Technical Assignment 3

Mechanical Systems and Existing Conditions Report

Park Place Corporate Center One

Findlay Township, PA

Table of Contents

Executive Summary

Park Place Corporate Center One (Park Place 1) was an underperforming, old, unoccupied office building. Once purchased by DiCicco Development, simple goals were laid out for the building to accomplish—the primary goal being to fill the unoccupied spaces with tenants. To do so, the building needed to be modernized and made economically efficient to the ownership. The first place investigated was the obsolete mechanical system. CJL Engineering was hired to design a relatively low first cost, energy efficient, easy to maintain system that would deliver reliable air quality to professionals that did not want to think about thermal comfort during their work day.

The solution to the problem was to install two identical packaged rooftop units that were capable of doing both heating and cooling, thus eliminating the need for the existing boilers, air handling unit, pumps, hot water distribution piping, and existing cooling equipment. Removing such systems would make operation simpler and probably more efficient from an energy consumption standpoint.

Information from Technical Reports 1 and 2 was used to help formulate opinions made throughout this technical report. Being that this is the third and final technical report done for the study of Park Place 1, preliminary proposals for improved systems need to be brainstormed. Generally for larger systems, using water to distribute heat or cooling energy is more efficient than using air. Because water has a higher heat capacity than air, less of it is required to be moved to the occupant in order to heat or cool that occupant by the same amount. The difference in energy savings is then seen in equipment efficiencies, reduced pumping and fan energy, and smaller ducts. The design challenge is finding where that balance between large and small actually occurs. In moving forward, the goal is to determine if using a water based system is more efficient than using an air based system.

Several advantages already exist for the proposal of a water based system, others are available. For example, several water system features are already in place such as pumps, piping, and boilers. The roof is also relatively empty, thus leaving space for more or larger equipment should the need come to fruition. That equipment, though further study is required, could be supported by a steel structure that has capacity for greater load than it is currently bearing. Should that option not be feasible, the parking lot is grotesquely oversized and could be used in more effective ways. Finally, Park Place 1 is a sister building to Park Place 2 which is also owned by DiCicco Development and is located about fifty yards away. The opportunity to combine the mechanical requirements of the two buildings could open many doors for improved mechanical system performance.

The mechanical systems of Park Place 1 are adequate to accomplish the goals they have been assigned to. They meet the needs of the owner and occupant and do so in a relatively cheap, efficient manner. The following reports demonstrate the adequacy of the systems but also show that there is room for improvement. Further studies will verify the feasibility of improved systems.

Mechanical Summary

Introduction

Park Place 1 has a central building mechanical system that serves 100% of the building to satisfy all heating, cooling, ventilation, and exhaust requirements. The building spaces are currently served by variable air volume (VAV) valves that allow for full mechanical modulation during part load occupancy. The base supply duct system is intended to suit future expansion with the assumption of VAV terminal boxes being used to supply air to individual spaces. Air will be supplied to these boxes through one of two vertical shafts that house both supply and return air ducts. Two packaged rooftop air handling units (RTU) equipped with variable speed drives will split the building loads equally. The RTU's are also responsible for heating the building with the option of retaining the two existing gas fired boilers and corresponding pumps that can supply hot water to perimeter terminal boxes should the need occur. The existing hot water system is, however, intended to be used as a redundant back up or at most supplemental heat. The RTU's are designed and sized to fulfill the heating load exclusively.

Design Criteria and Objectives

In the design of any system, several factors need to be weighed. The ultimate goal of a mechanical system is to provide air that both legally and practically meets the needs of the building occupants within the boundaries of cost. This is a relationship that involves three major parties: the owner, the occupant, and the government. Each party has needs that need to be addressed in the design process by the engineer. For the engineer to accomplish such a task, he or she must look at each party individually and then weigh the considerations. For the owner, system cost becomes the major focal point. This entails first cost, operating cost, and maintenance cost. For the occupant, air cleanliness, temperature, and humidity are the primary concerns all while maintaining a certain level of ventilation. For the government, compliance with modern codes is mandatory and therefore can be one of the minimum starting points for the design engineer.

The mechanical system of Park Place 1 is intended to meet all of the requirements of ASHRAE Standard 55 – 2004 Thermal Environmental Conditions for Human Occupancy, ASHRAE Standard 62.1 – 2007 Ventilation for Acceptable Indoor Air Quality, and ASHRAE Standard 52.2 which pertains to particle removal from the supply air stream. The new mechanical equipment that was installed during the building renovation is intended to meet the requirements of ASHRAE Standard 90.1 – 2007 Energy Standard for Buildings Except Low-Rise Residential Buildings. For further study on compliance with ASHRAE Standards 62.1 and 90.1, please see Technical Report 1. Such topics address the needs of compliance with government standards.

With respect to building occupancy, Park Place 1 is exclusively an office building. As examples, there are no laboratories requiring very specific air quality conditions, no garages that need special exhaust system considerations, and no gyms that need a very precise temperature set point. To design a successful space, typical office building assumptions in accordance with the ASHRAE standards were made. This implies that occupants would be relatively sedentary and wearing normal clothing, internal loads would be predominantly driven by lighting, people, and receptacle loads, and that construction would be of medium to low quality because of age.

The owner, DiCicco Development, has cost in mind. Park Place 1 is a building that was designed for profit. DiCicco Development wants their occupants to be happy with their experience of renting one of their spaces. With that said, the building owner made it clear to the design team that it was their goal to provide an environmentally responsible building that at the same time satisfied the occupants who would be exposed to the systems. Because of the buildings age and the consideration that the building is to be rented for profit, DiCicco Development wanted to find the best solution that weighed first cost, operating cost, system efficiency, and maintainability. While certain modern systems could potentially have been more viable in the long term, DiCicco Development did not want a system with a lengthy payback period. Their goal was a system with a reasonably low initial cost and a consideration for operating cost. They wanted to find an economic balance. It was also made clear to the design engineer that the personnel in charge of maintenance, while experienced, was not sophisticated enough to handle an extremely complicated system. Also, because the building was not LEED rated previously, it did not become a major priority for the design team.

Outdoor and Indoor Design Conditions

In determining equipment capacity, both outdoor and indoor design conditions must be determined. Indoor design conditions are chosen in accordance with ASHRAE Standard 55 and are subject to personal preference amongst the building occupancy. In other words, not everyone agrees on what is comfortable and therefore a range of temperature control must be provided. Outdoor design conditions are based on TMY2 weather data which is collected over years of recorded weather data and trends. Park Place 1 is located in Findlay Township, Pennsylvania, a suburb of Pittsburgh, Pennsylvania. Because Pittsburgh is the closest major city that has weather data accumulated and documented, it was used as the basis of location for design. Pittsburgh is known for having relatively cold winters and warm, humid summers as seen below in Table 2- Outdoor Design Conditions. The 0.4% and 99.6% design days were chosen to be used for equipment selection for Park Place 1. Together, both outdoor and indoor conditions must be considered to appropriately size mechanical equipment.

Thermostat Settings	
Cooling Dry Bulb (°F)	75
Heating Dry Bulb (°F)	70
Relative Humidity (Cooling Only) (%)	50
Cooling Driftpoint (°F)	81
Heating Driftpoint (°F)	64

Table 1- Indoor Design Conditions

In Table 1 above, the indoor design conditions can be seen. They are the typical set points for an office building. In Table 2 below, the outdoor ambient conditions are shown that were used to size the mechanical system equipment for capacity.

Outdoor Design Conditions		
	Summer (0.4 %)	Winter (99.6 %)
Dry Bulb (°F)	89.1	1.8
Wet Bulb (°F)	72.5	-
Dew Point (°F)	65.6	-
Clearness	0.97	0.97
Ground Reflectance	0.2	0.2
Wind Velocity	11.7	15

Table 2- Outdoor Design Conditions

System Design and Equipment Summaries

Given the design considerations outlined above, the design engineer chose to implement a system as described in the following sections that address air supply and exhaust as well as hot water systems.

Air Supply System

Packaged Rooftop Units

The building air supply is handled entirely but two identical rooftop units (RTU-1, RTU-2) for the heating and cooling seasons.

For cooling, the RTU's are direct transfer (DX) type, meaning the air stream is cooled by a cooling coil that has liquid refrigerant circulating through it. The RTU's have air-cooled condensers with accompanying fans that increase the heat transfer rejection rate to the ambient surroundings to turn the refrigerant from a compressed gas back to a liquid. The compressors are direct drive scroll type with hermetic motors. The supply air temperature from the RTU's can be modulated along with the supply cfm's, but for capacity was sized for a leaving air temperature of 55°F (the desired supply air temperature to the occupied space).

For heating, the RTU's have forced draft gas burners that are capable of providing 85°F air. When speaking with the design engineer, it was determined that the existing gas-fired boilers were capable of handling the entire heating load for the building but that the RTU's would be used as the main heating source following the renovation. During the heating season, the boilers' heating capacity will be used as a redundant back up, the primary purpose being to supply 180°F water to reheat coils around the building perimeter.

RTU-1 and RTU-2 are responsible for cooling air during the summer, warming air during the winter, and also moving air throughout the building during both seasons. There are no other air handling units in the building. To meet the air handling requirement, both RTU's have a supply (airfoil type) and return (forward curved type) fan equipped with variable speed drives that allow for full modulation of supply and return air quantities based on pressure differentials in the supply ducts. Because the system is a VAV system, the pressure measurement, as a rule of thumb, is to be taken about two-thirds of the way down the air stream. The RTU's are also equipped with a 100% outdoor air economizer which allows for each RTU to serve as a dedicated outdoor air system should the opportunity present itself. The economizers, in combination with the unit controls, are also capable of demand control ventilation based on CO_2 measurements taken in the occupied spaces. The RTU's are capable of providing 45,000 cfm's of supply air each. For air quality purposes, MERV 7 prefilters and MERV 13 final filters have been installed into the units to remove potential air contaminants. For safety, the units have been equipped with smoke detectors in both the supply and return ducts that are wired directly to the units' control systems.

Because controls are an ever increasing priority in the HVAC industry, the RTU's have been equipped with microprocessor controls. This system consists of temperature and pressure (thermistor and transducer) sensors and a human interface panel that are capable of tying into the building automation system (BAS) that is included as part of the building renovation.

The RTU's performance characteristics can be seen below in Table 3 – Rooftop Unit Schedule.

Rooftop Unit Schedule			
Name	RTU-1	RTU-2	Units
Air Quantity	45,000	45,000	cfm
Minimum Outdoor Air	4,500	4,500	cfm
Heat Output	1,100,000	1,100,000	Btu/Hr
Gas Input	1,380,000	1,380,000	Btu/Hr
Entering Air Temperature- Heating	63	63	°F
Leaving Air Temperature- Heating	85	85	°F
Cooling Capacity	115	115	Tons
Entering Air Temperature DB- Cooling	77.5	77.5	°F
Entering Air Temperature WB- Cooling	64.3	64.3	°F
Ambient Temperature- Cooling	89.1	89.1	°F

Table 3 – Rooftop Unit Schedule

Distribution

An essential part of any mechanical system is the delivery of air from the air handling unit to the occupied space. In this case, outdoor air and return air mix in the packaged rooftop units' mixing boxes where a portion of that air is exhausted, the rest of be recycled and sent through the system. Once that mixed air is re-filtered and re-conditioned in one of the two RTU's, it is pushed through one of two central shafts that run vertically through the center of the building. From these shafts, main branch ducts at every floor deliver supply air to individual terminal boxes where the air is then supplied to the space. If, in some cases, the run of duct work is over an extended length of duct, existing hot water duct reheat coils have been retained to increase the supply air temperature during the heating season. This is especially applicable to perimeter spaces. If a future designer desires the use of a fan-coil unit or a reheat coil in a VAV box, the ability to tap off of the main hot water supply line is feasible.

Supply Fans				
Unit	Type	hp	CFM	Service
RTU-1	AHU	75	45000	Whole Building
RTU-2	AHU	75	45000	Whole Building
FPCV-A	Terminal	1/6	200	Office Space
FPCV-B	Terminal	1/6	350	Office Space
FPCV-C	Terminal	1/4	750	Office Space
FPCV-D	Terminal	1/2	1000	Office Space
FPCV-E	Terminal	3/4	1400	Office Space
FPCV-F	Terminal	1	1800	Office Space
FPCV-G	Terminal	1	2300	Office Space
FPVV-A	Terminal	1/6	200	Office Space
FPVV-B	Terminal	1/6	350	Office Space
FPVV-C	Terminal	1/4	750	Office Space
FPVV-D	Terminal	1/2	1000	Office Space
FPVV-E	Terminal	3/4	1400	Office Space
FPVV-F	Terminal	1	1800	Office Space
FPVV-G	Terminal	1	2400	Office Space

Table 4 – Supply Fan Data

Return/Exhaust Fan Compliance				
Unit	Type	hp	CFM	Service
EF-1	Exhaust	1	3500	Restrooms
RTU-1	Return	40	40500	Whole Building
RTU-2	Return	40	40500	Whole Building

Table 5 – Return/Exhaust Fan Data

Terminal Units

Because the building is a tenant fit out, there is a variety of potential system designs that could be implemented in conjunction with the base building mechanical systems. According to the design engineer, VAV boxes, fan-powered boxes, or a number of other terminal units can be used to supply air to individual spaces. In the event that supplemental heat is needed, hot water from the boilers can be made available, though this should be a last resort. It is the intention of the owner and designer that the boilers be used as little as possible.

Air Exhaust/Return System

Once the air has passed through the occupied space, it is returned through a pressurized ceiling plenum where it is drawn by a return fan in the RTU's. A certain percentage of that air is exhausted, the remainder to go through the process again. Restroom exhaust is handled by a separate duct that runs through a separate vertical shaft as the supply/return air (one additional shaft for each side of the building). Any additional exhaust requirements, such as kitchen hoods can be connected to the restroom exhaust shafts. 100% of this restroom air is exhausted; none of it is recirculated.

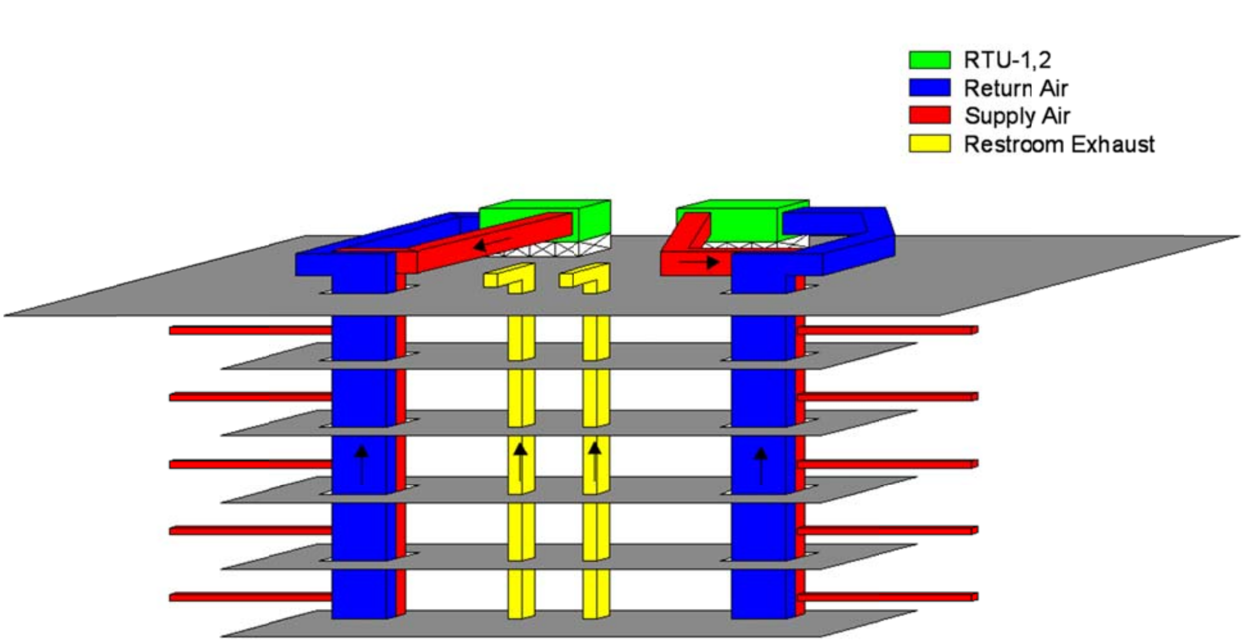

Figure 1 – Air Circulation Schematic

Seen above in Figure 1, the air circulation for Park Place 1 begins and ends on the roof. The RTU's shown in green above, are located just outside of the rooftop penthouse. The supply air ducts are shown in red and run to all occupied spaces on floors one through five. The air leaves from the unit, enters into the rooftop penthouse, is pushed down through one of two vertical shafts, and then is distributed through branch ducts to terminal boxes. The blue return ducts shown above are similar except that in place of branch ducts, a pressurized ceiling plenum returns air to the RTU's. The two ducts shown in yellow are restroom exhaust shafts that are completely separate of the rest of the mechanical system. These two shafts are powered by two exhaust fans located within the rooftop penthouse.

Hot Water System

The existing gas fired boilers may or may not remain throughout the renovation. The owner has opted to see multiple cost alternatives to keeping the system or not. If they do remain, these boilers will provide 180°F water that will be used for duct reheat coils and heating coils located in future terminal boxes. The water is pumped from the boilers through two inline pumps located adjacent to the boilers. Again, the hot water system is to be used as supplemental heat, if at all.

Lost Usable Space

The lost usable space in Park Place 1 due to mechanical equipment is almost negligible. Because the building has a rooftop penthouse that houses all mechanical equipment, none of the potentially occupied spaces are filled with heating or cooling equipment. This allows for the owner to rent out a greater percentage of the building's floor space and maximize profit. The small amount of waste that is created is from the mechanical shafts that run through the center of the building. This accounts for around 80 square feet of floor space per floor which is the size of a closet or small office. The ceiling plenum also requires vertical space but for office type occupancy, has little to no effect on the profit per square foot to the owner.

Ventilation Requirements

An in depth ventilation requirement study was performed on the building in Technical Report 1 for Park Place 1. The results of that report can be seen below in Table 6.

Outdoor Air Requirement		
E_v		0.9
Max Z_p		0.16
CFM of OA required- 1st Floor		3154
CFM of OA required- 2nd through 5th Floor		11411
Total Building OA Requirement (CFM)		14565
Available OA (CFM)	Minimum	9,000
	Maximum	up to 90,000

Table 6 – Outdoor Air Requirement

An individual space analysis was done for all occupied spaces. Only the totals are shown in Table 6 above. The important thing to note is that only the base building systems are truly being analyzed due to the fact that the building is a tenant fit out. The base building systems are more than capable of delivering the proper amount of outdoor air.

Heating and Cooling Loads

As part of the requirements for Technical Report 2, a total building energy simulation was done using Trane Trace 700. The total building load summary can be seen below in Figure

2 as an output of Trace 700. From this figure, it can be seen that the total cooling load required is about 225 Tons.

COOLING COIL PEAK					CLG SPACE PEAK	
Peaked at Time:		Mo/Hr: 7 / 15			Mo/Hr: 7 / 15	
Outside Air:		OADB/WB/HR: 86 / 71 / 95			OADB: 86	
	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	0	294,375	294,375	11	0	0
Glass Solar	343,786	0	343,786	13	343,786	24
Glass/Door Cond	101,024	0	101,024	4	101,024	7
Wall Cond	22,291	5,844	28,135	1	22,291	2
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	630,643		630,643	23	239,298	17
Sub Total ==>	1,097,744	300,218	1,397,962	52	706,399	50
Internal Loads						
Lights	279,353	69,838	349,191	13	279,353	20
People	306,629	0	306,629	11	170,350	12
Misc	166,281	0	166,281	6	166,281	12
Sub Total ==>	752,263	69,838	822,102	30	615,984	43
Ceiling Load	95,733	-95,733	0	0	95,733	7
Ventilation Load	0	0	304,412	11	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		-95,252	-95,252	-4		
Sup. Fan Heat			275,562	10		
Ret. Fan Heat		1	1	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	1,945,740	179,073	2,704,787	100.00	1,418,116	100.00

Figure 2 – Cooling Requirement Breakdown and Total

The heating requirement can be seen below in Figure 3. Both calculations are only approximations. A comparison between the modeled building and the installed equipment capacities as dictated by the design engineer can be seen below in Table 5.

HEATING COIL PEAK

Mo/Hr: Heating Design
OADB: 5

	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	0	-254,353	17.94
Glass Solar	0	0	0.00
Glass/Door Cond	-651,402	-651,402	45.95
Wall Cond	-123,223	-164,747	11.62
Partition/Door	0	0	0.00
Floor	0	0	0.00
Adjacent Floor	0	0	0
Infiltration	-1,414,035	-1,414,035	99.74
Sub Total ==>	-2,188,661	-2,484,538	175.24
Internal Loads			
Lights	13,303	16,628	-1.17
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	13,303	16,628	-1.17
Ceiling Load	-125,709	0	0.00
Ventilation Load	0	-678,912	47.89
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	1,769,274	1,769,274	-124.79
Exhaust Heat		124,859	-8.81
OA Preheat Diff.		-2,586	0.18
RA Preheat Diff.		-162,497	11.46
Additional Reheat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-531,793	-1,417,772	100.00

Figure 3 – Heating Requirement Breakdown and Total

Load Comparison vs. Designed Equipment Capacity			
Modeled		Designed	
Season	Load	Equipment Name	Equipment Capacity
Cooling	225.4 Tons	RTU-1,2	230 Tons
Heating	-1417.8 MBh	RTU-1,2	1,100 MBh
		Boiler 1,2	970 MBh

Table 7 – Load Comparison vs. Designed Equipment Capacity

Table 7 above shows that the designed cooling and heating equipment is similar in capacity to the results produced by the energy calculation done by Trane Trace 700. The boiler is to be considered a redundant piece of equipment that may or may not be used in the future.

Energy – Consumption, Cost, & Sources

Consumption

Figure 4 below shows the breakdown in energy consumption of the estimated building model. The model shows that the building is dominated by its heating load, which makes sense because the winter in Pittsburgh is cold and the summers are generally milder when cooling would be required. The fan energy takes into account both heating and cooling seasons which explains why it is fairly large. The receptacle and lighting consumption is reasonable for an office building.

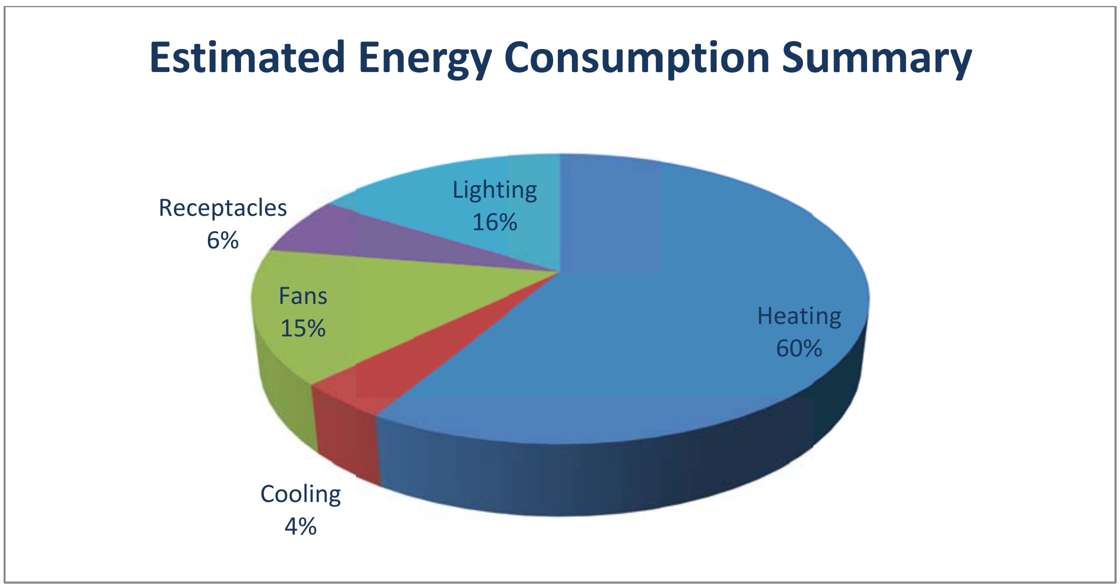

Figure 4 – Estimated Energy Consumption Summary

An important piece of information in the study of this building is the use of existing records of energy consumption and how they relate to the energy model output. The difficulty is that the building is not totally occupied in real life, yet it has been modeled as though it is. According to the owner, the building is about one-half occupied. As an assumption, increasing the heating requirement by a factor of two should represent a fully occupied building. Based on February of 2010 records for heating energy consumption and assuming full building occupancy, the model is only 3.5% different from the actual records. The results of the calculation are shown below in Table 8.

Reported Energy Consumption	Estimated Energy Consumption	% Difference
7130 therms	7389 therms	3.50%

Table 8 – Estimated vs. Actual Energy Consumption for February 2010

The annual energy consumption was calculated by Trace 700 as a part of the energy model for the entire building. The consumption is divided into electricity which is used by the RTU's, fans, pumps, receptacles, and lights. The other source of energy is gas which is consumed entirely for heating purposes. Shown below in Table 9 is the output report from Trace 700 showing the monthly energy consumption for a typical year.

	Monthly Energy Consumption													
	Month	January	February	March	April	May	June	July	August	September	October	November	December	Total
Electric	Consumption (kWh)	65,948	59,327	66,822	54,480	60,542	77,314	83,072	70,180	53,789	59,651	59,721	62,901	773,746
	Demand (kW)	199	198	215	219	387	500	541	452	351	216	215	199	541
Gas	Consumption (therms)	7,887	7,389	5,870	1,914	153	0	0	0	268	2,487	3,739	6,650	36,357

Table 9 – Monthly Energy Consumption

Sources

The energy costs for the building are determined by the resource providers which in this case are Duquesne Light and Columbia Gas. Shown below in Figure 5 is the distribution map of electricity providers for Pennsylvania. Findlay Township is located in the region shaded by orange.

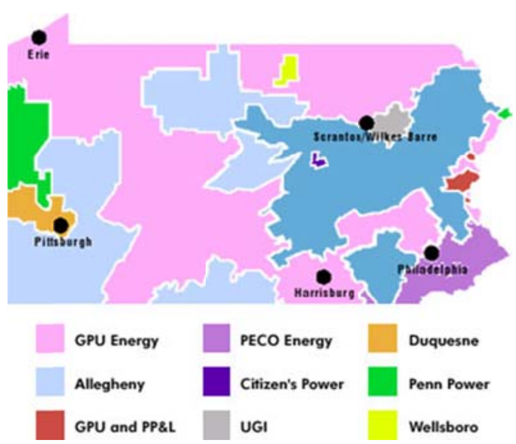

Figure 5 – Pennsylvania Power Distribution

Cost

The building operating cost is determined by cost of utilities given the sources shown above. The primary costs will be electricity and natural gas. The corresponding rates are shown below in Tables 10 and 11.

Duquesne Light Electricity Rates	
Demand	Usage
7.07 $/kW	0.1236 cents/kWh

Table 10 – Electricity Rates

Table 10 above shows the cost for both electric demand and usage of Duquesne Light. The demand is broken down into two subdivisions. The first stipulation is that if the demand is less than 300 kW, then the cost per kW is 7.07 $/kW. If the demand exceeds 300 kW, then the cost is reduced to 6.45 $/kW. These values are based on the assumption that Park Place 1 falls into the category of General Service Large. Table 11 provides the cost of natural gas for Park Place 1.

Pennsylvania Natural Gas Rate
8.9 $/MCF

Table 11 – Natural Gas Rates

The following charts display the monthly, as well as overall, energy costs for Park Place 1. The analysis is separated by energy type.

Electricity Cost				
	Consumption (kWh)	$	Demand (kW)	$
January	65,948	8,151.17	199	1,406.93
February	59,327	7,332.82	198	1,399.86
March	66,822	8,259.20	215	1,520.05
April	54,480	6,733.73	219	1,548.33
May	60,542	7,482.99	387	2,682.15
June	77,314	9,556.01	500	3,411.00
July	83,072	10,267.70	541	3,675.45
August	70,180	8,674.25	452	3,101.40
September	53,789	6,648.32	351	2,449.95
October	59,651	7,372.86	216	1,527.12
November	59,721	7,381.52	215	1,520.05
December	62,901	7,774.56	199	1,406.93
	Total	95,635.13	Total	25,649.22

Total Cost/Year	$121,284.35

Table 12 – Electricity Cost

The total energy cost for the building will be the sum of the electric energy cost from Table 12 above and the total natural gas cost from Table 13 below. When added together, this figure comes out to be $153,642.09 for the entire year. This number seems reasonable for a building of such size and occupancy.

Natural Gas Cost			
	therms	MCF	$
January	7,887	788.7	7019.43
February	7,389	738.9	6576.21
March	5,870	587	5224.3
April	1,914	191.4	1703.46
May	153	15.3	136.17
June	0	0	0
July	0	0	0
August	0	0	0
September	268	26.8	238.52
October	2,487	248.7	2213.43
November	3,739	373.9	3327.71
December	6,650	665	5918.5
		Total	32,358

Total Cost/Year	$32,357.73

Table 13 – Natural Gas Cost

Table 14 below shows the breakdown by percentage of energy use in the building.

Energy Cost Breakdown			
Element	Yearly Cost of Operation	$/SF	% of Total
Heating	$32,357.73	$0.32	21.0%
Lighting	$47,300.90	$0.46	30.8%
Receptacles	$17,707.51	$0.17	11.5%
Fans	$44,268.79	$0.43	28.8%
Cooling	$12,128.43	$0.12	7.9%
Total	$153,763.36	$1.50	100.0%

Table 14 – Energy Cost Breakdown by Element

LEED Major Renovation Discussion

Because of building age and profitability, the ownership of Park Place 1 decided not to pursue a LEED certification. The existing building systems were deemed to be reasonable and with modernization would be acceptable. If a LEED certification were to be pursued, several credits could, in all likelihood, be attained. The breakdown of potential, mechanical system related, credits are shown below.

LEED NC 2.2 For Major Renovation Study			
Energy & Atmosphere	**Yes**	**No**	**Possible**
EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems	1		
EA Prerequisite 2: Minimum Energy Performance		1	
EA Prerequisite 3: Fundamental Refrigerant Management	1		
EA Credit 1: Optimize Energy Performance			1
EA Credit 2: On-Site Renewable Energy		1	
EA Credit 3: Enhanced Commissioning			1
EA Credit 4: Enhanced Refrigerant Management			1
EA Credit 5: Measurement & Verification			1
EA Credit 6: Green Power			1
Indoor Environmental Quality			
EQ Prerequisite 1: Minimum IAQ Performance	1		
EQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control	1		
EQ Credit 1: Outdoor Air Delivery Monitoring	1		
EQ Credit 2: Increased Ventilation			1
EQ Credit 3.1: Construction IAQ Management Plan: During Construction		1	
EQ Credit 3.2: Construction IAQ Management Plan: Before Occupancy		1	
EQ Credit 4.1: Low-Emitting Materials: Adhesives & Sealants		1	
EQ Credit 4.2: Low-Emitting Materials: Paints & Coatings		1	
EQ Credit 4.3: Low-Emitting Materials: Carpet Systems		1	
EQ Credit 4.4: Low-Emitting Materials: Composite Wood & Agrifiber Products		1	
EQ Credit 5: Indoor Chemical & Pollutant Source Control		1	
EQ Credit 7.1: Thermal Comfort: Design			1
EQ Credit 7.2: Thermal Comfort: Verification			1

Table 15 – LEED NC 2.2 For Major Renovation Study

It is clear based on Table 15 that it would be a stretch for Park Place 1 to seek a LEED certification. The biggest barrier is the failure of Park Place 1 to comply with ASHRAE Standard 90.1. Because this is a prerequisite, Park Place 1 would need to comply as a minimum before even considering any of the other credits.

Evaluation of System

When Park Place 1 was originally constructed, it was done so with the intention that an interior air handler would use a split system for cooling and a gas fired boiler for heating. Because the two systems were separate, the controls were complicated and the system did not perform well. This caused inefficiencies and unhappy tenants. When DiCicco Development purchased the building and decided to improve the mechanical systems, they made an excellent choice to consolidate the two systems into one.

While some buildings have a hot/chilled water system, the design engineers saw an opportunity to economically use an air only system. Park Place 1 does have a hot water system but no chilled water system. To combine the two systems into one with a changeover would have been costly and required the further purchase of cooling equipment. The option of using modern rooftop units capable of providing both heating and cooling would eliminate the need for the boiler, pumps, and water system as a whole. Also, because the RTU's are new, they function more efficiently, are more reliable, easier to control, and require one service contract as opposed to several. While they are probably not the most energy efficient or cheapest choice over the life of the equipment, they come with minimal first cost and reliability. When the design considerations were taken into account, modern rooftop units were probably one best choices to meet the needs of the owner.

There is still some room for investigation however. Park Place 1 offers many opportunities for systems with higher first cost but lower operating cost. These systems will be explored throughout the rest of this study.

References

ASHRAE Handbook of Fundamentals 2005

CJL Engineering, Park Place Corporate Center One Renovation Mechanical, Electrical, and Plumbing Drawings and Specifications

DiCicco Development

LEED NC 2.2 Rating System

Past Thesis Technical Reports, e-Studio Archives, 2009-2010

WTW Architects, Park Place Corporate Center One Drawings

APPENDIX A

List of Figures and Tables

List of Figures

List of Tables