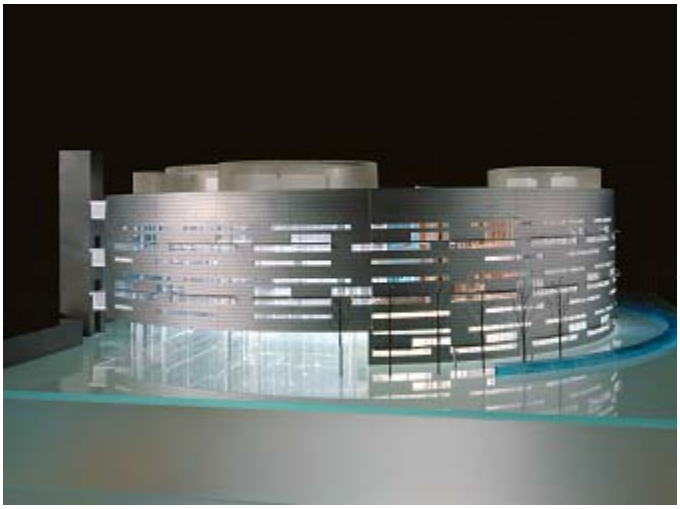
Technical Assignment 2

Building Mechanical & Energy Systems Option

Building and Plant
Energy Analysis Report



Hauptman-Woodward Medical Research Institute
Buffalo, New York

Justin D. Schultz
Mechanical Option

October 25, 2006

Prepared for: James Freihaut, Ph.D.

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Executive Summary

The Hauptman-Woodward Medical Research Institute is a 3 story, 73,000 square foot building which provides a full service biomedical research lab as well as supporting office and classroom spaces to the Buffalo-Niagara Medical Campus in Buffalo, New York. This report develops a detailed energy analysis of the building in addition to determining compliance with a number of standards.

The first analysis considers the U.S. Green Building Council (USGBC) LEED-NC 2004 checklist which provides a nationally-accepted benchmark for the design, construction and operation of energy efficient buildings. The Hauptman-Woodward Medical Research Institute was not initially designed to have a LEED-NC rating; however with moderate design modifications could have achieved certification.

The Hauptman-Woodward Medical Research Institute was also analyzed for compliance with ASHRAE Standard 90.1-2004, which provides minimum requirements for the efficiency of the building. The Standard is broken up into specific sections, of which Building Envelope, Service Water Heating, Power, Lighting and Electric Motor Efficiency were discussed. By use of the prescriptive method, it was determined that the majority of wall, roof, and fenestration assemblies were in compliance. The space-by-space method was used to calculate the performance of the lighting system at HWI. It was found that many of the rooms exceeded the lighting power density requirements set forth by the standard. In addition, electric motor efficiencies were compared to the standard and found to be compliant based on design specifications.

The total amount of lost rentable space was determined to be approximately 12% of the entire building area. This figure is inflated however, since a majority of the mechanical equipment is located in the roof penthouse which was included in the building area. The mechanical first cost was also calculated in this section, with a total cost of $2.9 Million. This equates to $40.33 per square foot.

Finally, Trane TRACE-700 was used to perform an energy analysis and calculate design loads at the Hauptman-Woodward Medical Research Institute. By entering design parameters into the program, it is able to estimate cooling and ventilation loads, in addition to providing a detailed breakdown of energy consumption for each part of the system. When utility rates were provided, the program was able to simulate operating costs and utility costs for the building on an annual basis.

LEED-NC Certification

In recent years, a focus on energy efficient building design led to the creation of the Leadership in Energy and Environmental Design (LEED) rating system. Developed by the U.S. Green Building council, it has become the nationally accepted benchmark for the design, construction, and operation of high performance green buildings.

The architects and engineers took several measures to ensure that the Hauptman-Woodward Medical Research Institute was energy efficient; however LEED-NC certification was not pursued during the design and construction phase of the project. Although the building was not designed to be certified, a review of the checklist can determine whether or not the current design would achieve a rating. The six major categories which comprise the LEED-NC checklist include Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and LEED Innovation credits.

According to the complete LEED-NC 2004 Checklist shown in Appendix A, the Hauptman-Woodward Medical Research Institute qualified for the following:

Yes	?	No	
18	2	49	**Project Totals** (pre-certification estimates) 69 Points

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

Figure I: LEED-NC 2004 Building Totals for HWI.

Upon inspection of the completed checklist found in Appendix A, The Hauptman-Woodward Medical Research Institute was short of receiving a LEED-NC rating based upon the design criteria. This is quite understandable as the building had not intended to be LEED certified. With additional thought and consideration of the rating system, the building could easily gain a certified rating. For example, HWI gained zero points in regards to the materials and resources used in the design. By incorporating environmentally friendly materials, and providing finished that comply with the Indoor air quality requirements, the building could easily have gained the necessary 8 points to become certified.

ASHRAE 90.1-2004 Compliance

The purpose of ASHRAE Standard 90.1-2004 is to provide minimum requirements for the energy-efficient design of buildings. For the purpose of this report, we will determine compliance of the Hauptman-Woodward Medical Research Institute in accordance with five sections of the Standard, each of which will be discussed below.

Section 5: Building Envelope

ASHRAE Standard 90.1-2004 establishes the minimum U-values and solar heat gain coefficients (SHGC) for wall and roof assemblies based on specific climate zones. In addition, the Standard provides two options for determining compliance of the building envelope. For the purpose of this report, I will be using the Prescriptive Building Envelope option to analyze the building envelope at the Hauptman Woodward Medical Research Institute.

Step 1: Determine Compliance Method:

To use the prescriptive building envelope method, the total vertical fenestration must be less than 50% of the gross wall area. In addition, the total skylight area must be less than 5% of the gross roof area, as specified in the Standard.

Elevation	Gross Wall Area	Gross Window Area	% Glazing
North	8502	2488	29.26%
South	13810	1562	11.31%
East	8116	3592	44.26%
West	9540	1653	17.33%
Total	39968	9295	23.26%

Gross Roof Area	Gross Window Area	% Glazing
29206	924	3.16%

Figure II: Percent Vertical Fenestration and Skylight Areas at HWI.

As shown in Figure II, the total vertical fenestration and skylight areas are within the prescribed limit of ASHRAE Standard 90.1-2004. Therefore, it is acceptable to use the Prescriptive Building Envelope Option.

Step 2: Determine Space Conditioning Categories:

The Hauptman-Woodward Medical Research Institute contains all non-residential space. Therefore, we will disregard the portion of the standard that regards residential buildings. In addition, it is assumed that all spaces within the building are conditioned space.

Step 3: Specify Climate Zone

The Hauptman-Woodward Medical Research Institute is located in Buffalo, New York. According to Appendix B, Table B-1 of ASHRAE Standard 90.1-2004, climate zone 5A shall be used to determine building compliance.

Step 4: Prescriptive Building Envelope Compliance:

The exterior building envelope must comply with the non-residential requirements as specified in Table 5.5-5 of the Standard, as appropriate for climate zone 5A. For opaque surfaces, compliance was determined by determining the maximum U-factor for each wall and roof assembly. For the purposes of this report, the following assemblies were analyzed: Roof, Walls, Floor and Opaque Doors.

Assembly Summary:	Assembly U-Value	Std 90.1 Max U-Val	Compliance
Roof Assembly	0.037	0.063	Yes
Wall #1 - South, West Elevations	0.036	0.084	Yes
Wall#2 - Lab Space (Floors 2,3)	0.061	0.084	Yes
Wall #3 - Lab Space (Floor 1)	0.065	0.084	Yes
Opaque Doors	0.69	0.7	Yes
Unheated Slab-On-Grade Floors	0.67	0.73	Yes
Unheated Slab-On-Grade Floors	0.67	0.73	Yes

Figure III: Compliance Summary for Opaque Surfaces at HWI.

As shown in Figure III, all opaque assemblies were in compliance with ASHRAE Standard 90.1-2004. For a complete breakdown of each assembly, refer to Appendix B.

Step 5: Fenestration

For compliance with ASHRAE Standard 90.1-2004, the building must have U-Factors and Solar Heat Gain Coefficients (SHGC's) for all vertical fenestration and skylights that are less than those prescribed in the Standard. Maximum U-Factors and SHGC's can be located in table 5.5-5 of the Standard for buildings in climate zone 5A. For latitudes greater than 10 degrees, the SHGC for north-oriented vertical fenestration shall be calculated separately from fenestration on other elevations, and shall comply with specific requirements from the same table. Based upon the prescribed method explained above and in Section 5 of ASHRAE Standard 90.1-2004, the following was determined:

		Design		Std 90.1-2004		
Name	**Description**	**U-Value**	**SHGC**	**U-Value** (fixed/ operable)	**SHGC** (All Orient / North Orient)	**Comply?**
GL-2	1" Low-E Insulated Glass, PPG Solarban 60	0.29	0.38	0.57	0.39	Yes
		0.29	0.38	0.67	0.49	
GL-3	1" Low-E Insulated Glass, PPG Solarban 80	0.29	0.24	0.57	0.39	Yes
		0.29	0.24	0.67	0.49	
GL-6	Low-E Coated Profilit Glass	0.32	0.31	0.57	0.39	Yes
		0.32	0.31	0.67	0.49	
CW-3	Glazed Skylight System	0.50	0.27	1.17	0.39	Yes

Figure IV: Fenestration Compliance Summary at HWI.

As shown in Figure IV, all glazing components are in compliance with ASHRAE Standard 90.1-2004 at the Hauptman-Woodward Medical Research Institute.

Section 7: Service Water Heating

ASHRAE Standard 90.1-2004 specifies that the service hot water heating must comply with specific mandatory previsions in addition to a prescriptive method showing compliance of each heating unit. Building information in regards to this division of the standard was unavailable at the time of the report and will not be discussed.

Section 8: Power

This section of the ASHRAE Standard determines the compliance of the building power systems at the Hauptman-Woodward Institute. For the building to comply, Primary Feeder conductors shall be sized for a maximum voltage drop of no greater than 2% at design load. In addition, branch circuit conductors must be sized for a maximum voltage drop no greater than 3% at design load. Although specific information was not available for this project, the electrical system was designed in accordance with the National Electric Code which states these provisions to be standard. In this respect, it is assumed that the main feeders and branch circuits are compliant with ASHRAE Standard 90.1-2004.

Section 9: Lighting

This section of the ASHRAE Standard requires the calculation of the lighting power density for each space. In order to complete this, the Space-by-Space method was used as prescribed in Section 9 of ASHRAE Std. 90.1-2004. Building area types were taken from Table 9.6.1 of the standard.

For a complete breakdown of the lighting power density of each space at the Hauptman Woodward Institute, consult Appendix C.

After completing the power density calculations for each space, it was determined that a majority of the spaces did not comply with Standard 90.1-2004. There could be many reasons for this to be the case. First and foremost, the Standard has changed since the last revision in 1999, and could account for some discrepancies. In addition, many of the spaces within the Hauptman Woodward Institute have redundant lighting systems which provide architectural merit to the building. Upon inspection, each lighting system is switched independently, which allows for the building occupants to monitor the light output at any one time.

Section 10: Electric Motors

The purpose of this section is to determine compliance of electric motors with the requirements of the Energy Act of 1992. ASHRAE Standard 90.1-2004 states that each motor shall comply with specific nominal efficiency requirements found in table 10.8 of the Standard. At the Hauptman-Woodward Medical Research Institute, motor

efficiencies were designed in compliance with NEMA Design B and tested in accordance with IEEE Standard 122 in accordance with the building design specifications. A comparison of the design requirements to ASHRAE Standard 90.1-2004 are as follows:

	Minimum Nominal Full-Load Efficiency for Open Motors (%)								
Motor Size	1200 RPM			1800 RPM			3600 RPM		
(hp)	Design	Standard	Comply?	Design	Standard	Comply?	Design	Standard	Comply?
1	82.5	80	Yes	85.5	82.5	Yes	77	0	Yes
1.5	86.5	84	Yes	86.5	84	Yes	84	82.5	Yes
2	87.5	85.5	Yes	86.5	84	Yes	85.5	84	Yes
3	88.5	85.5	Yes	89.5	86.5	Yes	85.5	84	Yes
5	89.5	87.5	Yes	89.5	87.5	Yes	86.5	85.5	Yes
7.5	90.2	88.5	Yes	91	88.5	Yes	88.5	87.5	Yes
10	91.7	90.2	Yes	91.7	89.5	Yes	89.5	88.5	Yes
15	91.7	90.2	Yes	93	91	Yes	90.2	89.5	Yes
20	92.4	91	Yes	93	91	Yes	91	90.2	Yes
25	93	91.7	Yes	93.6	91.7	Yes	91.7	91	Yes
30	93.6	92.4	Yes	94.1	92.4	Yes	91.7	91	Yes
40	94.1	93	Yes	94.1	93	Yes	92.4	91.7	Yes
50	94.1	93	Yes	94.5	93	Yes	93	92.4	Yes

Figure V: Design Motor Efficiencies vs.
ASHRAE Std. 90.1-2004 for Open Motors

	Minimum Nominal Full-Load Efficiency for Closed Motors (%)								
Motor Size	1200 RPM			1800 RPM			3600 RPM		
(hp)	Design	Standard	Comply?	Design	Standard	Comply?	Design	Standard	Comply?
1	82.5	80	Yes	85.5	82.5	Yes	77	75.5	Yes
1.5	87.5	85.5	Yes	86.5	84	Yes	84	82.5	Yes
2	88.5	86.5	Yes	86.5	84	Yes	85.5	84	Yes
3	89.5	87.5	Yes	89.5	87.5	Yes	86.5	85.5	Yes
5	89.5	87.5	Yes	89.5	87.5	Yes	88.5	87.5	Yes
7.5	91	89.5	Yes	91.7	89.5	Yes	89.5	88.5	Yes
10	91	89.5	Yes	91.7	89.5	Yes	90.2	89.5	Yes
15	91.7	90.2	Yes	92.4	91	Yes	91	90.2	Yes
20	91.7	90.2	Yes	93	91	Yes	91	90.2	Yes
25	93	91.7	Yes	93.6	92.4	Yes	91.7	91	Yes
30	93	91.7	Yes	93.6	92.4	Yes	91.7	91	Yes
40	94.1	93	Yes	94.1	93	Yes	92.4	91.7	Yes
50	94.1	93	Yes	94.5	93	Yes	93	92.4	Yes

Figure VI: Design Motor Efficiencies vs.
ASHRAE Std. 90.1-2004 for Closed Motors

Mechanical System First Cost

According to contract documents provided by Cannon Design, Inc, the first cost for all HVAC and Plumbing work at the Hauptman Woodward Medical Research Institute was $2,956,003. These two divisions were lumped together under one contract. After determining the total cost of the mechanical system, the cost per square foot can be calculated. For the Hauptman Woodward Institute, The cost per square foot is approximately $40.33 per square foot and was approximately 12.3% of the total budget for the Project.

Lost Rentable Space

At the Hauptman-Woodward Medical Research Institute, the majority of the mechanical equipment is located in the roof penthouse, which was included in the total design square footage of the building. I proceeded to calculate the lost rentable space by simply calculating the area of each space that was a mechanical room or other support space. In addition, the vertical shaft space was calculated by summing the area of each vertical duct shaft. In total, the building has approximately 8,710 square feet of lost rentable space, 55% of which is located in the penthouse. This figure includes all mechanical, electrical and telecommunication. Below is a summary of the lost rentable space. A detailed table with a breakdown of each space is located in Appendix D.

Space Description	Area (sq.ft.)
First Floor	2405
Second Floor	600
Third Floor	295
Penthouse	4780
Elevator Shafts	630
Total Building Area	73289
Total Lost Rentable Space	8710
Percent Lost Rentable Space	**11.9%**

Figure VII: Summary of Lost Rentable Space at HWI.

Design Load Energy Analysis:

Trane TRACE 700 was used extensively for the design load and energy simulation at the Hauptman-Woodward Medical Research Institute. By modeling design criteria into the computer, the program is able to estimate Heating and Cooling Loads, Ventilation Rates and Energy Consumption for each space as well as provide a summary for the building as a whole. Once the computer simulation is complete, the total supply air and ventilation supply air was compared to the original design documents. A summary of individual room loads is located in Appendix E.

Once the simulation was complete, a separate analysis was done by comparing actual design cooling values to the simulation. These results can be found in Appendix F. It was found that many of the spaces had a higher simulated SA quantity then initially designed for, while others had a lower simulated SA quantity. The overall air supply for units RTU-1 and RTU-2 as a whole was within 10% of the design. There could be many reasons for the fluctuation in design. Power densities calculated in the ASHRAE 90.1-2004 study seemed unusually high for office and lab spaces. These higher LPD were simulated in Trane TRACE-700 and may not reflect the actual design. In addition, it is difficult to model a 100% outdoor air system in the simulation, since the program does not allow for this system to be selected automatically. Therefore, it was required to specify 100% outdoor air for each individual zone for that unit, which may have caused a discrepancy. Many of the lab spaces have excessive amounts of supply air due to the experiments that taking place. These specifications are not supplied by Trane TRACE-700 nor broken down in ASHRAE 90.1-2004. Since the experiments do not carry loads they were not factored into the space design.

The computer simulation has the ability to account for any particular type of load for each space. In addition to occupancy, lighting and electrical loads, the simulation requires detailed building envelope specifications such as exterior wall and window dimensions, Roof Dimensions, U-Values, as well as perimeter calculations for slab-on-grade foundations. Once all the parameters are logged into the simulation, the building can be modeled. A detailed summary of the cooling loads can be found in Appendix G.

Yearly Energy Utilization:

The Hauptman-Woodward Medical Research Institute has been in operation for just over a year; however meter data and utility bills were not able to be released by the owner for this report. Although this information was unavailable, Trane TRACE 700 can adequately estimate the energy utilization data for the building. For operation of the building mechanical systems, two sources of energy are utilized. These sources include electric power (kWh) and natural gas (therm).

Electric Service at the Hauptman-Woodward Medical Research Institute is provided by National Grid, a primary electric service provider throughout Western New York. The electric rate is broken down into specific charges, as shown in Figure VIII.

	Charge
Basic Service Charge	$51.60
Delivery Charge for Demand (per kW)	$9.48
Delivery Charge (per kWh)	2.032¢
Delivery Charge Adjustment	0¢
Customer Service Credit (per kWh)***	0.2¢ per KWh
System Benefits Charge (per kWh)	.1619¢
Renewable Portfolio Surcharge (per kWh)	.0491¢
Electricity Supply Charge	0.05585¢

Figure VIII: National Grid Electric Tariffs (Courtesy of National Grid, Inc, Oct. 2006)

The Natural Gas Service for the Hauptman-Woodward Medical Research Institute is provided by National Fuel, which serves residential buildings and businesses in Western New York and Northern Pennsylvania. The building falls under the category SC-3: General Sales for buildings of like size and occupancy.

SC-3 General Sales & Transportation Service (Non-Residential)							
First 1 Mcf	$17.55	$2.00	($5.71)	$0.03	$13.87	$6.53	$20.40
Next 49 Mcf	$2.57806 /Mcf	$0.00	$0.0000	$0.02901	$2.60707	$6.52575	$9.13282
Next 950 Mcf	$1.99656 /Mcf	$0.00	$0.0000	$0.02901	$2.02557	$6.52575	$8.55132
All Over 1,000 Mcf	$1.62309 /Mcf	$0.00	$0.0000	$0.02901	$1.65210	$6.52575	$8.17785

Figure IX: National Fuel Natural Gas Tariffs (courtesy of National Fuel, Oct. 2006)

As shown in Figure IX, natural gas is provided on a tier basis, with a base charge of $17.55.

Annual Energy Consumption and Operating Costs:

The annual energy consumption and operating costs were calculated with the Trane TRACE-700 simulation software. As shown in the previous section, two sources of energy are utilized at the Hauptman-Woodward Medical Research Institute. After determining the utility rates from their providers; the yearly energy utilization was calculated with the Trane TRACE-700 program. As shown in Appendix H, the annual consumption of electricity (kWh) and natural gas (therm) are as follows:

Electricity: 1,323,558 kWh
Natural Gas: 55,959 therm

In addition, based on the prescribed utility rates in the previous section, an annual cost breakdown for each utility was able to be calculated. These results can be found in Appendix I.

The electrical loads took into account all mechanical equipment in addition to demand electrical and lighting loads within the building. The natural gas loads were primarily from the extensive primary and secondary boiler systems. Each of these loads was considered to operate at 100% design for the purpose of the simulation. The Trane TRACE-700 Simulation was able to simulate building schedules into the calculation as well. The building is currently scheduled during normal business hours, 5 days a week. The weather data provided by the ASHRAE Handbook of Fundamentals set climate criteria to execute the simulation for summer and winter months.

Due to the quick timeframe of this project, the mechanical engineers did not complete a preliminary energy load simulation for the entire building. Attention was paid specifically to the atrium space, due to its large volume and extensive use of windows and skylights. Trane TRACE-700 was used to simulate the atrium space during preliminary design phases, and the present simulation was quite different due to architectural changes during the design process.

All equipment at the Hauptman-Woodward Medical Research Institute was simulated as well. Appendix J gives a detailed breakdown of monthly and annual energy consumption for the chiller and boiler plants, fans, lighting system and electrical demands. In addition, Appendix K supplements this information by providing a cost summary analysis for all equipment in the building.

Conclusions:

In summary, this report developed a detailed energy analysis of the Hauptman-Woodward Medical Research building through the use of compliance methods set forth by ASHRAE, the U.S. Green Building Council and third-party energy modeling software.

The first analysis considered the U.S. Green Building Council (USGBC) LEED-NC 2004 checklist. This accreditation system provides a benchmark for the design, construction and operation of energy efficient buildings. The Hauptman-Woodward Medical Research Institute was not initially designed to have a LEED-NC rating, however with moderate design modifications could have achieved certification.

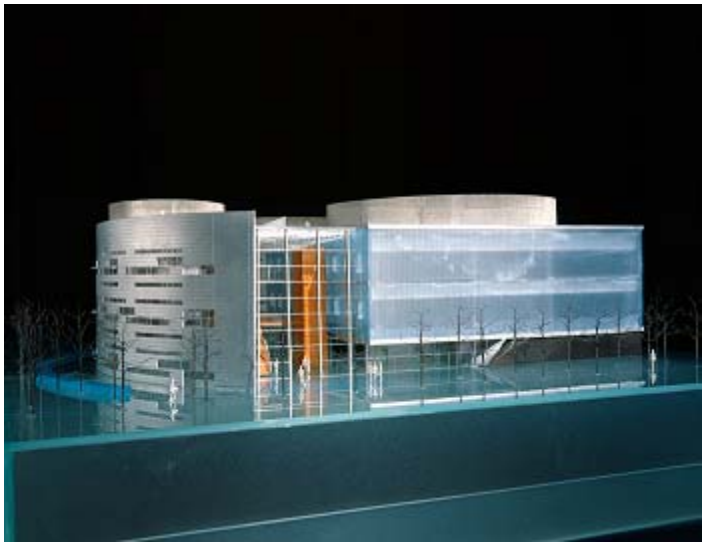
The Hauptman-Woodward Medical Research Institute was also analyzed for compliance with ASHRAE Standard 90.1-2004, which provides minimum requirements for the efficiency of the building. The report analyzed and discussed the Building Envelope, Service Water Heating, Power, Lighting and Electric Motor Efficiency at HWI. By use of the prescriptive method, it was determined that the majority of wall, roof, and fenestration assemblies were in compliance. The space-by-space method was used to calculate the performance of the lighting system. It was found that many of the rooms exceeded the lighting power density requirements set forth by the standard. In addition, electric motor efficiencies were compared to the standard and found to be compliant based on design specifications.

The total amount of lost rentable space was determined to be approximately 12% of the entire building area. This figure is inflated however, since a majority of the mechanical equipment is located in the roof penthouse which was included in the building area.

The mechanical first cost was determined based on documents supplied by the design engineer. The HVAC and Plumbing systems combined had a total cost of $2.9 Million. This equates to approximately $40.33 per square foot.

Finally, Trane TRACE-700 was used to perform an energy analysis and calculate design loads at the Hauptman-Woodward Medical Research Institute. Detailed breakdowns of estimated cooling and ventilation loads are compared to design documents in the following appendices. In addition, equipment energy consumption and utility costs were estimated by the simulation and summarized to provide an idea of the annual cost of building operation.

Appendices



Appendix A: LEED-NC 2004 Checklist

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

Hauptman-Woodward Medical Research Institute
Buffalo, New York

Yes	?	No			
4		10	**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
		N	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
		N	Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1
		N	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		N	Credit 5.1	**Site Development,** Protect of Restore Habitat	1
		N	Credit 5.2	**Site Development,** Maximize Open Space	1
		N	Credit 6.1	**Stormwater Design,** Quantity Control	1
		N	Credit 6.2	**Stormwater Design,** Quality Control	1
		N	Credit 7.1	**Heat Island Effect,** Non-Roof	1
		N	Credit 7.2	**Heat Island Effect,** Roof	1
		N	Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
2		3	**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
		N	Credit 2	**Innovative Wastewater Technologies**	1
		N	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		N	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
3		14	**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
2			Credit 1	**Optimize Energy Performance**	1 to 10
		N	Credit 2	**On-Site Renewable Energy**	1 to 3
		N	Credit 3	**Enhanced Commissioning**	1
		N	Credit 4	**Enhanced Refrigerant Management**	1
1			Credit 5	**Measurement & Verification**	1
		N	Credit 6	**Green Power**	1

Yes	?	No			
		13	**Materials & Resources**		13 Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		N	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
		N	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
		N	Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
		N	Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
		N	Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
		N	Credit 3.1	**Materials Reuse**, 5%	1
		N	Credit 3.2	**Materials Reuse**,10%	1
		N	Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1
		N	Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1
		N	Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regi	1
		N	Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regi	1
		N	Credit 6	**Rapidly Renewable Materials**	1
		N	Credit 7	**Certified Wood**	1
Yes	?	No			
6	2	7	**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
		N	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
		N	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
	?		Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
	?		Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
		N	Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
		N	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
		N	Credit 7.2	**Thermal Comfort**, Verification	1
		N	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		N	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
Yes	?	No			
3		2	**Innovation & Design Process**		5 Points
1			Credit 1.1	**Innovation in Design**: Provide Specific Title	1
1			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.3	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.4	**Innovation in Design**: Provide Specific Title	1
1			Credit 2	**LEED® Accredited Professional**	1
Yes	?	No			
18	2	49	**Project Totals** (pre-certification estimates)		69 Points

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

Appendix B:
ASHRAE 90.1-2004 Building Envelope Assembly Compliance

Roof Assembly

Layer Description	Thickness (inches)	Density (lb/ft3)	R-Value
Inside Surface Resistance	0	0	0.685
2" - 18 ga. composite steel deck	0.052	0.435	0.00011
Normal Weight Concrete Slab	4.5	38	0.405
Unfaced Glass-Fiber Board Insulation	5	1.6	25
Single-Ply Roofing	0.0375	70	0.33245
Outside Surface Resistance	0	0	0.333
	Total		26.75556
	Assembly Total U-Val		0.0373754
	Std 90.1-2004 Max U-Va		0.063
	Compliance		Yes

Wall Assembly 1 - South and West Elevations

Layer Description	Thickness (inches)	Density (lb/ft3)	R-Value
Inside Surface Resistance	0	0	0.685
5/8" Gypsum Board	0.63	50	0.56
4" Aluminum Stud Wall	-	-	-
Air Space	3	-	0.91
6" Batt Insulation between 6" Al Stud Wall	6	1.2	11
1/2" Gypsum Sheathing	0.5	50	0.45
2" Metal Panel System with Foam Core Insul.	2"	2.3	14
Outside Surface Resistance	0	0	0.333
	Total		27.938
	Assembly Total U-Val		0.0357935
	Std 90.1-2004 Max U-Va		0.084
	Compliance		Yes

Wall Assembly 2 - Laboratory Space (Floor 2 and 3)

Layer Description	Thickness (inches)	Density (lb/ft3)	R-Value
Inside Surface Resistance	0	0	0.685
5/8" Gypsum Board	0.63	50	0.56
6" Batt Insulation between 6" Al Stud Wall	6	1.2	11
Aluminum Soffit Panel	-	-	0.66
Air Space	3	-	0.91
Prolift™ U-Channel Glass Curtain Wall	6	-	2.38
Outside Surface Resistance	0	0	0.333
	Total		16.528
	Assembly Total U-Val		0.0605034
	Std 90.1-2004 Max U-Va		0.084
	Compliance		Yes

Wall Assembly 3 - Laboratory Space (Floor 1)

Layer Description	Thickness (inches)	Density (lb/ft3)	R-Value
Inside Surface Resistance	0	0	0.685
5/8" Gypsum Board	0.63	50	0.56
6" Batt Insulation between 8" Al Stud Wall	6	1.2	11
Air Space	2	-	0.91
1/2" Gypsum Sheathing	0.5	50	0.45
Sheet Waterproofing	-	-	0.06
Air Space	1	-	0.91
Face Brick Veneer	3.5	125	0.433
Outside Surface Resistance	0	0	0.333
	Total		15.341
	Assembly Total U-Val		0.0651848
	Std 90.1-2004 Max U-Va		0.084
	Compliance		Yes

Doors:

Description	Assembly Max U-Val	Std 90.1 Max U-Val	Compliance
Opaque Doors	0.69	0.7	Yes

Floors:

Description	Assembly Max U-Val	Std 90.1 Max U-Val	Compliance
Unheated Slab-On-Grade Floors	0.67	0.73	Yes

Appendix C:
ASHRAE 90.1-2004 Lighting Power Density Compliance

Zone 1 - West Wing, Floors 1-3

Room Number	Room Name	Space Discription	Area (sq.ft)	Lamp	Wattage Per Lamp	Lamps per Fixture	Number of Fixtures	Watts	Power Density (W/SqFt)	Required PD (W/sqft)	Std 90.1 Compliant ?
103	Seminar Room	Lecture Room	830	PC1	32	3	5	480	0.58	1.4	No
			830	FF2	32	2	12	768	0.93		
			830	PB2	26	2	4	208	0.25		
			830	PB2D	26	2	24	1248	1.50		
104	Lecture Room	Lecture Room	550	PC1	32	3	3	288	0.52	1.4	No
			550	FF2	32	2	8	512	0.93		
			550	PB2	26	2	3	156	0.28		
			550	PB2D	26	2	16	832	1.51		
114	Shower/Locker	Restroom	120	PC1	26	2	3	156	1.30	0.6	No
115	Storage	Storage	290	FC1	32	3	4	384	1.32	0.8	No
116	Storage	Storage	490	FR4	32	2	9	576	1.18	0.8	No
117	Purchasing	Office	350	FD1	32	4	4	512	1.46	1.1	No
119	Building Facilities	Office	210	FD1	32	4	2	256	1.22	1.1	No
120	Receiving/Storage/Loading	Shipping/Receiving	310	FR4	32	2	4	256	0.83	0.8	No
144	Elevator Machine Room	Mechanical	110	FR4	32	2	2	128	1.16	1.4	Yes
147	Telecommunications	Electrical	225	FR4	32	2	4	256	1.14	1.4	Yes
148	Electrical Room	Electrical	680	FR4	32	2	9	576	0.85	1.4	Yes
150	Elevator Machine Room	Mechanical	130	FR4	32	2	1	64	0.49	1.4	Yes
151	Plumbing	Mechanical	380	FR4	32	2	6	384	1.01	1.4	Yes
152	Generator	Electrical	300	FR6	48	2	6	576	1.92	1.4	No
154	Fan Room	Mechanical	255	FR6	48	2	5	480	1.26	1.4	Yes
202	Lunch Room/Kitchen	Multi-Purpose	1250	PC1	26	2	37	1924	6.41	1.2	No
			1250	PK1	150	1	4	600	2.35		
			1250	FX1	25	1	3	75	0.06		
219	IT Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
220	IT Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
221	Computer/ Visual Room	Computer Lab	270	FN3	39	4	2	312	1.16	1.1	No
			270	PL2	50	1	2	100	0.37		
223	Conferemce Room	Conference Room	440	PC2	18	2	2	72	0.16	1.3	No
			440	PB2D	26	2	10	520	1.18		
224	Server Room	Computer Room	350	FH3	32	3	4	384	1.10	1.1	Yes
225	Mens Restroom	Restroom	210	PC1	26	2	5	260	1.24	0.9	No
			210	FW2	25	1	2	50	0.24		
226	Womens Restroom	Restroom	190	PC1	26	2	5	260	1.37	0.9	No
			190	FW2	25	1	2	50	0.26		
227	Corridor	Corridor	780	FN3	39	4	10	1560	2.00	0.5	No
229	Elevator Vestibule	Corridor	250	PC1	26	2	3	156	0.62	0.5	No
230	Telephone	Office Space	60	FR4	32	2	1	64	1.07	1.1	Yes
231	Electrical	Mechanical Room	140	FR4	32	2	3	192	1.37	1.4	Yes
262	Storage	Storage	60	FA1	32	2	1	64	1.07	0.8	No
	Corridor	Corridor	330	PC1	26	2	11	572	1.73	0.5	No
301	Library	Library	1200	PC1	26	2	30	1560	1.30	1.3	Yes
319	ACA Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
320	ACA Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
321	IT Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
322	IT Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
323	IT Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
324	Conferemce Room	Conference Room	440	PC2	18	2	2	72	0.16	1.3	No
			440	PB2D	26	2	10	520	1.18		
325	IT Room	Office Space	350	FH3	32	3	4	384	1.10	1.1	Yes
326	Mens Restroom	Restroom	210	PC1	26	2	7	364	1.73	0.9	No
			210	FW2	25	1	2	50	0.24		
327	Womens Restroom	Restroom	190	PC1	26	2	8	416	2.19	0.9	No
			190	FW2	25	1	2	50	0.26		
328	Corridor	Corridor	780	FN3	39	4	10	1560	2.00	0.5	No
330	Elevator Vestibule	Corridor	250	PC1	26	2	3	156	0.62	0.5	No
331	Electrical	Mechanical Room	120	FR4	32	2	2	128	1.07	1.4	Yes
331	Telephone	Office Space	80	FR4	32	2	2	128	1.60	1.1	No
262	Storage	Storage	60	FA1	32	2	1	64	1.07	0.8	No
	Corridor	Corridor	330	PC1	26	2	11	572	1.73	0.5	No
100	Parking	Parking	7650	FR5	32	2	46	2944	0.38	0.2	No

Zone 2 - South Wing, Floors 1-3											
Room Number	Room Name	Space Discription	Area (sq.ft)	Lamp	Wattage Per Lamp	Lamps per Fixture	Number of Fixtures	Watts	Power Density (W/SqFt)	Required PD (W/sqft)	Std 90.1 Compliant ?
AT	Atrium	Atrium	4800	PF3	42	1	25	1050	0.22	0.6	No
			4800	PF2	32	1	25	800	0.17		
			4800	PC1	26	2	6	312	0.07		
			4800	PG1	350	1	9	3150	0.66		
			4800	PY2	100	1	14	1400	0.29		
			4800	PY3	70	1	14	980	0.20		
			4800	PP1	32	2	9	576	0.12		
121	Open Office	Office Space	1115	FK1	32	2	15	960	0.86	1.1	No
			1115	PF3	42	1	7	294	0.26		
			1115	PC2	18	2	7	252	0.23		
122	Personnel Manager	Office Space	105	FN3	39	4	2	312	2.97	1.1	No
123	Accounting	Office Space	110	FN3	39	4	2	312	2.84	1.1	No
124	Accounting	Office Space	110	FN3	39	4	2	312	2.84	1.1	No
125	Development	Office Space	110	FN3	39	4	2	312	2.84	1.1	No
126	Development	Office Space	110	FN3	39	4	2	312	2.84	1.1	No
127	Conference	Conference	190	FQ1	150	2	4	1200	6.32	1.3	No
			190	PC1D	26	2	3	156	0.82		
128	Development	Office Space	200	PL2	50	1	2	100	0.5	1.1	No
			200	FN3	39	4	1	156	0.78		
			200	FN4	54	4	1	216	1.08		
129	Board Member	Office Space	200	PL2	50	1	2	100	0.5	1.1	No
			200	FN3	39	4	1	156	0.78		
			200	FN4	54	4	1	216	1.08		
130	CFO	Office Space	200	PL2	50	1	2	100	0.5	1.1	No
			200	FN3	39	4	1	156	0.78		
			200	FN4	54	4	1	216	1.08		
131	Vice President	Office Space	200	PL2	50	1	2	100	0.5	1.1	No
			200	FN3	39	4	1	156	0.78		
			200	FN4	54	4	1	216	1.08		
132	President	Office Space	200	PL2	50	1	2	100	0.5	1.1	No
			200	FN3	39	4	1	156	0.78		
			200	FN4	54	4	1	216	1.08		
133	Executive Director	Office Space	200	PL2	50	1	2	100	0.5	1.1	No
			200	FN3	39	4	1	156	0.78		
			200	FN4	54	4	1	216	1.08		
134	Board Room	Conference Roor	775	PC3	18	2	1	36	0.05	1.3	No
			775	PW2D	26	2	9	468	0.60		
			775	PC1D	26	2	8	416	0.54		
			775	FQ1	150	2	5	1500	1.94		
135	Mens Restroom	Restroom	230	PC1	26	2	7	364	1.58	0.9	No
			230	FW2	25	1	2	50	0.22		
136	Womens Restroom	Restroom	220	PC1	26	2	8	416	1.89	0.9	No
			220	FW2	25	1	2	50	0.23		
137	Corridor/Kitchenette	Corridor	460	PC1	26	2	34	1768	3.84	0.5	No
			460	FX1	25	1	2	50	0.11		
139	Workroom Storage	Storage	300	FD1	32	4	3	384	1.28	0.8	No
140	Graphics	Office Space	340	FH3	32	3	7	672	1.98	1.1	No
145	Telephone Room	Electrical Room	90	FR4	32	2	1	64	0.71	1.5	Yes
146	Electrical Closet	Electrical Room	30	FR4	32	2	1	64	2.13	1.5	No
143	Reception	Office Space	530	FK1	32	2	5	320	0.60	1.1	No
			530	PB2	26	2	4	208	0.39		
			530	FR2	32	2	2	128	0.24		
			530	PF3	42	1	2	84	0.16		
204	Open Office	Office Space	2325	FK1	32	2	37	2368	1.02	1.1	No
			2325	PF3	42	1	17	714	0.31		
			2325	PC2	18	2	17	612	0.26		

Zone 2 - South Wing, Floors 1-3 (cont'd)											
Room Number	Room Name	Space Discription	Area (sq.ft)	Lamp	Wattage Per Lamp	Lamps per Fixture	Number of Fixtures	Watts	Power Density (W/SqFt)	Required PD (W/sqft)	Std 90.1 Compliant ?
205	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
206	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
207	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
208	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
209	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
210	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
211	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
212	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
213	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
214	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
215	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
216	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
217	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
218	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
302	Open Office	Office Space	2325	FK1	32	2	37	2368	1.02	1.1	No
			2325	PF3	42	1	17	714	0.31		
			2325	PC2	18	2	17	612	0.26		
305	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
306	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
307	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
308	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
309	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
310	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
311	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
312	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
313	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
314	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
315	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
316	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
317	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No
318	PI Office	Office Space	120	FN3	39	4	2	312	2.60	1.1	No

Zone 3 - Laboratory, Floors 1-3

Room Number	Room Name	Space Discription	Area (sq.ft)	Lamp	Wattage Per Lamp	Lamps per Fixture	Number of Fixtures	Watts	Power Density (W/SqFt)	Required PD (W/sqft)	Std 90.1 Compliant?
105	Inactive	Inactive	725	FR4	32	2	6	384	0.53	0.8	Yes
106	Storage	Storage	175	FD1	32	4	2	256	1.46	0.8	No
107	Scintillation Counter	Laboratory	210	FD1	32	4	3	384	1.83	1.4	No
108	Radioisotope Lab (Low Level)	Laboratory	125	FC1	32	3	2	192	1.54	1.4	No
109	Radioisotope Lab (High Level)	Laboratory	121	FC1	32	3	2	192	1.59	1.4	No
110	Radioisotope Storage	Storage	42	FC1	32	3	1	96	2.29	0.8	No
111	Material Storage	Storage	410	FC1	32	3	6	576	1.40	0.8	No
112	Corridor	Corridor	650	FB1	32	2	11	704	1.08	0.5	No
113	Bulk Storage	Storage	410	FC1	32	4	4	512	1.25	0.8	No
228-(1-5)	Research Lab	Laboratory	4250	FP2	54	3	24	3888	0.91	1.4	No
			4250	PB2	26	2	29	1508	0.35		
			4250	FN6	54	2	4	432	0.10		
			4250	PD1	26	2	18	936	0.22		
228-(6-8)	Research Lab	Laboratory	1965	FP2	54	3	12	1944	0.99	1.4	No
			1965	PB2	26	2	18	936	0.48		
			1965	PD1	26	2	9	468	0.24		
228-(9-10)	Research Lab	Laboratory	1800	FP2	54	3	9	1458	0.81	1.4	No
			1800	PB2	26	2	17	884	0.49		
			1800	PD1	26	2	7	364	0.20		
232	Support	Corridor	640	FN3	39	4	8	1248	1.95	0.5	No
238	CG Robotics Lab	Laboratory	700	FD1	32	4	8	1024	1.46	1.4	No
239,240	Equipment/Shared Cold Room	Equipment	600	FD1	32	4	5	640	1.07	0.8	No
243	Chromatography	Laboratory	240	FD1	32	4	3	384	1.60	1.4	No
252	Autoclave Room	Equipment	115	FM1	32	2	2	128	1.11	1.4	Yes
253	Insect Room	Laboratory	330	FD1	32	4	4	512	1.55	1.4	No
254	Bacteria	Laboratory	140	FD1	32	4	2	256	1.83	1.4	No
255	Dark Room	Laboratory	85	FD1	32	4	1	128	1.51	1.4	No
256	Chromatography	Laboratory	225	FD1	32	4	3	384	1.71	1.4	No
257	Yeast	Active Storage	110	FD1	32	4	1	128	1.16	1	No
245	Write-Up	Office	215	FH3	32	3	2	192	0.89	1.1	Yes
233	BSC Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
234	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
235	Fume Hood Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
236	Equipment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
237	Equipment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
244	Equipment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
246	Equipment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
247	Fume Hood Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
248	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
249	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
250	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
258	Fume Hood Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
259	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
260	Shared Cold Room	Equipment	110								
261	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
329-(1-5)	Research Lab	Laboratory	4250	FP2	54	3	24	3888	0.91	1.4	No
			4250	PB2	26	2	29	1508	0.35		
			4250	FN6	54	2	4	432	0.10		
			4250	PD1	26	2	18	936	0.22		
329-(6-8)	Research Lab	Laboratory	1965	FP2	54	3	12	1944	0.99	1.4	No
			1965	PB2	26	2	18	936	0.48		
			1965	PD1	26	2	9	468	0.24		
329-(9-10)	Research Lab	Laboratory	1800	FP2	54	3	9	1458	0.81	1.4	No
			1800	PB2	26	2	17	884	0.49		
			1800	PD1	26	2	7	364	0.20		

Zone 3 - Laboratory, Floors 1-3 (cont'd)											
Room Number	Room Name	Space Discription	Area (sq.ft)	Lamp	Wattage Per Lamp	Lamps per Fixture	Number of Fixtures	Watts	Power Density (W/SqFt)	Required PD (W/sqft)	Std 90.1 Compliant?
333	Support	Corridor	640	FN3	39	4	8	1248	1.95	0.5	No
339	Dishwashing	Laboratory	210	FM1	32	2	3	192	0.91	1.4	Yes
340	Autoclave	Laboratory	110	FM1	32	2	2	128	1.16	1.4	Yes
341	Insturment	Equipment	170	FD1	32	4	2	256	1.51	1.2	No
343	Equipment	Equipment	345	FD1	32	4	4	512	1.48	1.2	No
344	Chromatography	Laboratory	225	FD1	32	4	3	384	1.71	1.4	No
358	X-Ray Crystallography	Laboratory	725	FD1	32	4	8	1024	1.41	1.4	No
360	X-Ray Pump Room	Laboratory	110	FD1	32	4	1	128	1.16	1.4	Yes
361	E. coli Lab	Laboratory	110	FD1	32	4	1	128	1.16	1.4	Yes
334	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
335	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
336	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
337	Equipment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
338	Fume Hood Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
349	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
350	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
351	Equipment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
352	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
353	Fume Hood Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
354	Fume Hood Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
355	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
356	Inst/EQ Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
357	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
362	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
363	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
364	Insturment Alcove	Equipment	110	FD1	32	4	1	128	1.16	1.2	Yes
365	Insturment Alcove	Equipment	85	FD1	32	4	1	128	1.51	1.2	No

Appendix D:
Breakdown of Lost Rentable Space

Space Type	Floor Number	Room Number	Space Description	Area (sq.ft.)
Room	1	106A	Smoke Exhaust Fan Room	85
Room	1	144	Elevator Machine Room	108
Room	1	145	Telephone	72
Room	1	146	Electrical	30
Room	1	147	Telecommunications	225
Room	1	148	Electrical Room	680
Room	1	149	Plumbing	185
Room	1	150	Elevator Machine Room	85
Room	1	151	Plumbing	380
Room	1	152	Generator	300
Room	1	154	Fan Room	255
Room	2	224	Server Room	350
Room	2	230	Telephone	60
Room	2	231	Electrical	140
Room	3	331	Telephone	80
Room	3	332	Electrical	120
Room	R	402	Penthouse	4780
Shaft	All		Elevator	270
Shaft	All		Elevator	360
Shaft	2		Vertical Mechanical Shaft	7
Shaft	2		Vertical Mechanical Shaft	4.25
Shaft	2		Vertical Mechanical Shaft	5.4
Shaft	2		Vertical Mechanical Shaft	1.25
Shaft	2		Vertical Mechanical Shaft	4
Shaft	2		Vertical Mechanical Shaft	4
Shaft	2		Vertical Mechanical Shaft	1.5
Shaft	2		Vertical Mechanical Shaft	2.7
Shaft	2		Vertical Mechanical Shaft	5
Shaft	2		Vertical Mechanical Shaft	0.7
Shaft	2		Vertical Mechanical Shaft	1.9
Shaft	2		Vertical Mechanical Shaft	2.4
Shaft	2		Vertical Mechanical Shaft	3.4
Shaft	2		Vertical Mechanical Shaft	5
Shaft	3		Vertical Mechanical Shaft	6.75
Shaft	3		Vertical Mechanical Shaft	3.8
Shaft	3		Vertical Mechanical Shaft	3.75
Shaft	3		Vertical Mechanical Shaft	5.4
Shaft	3		Vertical Mechanical Shaft	1.3
Shaft	3		Vertical Mechanical Shaft	6.7
Shaft	3		Vertical Mechanical Shaft	5.5
Shaft	3		Vertical Mechanical Shaft	2.33
Shaft	3		Vertical Mechanical Shaft	4.3
Shaft	3		Vertical Mechanical Shaft	5
Shaft	3		Vertical Mechanical Shaft	5.6
Shaft	3		Vertical Mechanical Shaft	9
Shaft	3		Vertical Mechanical Shaft	0.7
Shaft	3		Vertical Mechanical Shaft	4.75
Shaft	3		Vertical Mechanical Shaft	1.9
Shaft	3		Vertical Mechanical Shaft	2.33
Shaft	3		Vertical Mechanical Shaft	9.1
Shaft	3		Vertical Mechanical Shaft	9.33
Shaft	3		Vertical Mechanical Shaft	5
			Total Lost Rentable Space:	8,710
			Total Building Area	73,289
			Percent Lost Rentable Space	**11.9%**

Appendix E:
Design Load Airflow Summary

Description **		Floor Area ft²	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	Percent OA Htg
103 - Seminar Room	Rm/Zn Tot	830	54.0	28,221	59,527	963	6.96	553	-11,104	0	84.1	100.0
104 - Lecture Room	Rm/Zn Tot	550	27.0	15,104	30,919	537	5.86	367	-7,358	0	75.4	100.0
115 - Storage	Rm/Zn Tot	290	0.0	4,140	4,337	193	4.00	193	-6,125	0	0.0	0.0
116 - Storage	Rm/Zn Tot	490	0.0	7,932	8,370	327	4.00	327	-9,053	0	0.0	0.0
117 - Purchasing	Rm/Zn Tot	350	1.0	5,081	6,184	233	4.00	233	-6,573	0	8.6	8.6
119 - Building Facilities	Rm/Zn Tot	210	1.0	3,135	4,070	140	4.00	140	-3,966	0	14.3	14.3
120 - Recieving	Rm/Zn Tot	310	1.0	5,507	6,200	255	4.93	207	-5,224	0	7.9	9.7
202 - Lunch Room	Rm/Zn Tot	1,250	50.0	46,686	86,022	1,747	8.39	833	-19,398	0	57.2	100.0
219 - IT Office	Rm/Zn Tot	120	1.0	5,709	6,417	244	12.21	80	-2,609	0	8.2	25.0
220 - IT Office	Rm/Zn Tot	120	1.0	5,709	6,417	244	12.21	80	-2,609	0	8.2	25.0
221 - Computer Lab/Visual Room	Rm/Zn Tot	270	6.0	12,104	15,910	508	11.28	180	-5,619	0	23.6	66.7
262 - Storage	Rm/Zn Tot	60	0.0	1,286	1,316	49	4.94	40	-1,147	0	0.0	0.0
223 - Conference Room	Rm/Zn Tot	440	44.0	27,758	55,778	995	13.57	293	-9,552	0	88.5	100.0
224 - Server Room	Rm/Zn Tot	350	1.0	4,677	5,299	233	4.00	233	-4,682	0	0.0	7.5
227 - Corridor	Rm/Zn Tot	780	0.0	10,501	11,441	520	4.00	520	-11,222	0	0.0	7.5
229 - Elevator Vestibule	Rm/Zn Tot	780	0.0	10,543	11,462	520	4.00	520	-13,319	0	0.0	7.5
230 - Telephone	Rm/Zn Tot	60	1.0	1,022	1,776	40	4.00	40	-803	0	50.0	50.0
231 - Electrical	Rm/Zn Tot	60	0.0	842	986	40	4.00	40	-803	0	7.5	7.5
227A - Corridor	Rm/Zn Tot	330	0.0	4,409	4,806	220	4.00	220	-4,415	0	0.0	7.5
328A - Corridor	Rm/Zn Tot	330	0.0	5,552	5,793	222	4.03	220	-4,415	0	0.0	7.5
331 - Electrical	Rm/Zn Tot	60	0.0	991	1,120	40	4.03	40	-803	0	7.4	7.5
332 - Telephone	Rm/Zn Tot	60	1.0	1,142	1,896	40	4.03	40	-803	0	49.6	50.0
330 - Elevator Vestibule	Rm/Zn Tot	780	0.0	12,937	13,530	520	4.00	520	-13,319	0	0.0	7.5
328 - Corridor	Rm/Zn Tot	330	0.0	5,552	5,793	222	4.03	220	-4,415	0	0.0	7.5
325 - IT Room	Rm/Zn Tot	350	2.0	5,798	7,582	235	4.03	233	-4,682	0	17.0	17.1
324 - Conference Room	Rm/Zn Tot	440	44.0	28,634	56,653	995	13.57	293	-9,552	0	88.5	100.0
310 - Library	Rm/Zn Tot	1,200	8.0	23,159	30,075	1,037	5.19	800	-18,729	0	15.4	20.0
319 - ACA Office	Rm/Zn Tot	120	1.0	5,709	6,417	244	12.21	80	-2,609	0	8.2	25.0
320 - ACA Office	Rm/Zn Tot	120	1.0	5,709	6,417	244	12.21	80	-2,609	0	8.2	25.0
321 - IT Office	Rm/Zn Tot	120	1.0	5,678	6,256	240	11.99	80	-2,609	0	8.3	25.0
322 - IT Office	Rm/Zn Tot	120	1.0	5,579	6,157	236	11.80	80	-2,609	0	8.5	25.0
323 - IT Office	Rm/Zn Tot	120	1.0	5,455	6,034	231	11.55	80	-2,609	0	8.7	25.0
RTU-1	Sys Tot/Ave	11,800	248.0	316,315	485,012	12,515			-195,338	0	36.5	39.3
RTU-1	Sys Block	11,800	248.0	296,992	470,346	12,456			-195,375	0	36.5	39.3
121 - Open Office	Rm/Zn Tot	1,115	9.0	18,096	26,617	743	4.00	743	-14,466	0	24.2	24.2
122 - Personnel Manager	Rm/Zn Tot	110	1.0	2,523	3,303	112	6.10	73	-2,196	0	17.9	27.3
123 - Accounting	Rm/Zn Tot	110	1.0	2,530	3,310	111	6.06	73	-2,196	0	18.0	27.3
124 - Accounting	Rm/Zn Tot	110	1.0	2,523	3,303	112	6.10	73	-2,196	0	17.9	27.3
125 - Development	Rm/Zn Tot	110	1.0	2,530	3,310	111	6.06	73	-2,351	0	18.0	27.3
126 - Development	Rm/Zn Tot	110	1.0	2,463	3,328	111	6.03	73	-2,351	0	18.1	27.3
127 - Conference	Rm/Zn Tot	190	8.0	7,713	13,785	284	8.98	127	-3,611	0	56.2	100.0
128 - Development	Rm/Zn Tot	200	1.0	4,668	5,509	192	5.76	133	-3,737	0	10.4	15.0
129 - Board Member	Rm/Zn Tot	200	1.0	4,590	5,645	192	5.77	133	-3,737	0	10.4	15.0
130 - CFO Office	Rm/Zn Tot	200	1.0	4,697	5,752	196	5.87	133	-3,737	0	10.2	15.0
131 - Vice President Office	Rm/Zn Tot	200	1.0	4,871	5,846	196	5.89	133	-3,737	0	10.2	15.0
133 - Executive Vice President	Rm/Zn Tot	200	1.0	4,871	5,846	196	5.89	133	-3,737	0	10.2	15.0
204 - Open Office	Rm/Zn Tot	2,325	24.0	38,653	60,451	1,550	4.00	1550	-29,458	0	31.0	31.0
302 - Open Office	Rm/Zn Tot	2,325	24.0	44,570	66,367	1,550	4.00	1550	-29,458	0	31.0	31.0
205 - PI Office	Rm/Zn Tot	120	1.0	2,593	3,385	114	5.72	80	-2,013	0	17.5	25.0
206 - PI Office	Rm/Zn Tot	120	1.0	2,601	3,392	114	5.69	80	-2,013	0	17.6	25.0
207 - PI Office	Rm/Zn Tot	120	1.0	2,535	3,413	113	5.67	80	-2,013	0	17.6	25.0
208 - PI Office	Rm/Zn Tot	120	1.0	2,535	3,413	113	5.67	80	-2,013	0	17.6	25.0
209 - PI Office	Rm/Zn Tot	120	1.0	2,604	3,532	115	5.73	80	-2,013	0	17.5	25.0
210 - PI Office	Rm/Zn Tot	120	1.0	2,658	3,585	115	5.75	80	-2,013	0	17.4	25.0
211 - PI Office	Rm/Zn Tot	120	1.0	2,766	3,707	118	5.89	80	-2,013	0	17.0	25.0
212 - PI Office	Rm/Zn Tot	120	1.0	2,849	3,790	119	5.93	80	-2,013	0	16.9	25.0
213 - PI Office	Rm/Zn Tot	120	1.0	2,919	3,860	121	6.06	80	-2,013	0	16.5	25.0
214 - PI Office	Rm/Zn Tot	120	1.0	2,926	3,867	121	6.07	80	-2,013	0	16.5	25.0
215 - PI Office	Rm/Zn Tot	120	1.0	2,970	3,911	122	6.12	80	-2,013	0	16.3	25.0
216 - PI Office	Rm/Zn Tot	120	1.0	2,980	3,921	122	6.11	80	-2,013	0	16.4	25.0
217 - PI Office	Rm/Zn Tot	120	1.0	3,073	3,946	123	6.14	80	-2,013	0	16.3	25.0
218 - PI Office	Rm/Zn Tot	120	1.0	3,095	3,967	124	6.18	80	-2,013	0	16.2	25.0

Description **		Floor Area ft²	People #	Coil Cooling Sensible Btu/h	Coil Cooling Total Btu/h	Space Design Max SA cfm	Air Changes ach/hr	VAV Minimum SA cfm	Main Coil Heating Sensible Btu/h	Heating Fan Max SA cfm	Percent OA Clg	Htg
305 - PI Office	Rm/Zn Tot	120	1.0	2,658	3,536	114	5.69	80	-2,013	0	17.6	25.0
306 - PI Office	Rm/Zn Tot	120	1.0	2,705	3,583	113	5.67	80	-2,013	0	17.6	25.0
307 - PI Office	Rm/Zn Tot	120	1.0	2,743	3,621	114	5.69	80	-2,013	0	17.6	25.0
308 - PI Office	Rm/Zn Tot	120	1.0	2,773	3,651	114	5.68	80	-2,013	0	17.6	25.0
309 - PI Office	Rm/Zn Tot	120	1.0	2,841	3,769	115	5.73	80	-2,013	0	17.5	25.0
310 - PI Office	Rm/Zn Tot	120	1.0	2,913	3,841	115	5.75	80	-2,013	0	17.4	25.0
311 - PI Office	Rm/Zn Tot	120	1.0	3,071	4,013	118	5.89	80	-2,013	0	17.0	25.0
312 - PI Office	Rm/Zn Tot	120	1.0	3,133	4,074	118	5.92	80	-2,013	0	16.9	25.0
313 - PI Office	Rm/Zn Tot	120	1.0	3,201	4,143	120	6.02	80	-2,013	0	16.6	25.0
314 - PI Office	Rm/Zn Tot	120	1.0	3,255	4,196	122	6.10	80	-2,013	0	16.4	25.0
315 - PI Office	Rm/Zn Tot	120	1.0	3,275	4,216	122	6.12	80	-2,013	0	16.3	25.0
316 - PI Office	Rm/Zn Tot	120	1.0	3,395	4,268	122	6.11	80	-2,013	0	16.4	25.0
317 - PI Office	Rm/Zn Tot	120	1.0	3,442	4,314	123	6.14	80	-2,013	0	16.3	25.0
318 - PI Office	Rm/Zn Tot	120	1.0	3,463	4,336	124	6.18	80	-2,013	0	16.2	25.0
134 - Board Room	Rm/Zn Tot	775	20.0	18,077	33,685	616	4.77	517	-9,801	0	64.9	77.4
137 - Corridor/Kitchenette	Rm/Zn Tot	460	1.0	7,281	8,747	307	4.00	307	-6,196	0	7.5	7.5
139 - Workroom Storage	Rm/Zn Tot	300	2.0	4,831	6,798	200	4.00	200	-3,794	0	20.0	20.0
140 - Graphics	Rm/Zn Tot	340	2.0	5,381	7,405	227	4.00	227	-4,300	0	17.6	17.6
145 - Telephone Room	Rm/Zn Tot	90	1.0	1,521	2,419	60	4.00	60	-1,138	0	33.3	33.3
Atrium w/25% tinted skylight	Rm/Zn Tot	6,012	40.0	369,515	565,184	17,084	3.41	10020	-366,440	0	29.3	50.0
RTU-2	Sys Tot/Ave	18,842	169.0	636,464	946,453	27,459			-555,010	0	29.5	40.7
RTU-2	Sys Block	18,842	169.0	626,251	938,338	25,774			-551,817	0	29.5	40.7
105 - Electron Microscopy (Inactive)	Rm/Zn Tot	725	21.8	15,308	31,946	494	4.08	483	-9,858	0	100.0	100.0
106 - Storage	Rm/Zn Tot	175	0.0	7,053	9,944	325	11.16	117	-4,802	0	100.0	100.0
107 - Scintillation	Rm/Zn Tot	210	1.0	5,406	8,169	243	6.94	140	-4,282	0	100.0	100.0
228 - (1-5) Research Lab and Supporting	Rm/Zn Tot	5,130	154.1	146,626	290,448	5,044	5.90	3420	-85,697	0	100.0	100.0
109 - Radioisotope High	Rm/Zn Tot	125	3.8	3,725	7,267	120	5.74	83	-2,869	0	100.0	100.0
111 - Material Storage	Rm/Zn Tot	410	0.0	8,670	14,878	273	4.00	273	-7,516	0	100.0	100.0
112 - Corridor	Rm/Zn Tot	650	0.0	13,329	23,171	433	4.00	433	-8,110	0	100.0	100.0
113 - Bulk Storage	Rm/Zn Tot	410	0.0	8,670	14,878	273	4.00	273	-7,516	0	100.0	100.0
228 - (6-8) and Supporting	Rm/Zn Tot	2,295	68.9	52,440	108,175	1,708	4.46	1530	-28,636	0	100.0	100.0
228 - (9-10) Lab and Supporting	Rm/Zn Tot	2,130	64.0	55,376	111,415	2,443	6.88	1420	-31,345	0	100.0	100.0
329 - (1-5) Lab and Supporting	Rm/Zn Tot	5,130	154.1	159,483	303,305	5,044	5.90	3420	-85,697	0	100.0	100.0
329 - (6-8) Lab and Supporting	Rm/Zn Tot	2,515	75.5	63,770	124,848	1,871	4.46	1677	-31,381	0	100.0	100.0
329 - (9-10) Lab and Supporting	Rm/Zn Tot	2,200	66.1	62,489	120,228	2,492	6.80	1467	-32,219	0	100.0	100.0
232 - Support Corridor	Rm/Zn Tot	640	19.2	14,624	30,167	476	4.46	427	-7,986	0	100.0	100.0
238 - CG Robotics	Rm/Zn Tot	700	21.0	15,995	32,995	521	4.46	467	-8,734	0	100.0	100.0
239 - Shared Equipment	Rm/Zn Tot	600	18.0	13,710	28,281	446	4.46	400	-7,487	0	100.0	100.0
243 - Chromatography	Rm/Zn Tot	240	7.2	5,484	11,312	179	4.46	160	-2,995	0	100.0	100.0
252 - Autoclave	Rm/Zn Tot	115	3.5	2,628	5,421	86	4.46	77	-1,435	0	100.0	100.0
253 - Insect Room	Rm/Zn Tot	330	9.9	7,540	15,555	246	4.46	220	-4,118	0	100.0	100.0
254 - Bacteria	Rm/Zn Tot	140	4.2	3,199	6,599	104	4.46	93	-1,747	0	100.0	100.0
255- Dark Room	Rm/Zn Tot	85	2.6	1,942	4,007	63	4.46	57	-1,061	0	100.0	100.0
256 - Chromatography	Rm/Zn Tot	225	6.8	5,141	10,605	167	4.46	150	-2,807	0	100.0	100.0
257 - Yeast	Rm/Zn Tot	110	0.0	2,256	3,921	73	4.00	73	-1,373	0	100.0	100.0
245 - Writeup	Rm/Zn Tot	215	6.5	4,913	10,134	160	4.46	143	-2,683	0	100.0	100.0
333 - Support Corridor	Rm/Zn Tot	640	19.2	16,228	31,771	476	4.46	427	-7,986	0	100.0	100.0
339 - Dishwashing	Rm/Zn Tot	210	6.3	5,325	10,425	156	4.46	140	-2,620	0	100.0	100.0
340 - Autoclave	Rm/Zn Tot	110	3.3	2,789	5,461	82	4.46	73	-1,373	0	100.0	100.0
341 - Instument	Rm/Zn Tot	170	5.1	4,311	8,439	126	4.46	113	-2,121	0	100.0	100.0
343 - Equipment	Rm/Zn Tot	345	10.4	8,748	17,126	257	4.46	230	-4,305	0	100.0	100.0
344 - Chromatography	Rm/Zn Tot	225	6.8	5,705	11,169	167	4.46	150	-2,807	0	100.0	100.0
358 - X-Ray Crystallography	Rm/Zn Tot	725	21.8	18,383	35,990	539	4.46	483	-9,046	0	100.0	100.0
360 - X-Ray Pump Room	Rm/Zn Tot	110	3.3	2,789	5,461	82	4.46	73	-1,373	0	100.0	100.0
361 - E Coli Lab	Rm/Zn Tot	110	3.3	2,789	5,461	82	4.46	73	-1,373	0	100.0	100.0
AHU-1,2	Sys Tot/Ave	28,150	787.3	749,430	1,461,560	25,254			-415,356	0	100.0	100.0
AHU-1,2	Sys Block	28,150	787.3	743,380	1,456,240	24,675			-415,355	0	100.0	100.0

Appendix F:
Design Load vs. Simulated Load Airflow Summary

Room Name	Area	Simulated Max SA	Design Max OA	% Design
103 - Seminar Room	830	963	1,200	80.26%
104 - Lecture Room	550	537	800	67.13%
115 - Storage	290	193	225	85.93%
116 - Storage	490	327	400	81.67%
117 - Purchasing	350	233	350	66.67%
119 - Building Facilities	210	140	200	70.00%
202 - Lunch Room	1,250	1,747	1,000	174.70%
219 - IT Office	120	244	200	122.12%
220 - IT Office	120	244	200	122.12%
221 - Computer Lab/Visual Room	270	508	300	169.20%
262 - Storage	60	49	75	65.81%
223 - Conference Room	440	995	450	221.09%
224 - Server Room	350	233	100	233.33%
227 - Corridor	780	520	1150	45.22%
229 - Elevator Vestibule	780	520	175	297.14%
230 - Telephone	60	40	75	53.33%
231 - Electrical	60	40	200	20.00%
227A - Corridor	330	220	250	88.00%
328A - Corridor	330	222	250	88.69%
331 - Electrical	60	40	60	67.19%
332 - Telephone	60	40	50	80.63%
330 - Elevator Vestibule	780	520	675	77.04%
328 - Corridor	330	222	650	34.11%
325 - IT Room	350	235	450	52.26%
324 - Conference Room	440	995	450	221.09%
310 - Library	1,200	1,037	700	148.19%
319 - ACA Office	120	244	150	162.82%
320 - ACA Office	120	244	175	139.56%
321 - IT Office	120	240	175	137.01%
322 - IT Office	120	236	125	188.74%
323 - IT Office	120	231	150	154.02%
RTU-1 Total	**11,490**	**12,261**	**11,410**	**107.46%**

Room Name	Area	Simulated Max SA	Design Max OA	% Design
121 - Open Office	1,115	743	1,950	38.12%
122 - Personnel Manager	110	112	125	89.40%
123 - Accounting	110	111	250	44.43%
124 - Accounting	110	112	200	55.88%
125 - Development	110	111	125	88.86%
126 - Development	110	111	250	44.25%
127 - Conference	190	284	300	94.83%
128 - Development	200	192	225	85.36%
129 - Board Member	200	192	225	85.41%
130 - CFO Office	200	196	225	86.98%
131 - Vice President Office	200	196	350	56.12%
133 - Executive Vice President	200	196	225	87.30%
204 - Open Office	2,325	1,550	3,250	47.69%
302 - Open Office	2,325	1,550	3,250	47.69%
205 - PI Office	120	114	225	50.89%
206 - PI Office	120	114	175	65.04%
207 - PI Office	120	113	200	56.72%
208 - PI Office	120	113	150	75.63%
209 - PI Office	120	115	200	57.26%
210 - PI Office	120	115	225	51.11%
211 - PI Office	120	118	150	78.55%
212 - PI Office	120	119	200	59.30%
213 - PI Office	120	121	200	60.57%
214 - PI Office	120	121	150	80.91%
215 - PI Office	120	122	225	54.41%
216 - PI Office	120	122	225	54.29%
217 - PI Office	120	123	150	81.80%
218 - PI Office	120	124	200	61.84%
305 - PI Office	120	114	175	65.04%
306 - PI Office	120	113	225	50.42%
307 - PI Office	120	114	175	65.01%
308 - PI Office	120	114	125	90.88%
309 - PI Office	120	115	225	50.90%
310 - PI Office	120	115	150	76.70%
311 - PI Office	120	118	225	52.36%
312 - PI Office	120	118	150	78.94%
313 - PI Office	120	120	125	96.27%
314 - PI Office	120	122	150	81.36%
315 - PI Office	120	122	150	81.61%
316 - PI Office	120	122	200	61.12%
317 - PI Office	120	123	150	81.80%
318 - PI Office	120	124	125	98.94%
134 - Board Room	775	616	750	82.13%
137 - Corridor/Kitchenette	460	307	375	81.78%
139 - Workroom Storage	300	200	350	57.14%
140 - Graphics	340	227	400	56.67%
Atrium w/25% tinted skylight	6,012	17,084	12,800	133.47%
RTU-2 Total	**18,842**	**27,399**	**30,650**	**89.39%**

Room Name	Area	Simulated Max SA	Design Max OA	% Design
105 - Electron Microscopy (Inactive)	725	494	1,300	37.97%
106 - Storage	175	325	200	162.73%
107 - Scintillation	210	243	325	74.74%
228 - (1-5) Research Lab and Supporting	5,130	5,044	11,000	45.86%
109 - Radioisotope High	125	120	250	47.85%
111 - Material Storage	410	273	650	42.05%
112 - Corridor	650	433	500	86.67%
113 - Bulk Storage	410	273	650	42.05%
228 - (6-8) and Supporting	2,295	1,708	5,400	31.62%
228 - (9-10) Lab and Supporting	2,130	2,443	3,300	74.03%
329 - (1-5) Lab and Supporting	5,130	5,044	11,000	45.86%
329 - (6-8) Lab and Supporting	2,515	1,871	4,300	43.52%
329 - (9-10) Lab and Supporting	2,200	2,492	3,700	67.36%
232 - Support Corridor	640	476	500	95.24%
238 - CG Robotics	700	521	1300	40.07%
239 - Shared Equipment	600	446	1100	40.59%
243 - Chromatography	240	179	500	35.72%
252 - Autoclave	115	86	900	9.51%
253 - Insect Room	330	246	1000	24.55%
254 - Bacteria	140	104	200	52.09%
255- Dark Room	85	63	200	31.62%
256 - Chromatography	225	167	650	25.76%
257 - Yeast	110	73	200	36.67%
245 - Writeup	215	160	375	42.66%
333 - Support Corridor	640	476	0	#DIV/0!
339 - Dishwashing	210	156	400	39.06%
340 - Autoclave	110	82	900	9.09%
341 - Insturment	170	126	500	25.30%
343 - Equipment	345	257	1000	25.67%
344 - Chromatography	225	167	700	23.92%
358 - X-Ray Crystallography	725	539	1275	42.31%
360 - X-Ray Pump Room	110	82	200	40.92%
361 - E Coli Lab	110	82	400	20.46%
AHU-1,2 Total	28,150	25,254	54,875	46.02%

Appendix G:
Design Cooling Load Summary

System - RTU-1
Type - Variable Volume Reheat (30% Min Flow Default)

Coil Location - System

Coil Peak Calculation Time: August, hour 15
Ambient DB/WB/HR: 85 / 72 / 103

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	44,606		44,606	9.5 %
Glass Transmission	4,979		4,979	1.1 %
Wall Transmission	9,197		9,197	2.0 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	53,035		53,035	11.3 %
People	62,760	49,790	112,550	23.9 %
Misc. Equipment Loads	20,137	0	20,137	4.3 %
Cooling Infiltration	6,275	14,208	20,483	4.4 %
Sub-Total ==>	200,989	63,998	264,987	56.3 %
Ventilation Load	48,293	109,356	157,649	33.5 %
Exhaust Heat	0	0	0	0.0 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	5,959		5,959	1.3 %
Roof Load to Plenum	4,675		4,675	1.0 %
Lighting Load to Plenum	13,259		13,259	2.8 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenu	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	23,818		23,818	5.1 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	296,992	173,354	470,346	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	78.9 / 66.7	°F
Coil Entering Humidity Ratio	81.27	gr/lb
Coil Leaving Air (DB / WB)	55.0 / 53.2	°F
Coil Leaving Humidity Ratio	59.34	gr/lb
Coil Sensible Load	296.99	MBh
Coil Total Load	470.35	MBh
Cooling Supply Air Temperature	55.00	°F
Total Cooling Airflow	11443.46	cfm
Resulting Room Relative Humidity	50.41	%

General Engineering Checks

Total Cooling Load	39.2	ton
Area / Load	301.05	ft²/ton
Total Floor Area	11,800	ft²
Cooling Airflow	1.06	cfm/ft²
Airflow / Load	317.80	cfm/ton
Percent Outdoor Air	36.5	%
Cooling Load Methodology	TETD-TA1	

System - RTU-2
Type - Variable Volume Reheat (30% Min Flow Default)

Coil Location - System

Coil Peak Calculation Time: August, hour 15
Ambient DB/WB/HR: 85 / 72 / 103

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	253,508		253,508	27.0 %
Glass Transmission	28,324		28,324	3.0 %
Wall Transmission	19,433		19,433	2.1 %
Roof Transmission	12,305		12,305	1.3 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	75,677		75,677	8.1 %
People	42,105	34,495	76,600	8.2 %
Misc. Equipment Loads	21,894	0	21,894	2.3 %
Cooling Infiltration	22,806	61,134	83,941	8.9 %
Sub-Total ==>	476,053	95,629	571,682	60.9 %
Ventilation Load	80,750	216,458	297,208	31.7 %
Exhaust Heat	-16,578	0	-16,578	-1.8 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	20,893		20,893	2.2 %
Roof Load to Plenum	10,192		10,192	1.1 %
Lighting Load to Plenum	13,790		13,790	1.5 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenu	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	41,152		41,152	4.4 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	626,251	312,087	938,338	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	79.2 / 65.3	°F
Coil Entering Humidity Ratio	73.93	gr/lb
Coil Leaving Air (DB / WB)	55.0 / 52.3	°F
Coil Leaving Humidity Ratio	55.55	gr/lb
Coil Sensible Load	626.25	MBh
Coil Total Load	938.34	MBh
Cooling Supply Air Temperature	55.00	°F
Total Cooling Airflow	24124.18	cfm
Resulting Room Relative Humidity	45.62	%

General Engineering Checks

Total Cooling Load	78.2	ton
Area / Load	240.96	ft²/ton
Total Floor Area	18,842	ft²
Cooling Airflow	1.37	cfm/ft²
Airflow / Load	329.62	cfm/ton
Percent Outdoor Air	29.5	%
Cooling Load Methodology	TETD-TA1	

System - AHU-1,2
Type - Variable Volume Reheat (30% Min Flow Default)

Coil Location - System

Coil Peak Calculation Time: August, hour 15
Ambient DB/WB/HR: 85 / 72 / 103

COOLING COIL LOAD INFORMATION

Load Component	Sensible Btu/h	Latent Btu/h	Total Btu/h	Percent of Total
Solar Gain	38,013		38,013	2.6 %
Glass Transmission	11,045		11,045	0.8 %
Wall Transmission	5,633		5,633	0.4 %
Roof Transmission	0		0	0.0 %
Floor Transmission	0		0	0.0 %
Partition Transmission	0		0	0.0 %
Net Ceiling Load	0		0	0.0 %
Lighting	115,291		115,291	7.9 %
People	196,834	196,834	393,668	27.0 %
Misc. Equipment Loads	91,460	0	91,460	6.3 %
Cooling Infiltration	14,968	29,739	44,708	3.1 %
Sub-Total ==>	473,244	226,573	699,818	48.1 %
Ventilation Load	244,759	486,287	731,046	50.2 %
Exhaust Heat	-50,291	0	-50,291	-3.5 %
Supply Fan Load	0		0	0.0 %
Return Fan Load	0		0	0.0 %
Net Duct Heat Pickup	0		0	0.0 %
Wall Load to Plenum	6,204		6,204	0.4 %
Roof Load to Plenum	31,302		31,302	2.1 %
Lighting Load to Plenum	28,823		28,823	2.0 %
Misc. Equip. Load to Plenum	0	0	0	0.0 %
Glass Transmission to Plenum	0		0	0.0 %
Glass Solar to Plenum	0		0	0.0 %
Over/Under Sizing	9,339		9,339	0.6 %
Reheat at Design	0	0	0	0.0 %
Total Cooling Loads	743,380	712,861	1,456,240	100.0 %

COOLING COIL SELECTION

Coil Selection Parameters

Coil Entering Air (DB / WB)	84.8 / 72.3	°F
Coil Entering Humidity Ratio	102.56	gr/lb
Coil Leaving Air (DB / WB)	55.0 / 52.9	°F
Coil Leaving Humidity Ratio	58.02	gr/lb
Coil Sensible Load	743.38	MBh
Coil Total Load	1456.24	MBh
Cooling Supply Air Temperature	55.00	°F
Total Cooling Airflow	23014.98	cfm
Resulting Room Relative Humidity	53.60	%

General Engineering Checks

Total Cooling Load	121.4	ton
Area / Load	231.97	ft²/ton
Total Floor Area	28,150	ft²
Cooling Airflow	0.88	cfm/ft²
Airflow / Load	203.33	cfm/ton
Percent Outdoor Air	100.0	%
Cooling Load Methodology	TETD-TA1	

Appendix H:
Annual Utility Consumption Monthly Breakdown

					------- Monthly Energy Consumption -------								
Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Electric													
On-Pk Cons. (kWh)	97,818	88,326	97,733	95,146	113,357	123,642	141,451	148,263	125,259	99,946	94,919	97,697	1,323,558
On-Pk Demand (kW)	133	134	133	149	254	308	337	358	299	183	142	135	358
Gas													
On-Pk Cons. (therms)	11,829	9,734	8,769	4,735	1,447	763	556	678	1,058	3,259	5,615	7,517	55,959
On-Pk Demand (therms/hr)	19	19	15	11	5	3	2	2	3	7	11	13	19

Building Energy Consumption =	172,017	Btu/(ft2-year)
Source Energy Consumption =	330,720	Btu/(ft2-year)
Floor Area =	58,792	ft2

Appendix I:
Annual Utility Cost Monthly Breakdown

					------- Monthly Utility Costs -------								
Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Electric													
On-Pk Demand ($)	52	52	52	52	52	52	52	52	52	52	52	52	619
Gas													
On-Pk Cons. ($)	1,961	1,621	1,464	809	275	155	114	138	212	570	952	1,261	9,534
Monthly Total ($):	2,013	1,673	1,516	861	327	207	166	190	264	621	1,004	1,313	10,153

Appendix J:
Annual Equipment Consumption Monthly Breakdown

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
	------- Monthly Consumption -------												
Lights													
Electric (kWh)	65,369.7	59,043.6	65,369.6	63,261.0	65,369.7	63,261.0	65,369.7	65,369.6	63,261.0	65,369.7	63,261.0	65,369.7	769,675.1
Peak (kW)	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
MISC LD													
Electric (kWh)	29,099.7	26,283.6	29,099.7	28,161.0	29,099.7	28,161.0	29,099.7	29,099.7	28,161.0	29,099.7	28,161.0	29,099.7	342,625.3
Peak (kW)	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1
Cpl 1: Cooling plant - 001													
McQuay Air Cooled Screw Chiller (Cooling Equipment)													
Electric (kWh)	0.0	0.0	0.0	389.0	14,201.8	26,512.3	39,940.0	45,909.5	27,499.4	1,626.9	229.4	0.0	156,308.3
Peak (kW)	0.6	1.4	1.0	15.0	113.9	162.4	188.4	208.0	153.8	48.4	8.5	2.4	208.0
Eq5221 - Condenser fan													
Electric (kWh)	0.0	0.0	0.0	258.6	2,329.7	3,762.4	5,337.6	6,051.8	3,949.7	700.4	171.7	0.0	22,561.8
Peak (kW)	0.6	0.9	0.7	3.1	13.3	18.7	21.1	23.2	18.1	6.1	2.3	1.2	23.2
Eq5302 - Cntl panel & interlocks (Misc Accessory Equipment)													
Electric (kWh)	0.0	0.0	0.0	33.0	74.4	72.0	74.4	74.4	72.0	58.9	24.0	0.0	483.1
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Hpl 1: Heating plant - 002													
Boiler - 001 (Heating Equipment)													
Gas (therms)	11,829.4	9,733.6	8,768.7	4,735.1	1,446.9	762.6	555.6	677.6	1,057.9	3,259.4	5,615.2	7,517.3	55,959.2
Peak (therms/Hr)	19.5	18.7	15.1	11.0	5.3	3.2	2.3	2.4	3.3	7.4	11.2	12.9	19.5
Eq5020 - Heating water circ pump (Misc Accessory Equipment)													
Electric (kWh)	1,109.6	1,002.2	1,109.6	1,073.8	832.2	689.0	601.0	647.3	850.1	1,109.6	1,073.8	1,109.6	11,207.9
Peak (kW)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Eq5240 - Boiler forced draft fan (Misc Accessory Equipment)													
Electric (kWh)	1,488.0	1,344.0	1,488.0	1,440.0	1,116.0	924.0	806.0	868.0	1,140.0	1,488.0	1,440.0	1,488.0	15,030.0
Peak (kW)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Hpl 1: Heating plant - 002													
Eq5307 - Boiler cntl panel & inter (Misc Accessory Equipment)													
Electric (kWh)	372.0	336.0	372.0	360.0	279.0	231.0	201.5	217.0	285.0	372.0	360.0	372.0	3,757.5
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Eq5032 - VV Cond Wtr Pump (12 F Delta T) (Misc Accessory Equipment)													
Electric (kWh)	379.4	316.5	294.2	169.5	54.2	29.5	21.2	26.0	40.6	121.3	198.1	257.8	1,908.3
Peak (kW)	0.6	0.6	0.5	0.4	0.2	0.1	0.1	0.1	0.1	0.3	0.4	0.4	0.6

Appendix K:
Annual Equipment Consumption Summary

	Elect Cons. (kWh)	Gas Cons. (therms)	Percent of Total Energy	Total Source Energy* (kBtu/yr)
Primary heating				
Primary heating	20,695.8	55,959.2	56.0 %	61,023.7
Primary cooling				
Cooling Compressor	156,308.3		5.3 %	16,006.0
Tower/Cond Fans	22,561.8		0.8 %	2,310.3
Condenser Pump			0.0 %	0.0
Other CLG Accessories	483.1		0.0 %	49.5
Cooling Subtotal....	179,353.2		6.1 %	18,365.8
Auxiliary				
Supply Fans			0.0 %	0.0
Circ Pumps	11,207.9		0.4 %	1,147.7
Base Utilities			0.0 %	0.0
Aux Subtotal....	11,207.9		0.4 %	1,147.7
Lighting				
Lighting	769,675.1		26.0 %	78,814.9
Receptacle				
Receptacles	342,625.3		11.6 %	35,084.9
Heating plant load				
Base Utilities			0.0 %	0.0
Cogeneration				
Cogeneration			0.0 %	0.0
Totals				
Totals**	1,323,557.3	55,959.2	100.0 %	194,437.0

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