University of Miami Interdisciplinary Laboratory

Mechanical Technical Report 2
Building and Plant Energy Analysis

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Miami, Florida
Mechanical Technical Report 2-Executive Summary
10/27/06

Executive Summary:

Considerations should be made in building design, not only for the intended building use, but also the impact of that building on the systems around it. These systems include environmental, energy, and cost. This report analyzes the impacts of the University of Miami Interdisciplinary Laboratory on the basis of USGBC LEED-NC Version 2.2 certification status, compliance to ASHRAE 90.1-2004, and actually building simulation data.

The University of Miami Interdisciplinary Laboratory design and construction meets the criteria for at least 26 LEED points, which is enough to classify it as LEED Certified.

The University of Miami Interdisciplinary Laboratory design meets most requirements for ASHRAE 90.1-2004. The solar heat gain coefficient (SHGC) for the window glazing is higher than the maximum required by Table 5.5-1 for the fenestration classification. Additionally, the interior and exterior lighting power densities exceed the lighting power densities allowed by Table 9.5.1, Table 9.6.1, and Table 9.4.5.

Building simulation has been carried out for the University of Miami Interdisciplinary Laboratory. Relevant cooling load, power consumption, and utility cost are given along with mechanical space and mechanical system cost data.

The University of Miami Interdisciplinary Laboratory is designed not only to fulfill the needs of its intended use, but also to reduce adverse impacts on the environment, through location, energy consumption, and emissions, and on the cost of operation to the owner.

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Load and Energy Analysis

A fully functioning building makes a tremendous impact in the lives of people. Socially, its use can determine their employment, recreation habits, or transportation routes and methods. A building system can play a large economic role, affecting rent, utility charges, and maintenance costs, both for owners and occupants. That system also influences health: ensuring or hindering personal comfort through temperature, humidity, lighting, and cleanliness of air. Additionally, the environment is affected: past wildlife habitat is lost to make space; natural resources are used for building materials; and the energy consumption to build and maintain systems eats up natural resources and adds pollution to the atmosphere. The state of the environment is a key factor in people's well being. With these aspects in mind, it is evident that certain measures need to be taken to ensure that a building does not make an adverse effect.

The purpose of this document is to explore the University of Miami Interdisciplinary Laboratory (hereafter referred to as the UMIL) building systems to determine their impact. The methods of analysis are first a building assessment using LEED-NC Version 2.2 by the US Green Building Council (USGBC), followed by a compliance check of ASHRAE Standard 90.1-2004, and, lastly, an actual building energy simulation.

LEED-NC Version 2.2

The USGBC LEED-NC Version 2.2 is a rating system designed to measure a building's positive impact on the environment. This is done by awarding points for certain environmentally friendly practices or components included in the building design and construction. These points are separated into topical categories. Distinctions are given to the buildings that have accrued a specific number of points: Certified (26-32 points), Silver (33-38), Gold (39-51), and Platinum (52-69). Upon analysis, the UMIL falls under LEED Certified, because it complies with 26 prescribed points. The following is a description of the points achieved in each category.

Sustainable Sites

-Prerequisite: The UMIL site meets this because it is located on an existing site, the site of the former Radiation Control Building, and so reduces the environmental impact.

-Credit 1: The site is on a college campus infrastructure (University of Miami), and has a building density over 60,000 square feet per acre.

-Credit 4.1: The building is located with a half mile of a Miami-Dade Transit Bus stop and Rail Line Stop.

-Credit 4.4: There is no parking provided on-site.

-Credit 7.1: Over half of the hardscape on-site is either shaded or has a light enough colored pavement that would have an SRI greater than 29.

-Credit 7.2: Roofing materials are star compliant.

-Credit 8: Interior and exterior light fixtures are not directed off-site or out of windows.

Water Efficiency

-Credit 2: Condensed water from the mechanical system is used to operate the toilets on the first 4 floors of the UMIL, which is over 50% of the sewage conveyance demand.

-Credit 3.1: Water efficient plumbing fixtures make up a system that surpasses the Energy Policy Act of 1992 standards by at least 20%.

Energy and Atmosphere

-Prerequisite: The UMIL does not fully comply with ASHRAE Standard 90.1-2004, which is discussed in detail below, so no points are possible in this category.

Materials and Resources

-Prerequisite: Appropriate recycling receptacles and pickup are arranged for the site.

-Credit 2.1: At least 50% of the non-hazardous construction materials and debris are being salvaged for reuse.

-Credit 4.1: At least 10% of the materials used on the project are of recycled content.

-Credit 5.1: Over 10% of the materials used in construction were harvested from natural resources located within 500 miles of the project site.

-Credit 5.2: Over 20% of the mater materials used in construction were harvested from natural resources located within 500 miles of the project site.

-Credit 6: At least 2.5% of the building materials are made from rapidly renewable sources.

-Credit 7: At least 50% of the wood-based products used in construction are certified by the Forest Stewardship Council.

Indoor Environmental Quality

-Prerequisite: The UMIL complies with ASHRAE Standard 62.1-2004.

-Prerequisite: The UMIL is a non-smoking building.

-Credit 1: The UMIL contains carbon dioxide monitors and outdoor air measuring devices.

-Credit 2: The outdoor air supplied to the spaces is greater than 30% of required by ASHRAE Standard 62.1-2004.

-Credit 3.1: A construction Indoor Air Quality Management Plan has been established.

-Credit 3.2: A pre-occupancy Indoor Air Quality Management Plan has been established.

-Credit 4.1: The sealants and adhesives used in the building have the appropriate VOC content.

-Credit 4.2: Paints and coatings have the appropriate chemical composition and VOC content.

-Credit 4.3: Carpets have the appropriate VOC content.

-Credit 4.4: Wood products used in construction contain no urea-formaldehyde resin.

-Credit 6.2: Individual comfort controls are provided for over 50% of regularly occupied, non-perimeter spaces.

Innovation and Design Process

-Credit 2: At least one LEED Accredited Professional was a key team member in the design of the UMIL.

ASHRAE Standard 90.1-2004

Like any machine, a major intent of design and construction of a building is to be efficient. If the designer is not conscientious, energy, money, and performance can be needlessly wasted where a few easy decisions at the beginning could have made a difference. ASHRAE Standard 90.1-2004 sets up a measurable benchmark to designing an efficient building. Compliance to this standard is carried out below.

5. Building Envelope

This section considers the heat transmission through the exterior skin of the building. The more impervious that skin is, the less energy it takes to condition the inside. When outside air conditions affect the inside air, the system has to work harder to keep that inside air at the desired state.

5.1 General

-5.1.2.1

The UMIL is made up of nonresidential conditioned spaces.

-5.1.4 Climate

The UMIL is located in Miami, Florida- Climate Zone 1A per Table B-1 Appendix B of the Standard.

5.2 Compliance Paths

The UMIL may be applied to Compliance Path 5.5 because its fenestration does not exceed 50% of the exterior wall area. This is determined in Table 5.2, the window to wall ratio (0.194) being less than 0.50.

	Wall Area (s.f.)	Total Window Area (s.f.)
South Face	35226	6802
North Face	35226	5832
East Face	18269	2367
West Face	18269	5746
Total	106990	20747
Ratio: Window/Wall	**0.194**	

Table 5.2

5.4 Mandatory Provisions

-5.4.3.4 Vestibules

It is important to note that the UMIL falls under exception (a) because it is located in Climate Zone 1. This means that doors separating conditioned spaces from the exterior do not require enclosed vestibules.

5.5 Prescriptive Building Envelope Option

-5.5.1 Table 5.5-1

Table 5.5-1, located in the Appendix, is applicable for the UMIL because it corresponds to Climate Zone 1A. Corresponding thermal resistances will be checked for nonresidential roofs, walls-above-grade, floors, slab-on-grade floors, opaque doors, and vertical glazing.

-5.5.3 Opaque Areas

U-Factors and C-Factors for the opaque elements are determined using Appendix A of the Standard. Those results are shown in Table 5.5. Listed with each component value is its source. Some values are derived from charts within Appendix A of the Standard. Others are taken from ASHRAE Fundamentals 2004 or directly from the UMIL Project Specifications Manual.

-5.5.3.1

A roof multiplier, as used in Equation 5-1, is not used, because the R-value of the roof assembly alone is sufficient to comply with Table 5.5-1.

-5.5.3.2

The exterior wall-above-grade U-Factor complies with Table 5.5-1.

-5.5.3.4

The floor U-value complies with Table 5.5-1.

-5.5.3.5

The slab-on-grade floor F-Factor complies with Table 5.5-1

-5.5.4

Fenestration falls on Table 5.5-1 under 10%-20% Vertical Glazing, Fixed. The U-Factor is compliant with the transparent glass as well as the aluminum curtain wall which is counted with the glass as fenestration because of its similar installation type, location, and thermal properties. The north facing SHGC fenestration is compliant. However, the other facing SHGC for the glass is noncompliant. There are window projections, but their geometry relative to the glass is such that the projection factors are insignificant, as shown in Table 5.5.4.

Summary: All compliant except vertical fenestration non-north-facing SHGC.

pf=projection depth(a)/[window height(b)+top of window to furthest projection(c)]

	a	b	c	pf	Adjusted SHGC*
Window 1	4	60	4	0.0625	0.35
Window 2	18	108	18	0.142857	0.3185
Window 3	20	108	20	0.15625	0.3184

*According to Table 5.5.4.4.1 in Standard 90.1

Table 5.5.4

6. Heating Ventilation and Air Conditioning

This section ensures that equipment used in the mechanical system is efficient. This equipment is responsible for the energy that goes into a mechanical system, so the less energy they consume, the better the system is.

The UMIL chilled water is supplied by the University of Miami through a remote chilled water plant. That means that the UMIL does not have its own chillers, so much of this section does not apply to this building. What does apply, however, is listed below.

6.5.1 Economizers

The UMIL is located in Climate Zone 1A, and does not need economizers for its air cooling systems, per Table 6.5.1 Standard 90.1-2004.

6.8.1

The UMIL natural gas fed, steam boilers have thermal efficiencies greater than 83% per Spec 15650 2.02-A of the Project Specifications Manual. This complies with Table 6.8.1F Standard 90.1-2004.

7. Service Water Heating

The natural gas fed, steam boilers are not listed on Table 7.8 Standard 90.1-2004, so do not have a minimum standard performance in heating water.

9. Lighting

This section applies to the location and distribution of interior and exterior lighting. Lighting can make up a significant portion of the building power consumption, and the wise and efficient use of it can make a big difference.

9.4.5

The exterior power lighting density is calculated by dividing the total exterior lighting power by the paved area. This calculation is shown in Table 9.4.5a. In this case, the exterior power lighting density is 0.29 W/sf. This is noncompliant with Table 9.4.5 Standard 90.1-2004 which demands 0.20 W/sf for plazas and walkways wider than ten feet.

Paved Areas (sf)	18632
Exterior Lighting (W)	5390
Power Density (W/sf)	**0.29**
Code (W/sf)	0.20

Table 9.4.5a

9.5/9.6

There are two methods prescribed for calculating the interior lighting power density. 9.5 instructs to use a building multiplier from Table 9.5.1 Standard 90.1-2004 with the total building area. 9.6 instructs to use space multipliers from Table 9.6.1 Standard 90.1-2004 with each space, and sum up the power. Both methods are used in this analysis. These are shown on Table 9.5 and Table 9.6 in the Appendix. The 9.6 method shows noncompliance. The 9.5 method shows the building lighting power density compared to three similar examples: a hospital, a school or university, and a workshop. Since there is no laboratory listed in the table, a building with similar uses is selected.

10. Other equipment

This section demands a minimum efficiency for equipment that runs on electric motors. At the present stage of design and equipment selection, actual efficiencies have not been ascertained. However, the equipment schedule calls for pumps used for the chilled water, hot water, and energy recovery water loops be at least 70% efficient. This mark falls far below Table 10.8 Standard 90.1-2004 values, which begin in the 80 to 90 percent range. See Table 10.8a in the Appendix for necessary efficiencies for UMIL equipment.

Summary

ASHRAE Standard 90.1-2004 is not easy to reach, but the UMIL does so in the majority of areas. Total compliance would be reached with a better fenestration SHGC and lower lighting power densities.

Building Energy Data

While keeping all the standards, due attention should also be paid to the actual building performance. How much energy is this building really going to expend and what will that cost? A simulation was run by the mechanical, plumbing, and electric systems designing firm. Key load, energy, and cost data taken from that simulation are shown in the Appendix on the Design Firm Simulation page. Further helpful system cost and space breakdown are located in the Appendix on the Mechanical Breakdown page.

Conclusion

The UMIL is a laboratory building. Precise and accurate results are essential to the activities intended for it. Thus, the first priority of this building is effectiveness towards intended use. Environmental impacts, energy efficiency, and low cost, however important are secondary, because if the intended purpose isn't fulfilled, there is no reason to build. In this situation, other important issues like the building's impact might be neglected. However, based on this report's assessment, the UMIL meets the criteria for an efficient as well as effective building. It meets LEED Certification criteria, and almost all the ASHRAE Standard 90.1-2004 conditions. These results suggest that it would not be easy to design a system for this building with lower energy demands.

Appendix

Material	U-Value	R-Value	Thickness	Source
Roof				
Insulating Concrete/insulation board		**19.00**		Spec 07527 2.03-I
Wall above Grade				
Inside Air Surface	1.47	0.68		A9.4.1 F Appendix A
Gypsum Board	1.79	0.56	5/8"	Table A9.4D
Batt. Insulation	0.14	7.10	6"	Table 4 F25.5-9 (R= 19) Table A9.2B 16" o.c. metal studs
Air Space	1.09	0.92	1"	Table A9.4A and A9.4B
Precast Concrete Panel	2.00	0.50	8"	Table A9.4D
Outside Air Surface	5.88	0.17		A9.4.1 F Appendix A
Total	**0.10**	9.93		
Floor				
Inside Air Surface	1.64	0.61		A5.2.1
Vinyl Tile	20.00	0.05	0.08"	Table 4 F25.5-9
Gypsum Board	1.79	0.56	5/8"	Table A9.4D
Matl. Furring	1.06	0.94	7/8"	Table 4 F25.5-9
Concrete Slab	2.00	0.50	8"	Table A9.4D
Matl. Furring	1.06	0.94	7/8"	Table 4 F25.5-9
Gypsum Board	1.79	0.56	5/8"	Table A9.4D
Inside Air Surface	1.64	0.61		A5.2.1
Total	**0.21**	4.77		
Slab on Grade	**F-Factor**			
Assembly	**0.73**			Table A6.3 (conservatively based on non-insulated)
Opaque Doors				
Metal	179.70	0.01	1/4"	Table 3 F39.3
Airgap	0.36	2.74	1/2"	Table A9.4A and A9.4B
Metal	179.70	0.01	1/4"	Table 3 F39.3
Total	**0.36**	2.75		
Vertical Glazing				
Summer	**0.28**	3.57		Spec 08800 2.07 B
Winter	**0.30**	3.33		Spec 08800 2.07 B
Aluminum Curtain Wall	**0.65**	1.54	1/2"	Spec 08920 1.03-E.2

Table 5.5

TABLE 5.5-1
Building Envelope Requirements For Climate Zone 1 (A,B)

		Nonresidential		Residential		Semiheated	
	Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs							
	Insulation Entirely above Deck	U-0.063	R-15.0 ci	U-0.063	R-15.0 ci	U-1.282	NR
	Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-1.280	NR
	Attic and Other	U-0.034	R-30.0	U-0.027	R-38.0	U-0.614	NR
Walls, Above Grade							
	Mass	U-0.580	NR	U-0.151[a]	R-5.7 ci[a]	U-0.580	NR
	Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-1.180	NR
	Steel Framed	U-0.124	R-13.0	U-0.124	R-13.0	U-0.352	NR
	Wood Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.292	NR
Wall, Below Grade							
	Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors							
	Mass	U-0.322	NR	U-0.322	NR	U-0.322	NR
	Steel Joist	U-0.350	NR	U-0.350	NR	U-0.350	NR
	Wood Framed and Other	U-0.282	NR	U-0.282	NR	U-0.282	NR
Slab-On-Grade Floors							
	Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
	Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors							
	Swinging	U-0.700		U-0.700		U-0.700	
	Non-Swinging	U-1.450		U-1.450		U-1.450	
	Fenestration	**Assembly Max. U (Fixed/ Operable)**	**Assembly Max. SHGC (All Orientations/ North-Oriented)**	**Assembly Max. U (Fixed/ Operable)**	**Assembly Max. SHGC (All Orientations/ North-Oriented)**	**Assembly Max. U (Fixed/ Operable)**	**Assembly Max. SHGC (All Orientations/ North-Oriented)**
Vertical Glazing,% of Wall							
	0-10.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$NR
	10.1-20.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$NR
	20.1-30.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$NR
	30.1-40.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.44	U_{oper}-1.27	$SHGC_{north}$-0.44	U_{oper}-1.27	$SHGC_{north}$NR
	40.1-50.0%	U_{fixed}-1.22	$SHGC_{all}$-0.19	U_{fixed}-1.22	$SHGC_{all}$-0.19	U_{fixed}-0.98	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.33	U_{oper}-1.27	$SHGC_{north}$-0.33	U_{oper}-1.02	$SHGC_{north}$NR
Skylight with Curb, Glass,% of Roof							
	0-2.0%	U_{all}-1.98	$SHGC_{all}$-0.36	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
	2.1-5.0%	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-0.16	U_{all}-1.98	$SHGC_{all}$-NR
Skylight with Curb, Plastic,% of Roof							
	0-2.0%	U_{all}-1.90	$SHGC_{all}$-0.34	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
	2.1-5.0%	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
Skylight without Curb, All,% of Roof							
	0-2.0%	U_{all}-1.36	$SHGC_{all}$-0.36	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR
	2.1-5.0%	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR
[a]	Exception to A3.1.3.1 applies.						

9.5 (per Table 9.5.1)

SPACE	TYPE	Length (ft)	Width (ft)	Area (sf)	Power (W)	Power Density (W/sf)	Density Allowance (W/sf)	
Building	Hospital			178,000	222,710	**1.25**	**1.20**	
	Workshop						**1.40**	
	School/University						**1.20**	

9.6 (per Table 9.6.1)

SPACE	TYPE	Length (ft)	Width (ft)	Area (sf)	Power (W)	Power Density (W/sf)	Density Allowance (W/sf)	Power Alloance (W)
3rd-9th								
900	Corridor	48	8	384	432	1.13	1.00	384.0
900.1	Alcove	7	6	42				
900.2	Reception	10	8	80	714	8.93	1.30	104.0
901	Corridor	21	5	105	375	3.57	1.00	105.0
902	Office	13	9	117	210	1.79	1.10	128.7
903	Office	13	10	130	282	2.17	1.10	143.0
904	Office	15.5	11.5	178	492	2.76	1.10	196.1
905	Office	13	12.5	163	420	2.58	1.10	178.8
906	Kitchenette	23	12	276	480	1.74	1.20	331.2
907	Corridor	40	5	200	625	3.13	1.00	200.0
908	Work Area	11.5	9	104	158	1.52	1.10	113.9
909	Work Area	11.5	9	104	158	1.52	1.10	113.9
910	Conference	21	12.5	263	1,000	3.81	1.30	341.3
911	Corridor	11	5	55	250	4.55	1.00	55.0
912	Work Area,Copy	10.5	8	84	240	2.86	1.10	92.4
913	Office	12	10	120	315	2.63	1.10	132.0
914	Office	15	10.5	158	420	2.67	1.10	173.3
915	Office	13	10	130	210	1.62	1.10	143.0
916	Office	13	10	130	210	1.62	1.10	143.0
917	Corridor	26	7.5	195	375	1.92	1.00	195.0

918	Corridor	21	7.5	158	375	2.38	1.00	157.5
919	Office	15.5	10.5	163	420	2.58	1.10	179.0
923	Equipment	23.5	10.5	247	360	1.46	1.20	296.1
924	Laboratory	105	31.5	3,308	3,600	1.09	1.40	4,630.5
925	Auxiliary	21	15	315	720	2.29	1.10	346.5
926	Corridor	12.5	5	63	375	6.00	1.00	62.5
927	Auxiliary	10.5	10.5	110	240	2.18	1.10	121.3
928	Auxiliary	10.5	11.5	121	240	1.99	1.10	132.8
929	Equipment	23.5	10.5	247	360	1.46	1.20	296.1
930	Auxiliary	10	10	100	120	1.20	1.10	110.0
931	Glasswash	13.5	10	135	120	0.89	1.20	162.0
932	Tissue Culture	20.5	23.5	387	720	1.86	1.40	541.5
932.1	Tissue Culture	10	9.5	95	120	1.26	1.40	133.0
933	Equipment	23.5	10	235	360	1.53	1.20	282.0
934	Tissue Culture	20.5	23.5	387	720	1.86	1.40	541.5
934.1	Tissue Culture	10	9.5	95	120	1.26	1.40	133.0
935	Radioisotope	10.5	10	105	240	2.29	0.40	42.0
936	Cold Room	13	10	130				
937	Linear Equipment Room	129	8	1,032	1,560	1.51	1.20	1,238.4
940	Office	15.5	10.5	163	420	2.58	1.10	179.0
941	Laboratory	105	31.5	3,308	3,600	1.09	1.40	4,630.5
	Janitor	11	5.5	61	125	2.07		0.0
	Telecom	10.5	10	105	140	1.33	1.50	157.5
	Electrical	12.5	10	125	140	1.12	1.50	187.5
	Men's WC	23	9	207	248	1.20	0.90	186.3
	Women's WC	23	9	207	248	1.20	0.90	186.3
	East Elevator Lobby	23	8.5	196	210	1.07	1.00	195.5
	West Stair	22	10	220	280	1.27	0.60	132.0
	East Stair	37.5	9	434	326	0.75	0.60	260.1
	West Elevators	32	11	352	120	0.34	1.00	352.0
				Total	**23,992**		**Total**	**19,145.7**
				Total x 7	**167,944**		**Total x 7**	**134,019.7**

SPACE	TYPE	Length (ft)	Width (ft)	Area (sf)	Power (W)	Power Density (W/sf)	Density Allowance (W/sf)	Power Alloance (W)
2nd								
200	Corridor	35	8	280	500	1.79	1.00	280.0
200.1	Reception	15	8	120	320	2.67	1.00	120.0
201	Corridor	8.5	5	43	125	2.94	1.00	42.5
202	Office	12	12	144	420	2.92	1.10	158.4
203	Office	34.5	8.5	293	420	1.43	1.10	322.6
204	Office	11	7.5	83	210	2.55	1.10	90.8
205	Office	11	11.5	127	210	1.66	1.10	139.2
206	Office	12.5	8	100	210	2.10	1.10	110.0
207	Corridor	44	6	264	750	2.84	1.00	264.0
208	Copy	11	6	66	105	1.59	1.10	72.6
209	Office	11	7.5	83	210	2.55	1.10	90.8
210	Office	11	7.5	83	210	2.55	1.10	90.8
211	Office	10.5	11.5	121	210	1.74	1.10	132.8
212	Office	10.5	8.5	89	210	2.35	1.10	98.2
213	Office	15.5	8.5	132	210	1.59	1.10	144.9
214	Corridor	21	4.5	95	375	3.97	1.00	94.5
215	Corridor	37	6	222	625	2.82	1.00	222.0
216	Break/Work	18	14	252	420	1.67	1.10	277.2
217	Holding	21	11.5	242	280	1.16	1.40	338.1
218	Holding	21	11.5	242	280	1.16	1.40	338.1
219	Procedure	34.5	19	398	840	2.11	1.40	556.5
223	Holding	21.5	12	258	420	1.63	1.40	361.2
224	Corridor	22	8	176	159	0.90	1.00	176.0
225	Procedure	17	8.5	145	360	2.49	1.40	202.3
226	Holding	17	16	272	420	1.54	1.40	380.8
227	Corridor	52.5	7	368	318	0.87	1.00	367.5
228	Procedure	17	8.5	145	360	2.49	1.40	202.3
229	Holding	17	16	272	420	1.54	1.40	380.8

230	Procedure	33	12.5	413	960	2.33	1.40	577.5
231	Holding	21.5	11	237	420	1.78	1.40	331.1
232	Holding	21.5	11	237	420	1.78	1.40	331.1
233	Holding	21.5	11	237	420	1.78	1.40	331.1
234	Holding	21.5	11	237	420	1.78	1.40	331.1
235	Holding	21.5	11	237	420	1.78	1.40	331.1
236	Holding	21.5	11	237	420	1.78	1.40	331.1
237	Corridor	34	7	238	212	0.89	1.00	238.0
238	Anteroom	16	7.5	120	240	2.00	1.40	168.0
239	Isolation	16.5	6.5	107	360	3.36	1.40	150.2
240	Iso. No. 3	9.5	9	86	140	1.64	1.40	119.7
241	Iso. No. 2	9.5	9	86	140	1.64	1.40	119.7
242	Iso. No. 1	9.5	9	86	140	1.64	1.40	119.7
243	Work Area	14.5	11	160	360	2.26	1.10	175.5
244	Clean Cage Storage	33	30	990	700	0.71	0.90	891.0
245	Cage Stage	18	9	162	346	2.14	1.20	194.4
246	Storage/Food	16	13.5	216	280	1.30	0.90	194.4
247	Lobby	29	9.5	276	371	1.35	1.30	358.2
248	Necropsy	16	10.5	168	600	3.57	1.40	235.2
250	Procedure	24	11	264	720	2.73	1.40	369.6
251	Quarantine	15	12	180	420	2.33	1.40	252.0
252	Holding	15	12	180	280	1.56	1.40	252.0
253	Holding	15	12	180	280	1.56	1.40	252.0
254	Holding	15	12	180	280	1.56	1.40	252.0
255	Corridor	103	7	721	689	0.96	1.00	721.0
256	Procedure	24	11	264	720	2.73	1.40	369.6
257	Holding	15	12	180	280	1.56	1.40	252.0
258	Holding	15	12	180	280	1.56	1.40	252.0
259	Holding	15	12	180	280	1.56	1.40	252.0
260	Holding	15	12	180	280	1.56	1.40	252.0
261	Procedure	24	11	264	720	2.73	1.40	369.6
262	Holding	15	12	180	280	1.56	1.40	252.0
263	Holding	15	12	180	280	1.56	1.40	252.0
264	Holding	15	12	180	280	1.56	1.40	252.0
265	Holding	15	12	180	280	1.56	1.40	252.0
266	Vestibule	13	7	91	173	1.90	1.30	118.3
267	Laundry	12.5	12	150	210	1.40	0.60	90.0

268	Corridor	16	8	128	267	2.09	1.00	128.0
	Janitor	11	5.5	61	125	2.07		
	Telecom	10.5	10	105	140	1.33	1.50	157.5
	Electrical	12.5	10	125	140	1.12	1.50	187.5
269	Men's WC	23	9	207	780	3.77	0.90	186.3
270	Women's WC	23	9	207	780	3.77	0.90	186.3
	East Elevator Lobby	23	8.5	196	210	1.07	1.00	195.5
	West Stair	22	10	220	280	1.27	0.60	132.0
	East Stair	37.5	9	434	326	0.75	0.60	260.1
	West Elevators	32	11	352	120	0.34	1.00	352.0
				Total	**26,866**			**18,430.0**

SPACE	TYPE	Length (ft)	Width (ft)	Area (sf)	Power (W)	Power Density (W/sf)	Density Allowance (W/sf)	Power Alloance (W)
1st								
100	Corridor	58	8	784	1,188	1.52	1.00	784.0
100.2	Secretary	12	12	144	321	2.23	1.10	158.4
C100	Corridor	44	5.5	242			1.00	242.0
101	Multi-Purpose	32	30	960	2,172	2.26	1.30	1,248.0
101.1	Storage	4	2.5	10			0.90	9.0
106	Corridor	26	6.5	169	500	2.96	1.00	169.0
107	Copy/Work	10	10	100	210	2.10	1.10	110.0
108	Office	17	12	204	525	2.57	1.10	224.4
109	Office	17.5	10.5	184	420	2.29	1.10	202.1
110	Office	9	11	99	210	2.12	1.10	108.9
111	Office	9	11	99	210	2.12	1.10	108.9
112	Corridor	29	5.5	160	625	3.92	1.00	159.5
113	Women's Bath	17	10.5	179	236	1.32	0.90	160.7
114	Men's Bath	17	10.5	179	236	1.32	0.90	160.7
115	Corridor	46.5	8	372	265	0.71	1.00	372.0
116	Scrub	10	8	76	120	1.58	1.40	106.4
117	Recovery	12	10	120	240	2.00	0.80	96.0
118	Operating Room	20	15.5	310	420	1.35	2.20	682.0
119	Sterile	15	13	195	360	1.85	1.40	273.0

123	Necropsy	12	17.5	210	420	2.00	1.40	294.0
124	Corridor	32.5	7	228	159	0.70	1.00	227.5
125	Laundry	11	6	66	140	2.12	0.60	39.6
127	Animal Cold Room	17	10.5	179				0.0
128	Corridor	43	7	301	371	1.23	1.00	301.0
129	Clean Cagewash Area	42	25	984	1,155	1.17	1.20	1,180.8
130	Corridor	32	12	384	318	0.83	1.00	384.0
131	Dirty Cagewash Area	65	32	1,900	2,205	1.16	1.20	2,280.0
132	Corridor	46.5	7.5	349	371	1.06	1.00	348.8
133	Holding	24	13.5	324	560	1.73	1.40	453.6
134	Holding	24	13.5	324	560	1.73	1.40	453.6
135	Holding	24	13.5	324	560	1.73	1.40	453.6
136	Holding	24	13.5	324	560	1.73	1.40	453.6
137	Holding	24	20	480	840	1.75	1.40	672.0
138	Procedure	21	8	168	360	2.14	1.40	235.2
139	Animal Prep	14	9.5	133	210	1.58	1.40	186.2
140	Food Storage	12	7	84	105	1.25	0.90	75.6
141	Food Cold Room	12.5	9	113			1.20	135.0
142	Bedding	17	13	215	420	1.96	0.90	193.1
143	Food	17	12.5	206	420	2.04	0.90	185.6
	Fireroom	11.5	10.5	121	140	1.16	1.50	181.1
	N.E.Exit Corridor	57	8	456				
	Janitor	11	5.5	61	125	2.07		
	Men's WC	23	9	207	248	1.20	0.90	186.3
	Women's WC	23	9	207	248	1.20	0.90	186.3
	East Elevator Lobby	23	8.5	196	240	1.23	1.00	195.5
	FP&L Vault	32	19	608	420	0.69	1.50	912.0

	Generator Room	32	19	608	420	0.69	1.50	912.0
	Fire Pump Room	16	15	240	280	1.17	1.50	360.0
	Emergency Elec.	20	16	320	280	0.88	1.50	480.0
	Main Elec.	24	14.5	348	420	1.21	1.50	522.0
	Main Telecom	14.5	12	174	280	1.61	1.50	261.0
	Main Mechanical	73	64	4,672	1,540	0.33	1.50	7,008.0
	Vivarium Receiving	34	12.5	425	560	1.32	1.50	637.5
	West Stair	22	10	220	280	1.27	0.60	132.0
	East Stair	37.5	9	434	326	0.75	0.60	260.1
	West Elevators	32	11	352	120	0.34	1.00	352.0
				Total	**23,919**			**26,513.5**

SPACE	TYPE	Length (ft)	Width (ft)	Area (sf)	Power (W)	Power Density (W/sf)	Density Allowance (W/sf)	Power Alloance (W)
Penthouse								
	Mechanical Floor	140	76	10,640	3,010	0.28	1.50	15,960.0
	West Stair	22	10	220	280	1.27	0.60	132.0
	East Stair	37.5	9	434	326	0.75	0.60	260.1
	East Elevator Lobby	23	8.5	196	240	1.23	1.00	195.5
	Janitor	11	5.5	61	125	2.07		
				Total	**3,981**			**16,547.6**
				Building Total	**222,710**			**195,510.8**

	ID	Room	Output HP	Code Efficiency
Pumps				
Heat Transfer Package	P-1-3	Main Mechanical	15	91
	P-1-4	Main Mechanical	15	91
Chilled Water	P-1-1	Main Mechanical	100	94.5
	P-1-2	Main Mechanical	100	94.5
ERU	P-P-1	Mech Penthouse	15	91
	P-P-2	Mech Penthouse	15	91
Deaerator	DA-1-1	Main Mechanical	15	91
Surge Tank Unit	ST-1-1	Main Mechanical	10	89.5
Condensate Return	CRU-1-1	Mech Penthouse	0.75	82.5
Fans				
Air Handlers	AHU-P-1	Mech Penthouse	100	94.5
	AHU-P-2	Mech Penthouse	100	94.5
	AHU-P-3	Mech Penthouse	100	94.5
	AHU-P-4	Mech Penthouse	100	94.5
	AHU-P-5	Mech Penthouse	100	94.5
	AHU-P-6	Mech Penthouse	3	87.5
	AHU-P-7	Mech Penthouse	3	87.5
	ERU-P-1	Mech Penthouse	50	93
	ERU-P-2	Mech Penthouse	50	93
	ERU-P-3	Mech Penthouse	50	93
	ERU-P-4	Mech Penthouse	50	93
High Induction Exh.	F-M-1	Roof	50	93
	F-M-2	Roof	50	93
	F-M-3	Roof	50	93
	F-M-4	Roof	40	93
	F-M-5	Roof	40	93
	F-M-6	Roof	40	93
Exhaust	F-1-1	Generator Room	1	82.5
	F-1-2	Vivarium Rec.	1.5	84
	F-1-3	Chemical Sto.	0.5	82.5
	F-2-1	Chemical Sto.	2	84
	F-M-8	Cage Wash	15	91
	F-M-9	Cage Wash	15	91
	F-M-10	Janitor	0.75	82.5
	F-P-1	Toilet	15	91
	F-P-2	Office Smoke	50	93
	F-P-3	Stairwell	5	87.5
	F-M-11	3rd Radio-Iso	1	82.5
	F-M-12	4th Radio-Iso	1	82.5
	F-M-13	5th Radio-Iso	1	82.5
	F-M-14	6th Radio-Iso	1	82.5
	F-M-15	7th Radio-Iso	1	82.5
	F-M-16	8th Radio-Iso	1	82.5
	F-M-17	9th Radio-Iso	1	82.5
	F-M-18	2nd Necropsy	1.5	84
	F-M-19	1st Necropsy	1.5	84
Computer Room Units	CRU-3-1	Linear Equip Rm	5.25	88
	CRU-3-2	Linear Equip Rm	5.25	88
	CRU-3-3	Linear Equip Rm	5.25	88

Table 10.8a

Design Peak Cooling Loads

System	MBh	cfm	tons	sf/ton	sf	cfm/sf	cfm/ton
Labs	16,999.56	169,481.36	1,454.60	72.00	104,729	1.62	116.51
Office	3,593.20	32,980.24	299.40	106.59	31,915	1.03	110.15
Penthouse	468.43	15,916.39	39.00	263.92	10,302	1.54	408.11
Main Mech FCU	152.15	3,548.55	12.70	793.88	4,333	0.82	279.41
3-9 Equip FCU	29.29	958.02	2.40	639.44	1,561	0.61	399.18
FirePump FCU	10.81	302.32	0.90	246.84	222	1.36	335.91
Main Elec FCU	10.06	313.72	0.80	455.68	382	0.82	392.15
Emer Elec FCU	8.93	277.94	0.70	452.97	337	0.82	397.06
Main Tele FCU	7.22	208.70	0.60	314.26	189	1.10	347.83
Total	**21,279.65**	**223,987.24**	**1,811.10**	**85.01**	**153,970**	**1.45**	**123.67**

Peak Airflow Rates

System	sf	OA	cfm/sf	Cooling	cfm/sf	Heating	cfm/sf	Return	cfm/sf	Exhaust	cfm/sf
Labs	104729	169,481	1.62	169,481	1.62	180,437	1.72	198,182	1.89	169,481	1.62
Office	31915	32,980	1.03	32,980	1.03	16,062	0.50	33,202	1.04	9,550	0.30
Penthouse	10302	0	0.00	15,916	1.54	15,916	1.54	17,204	1.67	0	0.00
Total	**146946**	**202,461**	**1.38**	**218,377**	**1.49**	**212,415**	**1.45**	**248,588**	**1.69**	**179,031**	**1.22**

Annual Power Consumption

	kBtu/yr	kWh/yr
Natural Gas	22,301,580	
Cooling	1,676,555	
Fans	14,546,066	4,261,959
Pumps	52,215	15,299
Lighting	50,471,174	857,511
Total	89,047,590	

Power Cost

		per year
Elec.	On Peak Cons.	$116,474.00
	On Peak Demand	$76,366.00
Gas	On Peak Cons.	$29,401.00
		$222,241.00
		/174,000 sf
		1.28 $/sf-yr

Design Firm Simulation

Mechanical Spaces

TYPE	Length (ft)	Width (ft)	Area (sf)
Boiler Room	73	64	4,672
Penthouse Mechanical	140	76	10,640
South East Shaft	22	16	3,520
North East Shaft	22	11	2,420
West Shaft	23	3	690
Total			21,942

Mechanical Cost Breakdown

Cost	
Total 1st Cost	$4,482,470.00
per sq. ft.	$25.18

Mechanical Breakdown