	Yes	Yes
Ramp	107	Corridor	200	0	0.06	0	0.00	12.0	1.0	12.0	0.40	0.6	12.0	20.0	30		30.0	50%	Yes	Yes

Maximum Zp	0.44

Reading Elementary School - Reading, PA
ASHRAE 62.1 2007 Minimum Ventilation Calculations
AEI Team 5

AHU	Capacity cfm	Percent OA	OA cfm
RTU-3	19302	100.0%	19302

System Population, Ps	227
Zone Population, Pz	227
Occupant Diversity, D = (Pz-Ps)/Pz	100%

b a =a/b

Room Name	Room Number	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Occupant Density	Breathing Zone O.A. Flow Required Vbz	Table 6-2 Zone Air Dist. Eff.	Zone outdoor airflow	Primary O.A. fraction	Table 6.3 System Vent. Eff.	Uncorrected O.A. Intake	Design O.A. Intake	Zone Primary Air Flow Set Point (cfm)	Percent OA	Actual O.A. Flow	% Above Min OA	Meets Standard?	Meets LEED 30%?
			Az	Rp	Ra	Pz,f		Vbz = Rp*Pz + Ra*Az	Ez	Voz = Vbz / Ez	Zp = Voz / Vpz	Ev	Vou = D*∑(Rp*Pz) + ∑(Ra*Az)	Vot = Vou / Ev	Vpz		OA = % * Vpz	=(OA/Vot) -1		
RTU-3										**4419.1**	**0.23**	**0.6**	**4419**	**7365**	**19302**	**100.0%**	**19302**	**162%**	**Yes**	**Yes**
Vestibule	100	Vestibule	140	0	0.06	0	0.00	8.4	1.0	8.4	0.01	0.6	8.4	14.0	850		850.0	5971%	Yes	Yes
Lobby	101	Lobby	1710	0	0.06	0	0.00	102.6	1.0	102.6	0.22	0.6	102.6	171.0	475		475.0	178%	Yes	Yes
Corridor	103	Corridor	980	0	0.06	0	0.00	58.8	1.0	58.8	0.45	0.6	58.8	98.0	130		130.0	33%	Yes	Yes
Principal Office	108	Office	250	5	0.06	1	4.00	20.0	1.0	20.0	0.03	0.6	20.0	33.3	591		591.0	1673%	Yes	Yes
Clerical	109	Office	330	5	0.06	1	3.03	24.8	1.0	24.8	0.24	0.6	24.8	41.3	104		104.0	152%	Yes	Yes
Reception	110	Office	285	5	0.06	2	7.02	27.1	1.0	27.1	0.07	0.6	27.1	45.2	367		367.0	713%	Yes	Yes
Community Office	111	Office	150	5	0.06	1	6.67	14.0	1.0	14.0	0.24	0.6	14.0	23.3	59		59.0	153%	Yes	Yes
Work Room	113	Office	290	5	0.06	2	6.90	27.4	1.0	27.4	0.27	0.6	27.4	45.7	100		100.0	119%	Yes	Yes
Custodial	116	Storage	60	0	0.12	0	0.00	7.2	1.0	7.2	0.36	0.6	7.2	12.0	20		20.0	67%	Yes	Yes
Storage	118	Storage	105	0	0.12	0	0.00	12.6	1.0	12.6	0.42	0.6	12.6	21.0	30		30.0	43%	Yes	Yes
Nurse	119/122	Pharmacy	1000	5	0.18	2	2.00	190.0	1.0	190.0	0.42	0.6	190.0	316.7	450		450.0	42%	Yes	Yes
Nurse's Office	120	Office	115	5	0.06	1	8.70	11.9	1.0	11.9	0.24	0.6	11.9	19.8	50		50.0	152%	Yes	Yes
Nurse's Exam Room	121	Pharmacy	160	5	0.18	2	12.50	38.8	1.0	38.8	0.39	0.6	38.8	64.7	100		100.0	55%	Yes	Yes
Storage	124	Storage	400	0	0.12	0	0.00	48.0	1.0	48.0	0.16	0.6	48.0	80.0	300		300.0	275%	Yes	Yes
Storage	125	Storage	140	0	0.12	0	0.00	16.8	1.0	16.8	0.42	0.6	16.8	28.0	40		40.0	43%	Yes	Yes
Locker Room	126	Locker Room	80	20	0.06	1	12.50	24.8	1.0	24.8	0.41	0.6	24.8	41.3	60		60.0	45%	Yes	Yes
Corridor	128	Corridor	210	0	0.06	0	0.00	12.6	1.0	12.6	0.21	0.6	12.6	21.0	61		61.0	190%	Yes	Yes
Office	129	Office	75	5	0.06	1	13.33	9.5	1.0	9.5	0.26	0.6	9.5	15.8	36		36.0	127%	Yes	Yes
Storage	130/131	Storage	120	0	0.12	0	0.00	14.4	1.0	14.4	0.36	0.6	14.4	24.0	40		40.0	67%	Yes	Yes
Kitchen	132	Kitchen	1640	7.5	0.18	6	3.66	340.2	1.0	340.2	0.45	0.6	340.2	567.0	750		750.0	32%	Yes	Yes
Storage	133	Storage	410	0	0.12	0	0.00	49.2	1.0	49.2	0.16	0.6	49.2	82.0	313		313.0	282%	Yes	Yes
Lobby	200	Lobby	2430	0	0.06	0	0.00	145.8	1.0	145.8	0.08	0.6	145.8	243.0	1800		1800.0	641%	Yes	Yes
Corridor	201	Corridor	980	0	0.06	0	0.00	58.8	1.0	58.8	0.45	0.6	58.8	98.0	130		130.0	33%	Yes	Yes
Conference	202	Conference	770	5	0.06	12	15.58	106.2	1.0	106.2	0.38	0.6	106.2	177.0	279		279.0	58%	Yes	Yes
Custodial	204	Storage	60	0	0.12	0	0.00	7.2	1.0	7.2	0.36	0.6	7.2	12.0	20		20.0	67%	Yes	Yes
Storage	206	Storage	105	0	0.12	0	0.00	12.6	1.0	12.6	0.42	0.6	12.6	21.0	30		30.0	43%	Yes	Yes
Assistant Principal	207	Office	250	5	0.06	1	4.00	20.0	1.0	20.0	0.13	0.6	20.0	33.3	150		150.0	350%	Yes	Yes
Library	208	Library	1960	5	0.12	26	13.27	365.2	1.0	365.2	0.17	0.6	365.2	608.7	2097		2097.0	245%	Yes	Yes
Library Support	209	Library	390	5	0.12	0	0.00	46.8	1.0	46.8	0.15	0.6	46.8	78.0	311		311.0	299%	Yes	Yes
Art Classroom	211/212	Art Classroom	1140	10	0.18	26	22.81	465.2	1.0	465.2	0.34	0.6	465.2	775.3	1350		1350.0	74%	Yes	Yes
Faculty Dining	213	Break Room	500	5	0.06	6	12.00	60.0	1.0	60.0	0.13	0.6	60.0	100.0	472		472.0	372%	Yes	Yes
Lobby	300	Lobby	2430	0	0.06	0	0.00	145.8	1.0	145.8	0.08	0.6	145.8	243.0	1837		1837.0	656%	Yes	Yes
Corridor	301	Corridor	980	0	0.06	0	0.00	58.8	1.0	58.8	0.15	0.6	58.8	98.0	380		380.0	288%	Yes	Yes
Psych Office	302	Office	130	5	0.06	2	15.38	17.8	1.0	17.8	0.12	0.6	17.8	29.7	150		150.0	406%	Yes	Yes
Conference	303	Conference	200	5	0.06	2	10.00	22.0	1.0	22.0	0.23	0.6	22.0	36.7	95		95.0	159%	Yes	Yes
IST	304	Storage	250	0	0.12	0	0.00	30.0	1.0	30.0	0.40	0.6	30.0	50.0	75		75.0	50%	Yes	Yes
Custodial	306	Storage	60	0	0.12	0	0.00	7.2	1.0	7.2	0.36	0.6	7.2	12.0	20		20.0	67%	Yes	Yes
Storage	308	Storage	105	0	0.12	0	0.00	12.6	1.0	12.6	0.42	0.6	12.6	21.0	30		30.0	43%	Yes	Yes
Guidance	309	Office	250	5	0.06	2	8.00	25.0	1.0	25.0	0.17	0.6	25.0	41.7	150		150.0	260%	Yes	Yes
Classroom	310	Classroom	755	10	0.12	26	34.44	350.6	1.0	350.6	0.35	0.6	350.6	584.3	1000		1000.0	71%	Yes	Yes
Classroom	311	Classroom	755	10	0.12	26	34.44	350.6	1.0	350.6	0.35	0.6	350.6	584.3	1000		1000.0	71%	Yes	Yes
Classroom	312	Classroom	755	10	0.12	26	34.44	350.6	1.0	350.6	0.35	0.6	350.6	584.3	1000		1000.0	71%	Yes	Yes
Classroom	313	Classroom	755	10	0.12	26	34.44	350.6	1.0	350.6	0.35	0.6	350.6	584.3	1000		1000.0	71%	Yes	Yes
Classroom	314	Classroom	755	10	0.12	26	34.44	350.6	1.0	350.6	0.35	0.6	350.6	584.3	1000		1000.0	71%	Yes	Yes

Maximum Zp	0.45

Reading Elementary School - Reading, PA
ASHRAE 62.1 2007 Minimum Ventilation Calculations
AEI Team 5

AHU	Capacity cfm	Percent OA	OA cfm
RTU-4	22699	60.0%	13619.4

System Population, Ps	463
Zone Population, Pz	463
Occupant Diversity, D = (Pz-Ps)/Pz	100%

b a =a/b

Room Name	Room Number	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Occupant Density	Breathing Zone O.A. Flow Required Vbz	Table 6-2 Zone Air Dist. Eff.	Zone outdoor airflow	Primary O.A. fraction	Table 6.3 System Vent. Eff.	Uncorrected O.A. Intake	Design O.A. Intake	Zone Primary Air Flow Set Point (cfm)	Percent OA	Actual O.A. Flow	% Above Min OA	Meets Standard?	Meets LEED 30%?
			Az	Rp	Ra	Pz,f		Vbz = Rp*Pz + Ra*Az	Ez	Voz = Vbz / Ez	Zp = Voz / Vpz	Ev	Vou = D*∑(Rp*Pz) + ∑(Ra*Az)	Vot = Vou / Ev	Vpz		OA = % * Vpz	=(OA/Vot) -1		
RTU-4										**6794.1**	**0.30**	**0.8**	**6787**	**8483**	**22699**	**60.0%**	**13619**	**61%**	**Yes**	**Yes**
Classroom	134	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Classroom	135	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Classroom	136	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Instructor Storage	137	Storage	245	0	0.12	0	0.00	29.4	0.8	36.8	0.27	0.8	29.4	36.8	135		81.0	120%	Yes	Yes
Special Education	140	Classroom	970	10	0.12	18	18.56	296.4	1.0	296.4	0.30	0.8	296.4	370.5	1000		600.0	62%	Yes	Yes
Classroom	141	Classroom	790	10	0.12	26	32.91	354.8	1.0	354.8	0.30	0.8	354.8	443.5	1200		720.0	62%	Yes	Yes
Classroom	142	Classroom	790	10	0.12	26	32.91	354.8	1.0	354.8	0.30	0.8	354.8	443.5	1200		720.0	62%	Yes	Yes
Classroom	143	Classroom	790	10	0.12	26	32.91	354.8	1.0	354.8	0.30	0.8	354.8	443.5	1200		720.0	62%	Yes	Yes
Classroom	144	Classroom	790	10	0.12	26	32.91	354.8	1.0	354.8	0.30	0.8	354.8	443.5	1200		720.0	62%	Yes	Yes
Classroom	145	Classroom	790	10	0.12	26	32.91	354.8	1.0	354.8	0.30	0.8	354.8	443.5	1200		720.0	62%	Yes	Yes
Custodial	147	Storage	55	0	0.12	0	0.00	6.6	1.0	6.6	0.33	0.8	6.6	8.3	20		12.0	45%	Yes	Yes
Corridor	149/150	Corridor	1670	0	0.06	0	0.00	100.2	1.0	100.2	0.29	0.8	100.2	125.3	350		210.0	68%	Yes	Yes
Conference	151	Conference	220	10	0.12	8	36.36	106.4	1.0	106.4	0.27	0.8	106.4	133.0	397		238.2	79%	Yes	Yes
Security	152	Office	65	5	0.06	1	15.38	8.9	1.0	8.9	0.27	0.8	8.9	11.1	33		19.8	78%	Yes	Yes
Conference	161	Conference	85	5	0.06	2	23.53	15.1	1.0	15.1	0.30	0.8	15.1	18.9	50		30.0	59%	Yes	Yes
Corridor	214/215	Corridor	1670	0	0.06	0	0.00	100.2	1.0	100.2	0.29	0.8	100.2	125.3	350		210.0	68%	Yes	Yes
Classroom	216	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Classroom	217	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Classroom	218	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Teacher Workroom	219	Office	245	5	0.06	0	0.00	14.7	1.0	14.7	0.11	0.8	14.7	18.4	135		81.0	341%	Yes	Yes
Special Education	222	Classroom	970	10	0.12	18	18.56	296.4	1.0	296.4	0.30	0.8	296.4	370.5	1000		600.0	62%	Yes	Yes
Classroom	223	Classroom	975	10	0.12	26	26.67	377.0	1.0	377.0	0.31	0.8	377.0	471.3	1200		720.0	53%	Yes	Yes
Classroom	224	Classroom	975	10	0.12	26	26.67	377.0	1.0	377.0	0.31	0.8	377.0	471.3	1200		720.0	53%	Yes	Yes
Classroom	225	Classroom	975	10	0.12	26	26.67	377.0	1.0	377.0	0.31	0.8	377.0	471.3	1200		720.0	53%	Yes	Yes
Classroom	226	Classroom	975	10	0.12	26	26.67	377.0	1.0	377.0	0.31	0.8	377.0	471.3	1200		720.0	53%	Yes	Yes
Classroom	227	Classroom	975	10	0.12	26	26.67	377.0	1.0	377.0	0.31	0.8	377.0	471.3	1209		725.4	54%	Yes	Yes
Custodial	229	Storage	55	0	0.12	0	0.00	6.6	1.0	6.6	0.33	0.8	6.6	8.3	20		12.0	45%	Yes	Yes
Corridor	315/316	Corridor	1430	0	0.06	0	0.00	85.8	1.0	85.8	0.25	0.8	85.8	107.3	350		210.0	96%	Yes	Yes
Classroom	317	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Classroom	318	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Classroom	319	Classroom	815	10	0.12	26	31.90	357.8	1.0	357.8	0.30	0.8	357.8	447.3	1200		720.0	61%	Yes	Yes
Instructor Storage	320	Storage	245	0	0.12	0	0.00	29.4	1.0	29.4	0.22	0.8	29.4	36.8	135		81.0	120%	Yes	Yes
Special Education	324	Classroom	970	10	0.12	18	18.56	296.4	1.0	296.4	0.30	0.8	296.4	370.5	1000		600.0	62%	Yes	Yes
Classroom	325	Classroom	750	10	0.12	26	34.67	350.0	1.0	350.0	0.29	0.8	350.0	437.5	1200		720.0	65%	Yes	Yes
Classroom	326	Classroom	750	10	0.12	26	34.67	350.0	1.0	350.0	0.29	0.8	350.0	437.5	1200		720.0	65%	Yes	Yes
Classroom	327	Classroom	750	10	0.12	26	34.67	350.0	1.0	350.0	0.29	0.8	350.0	437.5	1200		720.0	65%	Yes	Yes
Classroom	328	Classroom	750	10	0.12	26	34.67	350.0	1.0	350.0	0.29	0.8	350.0	437.5	1200		720.0	65%	Yes	Yes
Classroom	329	Classroom	750	10	0.12	26	34.67	350.0	1.0	350.0	0.29	0.8	350.0	437.5	1200		720.0	65%	Yes	Yes
Custodial	331	Storage	55	0	0.12	0	0.00	6.6	1.0	6.6	0.33	0.8	6.6	8.3	20		12.0	45%	Yes	Yes

Maximum Zp	0.33

Reading Elementary School - Reading, PA
ASHRAE 62.1 2007 Minimum Ventilation Calculations
AEI Team 5

AHU	Capacity cfm	Percent OA	OA cfm
RTU-5	8562	60.0%	5137.2

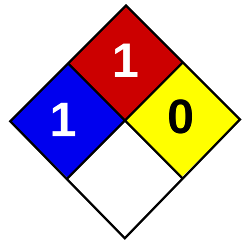
System Population, Ps	182
Zone Population, Pz	182
Occupant Diversity, D = (Pz-Ps)/Pz	100%

b a =a/b

Room Name	Room Number	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Occupant Density	Breathing Zone O.A. Flow Required Vbz	Table 6-2 Zone Air Dist. Eff.	Zone outdoor airflow	Primary O.A. fraction	Table 6.3 System Vent. Eff.	Uncorrected O.A. Intake	Design O.A. Intake	Zone Primary Air Flow Set Point (cfm)	Percent OA	Actual O.A. Flow	% Above Min OA	Meets Standard?	Meets LEED 30%?
			Az	Rp	Ra	Pz,f		Vbz = Rp*Pz + Ra*Az	Ez	Voz = Vbz / Ez	Zp = Voz / Vpz	Ev	Vou = D*∑(Rp*Pz) + ∑(Ra*Az)	Vot = Vou / Ev	Vpz		OA = % * Vpz	=(OA/Vot) -1		
RTU-5										**2667.2**	**0.31**	**0.8**	**2667**	**3334**	**8562**	**60.0%**	**5137**	**54%**	**Yes**	**Yes**
Corridor	153/154	Corridor	1085	0	0.06	0	0.00	65.1	1.0	65.1	0.33	0.8	65.1	81.4	200		120.0	47%	Yes	Yes
Classroom	155	Classroom	780	10	0.12	26	33.33	353.6	1.0	353.6	0.34	0.8	353.6	442.0	1050		630.0	43%	Yes	Yes
Vestibule	156	Vestibule	100	0	0.06	0	0.00	6.0	1.0	6.0	0.01	0.8	6.0	7.5	762		457.2	5996%	Yes	Yes
Maintenance	157/158	Storage	275	0	0.12	0	0.00	33.0	1.0	33.0	0.33	0.8	33.0	41.3	100		60.0	45%	Yes	Yes
Classroom	159	Classroom	780	10	0.12	26	33.33	353.6	1.0	353.6	0.35	0.8	353.6	442.0	1000		600.0	36%	Yes	Yes
Classroom	160	Classroom	780	10	0.12	26	33.33	353.6	1.0	353.6	0.35	0.8	353.6	442.0	1000		600.0	36%	Yes	Yes
Corridor	231/232	Corridor	1085	0	0.06	0	0.00	65.1	1.0	65.1	0.33	0.8	65.1	81.4	200		120.0	47%	Yes	Yes
Classroom	233	Classroom	730	10	0.12	26	35.62	347.6	1.0	347.6	0.33	0.8	347.6	434.5	1050		630.0	45%	Yes	Yes
Classroom	234	Classroom	1020	10	0.12	26	25.49	382.4	1.0	382.4	0.32	0.8	382.4	478.0	1200		720.0	51%	Yes	Yes
Classroom	235	Classroom	780	10	0.12	26	33.33	353.6	1.0	353.6	0.35	0.8	353.6	442.0	1000		600.0	36%	Yes	Yes
Classroom	236	Classroom	780	10	0.12	26	33.33	353.6	1.0	353.6	0.35	0.8	353.6	442.0	1000		600.0	36%	Yes	Yes

Maximum Zp	0.35

Science Lab.com
Chemicals & Laboratory Equipment



Health	1
Fire	1
Reactivity	0
Personal Protection	C

Material Safety Data Sheet
Ethylene glycol MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethylene glycol

Catalog Codes: SLE1072

CAS#: 107-21-1

RTECS: KW2975000

TSCA: TSCA 8(b) inventory: Ethylene glycol

CI#: Not available.

Synonym: 1,2-Dihydroxyethane; 1,2-Ethanediol; 1,2-Ethandiol; Ethylene dihydrate; Glycol alcohol; Monoethylene glycol; Tescol

Chemical Name: Ethylene Glycol

Chemical Formula: HOCH2CH2OH

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ethylene glycol	107-21-1	100

Toxicological Data on Ingredients: Ethylene glycol: ORAL (LD50): Acute: 4700 mg/kg [Rat]. 5500 mg/kg [Mouse]. 6610 mg/kg [Guinea pig]. VAPOR (LC50): Acute: >200 mg/m 4 hours [Rat].

Section 3: Hazards Identification

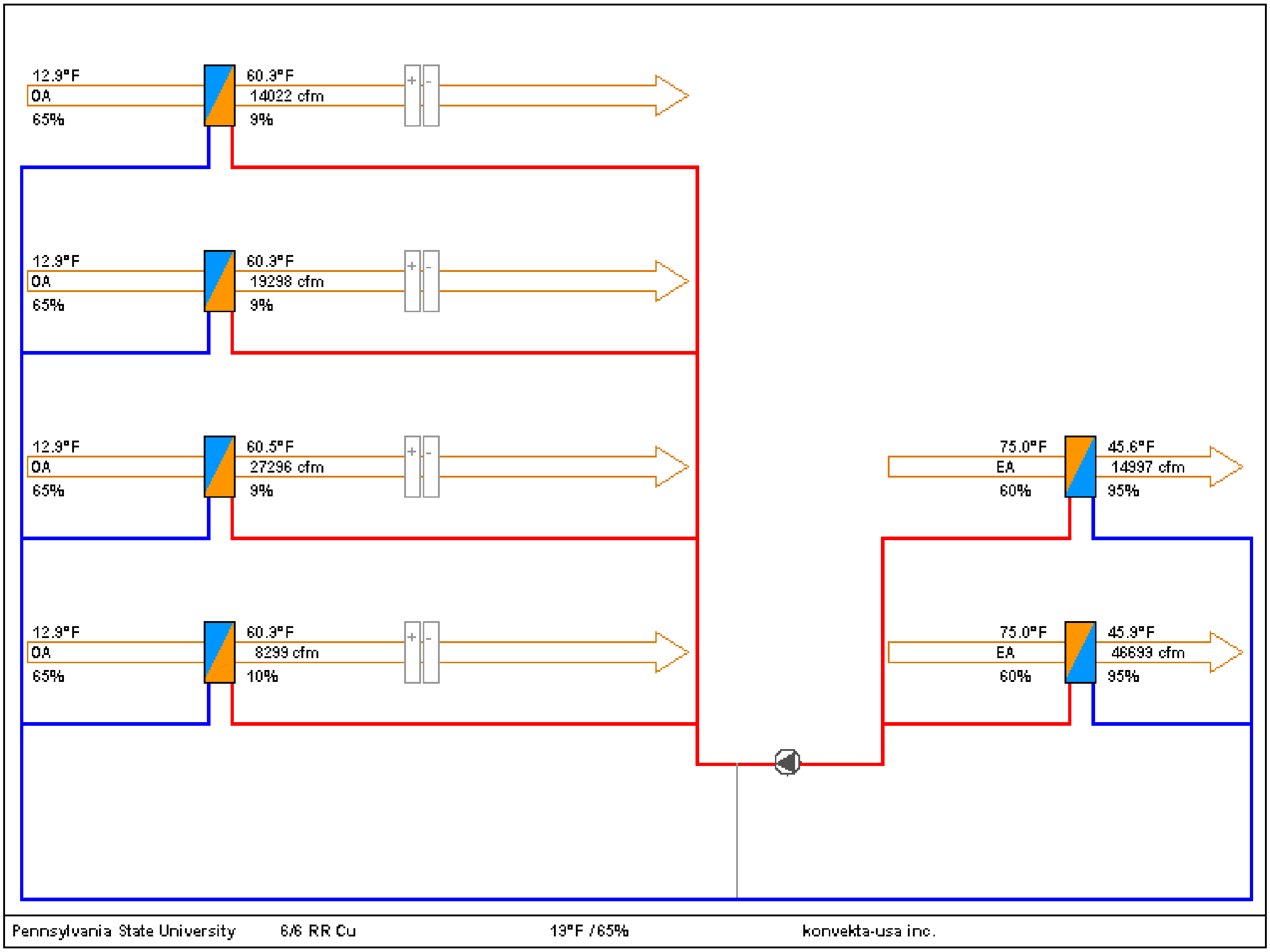
Potential Acute Health Effects:
Hazardous in case of ingestion. Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of inhalation. Severe over-exposure can result in death.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH. MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Non-mutagenic for bacteria and/or yeast. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance may be toxic to kidneys, liver, central nervous system (CNS). Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Date : **8. November 2012**
Site : **Pennsylvania State University**

100% Air Volumes



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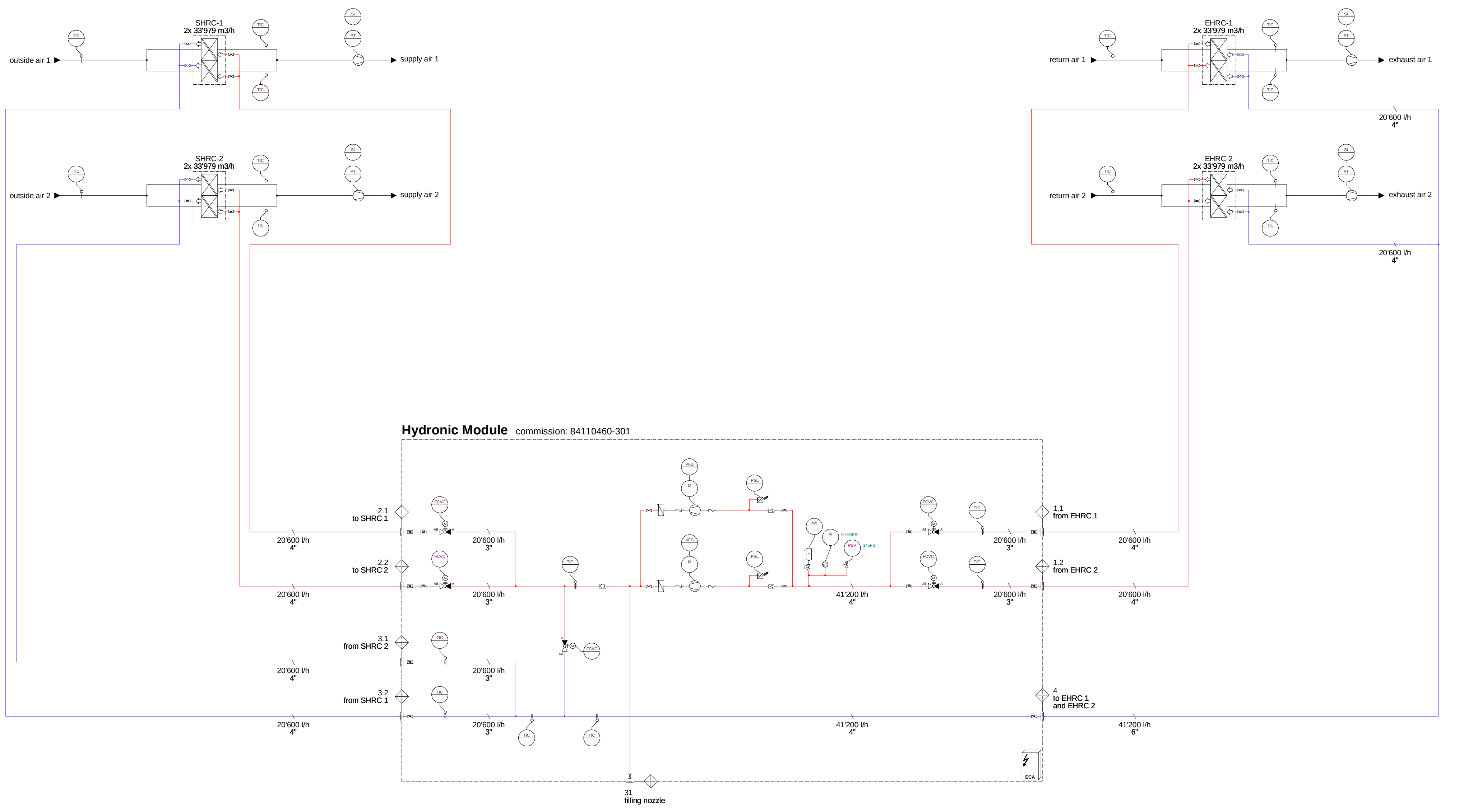

TAP: T_110721_013

		11.01.2012	dud	date	10.01.2012	project: Ramapo College	commission: 84110460-401
				revised	dud		
				checked			
state	revision	date	name	code		root	

konvekta

Ramapo College/ Alternative I

customer:

drawing no.: 20120111

version: 0.0

page no.: 32

page of: 18/18