STENGEL HALL – ACADEMIC CENTER FOR EXCELLENCE

Linden Hall School for Girls
Lititz, Pennsylvania

TECHNICAL REPORT 3

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EXECUTIVE SUMMARY

This report provides a comprehensive evaluation of the mechanical design, system components and energy use of the renovations and construction of the Stengel Hall – Academic Center for Excellence. Results from pervious technical reports exploring the mechanical compliance with ASHRAE Standards and energy simulation modeling were used to aid in the overall critique of the mechanical design.

The mechanical system for Stengel Hall is well designed, meeting all the criteria set by the Linden Hall School. Special attention was given to the physical limitations of the building as well as preserving the historic appearance of the building. The resulting design is comprised of boilers located in the basement and outdoor split system units located on the roof. Both systems provide the needed hot water and refrigerant to the many fan coil units located throughout the building.

Any available, cost effective, opportunity for decreasing energy use was utilized in the mechanical design. The boilers have an efficiency of 92.9%; far exceeding the efficiency of the existing steam system. Also, energy recovery ventilators were utilized to precondition the air for a majority of the classroom spaces. However, cost was the driving factor when final decisions were being made. The new mechanical system of Stengel Hall has a total cost of approximately one million dollars; 17% of the total cost of the renovation and addition.

Overall, the design sufficiently meets the requirements as well as providing opportunity for future changes and modifications to the system. The added flexibility of the designed system certainly can only benefit the Linden Hall School for Girls in the future if additional renovations are ever needed.

EXISTING CONDITIONS

Image 1| Image provided by bing.com

The Stengel Hall Academic Center for Excellence site, shown in red on Image-1, is located along Main Street in the small, historic town of Lititz, PA on the Linden Hall School for Girls campus. Linden Hall, founded in 1746, is one the most prestigious and oldest girls' preparatory schools in the country and helps define the heritage of this unique town.

Stengel Hall has been an integral part of this school since 1748 and has had many additions and renovations since. The current Stengel Hall renovation and addition involves 22,600 SF of new construction and approximately 14,300 SF in renovations to the existing building. The building is comprised of one level below grade, three levels above grade, and an unoccupied attic which will be used for mechanical equipment. Construction for this design-build project started on May 28th, 2011 and the majority of the demolition and excavation was completed over the summer of 2011. Construction is expected to be complete before students return for the 2012 school year (August 2012).

The goal of the Academic Center for Excellence is to provide the Linden Hall students a 20th century learning environment while keeping its historical roots. The architecture of this new addition and renovated areas is consistent with the existing building. This project is designed to replace recent additions to Stengel Hall, and infill the existing U-shaped footprint. This infill will provide a connection to the adjacent Steinman Performing Arts Center & Classrooms on the first level and basement level as well as create a new entrance off of Main Street on the north side of the building which can be seen in Image-2.

Image 2| Plan Courtesy of Chambers & Associates

The first level is mostly comprised of reception areas, and administrative offices that will address the buildings need for growth. The addition will also provide new classrooms with a modern technology-based atmosphere on the second and third levels as well as a large group room on the basement level. A new learning center is featured on the second level with a 2-story atrium that will allow daylight into computer labs, classrooms, and the library (See Image-3). Overall, the addition and renovations will increase the functionality of the campus and stimulate learning for the students of Linden Hall.

Rightfully, any construction on this site must comply with many historical requirements in addition to the standard zoning set by the Lititz Borough. The building must also comply with the 2009 International codes as well as the Americans with Disabilities Act.

The exterior elements of the addition are required to match those of the existing building. The façade of the building primarily consists of golden stucco on CMU or metal studs as well as clapboard on the inner surfaces of the third floor porch. The roofing consists of dimensional shingles and cooper flashing to also match the existing building. Powder Coated steel railings will be used to match those in the near vicinity and for ease of maintenance. New aluminum clad wood double-hung windows will be used to match the existing windows in Stengel Hall. These elements can be seen in Image-4. There is also a green roof designed for the lower roof level. Overall, the entire project will revamp Stengel Hall, and the Linden Hall Campus.

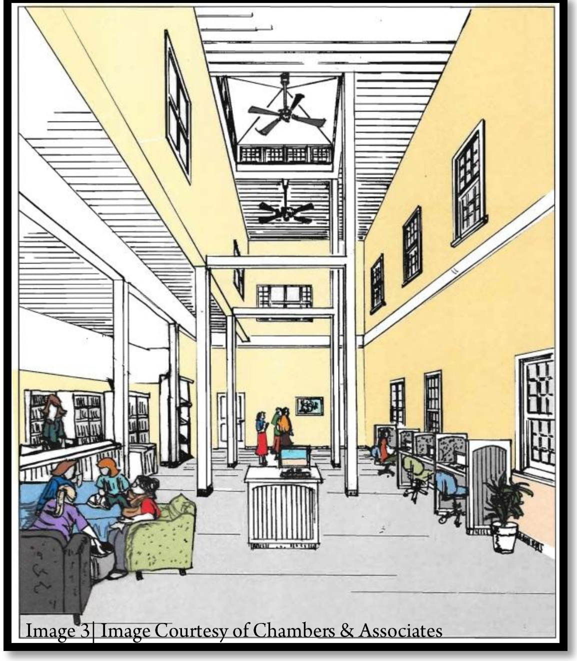


Image 3| Image Courtesy of Chambers & Associates

Image 4| Image Courtesy of Chambers & Associates

Objectives & Requirements

There are many goals and requirements associated with the mechanical system of Stengel Hall that have been outlined by the Linden Hall School. The design is required to meet all requirements set forth by local codes and ASHRAE standards. It is also important that the system is designed to be energy efficient. Furthermore, a minimum outdoor air quantity of 15 cfm per student is requested by the school. Lastly, the school requires all equipment to be safe, protected, and should be in good working order eliminating any hazards that could harm the building occupants.

Additionally, there are specific goals associated with the Stengel Hall renovation not outlined in the school's requirements. Improvements in overall comfort as well as system efficiency were much needed for the building. Also, the uses of scalable systems were important to allow the building to remain occupied during renovations.

Ventilation Requirements

A complete summary of outdoor air ventilation rates is summarized in Table 1A– Ventilation of the appendix based on individual zones. The total designed outdoor airflow, as per the mechanical schedule, is 7,880 CFM. This results in approximately 0.28 CFM per square foot of occupied space. The total calculated (from assignment 1) ventilation air required for Stengel Hall is 6,030 CFM; approximately 0.21 CFM square foot of occupied space. Although the calculated value differs from, and is generally less than, the designed zone outdoor air, the results are within reason, and this difference may be due to varying assumptions that the mechanical engineer used. For instance, it could be assumed that some zones are designed using more outdoor air than necessary because of the integration of energy recovery wheels which benefit from having a larger flow of outdoor air. Another goal may have been to provide better indoor air quality for spaces like the headmaster's office and the board room; once again providing more fresh air than required.

Design Conditions

The indoor design conditions were provided by the mechanical engineer and can be found in Table 2 – Indoor & Outdoor Design Conditions below. These set points are reasonable for the climate in which Stengel Hall is located.

The Linden Hall School for Girls is located in Lititz, PA and the ASHRAE weather data for Philadelphia, PA was assumed to be applicable seeing as it is in the surrounding Philadelphia area. When analyzing Stengel Hall the most extreme conditions were evaluated; 99.6% for heating and 0.4% for cooling. The temperatures for the outdoor conditions can be found in Table XX – Indoor & Outdoor Design Conditions below.

TABLE 2 – Indoor & Outdoor Design Conditions

CONDITION	COOLING	HEATING
Occupied Stengel Hall	75ºF	72ºF
Unoccupied Stengel Hall	80ºF	67ºF
Outdoor Design Conditions	11.3ºF	93.2ºF

The occupancy schedule that is used in analyzing this building can be found below in Table 3 – Occupancy Schedule. This is an assumed schedule for a boarding school facility which was determined based on combination of high school and middle school schedules with considerations given for the increased time students may spend outside of their dormitories.

TABLE 3 – Assumed School Schedule

	MONTHS	*TIME*	*~~%~~*
WEEKDAY	JANUARY -MAY	12AM-6AM	0
		6AM-7AM	10
		7AM-8AM	20
		8AM-11AM	80
		11AM-1PM	90
		1PM-3PM	80
		3PM-6PM	60
		6PM-12AM	0
	JUNE-AUGUST	12AM-8AM	0
		8AM-6PM	15
		6PM-12AM	0
	SEPTEMBER-DECEMBER	12AM-6AM	0
		6AM-7AM	10
		7AM-8AM	20
		8AM-11AM	80
		11AM-1PM	90
		1PM-3PM	80
		3PM-6PM	60
		6PM-12AM	0
WEEKEND	JANUARY-DECEMBER	12AM-8AM	0
		8AM-4PM	15
		4PM-12AM	0

Heading & Cooling Loads

The heating and cooling design was carefully compared to the calculated results of an energy simulation of Stengel Hall. Table 4-Load Comparison gives a summary of these results based on the area of the building. The results yielded some differences between the calculated loads and the designed loads. In particular the overall calculated heating load of the building was about 764,000 BTU/HR whereas the designed heating load is only 586,000 BTU/HR. Even when these values are compared based on the areas (simulated building area was larger than actual building area) the results still vary by 16%. All of these differences could have been due to many different reasons such as, load source assumptions, building occupancy schedule, outdoor design conditions, or errors in the simulation model. Overall, the simulated building model produced results within reason of the mechanical design.

TABLE 4 – Load Comparison			
	Designed	Computed	% Difference
Total Airflow (cfm/ft^2)	0.896	0.856	4.45%
Ventilation Airflow (cfm/ft^2)	0.275	0.269	2.18%
Cooling Load (ft^2/ton)	390.2	355.7	8.8%
Heating Load (Btuh/ft^2)	20.4	23.7	16%

Mechanical Space

Due to the space limitations for ductwork throughout Stengel Hall both the attic and basement needed to be utilized for equipment as well as allotting some areas within the occupied floor plan. The areas are broken down by floor and summarized in Table 5-Mechanical Space below. Twenty-five percent of this buildings floor space was dedicated to the building's mechanical equipment. The reason the design needed such a large portion of space is because the mechanical system is comprised of many small fan coils which all require their own individual clearances-quickly adding large areas to the overall mechanical space. The only large pieces of equipment in the design are the split system units on the roof of Stengel Hall. This area was not included in this analysis of mechanical space.

TABLE 5 – Mechanical Space				
LEVEL	**RENOVATED (SF)**	**NEW (SF)**	**SHAFT (SF)**	**TOTAL (SF)**
BASEMENT	1759	1565	0	3324
FIRST FLOOR	0	0	103	103
SECOND FLOOR	0	118	79	197
THIRD FLOOR	0	99	122	221
ATTIC	4618	616	0	5234
				9079 SF

Mechanical System Costs

The entire mechanical design was driven by cost and a summary of the costs can be found below in Table 6-Costs. The cost of the mechanical system in the new part of Stengel Hall is almost twice as much as the renovated costs. Additionally, the mechanical costs are 17% of the entire cost of the project.

TABLE 6-Costs

Building Area	Cost	Cost per SF
New Construction	$767,037.00	33.93 $/SF
Renovations	$255,679.00	17.88 $/SF
Total	$1,022,716.00	27.72 $/SF

Design Influences

Stengel Hall is a historical building within the Linden Hall School campus and has had many additions and renovations over the years. Due to the historical restrictions on the architectural design of the building, Stengel Hall was required to remain consistent with the existing structure. This limited the amount of glazing therefore aiding in the control of the solar heat gain to the building. However, the existing Stengel Hall has very low floor to floor heights which severely limited the amount of ductwork that could be distributed throughout the building. This eliminated the possibility of incorporating variable air volume terminal units.

Additionally, the renovations and construction of this project were driven by costs. Multiple potential solutions were evaluated when determining the mechanical system and the lowest cost option was ultimately chosen.

Schematic Drawings

Flow diagrams of both the air-side system (Image 5) and hydronic system (Image 6) can be viewed below and further system operation analysis can be found in the next section; System Operation.

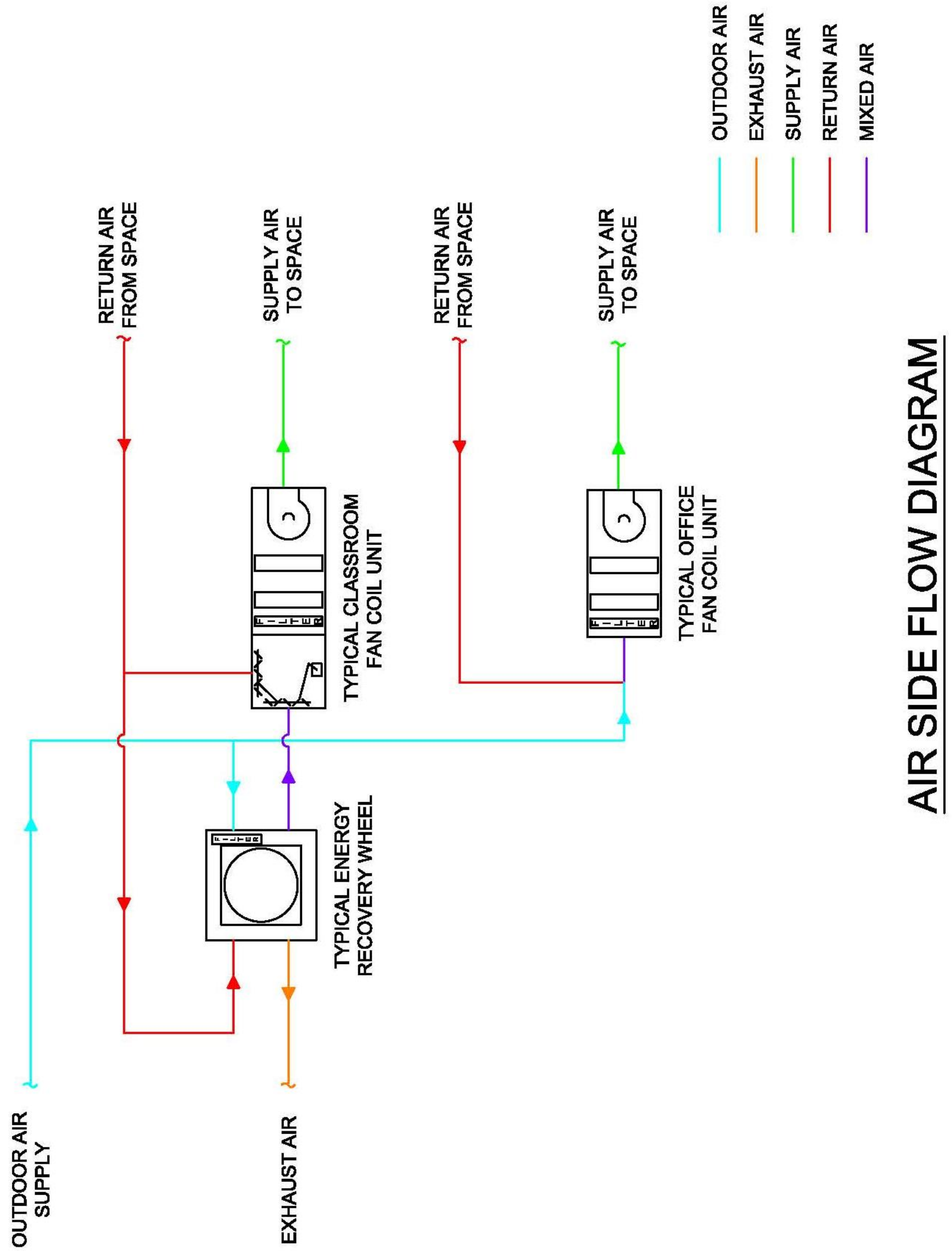
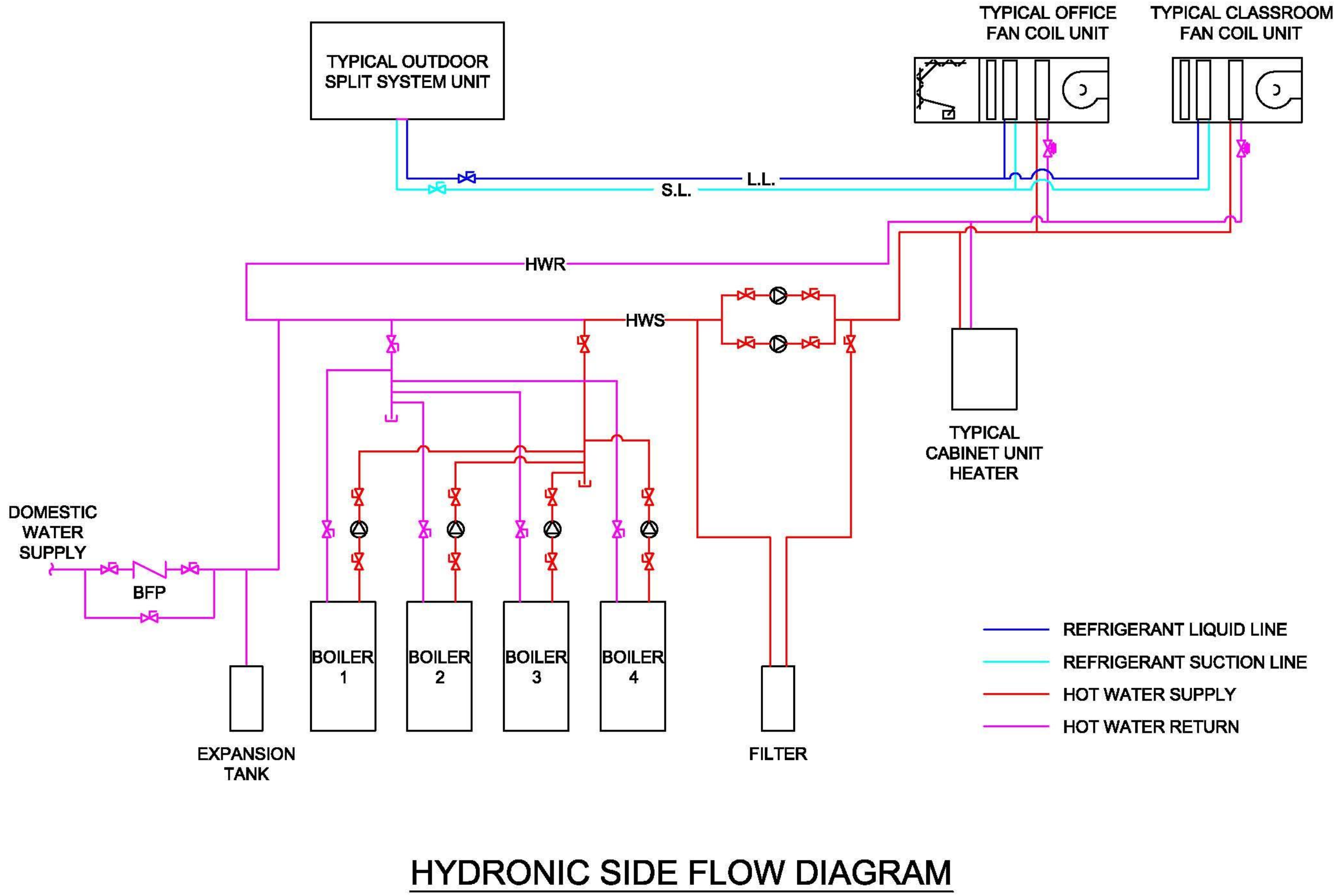


Image 5- Air Side Flow Diagram

Image 6- Hydronic Side Flow Diagram



System Operation

The air side of the mechanical design for Stengel Hall is mainly comprised of many small-scale constant volume fan coil units. Although the size of these units varies depending on the load, there are two main types; a horizontal unit and a vertical unit. The horizontal configuration is shown in the air-side flow diagram above and the vertical configuration can be viewed to the left in Image-7. Both of these units are packaged by the manufacturer and include the necessary filters, refrigerant cooling coils, hydronic heating coils, and properly sized fan. The vertical fan coil performs the same as the horizontal fan coil unit with the exception that the mixing box is located at the floor level and turns the air upwards through the filters and coils. The vertical configuration is utilized where necessary to save space throughout the building.

Image 7-Vertical Fan Coil Unit

In addition to the fan coil units supplying conditioned air to the spaces, energy recovery ventilators are utilized to precondition air for certain applications. The energy recovery configuration can be viewed in the air-side flow diagram as it supplies mixed air to the typical classroom within Stengel Hall and exhausts contaminated air from classroom spaces to the outside. The energy recovery ventilators reduce both sensible (temperature) and latent (humidity) load on the coils in the fan coil units. These units are also manufacturer assembled and include the properly sized fan, filter, motor, and enthalpy wheel within the unit. These components can be seen in Image 8 to the left.

Image 8-Energy Recovery Ventilator

The hydronic system, is comprised of five outdoor split system units for cooling and four high-efficiency boilers to supply hot water. The outdoor split system units supply refrigeration to the DX coils within each fan coil, as shown in hydronic flow diagram. A dual manifolded compressor is specified for all units in the Stengel Hall project. Additionally, hot water is supplied to the fan coil units from the boilers located in the basement, also shown in the hydronic flow diagram. The boilers are supplied water from the domestic water supply and a backflow preventer protects the domestic water supply from being contaminated. The boilers are connected in series and filters and expansion tanks are in place within the system. Due to the constant volume air system variable frequency drives on pumps were necessary to provide sufficient control of the system.

Limited control information is available at this time. However, it is evident that the small-scale units will definitely provide better control to the occupants due to the limited area each fan coil serves.

Major Equipment

All major equipment is summarized below in Table-7 through Table-10.

TABLE 7 – FAN COIL SCHEDULE

EQUIPMENT TAG	NOMINAL TONAGE	TOTAL CFM	LOCATION/SERVES	CONFIG.
AHU001	4	1400	BASEMENT	VERT
AHU002	1.5	525	BASEMENT	VERT
AHU003	4.5	1600	BASEMENT	VERT
AHU101	2	700	BASEMENT/1ST	VERT
AHU102	2.5	825	BASEMENT/1ST	VERT
AHU103	3	1050	BASEMENT/1ST	VERT
AHU104	2.5	875	BASEMENT/1ST	VERT
AHU105	4	1400	BASEMENT/1ST	VERT
AHU106	1.5	525	BASEMENT/1ST	VERT
AHU107	3.5	1225	BASEMENT/1ST	VERT
AHU201	1.5	525	ATTIC/2ND	HORIZ
AHU202	1.5	525	ATTIC/2ND	HORIZ
AHU203	4	1400	ATTIC/2ND	HORIZ
AHU204	1.5	525	2ND/2ND	VERT
AHU205	1.5	525	ATTIC/2ND	HORIZ
AHU206	2	700	ATTIC/2ND	HORIZ
AHU207	2.5	875	ATTIC/2ND	HORIZ
AHU208	3.5	1225	2ND/2ND	VERT
AHU209	3	1050	3RD/2ND	VERT
AHU210	2.5	875	ATTIC/2ND	HORIZ
AHU301	4	1400	ATTIC/3RD	HORIZ
AHU302	2.5	875	ATTIC/3RD	HORIZ
AHU303	2.5	875	ATTIC/3RD	HORIZ
AHU304	2	700	ATTIC/3RD	HORIZ
AHU305	2.5	875	ATTIC/3RD	HORIZ
AHU306	3.5	1225	ATTIC/3RD	HORIZ
AHU307	2	700	3RD/3RD	VERT
AHU308	2	700	3RD/3RD	VERT

TABLE 8 - BOILER SCHEDULE

EQUIPMENT TAG	FUEL	INPUT (BTU/HR)	EFFICIENCY	LOCATION
B1	NAT. GAS	310,000	92.9	BASEMENT
B2	NAT. GAS	310,000	92.9	BASEMENT
B3	NAT. GAS	310,000	92.9	BASEMENT
B4	NAT. GAS	310,000	92.9	BASEMENT

TABLE 9 - SPLIT SYSTEM SCHEDULE			
EQUIPMENT TAG	NOMINAL TONAGE	EFFICIENCY	LOCATION
ODU1	15	21.8	ROOF
ODU2	20	12	ROOF
ODU3	15	12.8	ROOF
ODU4	15	12.8	ROOF
ODU5	15	12.8	ROOF

TABLE 10 - ENERGY RECOVERY VENTILATOR SCHEDULE				
EQUIPMENT TAG	OUTSIDE AIR (CFM)	EXHAUST AIR (CFM	LOCATION	SERVES
ERV1	250	200	BASEMENT	BOARDROOM
ERV2	600	480	BASEMENT	DAY LOUNGE
ERV3	710	568	BASEMENT	LECTURE HALL
ERV4	500	400	ATTIC	CLASSROOM
ERV5	325	260	ATTIC	CLASSROOM
ERV6	700	560	ATTIC	CLASSROOM
ERV7	600	480	ATTIC	OFFICE/CLASSROOM
ERV8	625	500	ATTIC	CLASSROOM
ERV9	805	644	ATTIC	CLASSROOM/LEARN. CENT.
ERV10	300	240	ATTIC	CONF./LEARN. CENT.

Energy Sources

Electricity is provided to the Linden Hall campus by PPL Electric Utilities. It has been determined that Stengel Hall and the entire campus as a whole could be classified under the rate schedule of GS-3; Large General Service at Secondary Voltage. This rate schedule provides three-phase power at the necessary voltage. Additionally, the monthly minimum of 25kW would most likely be met over the entire campus. The exact rates can be found in Table X-Utility Rates below.

Natural gas as is provided to Linden Hall campus by UGI Utilities, Inc. From the information provided, it is assumed that natural gas is primarily used to fuel the boilers in Stengel Hall. In this case UGI provides a rate, cogeneration delivery service, for customers who will use no less than 25% of the total energy output in mechanical energy production. There would be a further classification of a "small firm" customer because Stengel Hall will not typically use more than 50MCF/day. However, the rates for this classification are determined by a negotiation between the customer and company. So, to evaluate the gas costs, the general non-residential service rate was explored. The exact charges at this rate can also be found in Table 11-Utility Rates below.

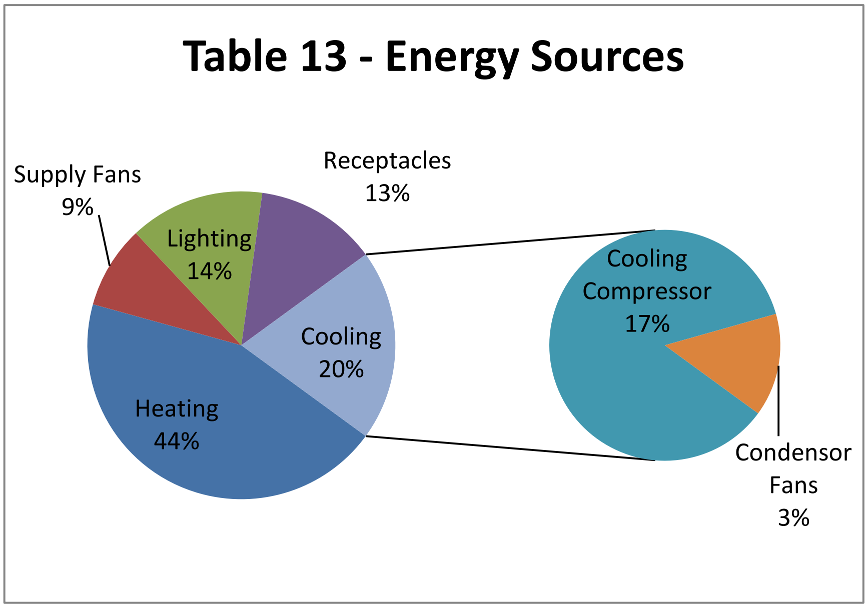
TABLE 11 – Utility Rates (Note: other charges may apply)

	Customer Charge	Distribution Charges	
Electric	$30.00 per month	$4.510 per kW	
Natural Gas	$8.55 per month	First 25MCF: $4.056 per MCF	Next 475 MCF: $3.5601 per MCF

Annual Energy Use

The annual energy consumption, which was estimated using Trane Trace®, is summarized in Table 12-Energy Consumption below. The estimated annual energy use for Stengel Hall was not provided by the design team. The electric operating rate below was determined based on the rates that were charged in 2006, not the rate from the above utility analysis. The results of this energy analysis are assumed reasonable for a facility of this nature. The average annual electricity usage is approximately 4.94 KWh/SF. Additionally, the energy sources are summarized in Table 13 by percent of the total energy consumption (including gas).

TABLE 12 - Energy Consumption				
SOURCE	ELECTRIC (KWh)	GAS (Kbtu)	TOTAL ENERGY (kBTU/yr)	ELECTRIC OPERATING COST (0.0842 $/kWh)
Heating	3,573	461,631	473,826	$301
Supply Fans	62,883		92,686	$7,806
Lighting	27,157		151,230	$12,736
Receptacles	44,310		136,374	$11,485
Cooling	39,957		214,620	$18,074
TOTALS	**177,880**	**461,631**	**1,068,736**	**$50,402**



LEED Assessment

At this point, the design team for the Stengel Hall-Center for Academic Excellence is not applying for any type of LEED certification. Many of the requirements for LEED credits would add cost to the project and this entire project is driven by costs. However, for the purposes of this analysis LEED credits were explored based on feasibility to the project, i.e. could the owner or design accomplish certain criteria if it were attempted. The LEED for Schools New Construction & Major Renovations Rating Systems publication was used for this analysis and only credits involving the designed mechanical system were explored; a summary of these credits are found below.

- EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems

The intent of this credit is simply to ensure that the energy-related systems are properly installed. To achieve this credit the project team would be required to designate a qualified person as the commissioning authority. Due to the small size of the project this person could be someone on the design or construction team. This is a feasible credit for this project but no points are award as it is required.

-EA Prerequisite 2: Minimum Energy Performance

This credit establishes a minimum level of energy efficiency for the building. The new construction must demonstrate a 10% energy improvement in relation to a case study building and the renovated areas must fulfill a 5% improvement in relation to the previous operating state. The design must also meet ASHRAE standards. This point is feasible and previously determined to comply with these requirements but is also a required credit and therefore does not receive any additional points.

-EA Prerequisite 3: Fundamental Refrigerant Management

The intent of this credit is to ensure that ozone-depleting refrigerants are not used within cooling components of the design. The refrigerant specified in the split system units is R-410A which complies with this requirement. No additional points awarded.

-EA Credit 1: Optimize Energy Performance

The intent of this credit is to increase energy performance beyond the minimum set by the prerequisite. Varying levels of points are awarded for increasing energy performance. To evaluate this credit the energy performance based was on the simulated energy results from Technical Assignment 2 and the 2006 energy bills as a basis for performance. The results of this comparison showed drastic improvements to the energy performance and this design may possible receive the full 19 points for this credit.

-EA Credit 2: On-site Renewable Energy

This credit recognizes efforts made to produce energy on site. Varying levels of points are granted for the increasing percentage of renewable energy. Renewable energy is not a component of the design for Stengel Hall or the Linden Hall Campus. No points would be awarded for this credit.

-IEQ Prerequisite 1: Minimum Indoor Air Quality Performance

The intent of this credit is to recognize buildings that provide proper amounts of ventilation to its occupants based on ASHRAE Standard 62.1. As previously analyzed this building meets all requirements set for ventilation rates by ASHRAE. This prerequisite is met.

-IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

This credit protects the occupants from exposure to tobacco smoke. The school would be required to prohibit smoking in the building as well as within 25 feet of any opening to the building. This is a feasible credit to accomplish.

-IEQ Prerequisite 3: Minimum Acoustical Performance

The intent of this credit is to ensure a quiet learning environment for students. The background noise of HVAC equipment and reverberation time within learning spaces must be limited. Information on the acoustical characteristics of equipment were not provided however it is assumed to be considered in the design of the mechanical system

-IEQ Credit 1: Outdoor Air Delivery Monitoring

The purpose of this credit is to promote occupant comfort and well-being. The design would require the monitoring of carbon dioxide throughout the building. This credit could be achieved by adding CO_2 monitors to areas that experience high occupancy.

-IEQ Credit 2: Increased Ventilation

The intent of this credit is to provide additional outdoor air ventilation. The current design does exceed the minimum set by ASHRAE Std 62.1 but not by the required 30% and would not receive points for this credit

-IEQ Credit 6.2: Controllability of Systems – Thermal Comfort

This credit is intended to give thermal control to at least 50% of the building occupants. At this time, very little information on the controls of this mechanical system has been provided. Therefore, it cannot be determined if this credit will be met.

It certainly seems viable for the Center for Academic Excellence to achieve LEED certification but the steps necessary will add cost to the overall project. LEED certification does not add any observable benefits to the school and may be the reason why it was not a goal of the project.

Operating History

Some previous energy information was provided by the architect to aid in the analysis of the energy usage. Both electric and gas bills for 2005 and 2006 were used as a comparison for the building simulation results. The monthly gas usage can be found in Table 14 below. The graph shows drastic differences between the existing usage and the simulation results. Due to the switch from an old steam system to new high efficiency boilers the drastic difference could easily be valid.

In addition, the monthly electrical use comparison can be found in Table 15. The calculated electric use is generally lower than the existing building usage by an average of 22%. This difference could be due to the upgrades in lighting, electrical, and mechanical equipment as well as differences load source assumptions. Although energy information was available for this analysis, it is important to keep in mind that the existing Stengel Hall is entirely representative of the new design.

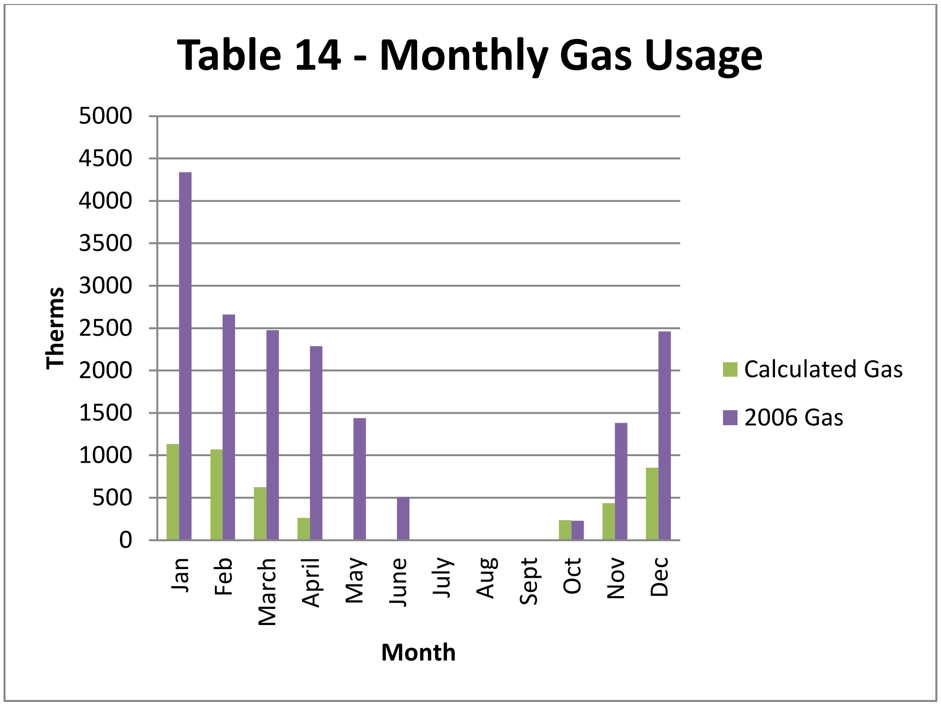


Table 14 - Monthly Gas Usage

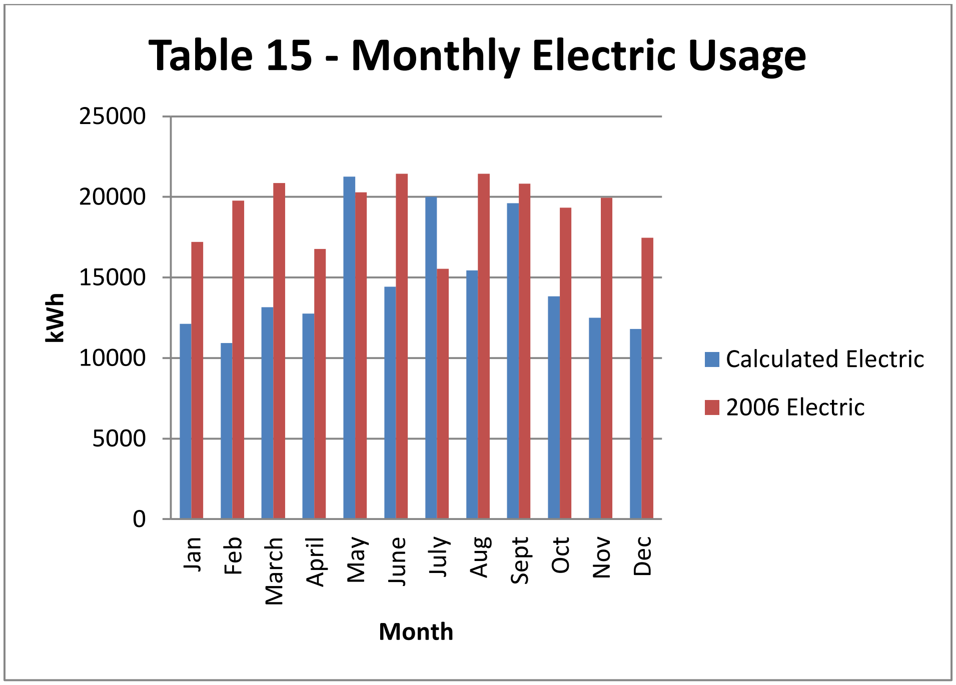


Table 15 - Monthly Electric Usage

Image 9-Window AC unit used as means for air conditioning,

The overall mechanical design properly addresses the school's need for an improved system. The previous two-pipe steam system has been replaced with high efficiency boilers serving individual fan coil units. The boilers not only decrease energy use but they provide a safer distribution system for the Academic Center for Excellence. The new mechanical design also provides air-conditioning to all occupied areas of the building. Therefore eliminating the use of window air conditioning units used in the existing Stengel Hall. Image-9 illustrates the inefficient air conditioning that was previously relied on.

However, the design team did have to sacrifice the opportunity for higher efficiency due to cost restraints for the project. The added first costs of other potential mechanical systems were too high for the budget of Linden Hall and therefor the lower cost option was chosen for the Stengel Hall renovation and addition.

In addition to cost restraints, the physical limitations of the building were a major challenge the design team successfully overcame. The low floor to floor heights and exposed ceilings eliminated areas which would traditionally be utilized for ductwork. The amount of exposed outdoor units also needed to be carefully considered in order to pass Historical Review by the Lititz Borough. The finished design resulted in only five pieces of outdoor equipment which were concealed on the roof. The use of several small units to supply air to zones also allowed for certain parts of Stengel Hall to remain occupied during construction by relieving the need for the mechanical design to be complete all at once.

One downside to having a large number of fan coil units and energy recovery ventilators is the added maintenance involved. Each piece of equipment has its own filters, and additional components which must be serviced routinely. This will ultimately add to the amount of attention provided to the Stengel Hall mechanical system. Nonetheless, the mechanical system determined by the design team was in the best possible interest of the Linden Hall School for Girls.

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TABLE 1A - Ventilation			
AHU	ROOMS SERVED FROM AIR HANDLING UNITS	CALCULATED OUTDOOR AIRFLOW, V_{oz} (CFM)	DESIGNED OUTDOOR AIR (CFM)
AHU-001	007-Day Lounge	258	600
AHU-002	002-Coridoor 005-Elevator Lobby 006-Coridoor	43	100
AHU-003	003-Testing/Lecture	566	710
AHU-101	134-Existing Entry 135-Headmaster	36	80
AHU-102	136-Board Room 137-Existing Passage	233	250
AHU-103	129-Business Manager 130-Business Assistant 131-Existing Passage 132-Conference 133-Mech/Elec	113	150
AHU-104	121-Manager 124-Corridor 126-Advancement Office 127-Director of Advancement 128-Existing Passage	73	80
AHU-105	101-North Entry 102-Centre Lobby 103-Receptionist 104-South Entry 106-Vestibule	238	380
AHU-106	118-Administrative Assistant 119-Director of Admissions 120-Assistant Director of Admissions	71	60
AHU-107	105-Corridor 107-Cot 108-Work Room 109-Faculty Work Room 110-Faculty 113-Conference 115-Display 117-Corridor	233	180

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TABLE 1A – Ventilation(continued)			
AHU	ROOMS SERVED FROM AIR HANDLING UNITS	CALCULATED OUTDOOR AIRFLOW, V_{oz} (CFM)	DESIGNED OUTDOOR AIR (CFM)
AHU-201	213-College Counseling 214-Offices 215-Offices 216-Corridor	65	60
AHU-202	217-Classroom	212	240
AHU-203	218-Corridor 219-Academic Dean 220-Corridor 221-Assistant 224-Assistant Head 225-Conference 226-Passage	139	150
AHU-204	222-Tech Office/Server Room	21	40
AHU-205	223-Conference	41	110
AHU-206	227-Classroom	207	300
AHU-207	201-Classroom 231-Classroom	464	465
AHU-208	208-Bookshelves 206-Work Room 202-Learning Center	284	340
AHU-209	202-Learning Center 206-Work Room 203-Conference 204-Learning Center 207-Library Office/Work Room	350	300
AHU-210	205-Conference 209-Passage 211-Passage 312-Corridor 313-Passage	100	240
AHU-301	316-Corridor 318-Classroom 319-Existing Classroom	385	500
AHU-302	320-Existing Classroom	270	320
AHU-303	321-Existing Classroom	298	360
AHU-304	323-Existing Classroom	239	340

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TABLE 1A – Ventilation (continued)

AHU	ROOMS SERVED FROM AIR HANDLING UNITS	CALCULATED OUTDOOR AIRFLOW, V_{oz} (CFM)	DESIGNED OUTDOOR AIR (CFM)
AHU-305	324-Archives 326-Office 327-Existing Storage	68	300
AHU-306	301-Classroom 304-Classroom	483	625
AHU-307	302-Corridor 309-Classroom	222	300
AHU-308	307-Classroom 309-Classroom	318	300