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Straumann USA
Andover, MA

Mechanical Technical Report 2
Building and Plant Energy Analysis Report

Straumann USA
Andover, MA

October 27, 2006

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1.0 Executive Summary

This report analyzes the Straumann USA facility to determine the number of expected LEED points generated and compliance with ASHRAE Standard 90.1-2004. A load and energy analysis is also performed, and compared with the design loads, and yearly energy data.

Straumann USA was not designed to be a LEED certified building but it did meet the requirements of 4 LEED points. However, the facility only met 3 of the 7 prerequisites. Several categories such as Sustainable Sites, Materials & Resources, and Water Efficiencies might have been able to produce points, but since LEED certification was not a goal of the project, such requirements were not pursued.

Overall, Straumann USA does not comply with the requirement of ASHRAE Standard 90.1-2004. However, there were several sections where the building did fully comply including the service water heating, power, and lighting sections of ASHRAE Standard 90.1. The building envelope section did not comply based on the vertical fenestration U, and SHGC values. Fan power limitations, and insulation thicknesses prevented section 6, HVAC systems, from complying.

The load estimate and energy cost summaries are summarized in Table 1.1. The cooling load and ventilation rates are reasonably comparable to the design values. However, the estimated heating load is significantly different, and could be attributed to the estimated distribution of lighting loads to the space and plenum. Since the heating loads are quite different, this also results in a large difference in fuel costs which serves only heating loads. The electricity costs estimated are actually close to those actually seen by Straumann USA. The slight variation could be a result of higher lighting and power requirements per square foot, or the application of the utility rates to the estimated load.

Annual Comparisons		
	Estimated	Design
Supply Air (CFM)	260992	282183
Cooling Load (MBH)	9388	8088
Heating Load (MBH)	1076	2786
	Estimated	Acutal
Fuel Costs	$19,277	$75,000
Electric Costs	$673,710	$622,650

Table 1.1 Annual Load, Ventilation, and Cost Comparisons

2.0 Introduction

Straumann USA is a combination manufacturing/office building located in Andover, MA. The Straumann facility is actually a portion of the larger 100 Minuteman Building, but is separated from the rest of a building by a firewall for zoning reasons. The Straumann USA projected included the gutting and complete renovation of the Straumann portion of the building. The central plants were not located on this side of the building and were not altered during this project.

Since the Straumann facility is only a two story building, and some areas are not a full two stories, there was no need for any duct or piping shafts. There was no lost rentable space in the Straumann USA space. All piping was run in plenums, or standard framed walls. The ductwork was also able to be run in a fashion where the plenum spaces were utilized avoiding any risers through the building floors. All of the central plant equipment was located on the other half of the building and all air-handlers were located on the roof of the Straumann facility. There were a few bulkheads that were created for some of the larger ducts but this had no effect on the rentable floor area. The mechanical system first cost for the project was $2.5 million, or $9.88/ft^2.

3.0 LEED-NC Version 2.2

The Leadership in Environmental Engineering Design Green Building Rating System is the nationally accepted benchmark for the design construction, construction, and operation of green buildings. The LEED system was created by the U.S. Green Building Council in order to make a credible standard for what constitutes a green building. There are several advantages associated with a LEED certified building. They typically provide healthy and comfortable spaces for occupants, reduce waste sent to landfills, conserve energy and water, and specifically in Massachusetts a green building tax program is being considered.

The Straumann USA Facility renovation project was not designed to attain any LEED ratings. The project was analyzed however to determine which the areas where LEED points would have been obtained. According to the analysis performed in this report, it was determined that a total of 4 points would have been obtained above the prerequisites. Of the perquisites, only three of the seven were met.

A summary of LEED points earned are listed in Appendix A.

4.0 Building Envelope ASHRAE Standard 90.1-2004

ASHRAE Standard 90.1-2004 provides minimum requirements for energy-efficient buildings with the exception of low rise residential buildings. Section 5 of ASHRAE Standard focuses on the specific requirements for the building envelope.

Located in Andover, MA, Straumann USA is in climate zone 5 as specified in Table B-1 of ASHRAE Standard 90.1. This is used to determine the building envelope requirements for the facility. The results of the analysis are listed in Table 4.1.

The first calculation of fenestration percentage for the building included the only the Straumann USA building. This resulted in 61.4% which is a larger area than allowed by Standard 90.1. However, upon further inspection of the entire 100 Minuteman building, the fenestration percentage was found to be 49% which is below the allowable limits. The entire building fenestration (49%) and was used for evaluating the fenestration heat transfer coefficient and solar heat gain coefficients, since Tables 5.5 in Standard 90.1 do not have compliance values for any fenestration above 50%.

ASHRAE Standard 90.1-2004 Section 5 Building Envelope Climate Zone 5			
Description	Actual Used in Straumann USA	Standard 90.1 Compliance Value	Compliance
Roof (Inuslated Entirely Above Deck)	U = 0.061	Max U = 0.063	Yes
Walls (Steel Framed)	U = 0.055	Max U = 0.084	Yes
Slab on Grade Floor (unheated)	F = 0.21	Max F = 0.730	Yes
Fenstration (40.1-50%, Fixed)	U = 0.5	Max U = 0.46	No
	SHGC = 0.42	Max SHGCall = 0.26	No
		Max SHGCnorth = 0.36	No
Skylight (0-2%, Fixed)	U = 0.5	Max = 1.17	Yes
	SHGC = 0.42	Max SHGCall = 0.49	Yes
Section 5 Compliance			No

Table 4.1 – ASHRAE Standard 90.1-2004 Building Envelope Compliance

The results of the analysis show that the Straumann USA facility does not comply with the building envelope criteria for the vertical fenestration.

5.0 HVAC Systems – ASHRAE Standard 90.1-2004

Section 6 of ASHRAE Standard 90.1-2004 specifies minimum efficiencies for mechanical equipment, insulation requirements for piping, and insulation requirements for ductwork. According to section 6.1.1 of Standard 90.1 only new equipment must comply. If existing systems are being used as in the case of the Straumann USA facility, the existing equipment does not need to comply with the minimum efficiencies specified. A summary of mechanical equipment compliances to Standard 90.1 section 6 can be found in Tables 5.1 – Table 5.3. Insulation compliances for piping and ductwork can be found in Table 5.5 and Table 5.4 respectively.

Section	Description	Unit	MBH	Compliance
6.5.1	Air Economing for sytesms greater than 65 MBH	RTU-1	984.9	Yes
		RTU-2	984.9	Yes
		RTU-3	310	Yes
		RTU-4	984.9	Yes
		RTU-5	667	Yes
		RTU-6	667	Yes
		RTU-7	984.9	Yes
		RTU-8	984.9	Yes
		RTU-9	984.9	Yes
		RTU-10	984.9	Yes

Table 5.1 ASHRAE 90.1-2004 Economizer Compliance

Section	Description	Unit	hp/cfm	Compliance
6.5.3.1	Fan Power Limitation > 20,000 cfm (VAV) max of 1.5hp/cfm <20,000 cfm (CAV) max of 1.5hp/cfm	RTU-1	1.5	No
		RTU-2	1.5	No
		RTU-3	1.2	No
		RTU-4	1.5	No
		RTU-5	1.5	No
		RTU-6	1.5	No
		RTU-7	1.5	No
		RTU-8	1.5	No
		RTU-9	1.5	No
		RTU-10	1.5	No

Table 5.2 ASHRAE 90.1-2004 Fan Power Compliance

Section	Description	Unit	SEER	Compliance
6.8.1	Air Cooled Air Conditioners (split sytem) < 65 MBH Min of 10.0 SEER	AC-3	11.6	Yes
		AC-6	11.6	Yes
		AC-7	11.6	Yes
		AC-8	11.6	Yes
		AC-9	11.6	Yes
	>65MBH, <135 MBH 10.3 SEER	AC-1	16.5	Yes
		AC-2	16.5	Yes
		AC-4	16.5	Yes
		AC-5	16.5	Yes

Table 5.2 ASHRAE 90.1-2004 Mechanical Equipment Compliance

ASHRAE Standard 90.1-2004			
Section 6 HVAC			
Duct Insulation - Climate Zone 5			
Space Type	Minimum Insulation Required	Insulation Used	Compliance
Indirectly Conditioned Space (plenum)	none	1.5" mineral fiber blanket	Yes
Exterior	R-6	1.5" mineral fiber blanket	Yes

Table 5.4 Minimum Duct Insulation

ASHRAE Standard 90.1-2004					
Section 6 HVAC					
Minimum Pipe Inuslation Thickness					
Pipe Type	Supply/Return	Pipe Size	Minumum Insulation Required	Inuslation Used	Compliance
Hot Water	Supply	< 1"	1.5	1	No
		1" - < 1.5"	1.5	1	No
		1.5" - < 2"	2	1	No
		1.5 " - < 4"	2	1.5	No
		4" - < 8"	2	1.5	No
		≥ 8"	2	1.5	No
	Return	< 1"	1	1	Yes
		1" - < 1.5"	1	1	Yes
		1.5" - < 2"	1	1	Yes
		1.5 " - < 4"	1	1.5	Yes
		4" - < 8"	1.5	1.5	Yes
		≥ 8"	1.5	1.5	Yes
Chilled Water	Supply and Return	< 1"	0.5	1.5	Yes
		1" - < 1.5"	0.5	1.5	Yes
		1.5" - < 4"	1	1.5	Yes
		4" - < 8"	1	1.5	Yes
		≥ 8"	1	1.5	Yes
Steam	Supply	< 1"	1.5	1	No
		1" - < 1.5"	1.5	1	No
		1.5" - < 2"	2	1	No
		1.5 " - < 4"	2	1.5	No
		4" - < 8"	2	1.5	No
		≥ 8"	2	1.5	No
Condensate	Return	< 1"	1	1	Yes
		1" - < 1.5"	1	1	Yes
		1.5" - < 2"	1	1	Yes
		1.5 " - < 4"	1	1.5	Yes
		4" - < 8"	1.5	1.5	Yes
		≥ 8"	1.5	1.5	Yes

Table 5.5Minimum Pipe Insulation Thickness

6.0 Service Water Heating – ASHRAE Standard 90.1-2004

No additional water heating equipment is installed in this project. Therefore, nothing needs to be evaluated by the requirements in section 7. The Straumann Project fully complies with section 7 of ASHRAE Standard 90.1-2004.

7.0 Power ASHRAE Standard 90.1-2004

According to the electrical engineer for the Straumann USA project all feeders and branch circuits were designed to comply with the voltage drop requirements of section eight of Standard 90.1. Feeders and branch circuits have a voltage drop of no more than 3% and 2% respectively. Based on this information, the project complies with section 8 of ASHRAE Standard 90.1-2004

8.0 Lighting ASHRAE Standard 90.1-2004

Section 9 of ASHRAE Standard 90.1 sets requirements on maximum lighting densities for a building. One of two ways can be used to show compliance with the standard. The space by space method can be used to show that each individual area does not exceed the lighting power density determined by the occupancy. The second method is the building area method, where the entire building is considered and the maximum power density is set by the type of building.

A space by space method power density analysis was performed on the Straumann USA. However, many spaces did not comply with the maximum requirements of Standard 90.1. The results of this method can be found in Appendix B.

A building are method lighting power density was also performed on the building. Since the building has to main occupancies, a weighted average of building are and occupancy type was used to calculate the allowable power density for the building. The results of this method are summarized in Table 8.1. Using the building area method, the project complies with section 9 of ASHRAE Standard 90.1-2004

ASHRAE Standard 90.1-2004		
Section 9 Lighting Power Density		
Building Type	Max Power Density	Area of Straumann USA
Manufacturing	1.3	75,000
Office	1	68,800
Weighted Avgerage	1.16	
Power Density of Straumann	1.02	
Compliance	Yes	

Table 8.1 Lighting Power Density Building Area Method

9.0 Load Estimation

Several values were assumed in order to produce the load analysis for the Straumann USA facility. Table 9.1 summarizes the values used for this estimated load, and the original design load for the facility.

Load Analysis Assumptions		
	Estimated	Design
OA Ventilation Rates	ASHRAE Standard 62.1-2004	ASHRAE Standard 62.1-2004
Lighting Loads		
Office	1.3 W/ft2	1.3 W/ft2
Manufacturing	2.2 W/ft2	2.2 W/ft2
Equipment Loads		
Office	3.0 W/ft2	3.0 W/ft2
Manufacturing	38W/ft2	38W/ft2
Design Conditions	ASHRAE Fundamentals 2005 (0.4%)	
Summer		
Dry Bulb	90.8	95
Mean Coincident Wet	73.1	75
Winter		
Dry Bulb	7.7	10

Table 9.1 Estimated and Design Load Assumptions

The equipment actually selected and scheduled on the design drawings were oversized in order to prevent a complete renovation of the space if the needs of the tenant changes. The estimated cooling and heating loads are compared to initial load design performed by the mechanical engineering designer. The areas, locations, and occupancies of the spaces may have changed slightly from the initial design, but loads should be a reasonably good source for comparison purposes. The heating and cooling load summaries are located in Table 9.1, along with the airflow rates of each unit.

Overall, the estimated cooling load is slightly higher than the design load. This could be attributed to several factors. First, Trane Trace was used to create the design loads while HAP was used for the estimates. The design loads were based on the preliminary design, and not the final construction documents. The size of some of the rooms, and occupancies may have changed slightly to create such differences. The total airflow supplied by the estimated units is slightly lower than the design airflow. This could be due to assumptions of load distributions. Since the cooling load is actually larger for the estimate but less air is supplied, it could be possible that a larger amount the roof load was assumed to directly heat the plenum air and not have as great an effect on the occupied space.

The puzzling result is the heating load. The heating load of the building, should be relatively low as many of the spaces do not have any exterior wall loads. However, the

estimated load is much lower than the design load. This could be due to the distribution of heat from the lighting fixtures. It is possible that in the estimate a larger percentage of the lighting load was transferred directly to the plenum therefore offsetting the cooling effect of the roof.

Estimated and Design Loads and Airflows						
	Estimated Cooling Load (MBTU)	Design Cooling (MBTU)	Estimated Heating Load (MBTU)	Design Heating (MBTU)	Estimated CFM	Design CFM
AC-1,2	120.4	118.3	0	0	5038	5650
AC-3	35.2	34.7	0	0	1275	1250
AC-4,5	120.4	118.3	0	0	5038	5650
AC-6	35.5	34.7	0	0	1275	1250
AC-7	41.3	34.7	0	0	1551	1250
AC-8	35.5	34.7	0	0	1275	1250
RTU-1	1118.6	861.6	204.1	466.4	20151	25704
RTU-2	1174.4	1022.3	300.7	587.8	20941	28329
RTU-3	258.9	260.8	41.3	214	4319	4543
RTU-4	1188.5	961	197.4	534.4	24186	26800
RTU-5	848.2	485.2	125.6	264.2	15360	15876
RTU-6	94.8	562.7	175.6	280.9	15723	16250
RTU-7,8,9,10	4316.6	3559	31.3	438.5	144860	148381
Total	9388.3	8088	1076	2786.2	260992	282183

Table 9.2 Estimated Design Loads and Airflows

Comparison of Estimated and Design Load and Ventilation Indices						
	Estimated Cooling ft^2/ton	Design Cooling ft^2/ton	Estimated Supply Air cfm/ft^2	Design Supply Air cfm/ft^2	Estimated Ventilation cfm/ft^2	Design Ventilation cfm/ft^2
AC-1,2	55	56	9.06	10.16	0.00	0.00
AC-3	57	58	7.63	7.49	0.00	0.00
AC-4,5	53	54	9.54	10.70	0.00	0.00
AC-6	178	183	2.41	2.37	0.00	0.00
AC-7	78	93	5.79	4.66	0.00	0.00
AC-8	66	67	6.57	6.44	0.00	0.00
RTU-1	269	410	0.80	0.87	0.36	0.11
RTU-2	222	281	0.96	1.18	0.64	0.24
RTU-3	182	181	1.10	1.16	0.78	0.77
RTU-4	226	290	1.08	1.15	0.43	0.21
RTU-5	154	282	1.41	1.39	0.56	0.15
RTU-6	1848	301	1.08	1.15	0.66	0.17
RTU-7,8,9,10	67	82	5.98	6.13	0.09	0.07
Total	160	98	2.09	2.13	0.43	0.17

Table 9.3 Comparison of Estimated and Design Load and Ventilation Indices

10.0 Energy Consumption and Operating Cost

There was no energy analysis performed for Straumann USA. There would have been an additional cost for the mechanical engineering company to perform such analysis, and the owner decided not to pursue this option.

The energy analysis for performed for this report was compiled using Carrier's Hourly Analysis Program. It was necessary to make several assumptions in regards to schedules, electric and fuel rates which can be found in Appendix D. Equipment performance characteristics are located in Appendix E.

The estimated annual energy costs for Straumann USA was found to be $692,997. The HVAC energy costs account for approximately 29% ($200,561) of the total annual energy cost. Table 10.1 summarizes the costs for each system component. The results of the finding can also be seen in the form of dollars per square foot in Table 10.2. Refer to Appendix F for additional cost breakdowns, and graphs. Along with the annual costs, the annual energy consumption rates were calculated and the results are summarized in Table 10.3.

Based on the results displayed in Table 10.4, the energy model predicts a slightly higher yearly electric cost, however, this could be due to the way the electric rate was calculated (Refer to Appendix D). It does not seem to be a large enough difference to cause any concern. The slight difference could also be caused by the assumed values for lighting and power per square foot differing from the amount of electricity actually consumed.

Once again, the predicted steam cost is much lower than the actual cost. One possible difference could be assuming that half of the heating energy is used by the Straumann facility. Straumann USA occupies the southern portion of the building and may use less than half of the heating for the building since it would have a higher solar heat gain which would decrease the actual costs heating costs. The other factor that would play an important role is the actual design heating load. As discussed earlier, the estimated heating load was significantly lower than the design load, which would also lead to a lower projected yearly cost.

Component	Straumann ($)
Air System Fans	72,647
Cooling	48,432
Heating	21,479
Pumps	19,052
Cooling Tower Fans	38,952
HVAC Sub-Total	**200,561**
Lights	68,570
Electric Equipment	423,845
Misc. Electric	0
Misc. Fuel Use	0
Non-HVAC Sub-Total	**492,415**
Grand Total	**692,977**

Table 10.1 Annual Component Energy Costs

Component	Straumann ($/ft²)
Air System Fans	0.581
Cooling	0.387
Heating	0.172
Pumps	0.152
Cooling Tower Fans	0.311
HVAC Sub-Total	**1.603**
Lights	0.548
Electric Equipment	3.388
Misc. Electric	0.000
Misc. Fuel Use	0.000
Non-HVAC Sub-Total	**3.936**
Grand Total	**5.539**

Table 10.2 Annual Component Energy Costs per Square Foot

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	1,564,042	12.501	5,585,866	44.648
Cooling	923,702	7.383	3,298,937	26.369
Heating	1,249,506	9.987	1,401,892	11.205
Pumps	428,824	3.428	1,531,516	12.242
Cooling Towers	765,774	6.121	2,734,908	21.860
HVAC Sub-Total	**4,931,849**	**39.420**	**14,553,118**	**116.324**
Lights	1,508,801	12.060	5,388,574	43.071
Electric Equipment	9,326,197	74.545	33,307,848	266.231
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**10,834,998**	**86.605**	**38,696,422**	**309.302**
Grand Total	**15,766,847**	**126.025**	**53,249,540**	**425.625**

Table 10.3 Annual Energy Consumption Rates by System Component

Annual Energy Costs		
	Estimated	Acutal
Fuel Costs	$19,277	$75,000
Electric Costs	$673,710	$622,650

Table 10.4 Annual Fuel and Electric Costs

11.0 References

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

LEED-NC - Version 2.2, Green Building Rating System For New Construction & Major Renovations. U.S. Green Building Council. October 2005.

ASHRAE Handbook - 2005 Fundamentals. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc. Atlanta, GA. 2005.

Straumann USA - Plans and Schedules. Construction Document Set. May 28, 2004.

12.0 Appendix A – LEED-NC Version 2.2 Evaluation

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist
Struamann USA
Andover, MA

Yes	?	No					
1		13	**Sustainable Sites**		**14** Points		**Action Taken**
N			Prereq 1	**Construction Activity Pollution Prevention**	Required		Certifcation was not been pursued so an ESC plan was not created.
1			Credit 1	**Site Selection**	1		Straumann USA was a rennovation project that did not further develop any of the restirected areas listed.
		1	Credit 2	**Development Density & Community Connectivity**	1		Not implemented since LEED Certification was not pursued.
		1	Credit 3	**Brownfield Redevelopment**	1		
		1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1		
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1		
		1	Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1		
		1	Credit 4.4	**Alternative Transportation**, Parking Capacity	1		
		1	Credit 5.1	**Site Development,** Protect of Restore Habitat	1		
		1	Credit 5.2	**Site Development,** Maximize Open Space	1		
		1	Credit 6.1	**Stormwater Design,** Quantity Control	1		
		1	Credit 6.2	**Stormwater Design,** Quality Control	1		
		1	Credit 7.1	**Heat Island Effect,** Non-Roof	1		
		1	Credit 7.2	**Heat Island Effect,** Roof	1		
		1	Credit 8	**Light Pollution Reduction**	1		

Yes	?	No					
		5	**Water Efficiency**		**5** Points		**Action Taken**
		1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1		Not implemented since LEED Certification was not pursued.
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1		
		1	Credit 2	**Innovative Wastewater Technologies**	1		
		1	Credit 3.1	**Water Use Reduction**, 20% Reduction	1		
		1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1		

Yes	?	No					
		6	**Energy & Atmosphere**		**17** Points		**Action Taken**
N			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required		Building was not commissioned
N			Prereq 2	**Minimum Energy Performance**	Required		Based on Technical report 2 Straumann USA dose not comply with all sections of ASHRAE Standard 90.1-2004
Y			Prereq 3	**Fundamental Refrigerant Management**	Required		New equipment did not use HFC's for refrigerant
		1	Credit 1	**Optimize Energy Performance**	1 to 10		Not implemented since LEED Certification was not pursued.
		1	Credit 2	**On-Site Renewable Energy**	1 to 3		
		1	Credit 3	**Enhanced Commissioning**	1		
		1	Credit 4	**Enhanced Refrigerant Management**	1		
		1	Credit 5	**Measurement & Verification**	1		
		1	Credit 6	**Green Power**	1		

Yes	?	No	Materials & Resources	13 Points	Action Taken
N			Prereq 1 **Storage & Collection of Recyclables**	Required	Not implemented since LEED Certification was not pursued.
		1	Credit 1.1 **Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1	
		1	Credit 1.2 **Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1	
		1	Credit 1.3 **Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1	
		1	Credit 2.1 **Construction Waste Management**, Divert 50% from Disposal	1	
		1	Credit 2.2 **Construction Waste Management**, Divert 75% from Disposal	1	
		1	Credit 3.1 **Materials Reuse**, 5%	1	
		1	Credit 3.2 **Materials Reuse**,10%	1	
		1	Credit 4.1 **Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1	
		1	Credit 4.2 **Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1	
		1	Credit 5.1 **Regional Materials**, 10% Extracted, Processed & Manufactured Region	1	
		1	Credit 5.2 **Regional Materials**, 20% Extracted, Processed & Manufactured Region	1	
		1	Credit 6 **Rapidly Renewable Materials**	1	
		1	Credit 7 **Certified Wood**	1	

Yes	?	No	Indoor Environmental Quality	15 Points	Action Taken
Y			Prereq 1 **Minimum IAQ Performance**	Required	Based on Technical Report 1 Straumann USA does comply with the ventilation requirements of ASHRAE Standard 62.1-2004
Y			Prereq 2 **Environmental Tobacco Smoke** (ETS) **Control**	Required	Straumann USA is a non-smoking facility
		1	Credit 1 **Outdoor Air Delivery Monitoring**	1	Not implemented since LEED Certification was not pursued.
1			Credit 2 **Increased Ventilation**	1	Based on Technical Report 1 Straumann USA does exceed the the ventilation requirements of ASHRAE Standard 62.1-2004 by 30%
		1	Credit 3.1 **Construction IAQ Management Plan**, During Construction	1	Not implemented since LEED Certification was not pursued.
		1	Credit 3.2 **Construction IAQ Management Plan**, Before Occupancy	1	
		1	Credit 4.1 **Low-Emitting Materials**, Adhesives & Sealants	1	
		1	Credit 4.2 **Low-Emitting Materials**, Paints & Coatings	1	
		1	Credit 4.3 **Low-Emitting Materials**, Carpet Systems	1	
		1	Credit 4.4 **Low-Emitting Materials**, Composite Wood & Agrifiber Products	1	
		1	Credit 5 **Indoor Chemical & Pollutant Source Control**	1	
		1	Credit 6.1 **Controllability of Systems**, Lighting	1	
1			Credit 6.2 **Controllability of Systems**, Thermal Comfort	1	Thermostats were locatedin at least 50% of spaces
1			Credit 7.1 **Thermal Comfort**, Design	1	According to mechanical designer facility was designed based on ASHRAE Standard 55
		1	Credit 7.2 **Thermal Comfort**, Verification	1	Not implemented since LEED Certification was not pursued.
		1	Credit 8.1 **Daylight & Views**, Daylight 75% of Spaces	1	Not Attained
		1	Credit 8.2 **Daylight & Views**, Views for 90% of Spaces	1	Not Attained

Yes	?	No	Innovation & Design Process	5 Points	Action Taken
		1	Credit 1.1 **Innovation in Design**: Provide Specific Title	1	None awared since LEED Certification was not pursued.
		1	Credit 1.2 **Innovation in Design**: Provide Specific Title	1	
		1	Credit 1.3 **Innovation in Design**: Provide Specific Title	1	
		1	Credit 1.4 **Innovation in Design**: Provide Specific Title	1	
		1	Credit 2 **LEED® Accredited Professional**	1	None listed on project

Yes	?	No	Project Totals (pre-certification estimates)	69 Points
4				

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

13.0 Appendix B – Space by Space Lighting Power Density Calculations

Space Name	Lamp Type	Number of Fixtures	Lamps per Fixture	Lamp Watts	Ballast Factor	Watts	AREA	POWER DENSITY AREA TYPE	MAX POWER DENSITY SPACE BY SPACE	ACTUAL LIGHTING POWER DENSITY	SPACE BY SPACE COMPLIANCE
Manufacturing	pmh1	67	1	400	1.08	28944	21128	MANUFACTURING	1.2	1.76	NO
Manufacturing	pmh2	19	1	400	1.08	8208	21128	MANUFACTURING			
Prototyping & Engin. Workshop	pmh1	4	1	400	1.08	1728	2299	MANUFACTURING	1.2	1.13	YES
Prototyping & Engin. Workshop	pmh2	2	1	400	1.08	864	2299	MANUFACTURING			
Office	rf2	7	3	32	1.08	725.76	782	OFFICE - ENCLOSED	1.1	0.93	YES
Corridor	rf2	2	3	32	1.08	207.36	131	CORRIDOR/TRANISTION	0.5	1.58	NO
Meeting Room	rf2	4	3	32	1.08	414.72	272	CONFERENCE	1.3	1.52	NO
Meeting Room	rf2	4	3	32	1.08	414.72	264	CONFERENCE	1.3	1.57	NO
Tel/Data	RF16	3	2	32	1.08	207.36	263	ELECTRICAL/MECHANICAL	1.5	0.79	YES
Oil Storage	SMH1	12	1	100	1.08	1296	776	ACTIVE STORAGE	0.8	1.76	NO
Oil Storage	SF4	1	2	32	1.08	69.12	776	ACTIVE STORAGE			
Shipping Dock	SF1	9	2	32	1.08	622.08	587	MANUFACTURING	1.2	1.06	YES
Receiving Office	RF2	2	3	32	1.08	207.36	248	OFFICE - ENCLOSED	1.1	1.67	NO
Receiving Office	RF2	2	3	32	1.08	207.36	248	OFFICE - ENCLOSED			
Trash	SF1	6	2	32	1.08	414.72	361	ACTIVE STORAGE	0.8	1.72	NO
Trash	rf2	2	3	32	1.08	207.36	361	ACTIVE STORAGE			
Acid Storage	SMH1	7	1	100	1.08	756	262	ACTIVE STORAGE	0.8	3.15	NO
Acid Storage	SF4	1	2	32	1.08	69.12	262	ACTIVE STORAGE			
Receiving Dock	SF1	12	2	32	1.08	829.44	841	MANUFACTURING	1.2	0.99	YES
Entry Vestibule	RF2	3	3	32	1.08	311.04	324	LOBBY	1.3	0.96	YES
Men's Locker	RF18	31	1	32	1.08	1071.36	826	LOCKER ROOM	0.6	1.30	NO
Women's Locker	RF18	24	1	32	1.08	829.44	761	LOCKER ROOM	0.6	1.09	NO
MCC	RF16	5	2	32	1.08	345.6	347	MANUFACTURING	1.2	1.00	YES
Trovalistion	RF2	6	3	32	1.08	622.08	659	MANUFACTURING	1.2	0.94	YES
Sand Blasting	RF2	3	3	32	1.08	311.04	308	MANUFACTURING	1.2	1.01	YES
Washing	RF2	9	3	32	1.08	933.12	920	MANUFACTURING	1.2	1.01	YES
Clean Room	SF1	4	2	32	1.08	276.48	1885	LABORATORY	1.4	0.15	YES
Storage	SF1	1	2	32	1.08	69.12	300	ACTIVE STORAGE	0.8	0.23	YES
Sand Blasting	SF1	1	2	32	1.08	69.12	253	MANUFACTURING	1.2	0.27	YES
Corridor	RF2	5	3	32	1.08	518.4	469	CORRIDOR/TRANISTION	0.5	1.11	NO
Purified Water	RF16	8	2	32	1.08	552.96	427	MANUFACTURING	1.2	1.29	NO
Final Washing	RF2	4	3	32	1.08	414.72	296	MANUFACTURING	1.2	1.40	NO
Storage	RF16	8	2	32	1.08	552.96	571	ACTIVE STORAGE	0.8	0.97	NO
Locker Room	RF16	2	2	32	1.08	138.24	173	LOCKER ROOM	0.6	0.80	NO
Office	RF2	2	3	32	1.08	207.36	167	OFFICE - ENCLOSED	1.1	1.24	NO
Office	RF2	2	3	32	1.08	207.36	167	OFFICE - ENCLOSED	1.1	1.24	NO
Promotional Storage	RF2	2	3	32	1.08	207.36	248	MANUFACTURING	1.2	0.84	YES
Corridor	RF2	8	3	32	1.08	829.44	984	CORRIDOR/TRANISTION	0.5	0.84	NO
Air Lock	RF2	1	3	32	1.08	103.68	114	CORRIDOR/TRANISTION	0.5	0.91	NO
Open Measurement	RF2	4	3	32	1.08	414.72	412	MANUFACTURING	1.2	1.01	YES
Measurement Dev. Mgt.	RF2	4	3	32	1.08	414.72	393	MANUFACTURING	1.2	1.06	YES
Measurement	RF2	1	3	32	1.08	103.68	117	MANUFACTURING	1.2	0.89	YES
Quality Assurance	RF2	11	3	32	1.08	1140.48	1158	MANUFACTURING	1.2	0.98	YES

Space Name	Lamp Type	Number of Fixtures	Lamps per Fixture	Lamp Watts	Ballast Factor	Watts	AREA	POWER DENSITY AREA TYPE	MAX POWER DENSITY SPACE BY SPACE	ACTUAL LIGHTING POWER DENSITY	SPACE BY SPACE COMPLIANCE
Open Tools	RF2	4	3	32	1.08	414.72	413	MANUFACTURING	1.2	1.00	YES
Tools Mgmt.	RF2	4	3	32	1.08	414.72	393	MANUFACTURING	1.2	1.06	YES
Corridor	RF2	7	3	32	1.08	725.76	861	CORRIDOR/TRANISTION	0.5	0.84	NO
Air Lock	RF2	1	3	32	1.08	103.68	114	CORRIDOR/TRANISTION	0.5	0.91	NO
Corridor	rf2	8	3	32	1.08	829.44	932	CORRIDOR/TRANISTION	0.5	0.89	NO
Janitor	sf1	3	2	32	1.08	207.36	194	ACTIVE STORAGE	0.8	1.07	NO
Life Safety	SF1	1	2	32	1.08	69.12	41	ACTIVE STORAGE	0.8	1.69	NO
Corridor	pf11	1	4	18	1.08	77.76	164	CORRIDOR/TRANISTION	0.5	0.47	YES
Secondary Manuf. Oper.	rf2	20	3	32	1.08	2073.6	1947	MANUFACTURING	1.2	1.07	YES
Laser Engrav.	rf2	4	3	32	1.08	414.72	417	MANUFACTURING	1.2	0.99	YES
Control Robot	RF16	4	2	32	1.08	276.48	367	MANUFACTURING	1.2	1.88	NO
Control Robot	rf2	4	3	32	1.08	414.72	367	MANUFACTURING	1.2		
Open Office	rf2	15	3	32	1.08	1555.2	1302	OFFICE - OPEN PLAN	1.1	1.19	NO
Meeting Room	rf2	6	3	32	1.08	622.08	393	CONFERENCE	1.3	1.58	NO
Storage	rf16	2	2	32	1.08	138.24	140	ACTIVE STORAGE	0.8	0.99	NO
Coffee Station	rf2	4	3	32	1.08	414.72	352	OFFICE - ENCLOSED	1.1	1.18	NO
Storage	RF16	20	2	32	1.08	1382.4	1520	ACTIVE STORAGE	0.8	0.91	NO
Storage	SF1	1	2	32	1.08	69.12	41	ACTIVE STORAGE	0.8	1.69	NO
Office	RF2	2	3	32	1.08	207.36	165	OFFICE - ENCLOSED	1.1	1.26	NO
Office	rf16	4	2	32	1.08	276.48	246	OFFICE - ENCLOSED	1.1	1.12	NO
Meeting Room	rf16	4	2	32	1.08	276.48	240	CONFERENCE	1.3	1.15	YES
Meeting Room	fm2	3	1	150	1.08	486	464	CONFERENCE	1.3	1.05	YES
Alcove	rf9	3	2	26	1.08	168.48	312	LOBBY	1.3	0.54	YES
Corridor	sf11	1	2	32	1.08	69.12	319	CORRIDOR/TRANISTION	0.5	0.22	YES
Corridor	wm4	2	LED		1	0	319	CORRIDOR/TRANISTION			
First Aid	rf2	4	3	32	1.08	414.72	290	NURSE STATION	0.8	1.43	NO
Alcove	rf2	4	3	32	1.08	414.72	361	LOBBY	1.3	1.15	YES
Corridor	rf2	4	3	32	1.08	414.72	260	CORRIDOR/TRANISTION	0.5	1.60	NO
Mail	rf16	4	2	32	1.08	276.48	212	OFFICE - ENCLOSED	1.1	1.30	NO
Print Room	rf2	6	3	32	1.08	622.08	315	OFFICE - ENCLOSED	1.1	1.97	NO
Server Room	rf15	3	3	32	1.08	311.04	556	ELECTRICAL/MECHANICAL	1.5	0.56	YES
Server Room	rf2	6	3	32	1.08	622.08	556	ELECTRICAL/MECHANICAL	1.5	1.12	YES
Tel/Data	sf1	3	2	32	1.08	207.36	167	ELECTRICAL/MECHANICAL	1.5	1.24	YES
Elecrtric Room	sf1	3	2	32	1.08	207.36	146	ACTIVE STORAGE	0.8	1.42	NO
Corridor	rf2	1	3	32	1.08	103.68	97	CORRIDOR/TRANISTION	0.5	1.07	NO
Coats/Luggage	rf2	3	3	32	1.08	311.04	274	ACTIVE STORAGE	0.8	1.14	NO
Corridor	pf11	6	4	18	1.08	466.56	275	CORRIDOR/TRANISTION	0.5	1.70	NO
Dressing	rf2	2	3	32	1.08	207.36	160	PATIENT ROOM	0.7	1.30	NO
Diagnostic Business Office	rf3	2	3	32	1.08	207.36	191	OFFICE - ENCLOSED	1.1	1.09	YES
Toilet	rf2	1	3	32	1.08	103.68	43	RESTROOMS	0.9	2.41	NO
Recovery	rf2	1	3	32	1.08	103.68	104	PATIENT ROOM	0.7	1.00	NO
Corridor	rf2	4	3	32	1.08	414.72	325	CORRIDOR/TRANISTION	0.5	1.28	NO
Diagnostic	rf3	2	3	32	1.08	207.36	206	PATIENT ROOM	0.7	1.01	NO

Space Name	Lamp Type	Number of Fixtures	Lamps per Fixture	Lamp Watts	Ballast Factor	Watts	AREA	POWER DENSITY AREA TYPE	MAX POWER DENSITY SPACE BY SPACE	ACTUAL LIGHTING POWER DENSITY	SPACE BY SPACE COMPLIANCE
Vacuum Pump room	rf2	1	3	32	1.08	103.68	74	OPERATING ROOM	2.2	1.40	YES
Diagnostic Xray	rf2	2	3	32	1.08	207.36	97	PATIENT ROOM	0.7	2.14	NO
Consultation Office	rf3	2	3	32	1.08	207.36	208	OFFICE - ENCLOSED	1.1	1.00	YES
Meeting Room	rf22	12	3	32	1.08	1244.16	1000	CONFERENCE	1.3	1.24	YES
Corridor	rf2	3	3	32	1.08	311.04	280	CORRIDOR/TRANISTION	0.5	1.11	NO
Clean Sterilization	rf2	2	3	32	1.08	207.36	97	EXAM/TREATMENT	1.5	2.14	NO
Dental Operatory	rf21	2	3	32	1.08	207.36	233	OPERATING ROOM	2.2	0.89	YES
Reading Room	rf3	2	3	32	1.08	207.36	147	OFFICE - ENCLOSED	1.1	1.41	NO
Clean Sterilization	rf2	2	3	32	1.08	207.36	97	EXAM/TREATMENT	1.5	2.14	NO
Dental Operatory	rf21	2	3	32	1.08	207.36	237	OPERATING ROOM	2.2	0.87	YES
Corridor	RF2	3	3	32	1.08	311.04	269	CORRIDOR/TRANISTION	0.5	1.16	NO
Meeting Room	RF2	4	3	32	1.08	414.72	145	CONFERENCE	1.3	2.86	NO
Tank Stor. 1	SF1	1	2	32	1.08	69.12	16	ACTIVE STORAGE	0.8	4.32	NO
Tech	RF2	9	3	32	1.08	933.12	560	OFFICE - ENCLOSED	1.1	1.67	NO
Storage	RF16	4	2	32	1.08	276.48	285	ACTIVE STORAGE	0.8	0.97	NO
Corridor	RF2	3	3	32	1.08	311.04	236	CORRIDOR/TRANISTION	0.5	1.32	NO
Prep	RF3	9	3	32	1.08	933.12	580	NURSE STATION	0.8	1.61	NO
Tank Stor. 2	SF1	1	2	32	1.08	69.12	22	ACTIVE STORAGE	0.8	3.14	NO
Casting	RF2	2	3	32	1.08	207.36	154	MANUFACTURING	1.2	1.35	NO
Simulation Lab	RF3	30	3	32	1.08	3110.4	1750	OFFICE - ENCLOSED	1.1	1.78	NO
Corridor	RF2	3	3	32	1.08	311.04	311	CORRIDOR/TRANISTION	0.5	1.00	NO
Storage	RF2	2	3	32	1.08	207.36	130	ACTIVE STORAGE	0.8	1.60	NO
Corridor	RF9	2	2	26	1.08	112.32	115	CORRIDOR/TRANISTION	0.5	0.98	NO
Auditorium	RF9	38	2	26	1.08	2134.08	1760	AUDIENCE/SEATING AREA	0.9	1.91	NO
Auditorium	RF12	27	1	42	1.08	1224.72	1760	AUDIENCE/SEATING AREA			
Control Room	RF2	2	3	32	1.08	207.36	153	CONROL ROOM	0.5	1.36	NO
Pantry	RF-2	2	3	32	1.08	207.36	181	OFFICE - ENCLOSED	1.1	1.15	NO
Stor. Lit.	rf16	2	2	32	1.08	138.24	122	ACTIVE STORAGE	0.8	1.13	NO
Events Coord.	rf2	9	3	32	1.08	933.12	750	OFFICE - ENCLOSED	1.1	1.24	NO
Raw Material Stock & Prep	PMH1	3	1	400	1.08	1296	1221	MANUFACTURING	1.2	1.42	NO
Raw Material Stock & Prep	PMH2	1	1	400	1.08	432	1221	MANUFACTURING			
Main Lobby	FM1	2	1	150	1.08	324	2293	LOBBY	1.3	0.77	YES
Main Lobby	PMH3	1	1	150	1.08	162	2293	LOBBY			
Main Lobby	RF20	6	2	42	1.08	544.32	2293	LOBBY			
Main Lobby	rf7	6	1	50	1.08	324	2293	LOBBY			
Main Lobby	sf11	6	2	32	1.08	414.72	2293	LOBBY			
Open Office	rf2	17	3	32	1.08	1762.56	1253	OFFICE - OPEN PLAN	1.1	1.41	NO
Corridor	rf10	21	2	42	1.08	1905.12	1515	CORRIDOR/TRANISTION	0.5	1.89	NO
Corridor	sf11	13	2	32	1.08	898.56	1515	CORRIDOR/TRANISTION			
Corridor	rf9	1	2	26	1.08	56.16	1515	CORRIDOR/TRANISTION			

Space Name	Lamp Type	Number of Fixtures	Lamps per Fixture	Lamp Watts	Ballast Factor	Watts	AREA	POWER DENSITY AREA TYPE	MAX POWER DENSITY SPACE BY SPACE	ACTUAL LIGHTING POWER DENSITY	SPACE BY SPACE COMPLIANCE
Corridor	rf2	6	3	32	1.08	622.08	1515	CORRIDOR/TRANISTION	0.5	0.41	YES
Corridor	pf6	3	1	200	1	600	6956	LOBBY	1.3	1.36	NO
Corridor	rf13	8	1	75	1	600	6956	LOBBY			
Corridor	rf9	23	2	26	1.08	1291.68	6956	LOBBY			
Corridor	rl2	12	3	75	1.08	2916	6956	LOBBY			
Corridor	sf11	5	2	32	1.08	345.6	6956	LOBBY			
Corridor	wm2	23	1	150	1.08	3726	6956	LOBBY			
Corridor	wm4	6	LED		1	0	6956	LOBBY			
Corridor	RF2	14	3	32	1.08	1451.52	1658	CORRIDOR/TRANISTION	0.5	0.88	NO
Packaging	RF2	89	3	32	1.08	9227.52	6470	MANUFACTURING	1.2	1.43	NO
Board Room	RL1	4	4	75	1.08	1296	553	CONFERENCE	1.3	3.34	NO
Board Room	RI1	11	1	50	1	550	553	CONFERENCE			
Reception	PF5	1	2	35	1.08	75.6	1187	LOBBY	1.3	1.49	NO
Reception	RF10	2	2	42	1.08	181.44	1187	LOBBY			
Reception	RF9	2	2	26	1.08	112.32	1187	LOBBY			
Reception	RI2	2	1	50	1	100	1187	LOBBY			
Reception	RL2	4	3	75	1.08	972	1187	LOBBY			
Reception	RL3	11	1	28	1.08	332.64	1187	LOBBY			
Reception	RL3		1	28	1.08	0	1187	LOBBY			
Chariman Office	PF5	2	2	35	1.08	151.2	274	OFFICE - ENCLOSED	1.1	0.93	YES
Chariman Office	RF18	3	1	32	1.08	103.68	274	OFFICE - ENCLOSED			
COO Office	PF5	2	2	35	1.08	151.2	275	OFFICE - ENCLOSED	1.1	0.93	YES
COO Office	RF18	3	1	32	1.08	103.68	275	OFFICE - ENCLOSED			
Administrative	PF5	2	2	35	1.08	151.2	272	OFFICE - ENCLOSED	1.1	0.94	YES
Administrative	RF18	3	1	32	1.08	103.68	272	OFFICE - ENCLOSED			
CEO Office	PF5	3	2	35	1.08	226.8	542	OFFICE - ENCLOSED	1.1	1.15	NO
CEO Office	RF11	2	1	50	1	100	542	OFFICE - ENCLOSED			
CEO Office	RF24	7	1	32	1.08	241.92	542	OFFICE - ENCLOSED			
CEO Office	RF7	1	1	50	1.08	54	542	OFFICE - ENCLOSED			
Pantry	RF16	2	2	32	1.08	138.24	108	OFFICE - ENCLOSED	1.1	2.06	NO
Pantry	UC1	3	2	13	1.08	84.24	108	OFFICE - ENCLOSED			
Legal Office	RF21	2	3	32	1.08	207.36	172	OFFICE - ENCLOSED	1.1	1.61	NO
Legal Office	RF18	2	1	32	1.08	69.12	172	OFFICE - ENCLOSED			
VP office	RF21	2	3	32	1.08	207.36	172	OFFICE - ENCLOSED	1.1	1.61	NO
VP office	RF18	2	1	32	1.08	69.12	172	OFFICE - ENCLOSED			
VP office	RF21	2	3	32	1.08	207.36	172	OFFICE - ENCLOSED	1.1	1.61	NO
VP office	RF18	2	1	32	1.08	69.12	172	OFFICE - ENCLOSED			
Copy/Equipment	RF2	2	3	32	1.08	207.36	156	OFFICE - ENCLOSED	1.1	1.33	NO
Corridor	PF2	162	1	54	1.08	9447.84	17275	OFFICE - OPEN PLAN	1.1	0.55	YES
Meeting Room	PF1	2	4	54	1.08	466.56	357	CONFERENCE	1.3	1.31	NO
Coats	RF16	2	2	32	1.08	138.24	148	ACTIVE STORAGE	0.8	0.93	NO
Office	PF1	1	4	54	1.08	233.28	164	OFFICE - ENCLOSED	1.1	1.42	NO
Office	PF1	1	4	54	1.08	233.28	164	OFFICE - ENCLOSED	1.1	1.42	NO
Operations Manager Office	PF10	1	6	54	1.08	349.92	198	OFFICE - ENCLOSED	1.1	1.77	NO
Accounting Office	PF10	1	6	54	1.08	349.92	198	OFFICE - ENCLOSED	1.1	1.77	NO

Space Name	Lamp Type	Number of Fixtures	Lamps per Fixture	Lamp Watts	Ballast Factor	Watts	AREA	POWER DENSITY AREA TYPE	MAX POWER DENSITY SPACE BY SPACE	ACTUAL LIGHTING POWER DENSITY	SPACE BY SPACE COMPLIANCE
Office	PF1	1	4	54	1.08	233.28	162	OFFICE - ENCLOSED	1.1	1.44	NO
Electric Room	SF1	3	2	32	1.08	207.36	135	ACTIVE STORAGE	0.8	1.54	NO
Coffee Area	PF12	3	1	18	1.08	58.32	326	LOBBY	1.3	0.18	YES
Coffee Area	UC1	4	2	13	1.08	112.32	326	LOBBY	1.3	0.34	YES
Coats	RF2	1	3	32	1.08	103.68	70	ACTIVE STORAGE	0.8	1.48	NO
Copy/Equipment	RF2	5	3	32	1.08	518.4	256	OFFICE - ENCLOSED	1.1	2.30	NO
Copy/Equipment	RF4	1	2	32	1.08	69.12	256	OFFICE - ENCLOSED			
Storage	RF2	2	3	32	1.08	207.36	150	ACTIVE STORAGE	0.8	2.51	NO
Storage	RF9	3	2	26	1.08	168.48	150	ACTIVE STORAGE			
Tele/Data	RF16	4	2	32	1.08	276.48	189	ELECTRICAL/MECHANICAL	1.5	1.46	YES
Office	PF10	1	6	54	1.08	349.92	213	OFFICE - ENCLOSED	1.1	1.64	NO
Office	PF1	1	4	54	1.08	233.28	169	OFFICE - ENCLOSED	1.1	1.38	NO
Office	PF1	1	4	54	1.08	233.28	169	OFFICE - ENCLOSED	1.1	1.38	NO
Office	PF1	1	4	54	1.08	233.28	169	OFFICE - ENCLOSED	1.1	1.38	NO
Office	PF1	1	4	54	1.08	233.28	169	OFFICE - ENCLOSED	1.1	1.38	NO
Office	PF1	1	4	54	1.08	233.28	165	OFFICE - ENCLOSED	1.1	1.41	NO
Office	PF1	1	4	54	1.08	233.28	166	OFFICE - ENCLOSED	1.1	1.41	NO
Office	PF1	1	4	54	1.08	233.28	166	OFFICE - ENCLOSED	1.1	1.41	NO
Meeting Room	PF10	1	6	54	1.08	349.92	179	CONFERENCE	1.3	1.95	NO
Meeting Room	PF1	2	4	54	1.08	466.56	263	CONFERENCE	1.3	1.77	NO
Corridor	RF2	3	3	32	1.08	311.04	827	CORRIDOR/TRANISTION	0.5	0.38	YES
Corridor	RF16	8	2	32	1.08	552.96	827	CORRIDOR/TRANISTION	0.5	0.67	NO
Server Room	RF16	3	2	32	1.08	207.36	528	ELECTRICAL/MECHANICAL	1.5	1.18	YES
Server Room	RF17	6	2	32	1.08	414.72	528	ELECTRICAL/MECHANICAL			
MER	RF9	8	2	26	1.08	449.28	268	ELECTRICAL/MECHANICAL	1.5	1.68	NO
STAIR	wm5	1	6	32	1.08	207.36	197	STAIRS - ACTIVE	0.6	1.05	NO
SE Men	SF5	7	2	32	1.08	483.84	262	RESTROOMS	0.9	2.49	NO
SE Men	RF9	3	2	26	1.08	168.48	262	RESTROOMS			
SE Women	SF5	7	2	32	1.08	483.84	240	RESTROOMS	0.9	2.72	NO
SE Women	RF9	3	2	26	1.08	168.48	240	RESTROOMS			
NW Men	RF9	5	2	26	1.08	280.8	308	RESTROOMS	0.9	2.93	NO
NW Men	SF5	9	2	32	1.08	622.08	308	RESTROOMS			
NW Women	SF5	9	2	32	1.08	622.08	332	RESTROOMS	0.9	2.72	NO
NW Women	RF9	5	2	26	1.08	280.8	332	RESTROOMS			
Janitor	SF1	1	2	32	1.08	69.12	42	ACTIVE STORAGE	0.8	1.65	NO
Men's Shower	RF14	4	1	32	1.08	138.24	311	LOCKER ROOM	0.6	0.99	NO
Men's Shower	RF9	3	2	26	1.08	168.48	311	LOCKER ROOM			
Women's Shower	RF14	2	1	32	1.08	69.12	248	LOCKER ROOM	0.6	0.73	NO
Women's Shower	RF9	2	2	26	1.08	112.32	248	LOCKER ROOM			

14.0 Appendix C – HAP System Sizing

Air System Sizing Summary for RTU-1

Air System Information

Air System Name	**RTU-1**		Number of zones	**32**	
Equipment Class	**CW AHU**		Floor Area	**25072.0**	ft²
Air System Type	**VAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Peak zone sensible load**		Calculation Months	**Jan to Dec**	
Space CFM	**Individual peak space loads**		Sizing Data	**Calculated**	

Central Cooling Coil Sizing Data

Total coil load	**93.2**	Tons	Load occurs at	**Jul 1500**	
Total coil load	**1118.6**	MBH	OA DB / WB	**90.3 / 73.0**	°F
Sensible coil load	**845.2**	MBH	Entering DB / WB	**91.6 / 69.2**	°F
Coil CFM at Jul 1500	**19651**	CFM	Leaving DB / WB	**51.7 / 49.9**	°F
Max block CFM at Jun 1600	**20151**	CFM	Coil ADP	**47.3**	°F
Sum of peak zone CFM	**20151**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.756**		Resulting RH	**37**	%
ft²/Ton	**269.0**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**44.6**		Zone T-stat Check	**31 of 32**	OK
Water flow @ 10.0 °F rise	**223.84**	gpm	Max zone temperature deviation	**0.2**	°F

Preheat Coil Sizing Data

Max coil load	**201.4**	MBH	Load occurs at	**Des Htg**	
Coil CFM at Des Htg	**3946**	CFM	Ent. DB / Lvg DB	**7.7 / 55.0**	°F
Max coil CFM	**8985**	CFM			
Water flow @ 20.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM at Jun 1600	**20151**	CFM	Fan motor BHP	**29.17**	BHP
Standard CFM	**20129**	CFM	Fan motor kW	**21.75**	kW
Actual max CFM/ft²	**0.80**	CFM/ft²	Fan static	**5.52**	in wg

Return Fan Sizing Data

Actual max CFM at Jun 1600	**20151**	CFM	Fan motor BHP	**7.93**	BHP
Standard CFM	**20129**	CFM	Fan motor kW	**5.91**	kW
Actual max CFM/ft²	**0.80**	CFM/ft²	Fan static	**1.50**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**8985**	CFM	CFM/person	**80.22**	CFM/person
CFM/ft²	**0.36**	CFM/ft²			

Air System Sizing Summary for RTU-2

Air System Information

Air System Name	**RTU-2**		Number of zones	**30**	
Equipment Class	**CW AHU**		Floor Area	**21761.0**	ft²
Air System Type	**VAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Peak zone sensible load**		Calculation Months	**Jan to Dec**	
Space CFM	**Individual peak space loads**		Sizing Data	**Calculated**	

Central Cooling Coil Sizing Data

Total coil load	**97.9**	Tons	Load occurs at	**Jul 1500**	
Total coil load	**1174.4**	MBH	OA DB / WB	**90.3 / 73.0**	°F
Sensible coil load	**775.0**	MBH	Entering DB / WB	**87.6 / 70.0**	°F
Coil CFM at Jul 1500	**20059**	CFM	Leaving DB / WB	**51.8 / 50.5**	°F
Max block CFM at Jul 1500	**20905**	CFM	Coil ADP	**47.8**	°F
Sum of peak zone CFM	**20941**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.660**		Resulting RH	**41**	%
ft²/Ton	**222.4**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**54.0**		Zone T-stat Check	**26 of 30**	OK
Water flow @ 10.0 °F rise	**235.00**	gpm	Max zone temperature deviation	**0.4**	°F

Preheat Coil Sizing Data

Max coil load	**300.7**	MBH	Load occurs at	**Des Htg**	
Coil CFM at Des Htg	**5892**	CFM	Ent. DB / Lvg DB	**7.7 / 55.0**	°F
Max coil CFM	**13929**	CFM			
Water flow @ 20.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM at Jul 1500	**20905**	CFM	Fan motor BHP	**30.26**	BHP
Standard CFM	**20883**	CFM	Fan motor kW	**22.56**	kW
Actual max CFM/ft²	**0.96**	CFM/ft²	Fan static	**5.52**	in wg

Return Fan Sizing Data

Actual max CFM at Jul 1500	**20905**	CFM	Fan motor BHP	**8.22**	BHP
Standard CFM	**20883**	CFM	Fan motor kW	**6.13**	kW
Actual max CFM/ft²	**0.96**	CFM/ft²	Fan static	**1.50**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**13929**	CFM	CFM/person	**48.87**	CFM/person
CFM/ft²	**0.64**	CFM/ft²			

Air System Sizing Summary for RTU-3

Air System Information

Air System Name	**RTU-3**		Number of zones	**1**	
Equipment Class	**CW AHU**		Floor Area	**3928.0**	ft²
Air System Type	**SZCAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Sum of space airflow rates**		Calculation Months	**Jan to Dec**	
Space CFM	**Individual peak space loads**		Sizing Data	**Calculated**	

Central Cooling Coil Sizing Data

Total coil load	**21.6**	Tons	Load occurs at	**Jul 1400**	
Total coil load	**258.9**	MBH	OA DB / WB	**89.1 / 72.6**	°F
Sensible coil load	**169.2**	MBH	Entering DB / WB	**90.1 / 71.6**	°F
Coil CFM at Jul 1400	**4282**	CFM	Leaving DB / WB	**53.5 / 52.1**	°F
Max block CFM	**4319**	CFM	Coil ADP	**49.4**	°F
Sum of peak zone CFM	**4319**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.654**		Resulting RH	**48**	%
ft²/Ton	**182.1**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**65.9**		Zone T-stat Check	**1 of 1**	OK
Water flow @ 7.0 °F rise	**74.00**	gpm	Max zone temperature deviation	**0.0**	°F

Preheat Coil Sizing Data

Max coil load	**41.3**	MBH	Load occurs at	**Jan 0800**	
Coil CFM at Jan 0800	**2248**	CFM	Ent. DB / Lvg DB	**38.0 / 55.0**	°F
Max coil CFM	**3071**	CFM			
Water flow @ 20.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM	**4319**	CFM	Fan motor BHP	**2.80**	BHP
Standard CFM	**4314**	CFM	Fan motor kW	**2.09**	kW
Actual max CFM/ft²	**1.10**	CFM/ft²	Fan static	**2.47**	in wg

Return Fan Sizing Data

Actual max CFM	**4319**	CFM	Fan motor BHP	**1.13**	BHP
Standard CFM	**4314**	CFM	Fan motor kW	**0.84**	kW
Actual max CFM/ft²	**1.10**	CFM/ft²	Fan static	**1.00**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**3071**	CFM	CFM/person	**20.33**	CFM/person
CFM/ft²	**0.78**	CFM/ft²			

Air System Sizing Summary for RTU-4

Air System Information

Air System Name	**RTU-4**		Number of zones	**37**	
Equipment Class	**CW AHU**		Floor Area	**22411.0**	ft²
Air System Type	**VAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Peak zone sensible load**		Calculation Months	**Jan to Dec**	
Space CFM	**Individual peak space loads**		Sizing Data	**Calculated**	

Central Cooling Coil Sizing Data

Total coil load	**99.0**	Tons	Load occurs at	**Aug 1500**	
Total coil load	**1188.5**	MBH	OA DB / WB	**90.3 / 73.0**	°F
Sensible coil load	**883.1**	MBH	Entering DB / WB	**87.1 / 67.8**	°F
Coil CFM at Aug 1500	**23052**	CFM	Leaving DB / WB	**51.6 / 50.1**	°F
Max block CFM at Aug 1500	**23301**	CFM	Coil ADP	**47.7**	°F
Sum of peak zone CFM	**24186**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.743**		Resulting RH	**38**	%
ft²/Ton	**226.3**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**53.0**		Zone T-stat Check	**35 of 37**	OK
Water flow @ 10.0 °F rise	**237.82**	gpm	Max zone temperature deviation	**0.3**	°F

Preheat Coil Sizing Data

Max coil load	**197.4**	MBH	Load occurs at	**Des Htg**	
Coil CFM at Des Htg	**3868**	CFM	Ent. DB / Lvg DB	**7.7 / 55.0**	°F
Max coil CFM	**9636**	CFM			
Water flow @ 20.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM at Aug 1500	**23301**	CFM	Fan motor BHP	**33.73**	BHP
Standard CFM	**23276**	CFM	Fan motor kW	**25.15**	kW
Actual max CFM/ft²	**1.04**	CFM/ft²	Fan static	**5.52**	in wg

Return Fan Sizing Data

Actual max CFM at Aug 1500	**23301**	CFM	Fan motor BHP	**7.09**	BHP
Standard CFM	**23276**	CFM	Fan motor kW	**5.29**	kW
Actual max CFM/ft²	**1.04**	CFM/ft²	Fan static	**1.16**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**9636**	CFM	CFM/person	**47.70**	CFM/person
CFM/ft²	**0.43**	CFM/ft²			

Air System Sizing Summary for RTU-5

Air System Information

Air System Name	**RTU-5**		Number of zones	**15**	
Equipment Class	**CW AHU**		Floor Area	**10877.0**	ft²
Air System Type	**VAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Peak zone sensible load**		Calculation Months	**Jan to Dec**	
Space CFM	**Individual peak space loads**		Sizing Data	**Calculated**	

Central Cooling Coil Sizing Data

Total coil load	**70.7**	Tons	Load occurs at	**Jul 1500**	
Total coil load	**848.2**	MBH	OA DB / WB	**90.3 / 73.0**	°F
Sensible coil load	**647.3**	MBH	Entering DB / WB	**91.7 / 68.6**	°F
Coil CFM at Jul 1500	**14383**	CFM	Leaving DB / WB	**50.0 / 48.2**	°F
Max block CFM at Jul 1500	**14625**	CFM	Coil ADP	**45.4**	°F
Sum of peak zone CFM	**15360**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.763**		Resulting RH	**35**	%
ft²/Ton	**153.9**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**78.0**		Zone T-stat Check	**11 of 15**	OK
Water flow @ 7.0 °F rise	**242.46**	gpm	Max zone temperature deviation	**0.8**	°F

Preheat Coil Sizing Data

Max coil load	**125.6**	MBH	Load occurs at	**Des Htg**	
Coil CFM at Des Htg	**2461**	CFM	Ent. DB / Lvg DB	**7.7 / 55.0**	°F
Max coil CFM	**6040**	CFM			
Water flow @ 20.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM at Jul 1500	**14625**	CFM	Fan motor BHP	**31.52**	BHP
Standard CFM	**14609**	CFM	Fan motor kW	**23.50**	kW
Actual max CFM/ft²	**1.34**	CFM/ft²	Fan static	**5.89**	in wg

Return Fan Sizing Data

Actual max CFM at Jul 1500	**14625**	CFM	Fan motor BHP	**5.75**	BHP
Standard CFM	**14609**	CFM	Fan motor kW	**4.29**	kW
Actual max CFM/ft²	**1.34**	CFM/ft²	Fan static	**1.50**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**6040**	CFM	CFM/person	**69.43**	CFM/person
CFM/ft²	**0.56**	CFM/ft²			

Air System Sizing Summary for RTU-6

Air System Information

Air System Name	**RTU-6**		Number of zones	**12**	
Equipment Class	**CW AHU**		Floor Area	**14597.0**	ft²
Air System Type	**VAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Peak zone sensible load**		Calculation Months	**Jan to Dec**	
Space CFM	**Individual peak space loads**		Sizing Data	**Calculated**	

Central Cooling Coil Sizing Data

Total coil load	**79.0**	Tons	Load occurs at	**Jul 1500**	
Total coil load	**948.2**	MBH	OA DB / WB	**90.3 / 73.0**	°F
Sensible coil load	**666.0**	MBH	Entering DB / WB	**91.6 / 70.6**	°F
Coil CFM at Jul 1500	**15617**	CFM	Leaving DB / WB	**52.1 / 50.5**	°F
Max block CFM at Jun 1500	**15718**	CFM	Coil ADP	**47.7**	°F
Sum of peak zone CFM	**15723**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.702**		Resulting RH	**38**	%
ft²/Ton	**184.7**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**65.0**		Zone T-stat Check	**11 of 12**	OK
Water flow @ 7.0 °F rise	**271.05**	gpm	Max zone temperature deviation	**0.4**	°F

Preheat Coil Sizing Data

Max coil load	**175.6**	MBH	Load occurs at	**Des Htg**	
Coil CFM at Des Htg	**3441**	CFM	Ent. DB / Lvg DB	**7.7 / 55.0**	°F
Max coil CFM	**9657**	CFM			
Water flow @ 20.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM at Jun 1500	**15718**	CFM	Fan motor BHP	**19.50**	BHP
Standard CFM	**15701**	CFM	Fan motor kW	**14.54**	kW
Actual max CFM/ft²	**1.08**	CFM/ft²	Fan static	**5.52**	in wg

Return Fan Sizing Data

Actual max CFM at Jun 1500	**15718**	CFM	Fan motor BHP	**5.30**	BHP
Standard CFM	**15701**	CFM	Fan motor kW	**3.95**	kW
Actual max CFM/ft²	**1.08**	CFM/ft²	Fan static	**1.50**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**9657**	CFM	CFM/person	**101.65**	CFM/person
CFM/ft²	**0.66**	CFM/ft²			

Air System Sizing Summary for RTU-7,8,9,10

Air System Information

Air System Name	**RTU-7,8,9,10**		Number of zones	**1**	
Equipment Class	**CW AHU**		Floor Area	**24222.0**	ft²
Air System Type	**VAV**		Location	**Boston, Massachusetts**	

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	**Peak zone sensible load**	Calculation Months	**Jan to Dec**
Space CFM	**Individual peak space loads**	Sizing Data	**Calculated**

Central Cooling Coil Sizing Data

Total coil load	**359.7**	Tons	Load occurs at	**Jul 1600**	
Total coil load	**4316.6**	MBH	OA DB / WB	**90.8 / 73.1**	°F
Sensible coil load	**4241.3**	MBH	Entering DB / WB	**81.9 / 62.2**	°F
Coil CFM at Jul 1600	**131695**	CFM	Leaving DB / WB	**52.0 / 50.2**	°F
Max block CFM at Aug 1600	**144860**	CFM	Coil ADP	**48.7**	°F
Sum of peak zone CFM	**144860**	CFM	Bypass Factor	**0.100**	
Sensible heat ratio	**0.983**		Resulting RH	**36**	%
ft²/Ton	**67.3**		Design supply temp.	**55.0**	°F
BTU/(hr-ft²)	**178.2**		Zone T-stat Check	**1 of 1**	OK
Water flow @ 7.0 °F rise	**1233.96**	gpm	Max zone temperature deviation	**0.0**	°F

Preheat Coil Sizing Data

Max coil load	**31.3**	MBH	Load occurs at	**Jan 0800**	
Coil CFM at Jan 0800	**1708**	CFM	Ent. DB / Lvg DB	**38.0 / 55.0**	°F
Max coil CFM	**2094**	CFM			
Water flow @ 48.0 °F drop	**N/A**				

Supply Fan Sizing Data

Actual max CFM at Aug 1600	**144860**	CFM	Fan motor BHP	**209.67**	BHP
Standard CFM	**144703**	CFM	Fan motor kW	**156.35**	kW
Actual max CFM/ft²	**5.98**	CFM/ft²	Fan static	**5.52**	in wg

Return Fan Sizing Data

Actual max CFM at Aug 1600	**144860**	CFM	Fan motor BHP	**56.98**	BHP
Standard CFM	**144703**	CFM	Fan motor kW	**42.49**	kW
Actual max CFM/ft²	**5.98**	CFM/ft²	Fan static	**1.50**	in wg

Outdoor Ventilation Air Data

Design airflow CFM	**2094**	CFM	CFM/person	**25.23**	CFM/person
CFM/ft²	**0.09**	CFM/ft²			

Zone Sizing Summary for AC-1,2

Air System Information

Air System Name **AC-1,2**
Equipment Class ..... **TERM**
Air System Type ..... **SPLT-FC**
Number of zones **1**
Floor Area ..... **556.0** ft²
Location ..... **Boston, Massachusetts**

Sizing Calculation Information

Zone and Space Sizing Method:
Zone CFM ..... **Sum of space airflow rates**
Space CFM ..... **Individual peak space loads**
Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	108.7	5038	5038	Jan 0000	0.0	556.0	9.06

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	120.4	110.7	75.9 / 62.6	55.5 / 54.3	-	Jan 2200

Terminal Unit Sizing Data - Heating, Fan, Ventilation

	HEATING COIL SIZING DATA			FAN SIZING DATA			VENT
Zone Name	Coil Load (MBH)	Coil Ent/Lvg DB (°F)	Water Flow @20.0 °F (gpm)	Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	Design Airflow (CFM)
Zone 1	0.0	0.0 / 0.0	0.00	5038	0.793	0.591	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
119 Server Room ac-1,2	1	108.7	Jan 0000	5038	0.0	556.0	9.06

Zone Sizing Summary for AC-3

Air System Information

Air System Name **AC-3**
Equipment Class ..... **TERM**
Air System Type ..... **SPLT-FC**
Number of zones **1**
Floor Area ..... **167.0** ft²
Location ..... **Boston, Massachusetts**

Sizing Calculation Information

Zone and Space Sizing Method:
Zone CFM ..... **Sum of space airflow rates**
Space CFM ..... **Individual peak space loads**
Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	27.5	1275	1275	Jan 0000	0.0	167.0	7.63

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	35.2	28.0	75.9 / 63.9	55.6 / 54.5	-	Jan 0500

Terminal Unit Sizing Data - Heating, Fan, Ventilation

	HEATING COIL SIZING DATA			FAN SIZING DATA			VENT
Zone Name	Coil Load (MBH)	Coil Ent/Lvg DB (°F)	Water Flow @20.0 °F (gpm)	Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	Design Airflow (CFM)
Zone 1	0.0	0.0 / 0.0	0.00	1275	0.201	0.150	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
120 Tel/Data ac-3	1	27.5	Jan 0000	1275	0.0	167.0	7.63

Zone Sizing Summary for AC-4,5

Air System Information

Air System Name **AC-4,5**
Equipment Class ..... **TERM**
Air System Type ..... **SPLT-FC**
Number of zones **1**
Floor Area ..... **528.0** ft²
Location ..... **Boston, Massachusetts**

Sizing Calculation Information

Zone and Space Sizing Method:
Zone CFM ..... **Sum of space airflow rates**
Space CFM ..... **Individual peak space loads**
Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	108.7	5038	5038	Jan 0000	0.0	528.0	9.54

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	120.4	110.7	75.9 / 62.6	55.5 / 54.3	-	Jan 2300

Terminal Unit Sizing Data - Heating, Fan, Ventilation

	HEATING COIL SIZING DATA			FAN SIZING DATA			VENT
Zone Name	Coil Load (MBH)	Coil Ent/Lvg DB (°F)	Water Flow @20.0 °F (gpm)	Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	Design Airflow (CFM)
Zone 1	0.0	0.0 / 0.0	0.00	5038	0.793	0.591	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
M45 Server Room ac4,5	1	108.7	Jan 0000	5038	0.0	528.0	9.54

Zone Sizing Summary for AC-6

Air System Information

Air System Name **AC-6**
Equipment Class ..... **TERM**
Air System Type ..... **SPLT-FC**
Number of zones **1**
Floor Area ..... **528.0** ft²
Location ..... **Boston, Massachusetts**

Sizing Calculation Information

Zone and Space Sizing Method:
Zone CFM ..... **Sum of space airflow rates**
Space CFM ..... **Individual peak space loads**
Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	27.5	1275	1275	Jan 0000	0.0	528.0	2.41

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	35.5	28.3	75.9 / 63.8	55.3 / 54.2	-	Feb 1200

Terminal Unit Sizing Data - Heating, Fan, Ventilation

	HEATING COIL SIZING DATA			FAN SIZING DATA			VENT
Zone Name	Coil Load (MBH)	Coil Ent/Lvg DB (°F)	Water Flow @20.0 °F (gpm)	Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	Design Airflow (CFM)
Zone 1	0.0	0.0 / 0.0	0.00	1275	0.201	0.150	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
M45 Server Room ac-6	1	27.5	Jan 0000	1275	0.0	528.0	2.41

Zone Sizing Summary for AC-7

Air System Information

Air System Name **AC-7**
Equipment Class ..... **TERM**
Air System Type ..... **SPLT-FC**
Number of zones **1**
Floor Area ..... **268.0** ft²
Location ..... **Boston, Massachusetts**

Sizing Calculation Information

Zone and Space Sizing Method:
Zone CFM ..... **Sum of space airflow rates**
Space CFM ..... **Individual peak space loads**
Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	33.5	1551	1551	Jun 1500	1.1	268.0	5.79

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	41.3	34.1	75.6 / 63.3	55.2 / 54.1	-	Jun 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

	HEATING COIL SIZING DATA			FAN SIZING DATA			VENT
Zone Name	Coil Load (MBH)	Coil Ent/Lvg DB (°F)	Water Flow @20.0 °F (gpm)	Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	Design Airflow (CFM)
Zone 1	0.3	74.9 / 75.1	-	1551	0.244	0.182	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
M49 MER ac-7	1	33.5	Jun 1500	1551	1.1	268.0	5.79

Zone Sizing Summary for AC-8

Air System Information

Air System Name **AC-8**
Equipment Class ..... **TERM**
Air System Type ..... **SPLT-FC**
Number of zones **1**
Floor Area ..... **194.0** ft²
Location ..... **Boston, Massachusetts**

Sizing Calculation Information

Zone and Space Sizing Method:
Zone CFM ..... **Sum of space airflow rates**
Space CFM ..... **Individual peak space loads**
Calculation Months ..... **Jan to Dec**
Sizing Data ..... **Calculated**

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	27.5	1275	1275	Jan 0000	0.0	194.0	6.57

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	35.5	28.3	75.6 / 63.6	55.1 / 54.0	-	Feb 0100

Terminal Unit Sizing Data - Heating, Fan, Ventilation

	HEATING COIL SIZING DATA			FAN SIZING DATA			VENT
Zone Name	Coil Load (MBH)	Coil Ent/Lvg DB (°F)	Water Flow @20.0 °F (gpm)	Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	Design Airflow (CFM)
Zone 1	0.0	0.0 / 0.0	0.00	1275	0.201	0.150	0

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
M30 Tele/Data ac-8	1	27.5	Jan 0000	1275	0.0	194.0	6.57

15.0 Appendix D – Schedules

Auditorium Schedule	- Full load during regular business hours 8am -5pm, three days a week. - Zero load two days a week during business hours. - Zero load during non-business hours, holidays, and weekends.
Office/Manufacturing Schedule	- Full load during regular business hours 8am - 5pm every week day, - Zero load during non-business hours, weekends, and holidays.
Data Cooling Schedules (AC's)	- Full load 24 hours a day, 365 days a year
Data Cooling Fans	- Occupied 24 hours a day, 365 days a year
RTU Fan Schedules	- Full load during regular business hours 8am - 5pm every week day, - Zero load during non-business hours, weekends, and holidays.
Electric Rates	- High: July - October - Medium: January, May, December - Low: February, March, April
Fuel Rates	- High: January August December - Medium: February - April, June, July, September - November - Low: May

Electric and fuel rates were based on information from electric and fuel rates from the past year. The rate were grouped into three categories (high, medium, and low) and then were averaged for each category in order to make a rate structure that could be implemented into HAP. Table D.1 and D.3 provide the monthly rates used to formulate high medium and low rates to apply to electricity and fuel consumption respectively. Tables D.2 and D.3 provide the scheduled rate applied to each category for electricity and fuel.

The monthly consumption and cost data is for the entire 100 Minuteman facility. Struaman USA occupies approximately half of the building and would therefore be responsible for half of the energy costs.

Electric Rates				
	Monthly Electric Cost per kWh	Monthly kWh Consumption	Monthly Cost	Assigned Schedule
Jan	0.1672	658000	$110,018	mid
Feb	0.1973	630000	$124,299	high
Mar	0.198	658300	$130,343	high
April	0.1774	669800	$118,823	high
May	0.151	584600	$88,275	mid
June	0.1211	729800	$88,379	low
July	0.1301	1229100	$159,906	low
August	0.1341	544400	$73,004	low
Sept	0.1325	831600	$110,187	low
Oct	0.1099	654200	$71,897	low
Nov	0.1134	617000	$69,968	low
Dec	0.1492	671600	$100,203	mid
Yearly Totals		8478400	$1,245,300	

Table D.1 Electric Rates

Electric Schedule	
0.124	low
0.156	mid
0.191	high

Table D.2 Electric Schedules

Gas Rates				
	Cost per Therm	Monthly Therm Consumption	Monthly Cost	Assigned Schedule
Jan	1.6803	19671	$33,053	high
Feb	1.5686	16125	$25,294	mid
Mar	1.5267	16574	$25,304	mid
April	1.5703	6154	$9,664	mid
May	1.3863	4181	$5,796	low
June	1.523	1436	$2,187	mid
July	1.5172	681	$1,033	mid
August	1.6792	1302	$2,186	high
Sept	1.6127	1107	$1,785	mid
Oct	1.4964	3731	$5,583	mid
Nov	1.6266	10630	$17,291	mid
Dec	1.7743	22766	$40,394	high
Yearly Totals		104358	$169,569	

Table D.3 Fuel Rates

Fuel Schedule	
low	1.386
mid	1.555
high	1.711

Table D.4 Fuel Schedules

16.0 Appendix E – Equipment Characteristics

The equipment characteristics used for modeling the Straumann USA are displayed in figures E.1 – E.5

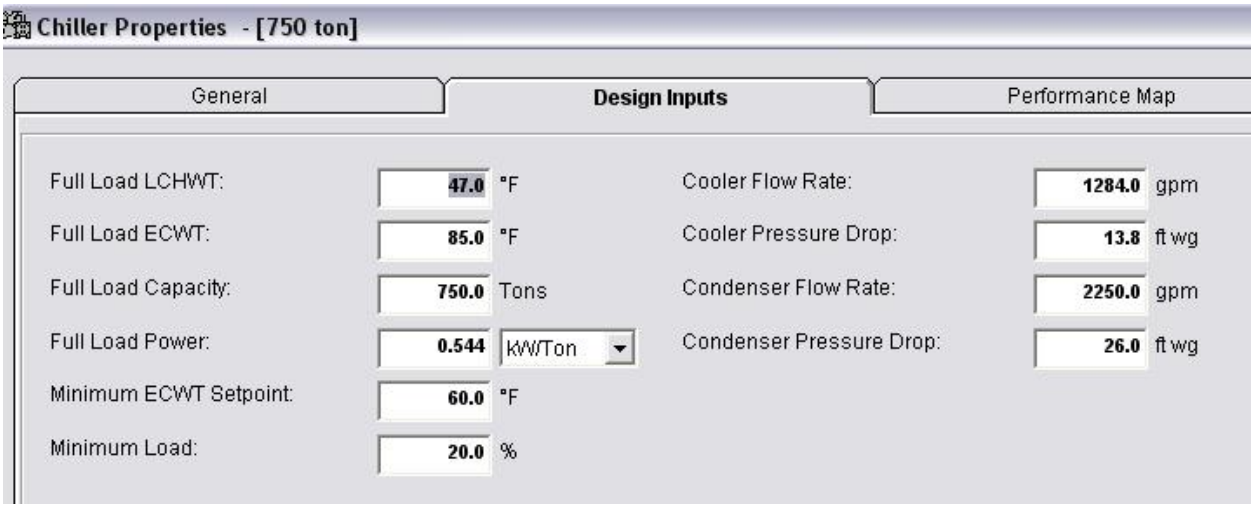

Figure E.1 750 Ton Chiller Characteristics

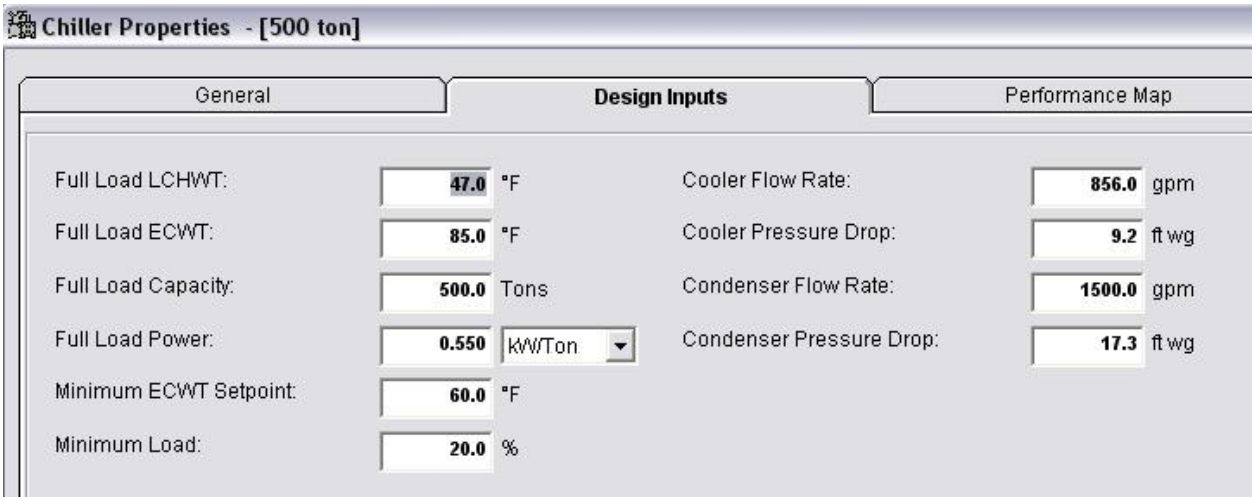

Figure E.2 500Ton Chiller Characteristics

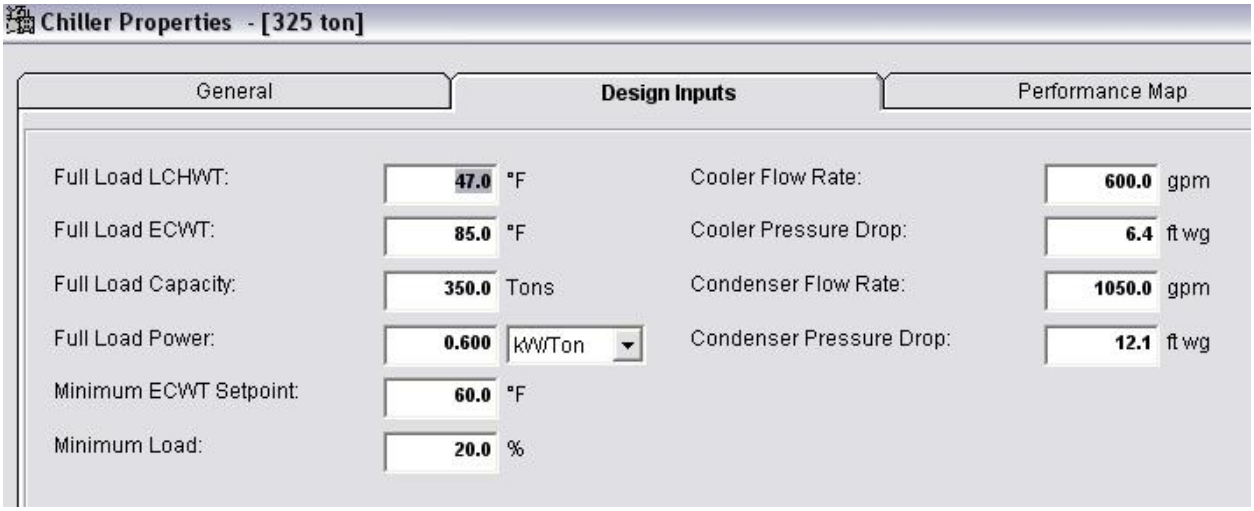

Figure E.3 350 Ton Chiller Characteristics

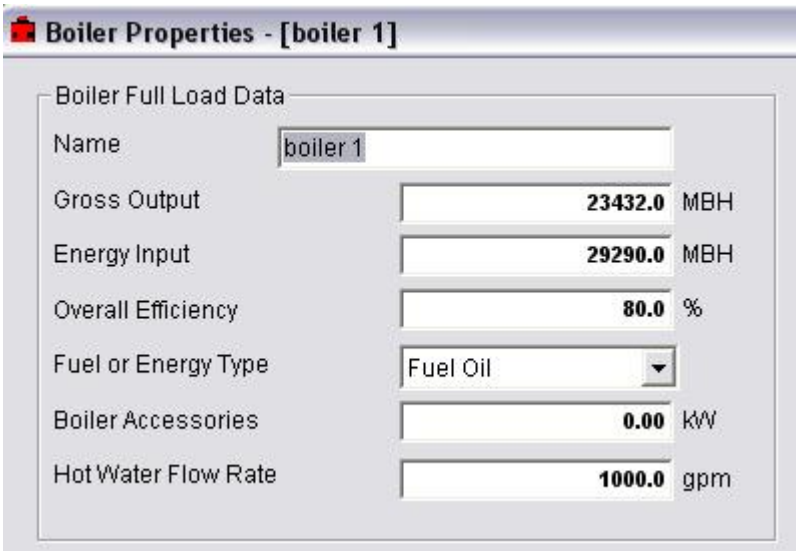

Figure E.4 Fuel Oil Boiler Characteristics

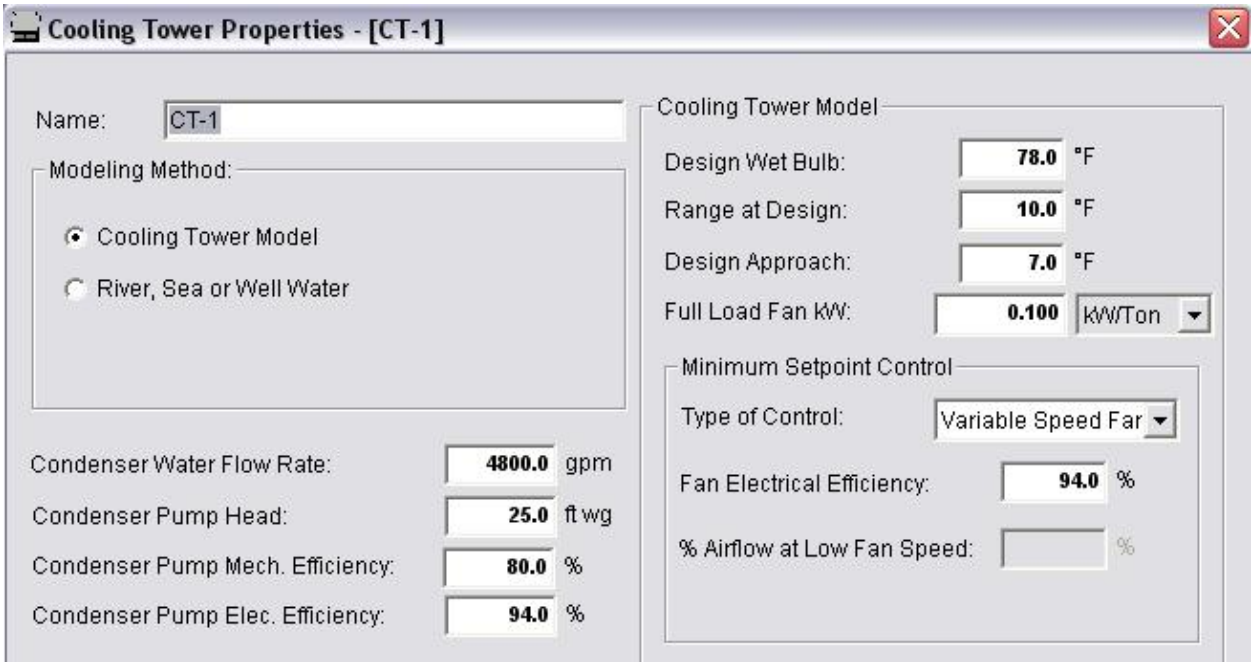

Figure E.5 Cooling Tower Characteristics

17.0 Appendix F – Energy and Cost Analysis

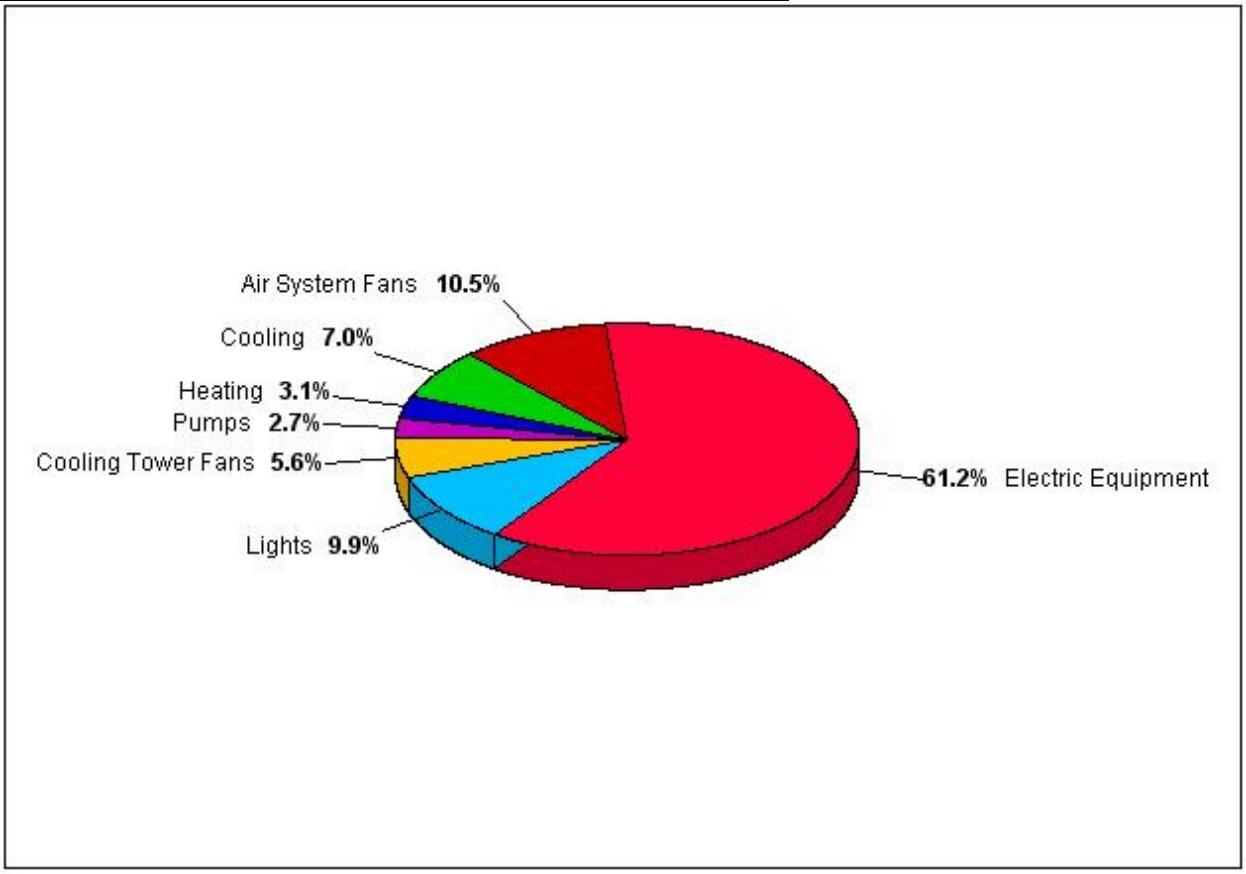

Figure F.1 Percentage of Energy Cost per System Component

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	72,647	0.581	10.5
Cooling	48,432	0.387	7.0
Heating	21,479	0.172	3.1
Pumps	19,052	0.152	2.7
Cooling Tower Fans	38,952	0.311	5.6
HVAC Sub-Total	**200,561**	**1.603**	**28.9**
Lights	68,570	0.548	9.9
Electric Equipment	423,845	3.388	61.2
Misc. Electric	0	0.000	0.0
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**492,415**	**3.936**	**71.1**
Grand Total	**692,977**	**5.539**	**100.0**

Table F.1 Energy Cost per System Component

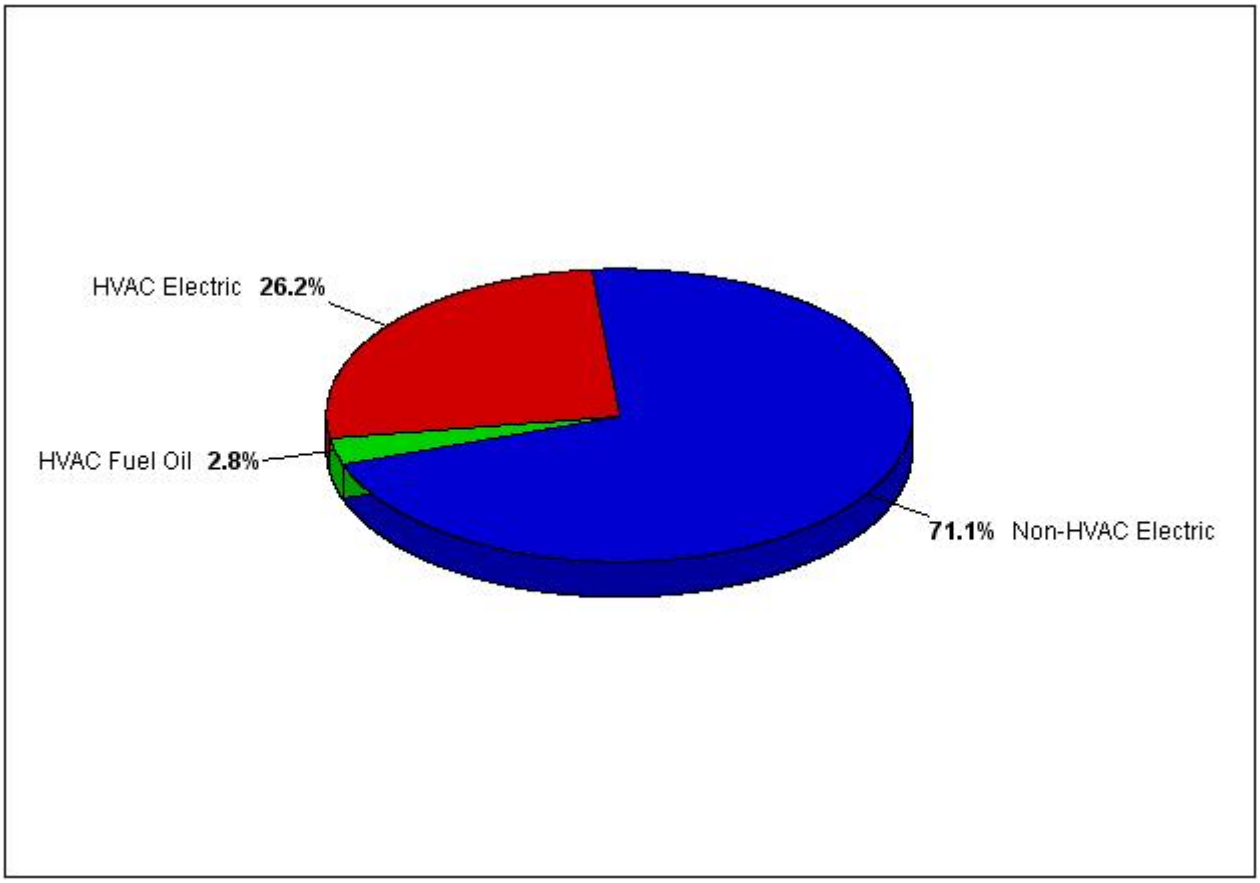

Figure F.2 Percentage of Annual Energy Cost

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	200,581	1.603	28.9
Non-HVAC	492,415	3.936	71.1
Grand Total	**692,977**	**5.539**	**100.0**

Table F.2 Annual HVAC/Non-HVAC Energy Costs

HVAC Sub-Total	**200,571**	**1.603**	**28.9**
Non-HVAC Components			
Electric	492,416	3.936	71.1
Component	**Annual Cost ($/yr)**	**($/ft²)**	**Percent of Total (%)**
HVAC Components			
Electric	181,294	1.449	26.2
Fuel Oil	19,277	0.154	2.8
Non-HVAC Sub-Total	**492,416**	**3.936**	**71.1**
Grand Total	**692,986**	**5.539**	**100.0**

Table F.3 Annual Costs per Fuel Type