Mechanical Technical Assignment Two
Building and Plant Energy Analysis Report

The Hospital for Special Surgery River Building
New York, New York

Prepared For:

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1 Executive Summary

In recent times, the global energy market is seeing an energy crisis as China and India are demanding more energy than the amount produced. Due to this, many buildings are considering using less energy and developing "greener" designs. Many standards and qualifications have been developed in order to assess current buildings energy and environmental impacts. Such standards and qualifications can be seen in ASHRAE Standard 90.1-2004 and LEED NC 2.2. ASHRAE 90.1-2004 provides "minimum requirements for the energy-efficient design of buildings" and LEED NC 2.2 provides a "national benchmark for high performance green buildings".

The Hospital for Special Surgery River Building raises twelve stories high on the Upper Eastside of Manhattan, right above the FDR Drive. This report will investigate the HSS River Building plant and energy performance to determine whether or not it complies with ASHRAE 90.1-2004, and meets LEED certification. This report will also calculate and analyze the annual building energy costs, demands, and loss of rentable square footage of the building due to the mechanical system.

During analysis, software programs such as Trane Trace, ComCheck and EnvStd were used to calculate energy modeling, interior lighting and building envelope compliance with ASHRAE 90.1 respectively. Trane Trace also helped in calculating building energy costs. Information needed for the analysis was gathered from the 100% Pricing Set, 2005 ASHRAE Fundamentals Handbook, HSS Specifications Manual, RS Means Mechanical 2007 and Cannon Design HVAC Designers.

In conclusion, the HSS River building did not meet half of the requirements set forth by ASHRAE 90.1-2004. Some areas that did not comply are interior lighting wattage consumption, and mechanical equipment efficiency. But overall, the building had a 7% reduction in wattage usage specified by ASHRAE 90.1. The HSS River building was not designed for LEED certification of any stature and when assessed, it tallied 17 points, falling short to meet the 26 point minimum for the first class of certification. If some changes are made during the final design phase, the HSS River Building may be able to obtain a LEED Silver rating.

The HSS River building's mechanical system cost \$40/ft^2 equaling \$3.5 million. The building uses 2,500,000 kWhr of energy a year equaling \$3.5 million in annual energy costs. Overall the HVAC accounted for 38% of the energy use while the majority went to receptacle loads.

The entire building contains 88,425 ft^2 of gross area, with 88% of that being rentable (78,382 ft^2). The HVAC equipment in the building takes up less than 1% of the rentable area as all of the equipment is housed in the penthouse and concealed in the plenum.

2 ASHRAE Standard 90.1-2004

Building Envelope

ASHRAE Standard 90.1-2004 sets forth a "minimum requirements for the energy-efficient design of buildings". Specifically, Section 5 provides requirements for the building envelope by the Prescriptive Building Envelope method or the Building Envelope Trade-Off method. The standards states that the total vertical fenestration must not exceed 50% of the gross wall area in order to use the Prescriptive Building Envelope option. Since the HSS River Building is constructed with a curtain wall system, it exceeds the 50% (**Appendix A**) requirement; therefore, the Building Envelope Trade-Off method will be performed instead.

East Elevation

North Elevation

South Elevation

Here are the conditions to calculate the compliance to ASHRAE 90.1-2004, Section 5:

- Location: New York, New York - LaGuardia Airport
- Climate zone: 4A
- Fenestration: 61% **(Appendix A)**
- Typical floor area: 8,853[sq.ft.]
- Typical floor height: 12 [ft]
- Typical wall area: 1129 [sq.ft.]
- Typical wall type:
    1. Curtain Wall, U-0.290, R-5, 1-in Frame

2. Zinc Panel, U-0.038, R-18 insulation

- Typical glazing type:
    1. GL-1, Viracon 1-2M, U-0.29, SHGC-0.380
    2. GL-4,Viracon 8-85, U-0.31, SHGC-0.320
- North, South and East Elevations are 100% glazing. West elevation is 100% Zinc Paneling.

The Building Envelope Trade-Off method is more flexible than the Prescriptive Approach method. It requires the Envelope Performance Factor Standard (EPF standard) to be higher than the design envelope of the building (EPF proposed). Due to the complexity in nature of the Building Envelope Factor, EnvStd 4.0 by AEC was used to calculate the compliance.

In conclusion, the HSS River Building complied with ASHRAE 90.1-2004 Section 4 as the EPF Proposed of 2341 was less than the EPF Standard of 2364. Please refer to **Appendix B** for detailed analysis of the compliance.

Heating, Ventilating, and Air Conditioning

Section 6 in ASHRAE 90.1-2004 provides requirements for "mechanical equipment and systems serving the heating, cooling, or ventilating needs of new buildings". There are two methods to comply with Section 6, the Simplified Approach option or the Prescriptive Path. Due to the fact that the building as a gross floor area of more than 25,000 sq.ft, the Simplified Approach method cannot be used. In this case, the Mandatory Provisions approach will be assessed. The Mandatory Provision lists the equipment being used in the building and compares its efficiency performance to the standard. The rated equipments in the HSS River building are:

- (10) Typical Terminal Air Cooled Heat Pumps (9,00-61,000 BTU)
- (1) 375 Tons Cooling Tower
- (1) 13,000 CFM, 20HP Motor Fan

By comparing these equipments to ASHRAE 90.1 Section 6, it is found that most of them do not comply as shown below:

Table 1 – ASHRAE Mechanical Equipment Compliance

Terminal Air Cooled Heat Pumps				
Unit Label	BTU/H	EER	ASHRAE 90.1 Rating	Compliance
A	8618	11.01	11.2	No
B	12330	10.69	12	No
C	15498	12.49	12	Yes
D	19303	11.86	12	No
E	24033	11.61	12	No
F	32154	12.35	12	Yes
G	35823	12.08	12	Yes
H	41558	12.19	12	Yes
I	46822	11.6	12	No
J	61067	11.46	12	No
917 GPM, 20 HP, 375 Tons Cooling Tower				
GPM/HP			ASHRAE 90.1 Rating	Compliance
30.56			38.3	No
13,000 CFM, 20 HP Air Handler Fan				
HP/CFM			ASHRAE 90.1 Rating	Compliance
1.5/1000			1.2/1000	No

In conclusion, by comparing the design mechanical equipment with the standards, 6 out of 10 typical terminal air cooled heat pumps did not comply with ASHRAE 90.1 EER requirements. The 375 ton cooling tower did not comply with ASHRAE 90.1 GPM/HP requirements. And lastly, the fan in the air handling unit also did not comply with the 1.2HP/1000CFM compliance specified in Section 6.

Interior Lighting System

Section 9 in ASHRAE 90.1 provides requirements for interior lighting wattage usage. In order to comply with ASHRAE 90.1 Section 9, there are again two methods in doing so. One method is the Building Area Method and the second is Space by Space Method. In this report, analysis of the lighting system will be done by the Building Area Method and here are the steps:

1. Determine the building space type from Table 9.5.1 (ASHRAE 90.1-2004) and its allowed lighting power density [W/Ft2].
2. Calculate the total floor area of each building space type.
3. Multiply **Step 2** with the power density found in **Step 1**.
4. Sum up all the allowances in each different area to determine the interior lighting power allowance.
5. Sum up all the designed interior lighting power. This must not exceed the interior power allowance.

For analysis, the 100% Bid Price Set drawings were used to determine each building function area as well as number of luminaires used and wattages. ComCheck 3.5 by the US Department of Energy is a computer program used to help organize and determine whether or not HSS River Building complied with Section 9. The building space types at HSS River building include:

- Hospital: Exam/Treatment 1.5 W/ft^2
- Corridors 1.0 W/ft^2
- Office – Enclosed 1.1 W/ft^2
- Dressing/Locker/Changing 0.6 W/ft^2
- Gymnasium/Exercise Center 0.9 W/ft^2
- Lobby 1.3 W/ft^2
- Conference/Lounge 1.3 W/ft^2
- Hospital: Active Storage 0.9 W/ft^2

In conclusion, the HSS River building complies and exceeds overall ASHRAE 90.1 Section 9 requirements by 9%, even though the exam rooms, and locker/changing rooms did not comply for their area type individually. Please refer to **Appendix C** for a detailed breakdown of wattage luminaire schedules per area type and compliance calculations.

3 LEED NC 2.2 Certification Rating

The Leadership in Energy and Environmental Design (LEED) rating system is a national benchmark for the design, construction and operation of high performance buildings created by the United States Green Building Council (USGBC). It provides a systematic assessment of buildings in five areas of Sustainable Sites, Water Efficiency, Energy and Atmosphere, Material Resources, and Environmental Quality. The last category of Innovation in Design is intended for recognizing "projects for innovative building features and sustainable building knowledge". The rating system tallies points from each section and together, they are clustered into certification titles. The breakdown is as follows:

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

When the HSS River Building was designed, the designer and engineer did not design the building intending to receive any LEED certification. This can be due to many reasons such as the owner's request, the cost inquired, or any other decision choices. When analyzed, the HSS River Building received the following secured and possible points:

Table 2 – LEED NC 2.2 Points

	Sustainable Sites	Water Efficiency	Energy and Atmosphere	Materials and Resources	Indoor Environmental Quality	Innovation in Design	Total
Secure Points	4	2	0	0	10	1	17
Possible Points	2	2	6	6	3	0	19

Through the assessment, the HSS River Building falls short on receiving LEED Certified status by 9 points. But if the designers were able to adjust minor changes during the late design phase, the HSS River Building would be able to obtained 36 points, making it a LEED Silver building. Some of the possible points and their reason for feasibility are as follows:

Site Selection – 2 possible points

Credit 7.1 – Heat Island Effect, Non-Roof – The HSS River Building is in fact sitting on top of the FDR Drive, covering 100% of it on the site area. Though LEED does not specifically write out covering roads with a building, a Credit Information Request (CRI) can be done and I am confident this credit can be obtained easily without additional cost or changes.

Credit 7.2 – Heat Island Effect, Roof – By providing high albedo materials in OPTION 3 of Credit 7.2, HSS River Building can achieve one point by simply specifying a different material for its rooftop.

Water Efficiency – 2 possible points

Credit 3.1 & 3.2 – Water Use Reduction, 20% and 30% - The HSS River Building is designed with standard plumbing fixtures that can be replaced with higher efficiency fixtures, dry fixtures or sensors to reduce water usage. Though this does require resizing plumbing piping to handle a new and reduced load, the points are still very possible to achieve during the late design phase.

Energy & Atmosphere – 6 possible points

Credit 1 – Optimize Energy Performance – Since an energy analysis under Building Performance Rating Method in Appendix G of ASHRAE was not performed, the HSS River Building did not receive any points from this credit. With 3 points equaling 17.5% reduction in energy costs, I am very confident that these points can be obtained through minor adjustments.

Credit 3 – Enhanced Commissioning – By providing a review during construction documents, a review of contractor submittals, and a systems manual, the HSS River Building would be able to achieve this credit while also training maintenance workers and reviewing the building within 10 months.

Credit 4 – Enhanced Refrigerant Management – By calculating the global warming and ozone depletion potential and having both be less than a value of 100, the HSS River Building will be able to obtain this credit.

Credit 5 – Measurement & Verification – The HSS River Building will obtain this credit easily by developing and providing a Measurement & Verification Plan for the building.

Materials & Resources – 6 possible points

Credit 2.1 and 2.1 – Construction Waste Management, Divert 50% - 70% from Disposal – Communicating with the contractor can help significantly reduce the overall construction waste. By diverting 70% of the waste to recyclers by sorting waste, these credits can be easily

obtained.

Credit 4.1 and 4.2 – Recycled Content 10% and 20% - Since materials in this category can be counted for one or more credits, this credit can be integrated with Credit 5.1 and 5.2 by simply researching and specifying local recycled materials.

Credit 5.1 and 5.2 – Regional Materials, 10% -20% - Communicating with the contractor can help significantly reduce the distance of materials being hauled and processed. Being that the HSS River Building is in New York City, a 500 mile radius around New York provides plenty of material choices to be harvested and processed locally.

Indoor Environmental Quality – 3 possible points

Credit 1 – Outdoor Air Delivery Monitoring – Adding a couple more controls sequences in the HVAC controls by installing Co2 sensors and outdoor air measurements will allow the HSS River Building to monitor outdoor air quality and gain this point.

Credit 3.2 – Construction IAQ Management Plan, Before Occupancy – Performing a flush out and bringing 100% outdoor air into the building before occupancy in OPTION 1 will obtain a point for this credit. If done during the right weather conditions, the air will not have to be conditioned and will not use more energy to flush out the building.

Credit 7.2 – Thermal Comfort – Verification – By implementing a thermal comfort survey and a plan to correct whatever is wrong 6 to 18 months will achieve this credit. By designing an efficient and controllable mechanical system, the survey can perhaps result in minor or little changes needed for the system.

In conclusion, the HSS River Building can obtain 19 more possible points through these recommendations to receive LEED Silver building. Please refer to **Appendix D** for the LEED NC 2.2 Check-list assessing each point as secure, possible, or not achievable.

3 Square Foot Analysis

Since the HSS River Building was originally designed as a Core and Shell, the designers at Cannon Design wanted the maximum amount of square footage available for rent. Also, the building is located in Manhattan, where real estate and land is expensive, adding even more incentive to provide rentable space to the owner.

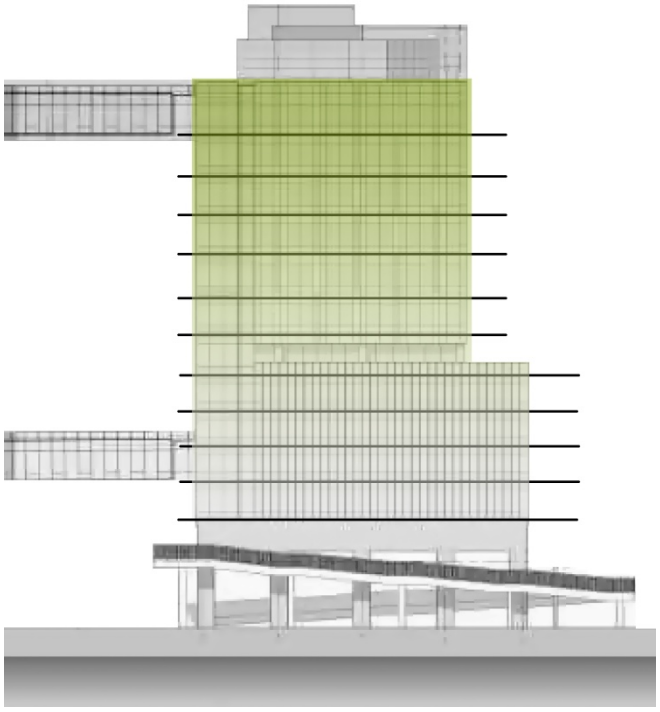


Table 3 – Total Gross Area

	Total Gross Area
12th Floor	7,048 sq. ft.
11th Floor	7,743 sq. ft.
10th Floor	7,078 sq. ft.
9th Floor	7,093 sq. ft.
8th Floor	7,107 sq. ft.
7th Floor	7,218 sq. ft.
6th Floor	6,910 sq. ft.
5th Floor	9,175 sq. ft.
4th Floor	9,187 sq. ft.
3rd Floor	9,880 sq. ft.
2nd Floor	9,806 sq. ft.
Total	88,245 sq. ft.

The HSS River Building contains 11 rentable floors with a total gross area of 88,245 sq. ft. Each floor has a different floor area due to the geometry of the building slanting toward the top on the east side. A typical floor area is shown below. The mechanical room is located at the penthouse of the building, above all occupying floors preventing rentable area loss.

In order to calculate the amount of rentable space available, the area of the columns, core, and mechanical shafts had to be subtracted from the gross area per floor. They are as follows:

- Core 836 sq.ft./floor
- Columns 62 sq.ft./floor
- Mech. Shafts 68 sq.ft./floor

Table 4 – Total Rentable Area

	Total Rentable
12th Floor	6151 sq. ft.
11th Floor	6846 sq. ft.
10th Floor	6181 sq. ft.
9th Floor	6196 sq. ft.
8th Floor	6210 sq. ft.
7th Floor	6321 sq. ft.
6th Floor	6013 sq. ft.
5th Floor	8278 sq. ft.
4th Floor	8290 sq. ft.
3rd Floor	8983 sq. ft.
2nd Floor	8909 sq. ft.
Total	78382 sq. ft.

In conclusion, 88% of the total gross floor area is rentable for the owner and only 1% of the floor area is being used for mechanical shafts. By placing the mechanical equipments such as the air handler, heat exchangers, and pumps up in the penthouse, it saves considerable amounts of floor space. Also, terminal heat pump units are ceiling hung, thus preventing loss of rentable space for the client.

4 Building Simulated Model

Design Load Analysis

In order to model the energy performance and annual costs of the HSS River Building, Trane Trace 700 was used to model the building's energy. The data that were collected came from drawings provided by Cannon Design. The information coming from the drawings were:

- Room areas and dimensions
- Number of people
- Wall types
- Window Types
- Wall orientation
- Mechanical equipment details
- Mechanical design descriptions
- Internal loads such as lighting, receptacles, and people

The analysis was done by setting up each 450 rooms with its orientation, area, wall construction, and internal loads. After all the rooms were set up, all 157 terminal heat pump units were created and matched to its corresponding serving zones. Other mechanical equipments were then added such as the cooling tower, pumps, and heat exchangers. The core containing elevators and stairs were not modeled because the building area was large enough for them to be insignificant. Other conditions that were needed to model the building were:

- Location: New York, New York
- Load Schedule:

	Lighting	People
12am - 7am	30%	5%
7am - 5pm	100%	100%
5pm - 8pm	80%	30%
8pm - 12am	30%	5%

Appendix E *contains additional Trane Trace inputs used to run the energy model.*

By comparing the modeled building with the actual design, the HSS River Building mechanical equipments were found to be well designed. The tables below shows the difference between the design cooling load, and ventilation supply for the whole building as only one air handling unit serves the entire building. The supply air was summed up by all the terminal heat pump units and compared with the computed value.

Table 5 – Computed and Designed Loads

	Cooling Load	Supply Air	Ventilation Supply
Computed	362 ft^2/Ton	0.91 cfm/ft^2	0.15 cfm/ft^2
Designed	415 ft^2/Ton	0.57 cfm/ft^2	0.15 cfm/ft^2

In conclusion, the energy model provided more cooling and supply air than what was designed for the HSS River building. This may be because the computer model perhaps overestimated the internal loads such as receptacle loads for the building. Also, since the building is 60% glass, the wall construction and glass insulation could have been underestimated making the model provide more cooling than necessary. The ventilation supply rate was similar because the same people loads were used in the model and actual design.

Energy Consumption Analysis

The HSS River Building consumes annually 2,500,000 kWhr of energy. 50% of the energy goes to appliance loads, 10% to lighting, and 30% to HVAC equipments.

Figure 1- Energy Consumption Pie Chart.

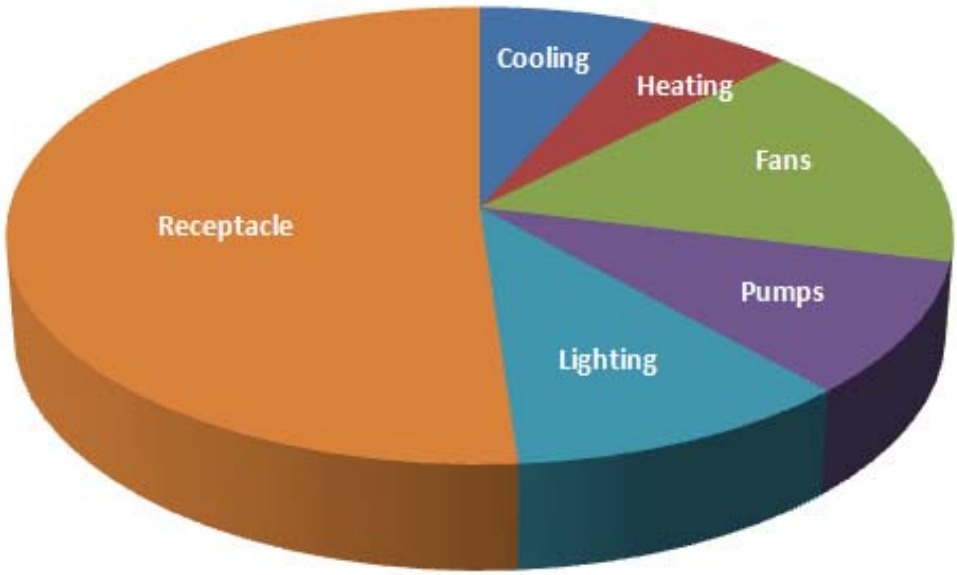


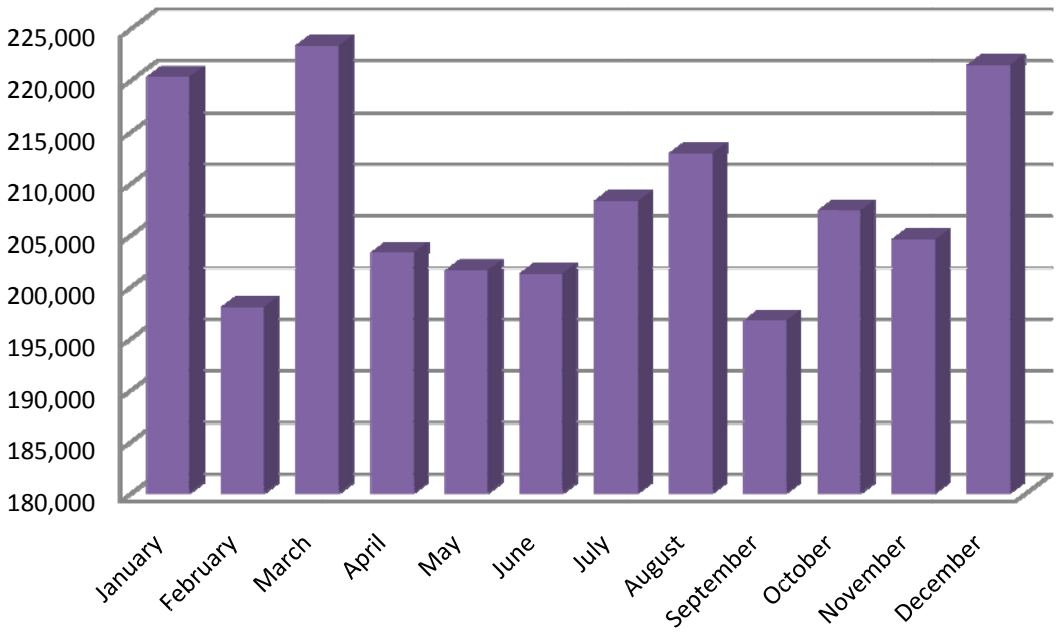
Table 6 – Total Energy Distribution.

5.6%	Heating	139,709 kWh	16.4%	Fans	408,374 kWh
6.8%	Cooling	169,766 kWh	9.5%	Pumps	236,803 kWh
10.6%	Lighting	265,618 kWh	50.1%	Receptacle	1,278,366 kWh

38%	HVAC	954,452 kWh
62%	Non HVAC	1,543,984 kWh

The HSS River building is dominated by receptacle loads because each office room contains a computer, printer, and copier. Also, the exam rooms contain X-Ray machines and other equipment needed to examine patients.

Figure 2 – Monthly Energy Usage.



The graph above shows the amount of kWh used per each month. As suspected, the winter months and peak summer months show the highest use of energy, while the transitional season months do not. There is an anomaly in this chart as February has a low amount of energy use. This could be due to fewer amounts of days in February accounting for less energy use. Another unusual characteristic of the graph is that the summer months use less energy than the winter. Upon re-evaluating the system, all the inputs were correct and a reason for the higher energy use during winter time will need further investigation.

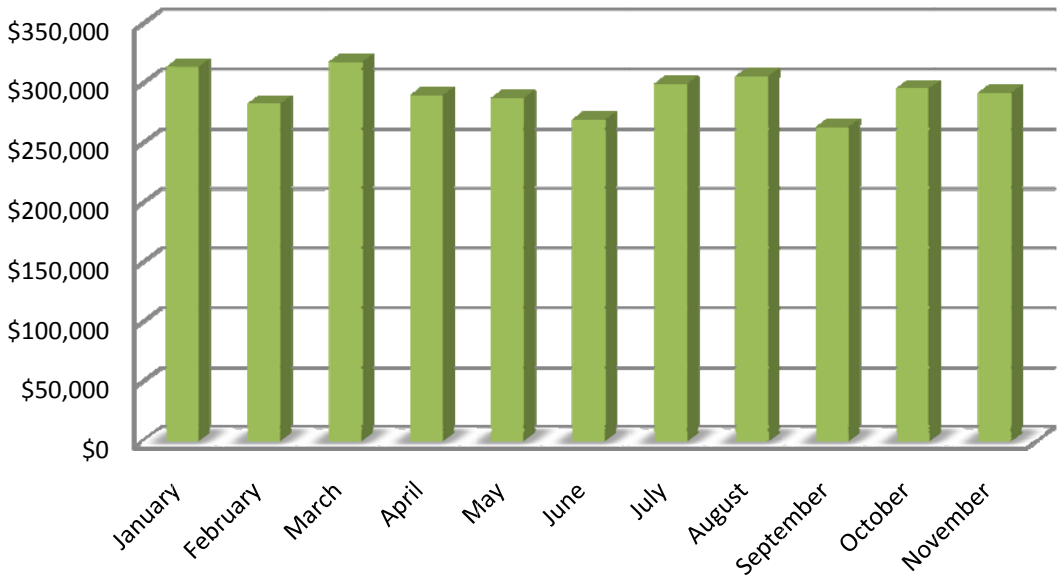
Cost Estimate Analysis

The utility provider for the HSS River building is Consolidated Edison Company (Con Ed). The Hospital for Special Surgery has a contract with Con Ed for a utility rate which is not available for the public. Through Con Edison's website, an estimated on peak demand, on peak consumption, and steam prices are as follows:

- Demand charge – June to September: $15.58/kW
- Demand charge – October to May: $12.04/kW
- Consumption rate: $1.39/kWhr
- Steam – All year: $2.08/therm

Purchased steam from Con Ed is used in the building, but unfortunately there were some technical difficulty specifying the heat exchangers to steam in Trane Trace. For the purpose of this report, steam usage data will not be available.

Figure 3 – Monthly Energy Cost.



The monthly energy cost remains relatively consistent as the demand charge during the summer months are more expensive than the winter and transitional months. The low summer load with the high prices evens out with the high winter loads with low prices. The annual energy cost is $3.5 million.

The River Building was designed as a Core and Shell project, leaving the floor spaces untouched for the owner to decide what to do. Being so, the mechanical installation did not involve diffusers,

balancing and testing, and ductwork leading from the diffuser to the terminal heat pumps. The mechanical equipment and installation cost was a bid package done between the owner and Turner Construction only, making it unavailable to the public. For this report, the estimation came from the 2007 RS Means Mechanical Cost Data book and with the help of Cannon Design HVAC designers through previous jobs with similar mechanical units. The initial mechanical cost breakdown can be found in **Appendix F**. Below are the estimated mechanical initial cost and annual maintenance cost:

- Mechanical initial cost: $40/sq. ft.
- Annual mechanical maintenance cost: $14/sq.ft.

The annual mechanical maintenance cost was estimated with the help from Cannon Design HVAC designers to the following breakdown:

- Maintenance for occupied floors, 4 visits a year: $110,000
- Maintenance for mechanical room, 4 visits a year: $20,000
- Cost of repair parts: $20,000

  Total annual maintenance cost: $150,000

Emission Analysis

Con Edison, the utility provider for the HSS River Building does not generate their own power but rather purchases the electricity from other suppliers. This information would be impossible to get for the emissions calculation as they are confidential to the company. This emission cost is an estimate used by the Department of Energy made possible by a Penn State AE faculty.

Table 6 – Amount of Emissions in Pounds.

Pollutant	NO_x	SO_x	CO_2	Particulates
Pounds	12,655	41,414	7,108,200	3,557

5 References

ASHRAE. 2004, ANSI/ASHRAE, Standard 90.1 – 2004, Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta, GA. 2004.

LEED. 2005, LEED 2005 Green Building Rating System For New Construction & Major Renovations. Leadership in Energy & Environmental Design, Washington, DC. 2003.

Cannon Design. 2007. Mechanical Documents. Cannon Design, New York, New York. 2007

RS Means Company. 2007, RS Means Mechanical Cost Data. RS Means, Kingston, MA. 2006.

Appendix A – Fenestration Calculation

Type	Area (ft2)
Fascade	1,168,340.00
Metal	452,245.25
% Glass	0.61

Appendix B – Building Envelope Compliance

Envelope Compliance Test Results **HSS_River_Building**

Surface_West	Wall	C-2	1129	West	n.a.
Surface_East	Wall	C-1	1129	East	n.a.
Total			4516		

Openings

Name	Type	Const. Code	Area	Orient.	Notes
GL-4	Window	G-2	451	North	n.a.
GL-1	Window	G-1	678	North	n.a.
GL-1	Window	G-1	678	South	n.a.
GL-4	Window	G-2	451	South	n.a.
GL-1	Window	G-1	677	East	n.a.
GL-4	Window	G-2	452	East	n.a.
Total			3386		

Envelope Compliance Test Results **HSS_River_Building**

Project Summary Information
Name: HSS_River_Building
Address: 535 East 70th St
City/State/Zip: New York, New York 10017
Climate Location: N Y La Guardia WSO AP, New York
Standard EnvStd climate data is used for compliance
Floor Area (ft²): 8853
Gross Wall Area (ft²): 4516
Window Area (ft²): 3386
Window Wall Ratio: 0.750
Gross Roof Area (ft²): 0
Skylight Area (ft²): 0
Skylight Roof Ratio: 0.000
Door Area (ft²): 0

Compliance Summary -- PASSES

EPF	Proposed	Standard	Margin
Roofs	0	0	0
Skylights	0	0	0
Exterior Walls and Windows	1645	1657	12
Below-Grade Walls	0	0	0
Floors	0	0	0
Slabs	0	0	0
Daylighting Potential	696	707	11
Total	2341	2364	23

Opaque Construction Schedule

Code	Description	Net Area/Length	U-factor	HC	R-Cav	R-Shth
C-1	User Defined-Wall, Above Grade-Metal Framing-3.5 in. (89 mm) studs at 24 in. (600 mm) o.c.-Wall,_Curtain_Wall (User Defined)	1	0.290	n.a.	5.0	0.0
C-2	User Defined-Wall, Above Grade-Metal Framing-3.5 in. (89 mm) studs at 24 in. (600 mm) o.c.-Wall,_Zinc_Panel (User Defined)	1129	0.038	n.a.	18.0	0.0
Total		1130				

Fenestration Schedule

Code	Description	Area	U-factor	SHGC	SC	Tvis
G-1	User Defined-Window-Fixed-Structural Glazing-Tinted-GL-1 (User Defined)	2032	0.290	0.380	0.442	0.360
G-2	User Defined-Window-Fixed-Structural Glazing-Other-GL-4 (User Defined)	1354	0.310	0.320	0.372	0.570
Total Area		3386				

Space Category: Typical_Floor
Floor Area (ft²): 8853
Gross Wall Area (ft²): 4516
Window Area (ft²): 3386
Window Wall Ratio: 0.750
Gross Roof Area (ft²): 0
Skylight Area (ft²): 0
Skylight Roof Ratio: 0.000
Door Area (ft²): 0

Surfaces

Name	Type	Const. Code	Area	Orient	Notes
Surface_North	Wall	C-1	1129	North	n.a.
Surface_South	Wall	C-1	1129	South	n.a.

ASHRAE/IESNA Standard 90.1-2001 **10/28/07**

Appendix C – ASHRAE 90.1-2004 Lighting Compliance

Type Space	W/ft^2	Area	Required maximum wattage	Fixture Name	Fixture Type	Fixture Wattage	Number of Fixtures	Actual Wattage
Exam/Treatment	1.5	15697	23546	FB5	(4) 32W T8	128	140	17920
				FK10	(2) 24W	48	40	1920
				PC4	(2) 26W Compact	52	120	6240
								26080
Corridors	1	15654	15654	FK10	(2) 24W	48	120	5760
				PY6	(1) 10W Sconce	10	100	1000
				FR11	(2) 32W T8	64	33	2112
				FT6	(1) 32W	32	110	3520
				PC4	(2) 26W Compact	52	14	728
								13120
Office - Enclosed	1.1	25374	27911	FK10	(2) 24W	48	480	23040
				PC4	(2) 26W Compact	52	70	3640
								26680
Dressing/Locker	0.6	2394	1436	PC4	(2) 26W Compact	52	40	2080
Exercise Area	0.9	4121	3709	FK10	(2) 24W	48	26	1248
				PC4	(2) 26W Compact	52	9	468
				FQ4	(1) 32W T8	32	11	352
								2068
Lobby	1.3	9296	12085	PC4	(2) 26W Compact	52	55	2860
				FT5	(1) 32W	32	133	4256
								7116
Conference	1.3	1293	1681	FK10	(2) 24W	48	30	1440

Appendix D – LEED New Construction 2.2 Checklist

Yes	?	No			
4	2	8	**Sustainable Sites**		**14** Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
1			Credit 1	**Site Selection**	1
1			Credit 2	**Development Density & Community Connectivity**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Low-Emitting & Fuel-Efficient Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Site Development,** Protect or Restore Habitat	1
		1	Credit 5.2	**Site Development,** Maximize Open Space	1
		1	Credit 6.1	**Stormwater Design,** Quantity Control	1
		1	Credit 6.2	**Stormwater Design,** Quality Control	1
	1		Credit 7.1	**Heat Island Effect,** Non-Roof	1
	1		Credit 7.2	**Heat Island Effect,** Roof	1
		1	Credit 8	**Light Pollution Reduction**	1

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

	6	2	**Energy & Atmosphere**		**17** Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required

***Note for EAc1**: All LEED for New Construction projects registered after June 26th, 2007 are required to achieve at least two (2) points under EAc1.

	3		Credit 1	**Optimize Energy Performance**	1 to 10
				10.5% New Buildings or 3.5% Existing Building Renovations	1
				14% New Buildings or 7% Existing Building Renovations	2
				17.5% New Buildings or 10.5% Existing Building Renovations	3
				21% New Buildings or 14% Existing Building Renovations	4
				24.5% New Buildings or 17.5% Existing Building Renovations	5
				28% New Buildings or 21% Existing Building Renovations	6
				31.5% New Buildings or 24.5% Existing Building Renovations	7
				35% New Buildings or 28% Existing Building Renovations	8

				38.5% New Buildings or 31.5% Existing Building Renovations	9
				42% New Buildings or 35% Existing Building Renovations	10
		1	Credit 2	**On-Site Renewable Energy**	1 to 3
				2.5% Renewable Energy	1
				7.5% Renewable Energy	2
				12.5% Renewable Energy	3
	1		Credit 3	**Enhanced Commissioning**	1
	1		Credit 4	**Enhanced Refrigerant Management**	1
	1		Credit 5	**Measurement & Verification**	1
		1	Credit 6	**Green Power**	1

continued…

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

Yes	?	No			
10	3	2		**Indoor Environmental Quality**	**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
	1		Credit 1	**Outdoor Air Delivery Monitoring**	1
		1	Credit 2	**Increased Ventilation**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	1		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems**, Lighting	1
1			Credit 6.2	**Controllability of Systems**, Thermal Comfort	1
1			Credit 7.1	**Thermal Comfort**, Design	1

	1		Credit 7.2	**Thermal Comfort**, Verification	1
1			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No			
1				**Innovation & Design Process**	**5** Points

			Credit 1.1	**Innovation in Design**: Provide Specific Title	1
			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
			Credit 1.3	**Innovation in Design**: Provide Specific Title	1
			Credit 1.4	**Innovation in Design**: Provide Specific Title	1
1			Credit 2	**LEED® Accredited Professional**	1
Yes	?	No			
17	19	20		**Project Totals (pre-certification estimates)**	**69** Points

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

Appendix E – Trane Trace 700 Data Inputs

Weather Condition

Summer	Dry bulb	88	°F
	Wet bulb	73	°F
Winter	Dry bulb	15	°F
Clearness	Summer	0.85	
	Winter	0.85	
Ground reflectance	Summer	0.2	
	Winter	0.2	

Wall Construction

Alternative: Alternative 1

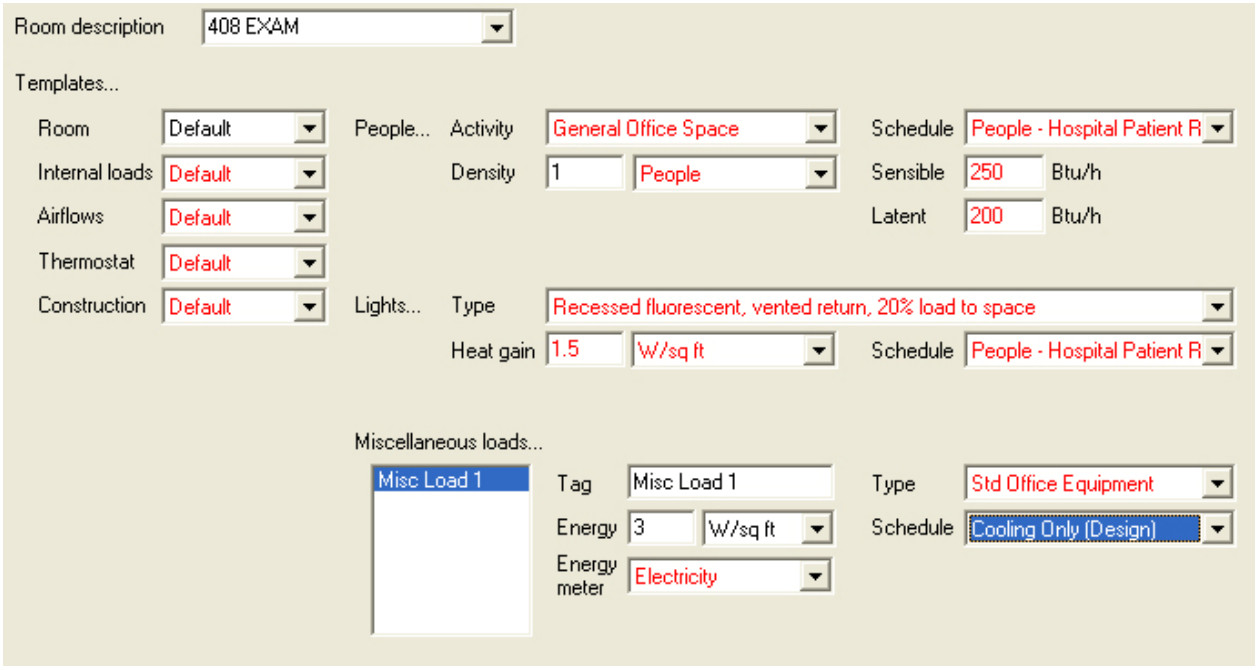
Description: Default

Construction...		U-factor Btu/h·ft²·°F
Floor	4" LW Concrete	0.21261
Roof	4" HW Conc, 4" Ins	0.055
Wall	8" LW Block, 2" Ins	0.09938
Partition	0.75" Gyp Frame	0.38795

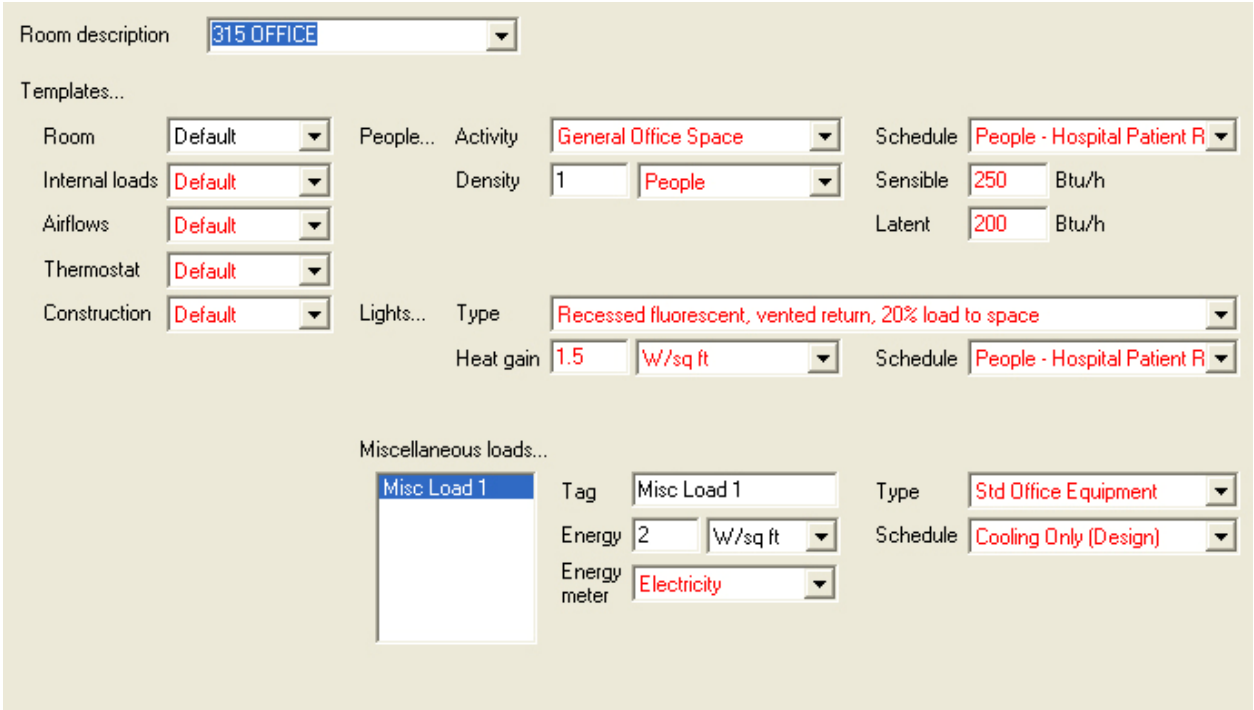
Glass type...		U-factor Btu/h·ft²·°F	Shading coeff
Window	Double Coated 1/4"	0.3	0.44
Skylight	Single Clear 1/4"	0.95	0.95

Height...		
Wall	9	ft
Flr to flr	12	ft
Plenum	2.5	ft

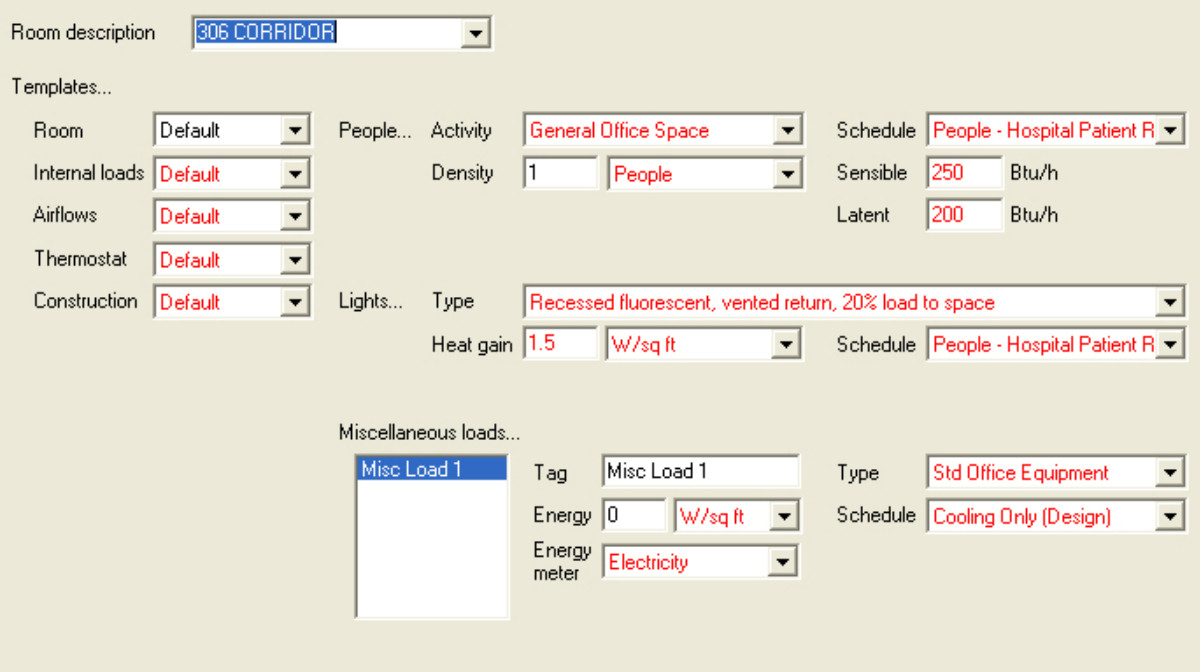
Typical Exam Room



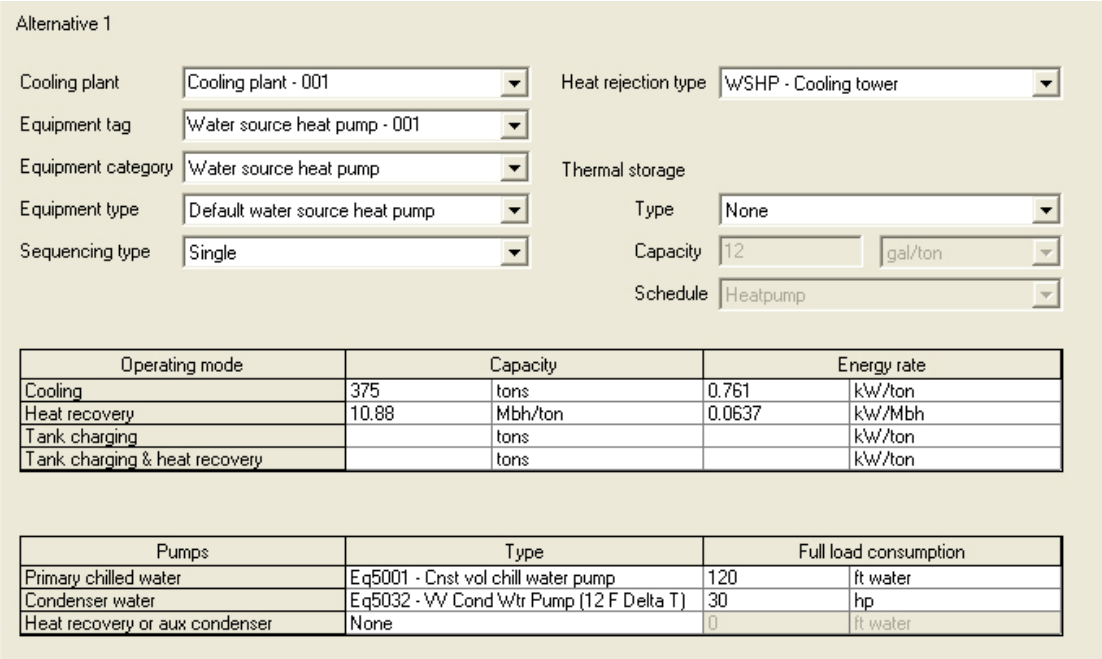
Typical Office Room



Typical Corridor



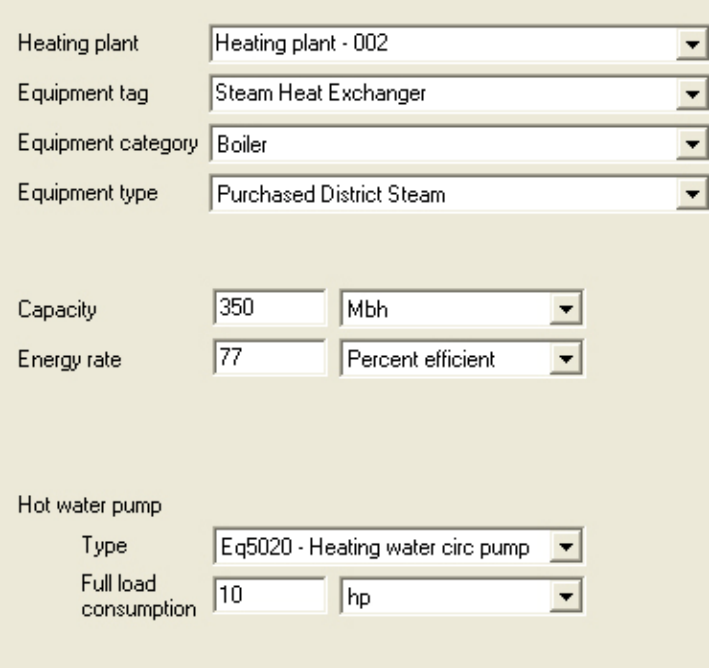
Cooling System



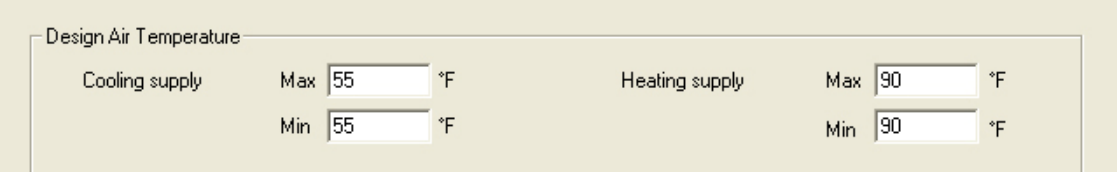
Operating mode	Capacity		Energy rate	
Cooling	375	tons	0.761	kW/ton
Heat recovery	10.88	Mbh/ton	0.0637	kW/Mbh
Tank charging		tons		kW/ton
Tank charging & heat recovery		tons		kW/ton

Pumps	Type	Full load consumption	
Primary chilled water	Eq5001 - Cnst vol chill water pump	120	ft water
Condenser water	Eq5032 - VV Cond Wtr Pump (12 F Delta T)	30	hp
Heat recovery or aux condenser	None	0	ft water

Heating System



Terminal Heat Pump - Temperature Data



Terminal Heat Pump – Fan Data

	Type	Static Pressure (in. wg)	Full Load Energy Rate	Full Load Energy Rate Units	Schedule
Primary	Eq4361 - Air cool inc heat pump fan	0	0.00038	kW/Cfm	Cooling Only (Design)

Appendix F – Detailed Cost Estimate Breakdown

Unit	Quantity	Price/Ea	Price
Ventilation Equipments			
13,000CFM Air Handler Unit	1	$22,000.00	$22,000.00
General Exhaust Fans	6	3,000	$18,000.00
System Heat Pumps			
40 Ton	1	$34,900.00	$34,900.00
50 Ton	1	$41,200.00	$41,200.00

Terminal Heat Pumps			
5 Ton	31	$4,700.00	$145,700.00
4 Ton	31	$4,000.00	$124,000.00
3 Ton	31	$3,500.00	$108,500.00
2 Ton	31	$2,800.00	$86,800.00
1 Ton	31	$2,550.00	$79,050.00
Heat Exchangers			
240GPM	1	$20,300.00	$20,300.00
600 GPM	1	$41,700.00	$41,700.00
Cooling Tower			
375 Tons	1	$50,000.00	$50,000.00
Pumps			
1100 GPM	2	$8,000.00	$16,000.00
220 GPM	2	$5,500.00	$11,000.00
Refrigerant			
Glycol + Water ($/gallon)	1507	$15.00	$22,605.00
Equipment & Chemicals	1	$20,000.00	$20,000.00
Misc Equipment			
Vibration Isolation	1	$20,000.00	$20,000.00
Equipment Insulation ($/sq)	3200	$8.00	$25,600.00
Ductwork			
Rectangular Duct ($/lb)	80000	$10.00	$800,000.00
Piping			
2" & Under ($/lf)	10000	$76.01	$760,100.00
Insulation ($/lf)	10000	$8.20	$82,000.00
PRV			
PRV Station including labor	2	$40,000.00	$80,000.00
Labor			
Q-6 ($/laborhour)	1000	$80.00	$80,000.00
Rigging	1	$23,000.00	$23,000.00
Water Balancing			$45,000.00
Total			$2,757,455.00
Miscellanous Items	30%		$827,236.50
Total			$3,584,691.50
			$40.28/ft2