201 ROUSE BOULEVARD

Technical Report 2

201 Rouse Boulevard
The Navy Yard
Philadelphia, PA 19112

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Option: Mechanical; Advisor: Dr. Miller

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Contents

Executive Summary

In 2013, commercial buildings will consume 35.9% of the United State's electricity supply, making it the second largest consumer by market (trailing only residential buildings). With the rise of technology in the 2000s coupled with the growing demand and increased cost, building designers and constructors have taken note and worked to decrease building energy use, and have been successful in a national reduction of energy consumption per sqft (a 12 kBTU/sqft reduction).

To help achieve every possible energy savingings and to meet tightening constructions standards and rating programs such as LEED, more and more building designers and engineers are turning to comprehensive energy modeling through multiple stages of the building's design. As such was the case with 201 Rouse Boulevard.

201 Rouse Boulevard, a 84,00 sqft spec office building in Philadelphia PA, uses all the modern equipment and high efficiency materials that one would expects of a building in 2013, without utilizing any of the burgeoning building technologies such as ground coupled heat pumps, photovoltaics, or green roofs.

To analyze how 201 Rouse performed over the course of a year the Department of Energy's EnergyPlus was utilized. This comprehensive software models the heating, cooling, lighting, ventilation, other energy flows, and water use. It takes a comprehensive input of weather, thermal zones, building equipment and people schedules, internal gains, HVAC systems and control schemes.

Upon completion of the energy simulation over a year period, it can be seen that 201 Rouse outperforms its competition with a yearly consumption of 72.8 kBTU/sqft, with its only energy source being electricity. The EnergyPlus simulation also yields that he heating loads of the HVAC system were the biggest consumer throughout the year, and that both the peak demand and largest monthly consumption are both in January. 201 Rouse also meets site and source emissions standards thanks to little on site equipment and the clean energy available through the utility.

A professional energy modeling team was involved with the design of 201 Rouse through all stages of its design and continuing development. This team was essential in multiple energy focused design and material changes during initial design, and now during construction they are performance testing and doing energy models for LEED Certification.

Building Overview

Name:

201 Rouse Boulevard

Location:

201 Rouse Boulevard
The Navy Yard
Philadelphia, PA 19112

Occupant:

Franklin Square Capital Partners

Function:

Class A Office, Cafe, fitness center

Size:

84,730 sqft.

Construction:

September 2013 till Q1 2015

Project Team:

Architects:

- DIGSAU (Primary Architect)
- Re:vision Architects (LEED Consultant)
- Francis Cauffman (Interior Architecture)
- Fury Design (Interior Design)

Engineers:

- Environetics (Structural Design)
- Pennoni Associates (Site and Civil)
- In Posse (Energy Consultants)

Owners:

- Liberty Property Trust (owner)
- Synterra Partners (Developers)

Construction:

- Turner Construction (General Contractor)

Mechanical System Overview

Heating & Cooling

201 Rouse Boulevard's heating and cooling is provided via three rooftop packaged units in conjunction with 4 electric unit heaters (used at entrances and equipment spaces). The building's primary spaces are conditioned by two large 33,600 SCFM (standard cubic feet per min.) rooftop air handling units (AHUs) with variable frequency drives (VFDs) that provide up to 1,500 kBTU/hr cooling (using R-410A refrigerant and an Energy Efficiency Ratio of 9.8) and 750 kBTU/hr heating each. Both AHUs utilize a economizer system with the return air, more details available in the Controls summary. The third rooftop unit is a smaller 1,600 SCFM packaged unit that provides the condition for the bathrooms and building core. Additionally 201 Rouse Boulevard utilizes single duct Variable Air Volume (VAV) Terminals of four varying sizes; all with electric reheat coils. The locations of the VAVs have not been specified yet as the internal layout is not finalized.

Ventilation

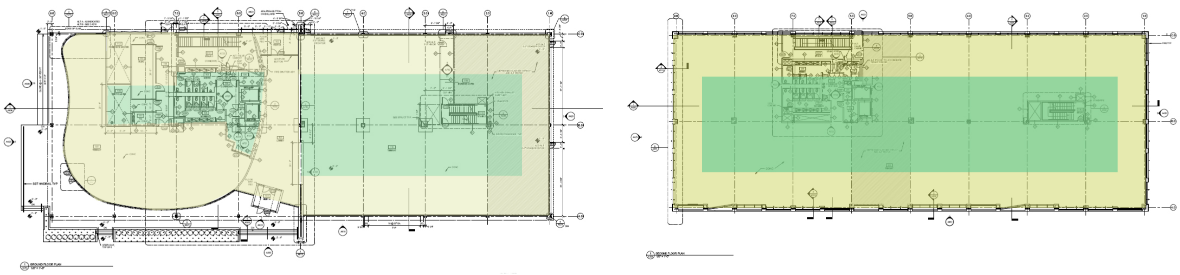
The ventilation is handled by two rooftop exhaust fans, with additional localized room exhaust provided by transfer fans. The rooftop units are belt driven centrifugal exhaust fans that provide 5,300 SCFM and 865 SCFM for toilet exhaust and janitor's closets (always on) respectfully. The smaller (~400 SCFM) Transfer fans handle the ventilation from the electric closets and machine rooms and is controlled by the space's thermostat. In addition to the exhaust systems, each of the two large rooftop AHUs have a return system with 27,500 SCFM capacity each. This air return system uses the mechanical shaft as the supply system and is integrated in the AHU with an economizer.

Controls

201 Rouse Boulevard has a standard control system. The primary space AHUs have four scheduling modes: occupied, unoccupied, morning warm-up, and morning cool-down. The smaller core AHU has only two scheduling modes, occupied or unoccupied. When in occupied modes, the control sequence maintains a minimum outside air flow (set by ASHRAE 62.1), manages the variable volume control of the supply and return fans using system air balancing, uses stepped electric resistance heating to maintain the temperature setpoint, and utilizes economizer cooling when the outdoor air enthalpy is lower than the return air enthalpy. When in unoccupied mode, the outside air dampers are closed and the AHUs cycle to maintain the discharge air temperature setpoints.

Zones

Thermal zones were created in the building to analyze the heating and cooling loads. The zones were determined by an area's proximity to outdoor conditions and exterior windows. These zones create the best model for the building as it is currently just a shell and core building an has no zone created by rooms, and all the spaces are specced out according to standards for office spaces. Figure 1 below illustrates the thermal zones for the 1st floor and the typical (2nd-4th floors) zones of 201 Rouse.



Color	Zone
(green)	Interior
(yellow)	Exterior

Figure 1 :Thermal Zones of 201 Rouse

EnergyPlus Simulation

Introduction

Weather

201 Rouse is in Philadelphia, PA (ASHRAE Climate Zone 4a). For an EnergyPlus (energy+) simulation, an EnergyPlus Weather file (.epw) must be used. An epw file contains 30+ years of historical weather data from a certified US NOAA weather station. The data is then generated into design conditions according to "Climate Design Data 2009 ASHRAE Handbook" to be representative of a location in heating/cooling load calculations.
See Appendix A for a sample of the epw's weather data for Philadelphia.

Schedules

Occupancy

201 Rouse is a standard office building. As such its primary hours of operation are from 8 am to 5 pm. The building supports a max occupancy of 730 (for a breakdown of occupancy by space see Appendix B). Figure 2 below illustrates a typical weekday occupancy schedule, the model also utilizes separate occupancy schedules for Saturday, Sunday, Holidays, and summer months.

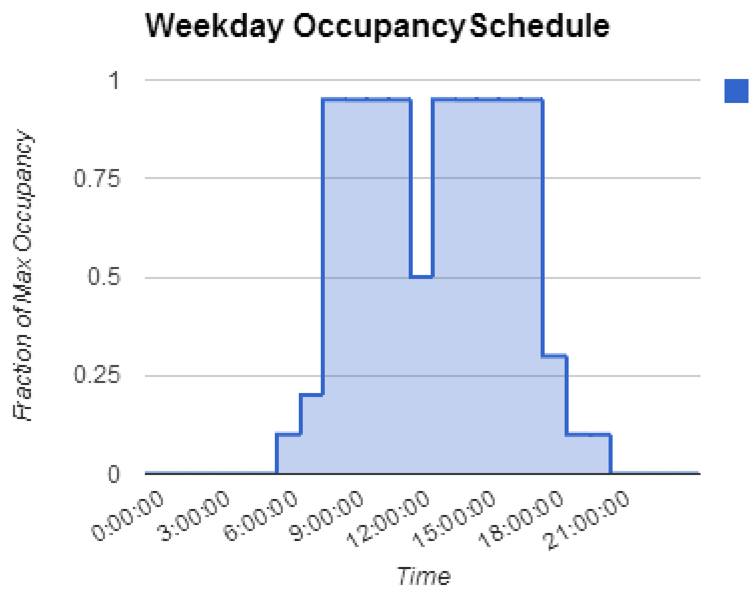


Figure 2 :Weekday Occupancy Schedule

Equipment

Equipment loads (see Appendix D for calculations) have a higher constant load level, especially as offices have more and more on premise IT. Figure 3 shows the typical weekday equipment load schedule for 201 Rouse, energy+ had additional schedules for weekends and holidays.

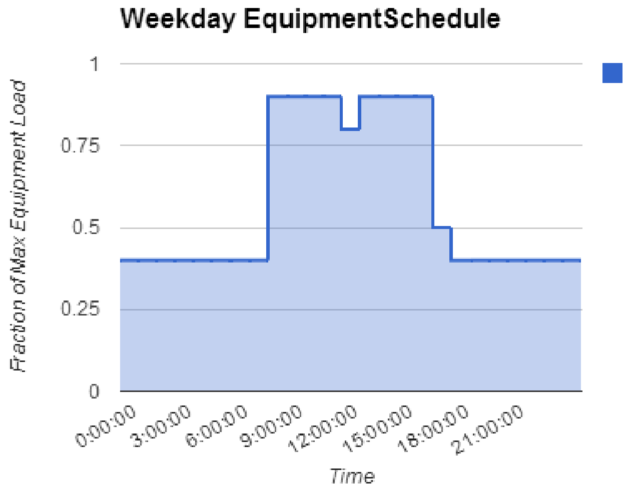


Figure 3 : Weekday Equipment schedule

Lighting

Lighting at a standard office building has some always on and night only loads, but typically the lighting intensity usage matches the occupancy hours of the building. To see 201 Rouse's lighting loads (only for emergency and public spaces as tenant fit out has not occurred yet) see Appendix C. Figure 4 below shows a typical weekday lighting schedule.

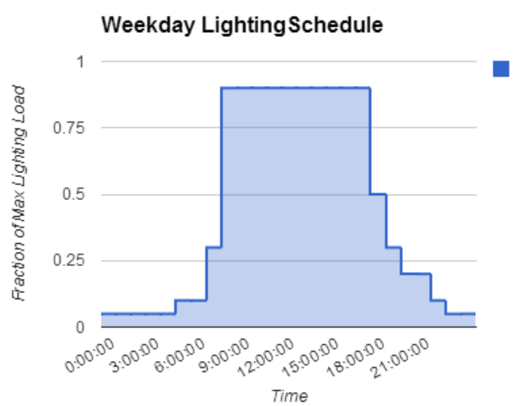


Figure 4 : Weekday Lighting Schedule

HVAC

201 Rouse Boulevard has a rooftop HVAC system that's control modes most depend upon occupancy and warm up and cool down periods. Using the control schedule, Figure 5 shows a typical weekday HVAC operation schedule, energy+ has additional schedules for other periods of reduces operation.

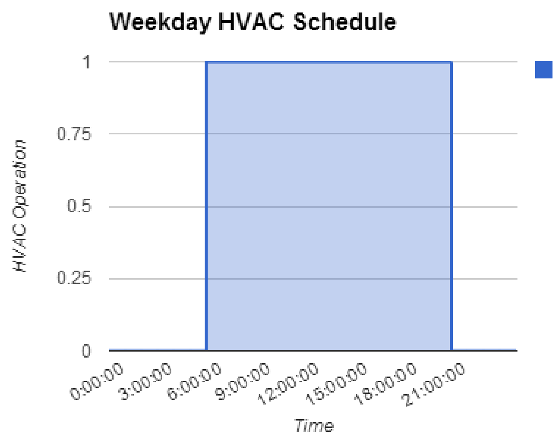


Figure 5: Weekday HVAC Schedule

Materials

Energy+ utilizes a complex materials schedule and instinctively maps them to its model of the building. To keep the model accurate to 201 Rouse, some changes had to be made to basic building model it made with insulation entirely above deck and a steel-framed wall structure. The main systems that had to be altered were the windows, as high grade efficiency windows were specified, and the unique zinc clad exterior facade were a noticeable variance from the defaults.

Thermal Zones

The thermal zones of 201 Rouse were created around the perimeter of the building. Each floor has 5 zones: 4 perimeter zones facing (north, south, east, west) and and interior zone. See Figure 1 :Thermal Zones of 201 Rouse. The exterior and interior zones have an additional simple convection calculation attached to them which accounts for thermal plumes. The thermal zones of the building would be like to change once the tenant fit out occurs, however this simple interior exterior zone modeling performs reasonably accurately for even more complex systems.

Internal Gains

The intensities for all the internal loads were calculated (See Appendix B,C,D) and then they were averaged out over the 20 thermal zones (see Appendix E for zone breakdowns).

People

Each of the thermal zones have a load due to people. The load accounts for total heat, radiant fraction(30%), and carbon dioxide emissions (0.0000000382 m^3 /sW) (see Appendix E for zone breakdowns).

Lights

The lighting load per thermal zone is based upon the total lighting level of the building using the lighting load already calculated and then adding 1 W/sqft for all the office areas that are not specced out yet (see Appendix E for zone breakdowns).

Electrical Equipment

Each zone has it share of of the total building's electrical equipment load. Each of these loads is categorized as miscellaneous plug loads and will be calculated using the equipment level method and have a radiant fraction of 0.5 (see Appendix E for zone breakdowns).

Zone Infiltration Airflow

The building has a minimum outside air flow of 0.228 CFM per ft^2 and an infiltration rate of 0.5 per hour. Using these building parameters energy+ runs a model using these averages over the three different zones (north/south exterior, east/west exterior, and interior) on each floor of 201 Rouse.

Zone	Design Zone Infiltration Rate (CFM)
Exterior N/S	**253**
Exterior E/W	**82**
Interior	**913**

HVAC

Designing the HVAC system in Energy+ began with selected the corresponding baseline system from ASHRAE standard 90.1 Appendix G. The HVAC system at 201 Rouse matches system 6, an all electric packaged VAV with PFP.

6. Packaged VAV with PFP Boxes	Packaged rooftop VAV with parallel fan power boxes and reheat	VAV	Direct expansion	Electric resistance

Figure 6: System 6 from ASHRAE 90.1 Appendix G

Furthermore see Appendix E for examples of the HVAC zone sizing and the system sizing. Energy+ also creates a temperature based schedule for the use of the VAV boxes with reheat that 201 Rouse has, and will modeling their effect upon the building systems based upon the weather data provided.

Outside Airflow Rate	**0.228**	**CFM/sqft**
Zone	Size	Min Outside Air (CFM)
Exterior N/S	3,371.22	768.64
Exterior E/W	1,094.08	249.45
Interior	12,177.09	2,776.38

Figure 7: Outside Airflow Zone Breakdown

	Supply		Return	DX Coil			Electric Heat
Units	Max SCFM	Min SCFM	SCFM	Total Capacity (MBH)	Sensible Capacity (MBH)	EER	Total Capacity (MBH)
Rooftop Unit 1&2	**33,600**	**8,230**	**27,500**	**1,502**	**1,093**	**10**	**749**
Rooftop Unit 3	**1,600**	**165**	**1,600**	**49**	**38**	**-**	**66**

Figure 8: 201 Rouse HVAC Equipment

Controls

When doing the building's simulation energy+ also relies upon a HVAC controls structure of occupancy modes and setpoints. The HVAC system of 201 Rouse has a On/Off occupancy mode with morning warm up and morning cooldown. To simulate these capabilities energy plus has a similar occupancy mode and the step settings of cooling energization (¼ steps).

Simulation Analysis

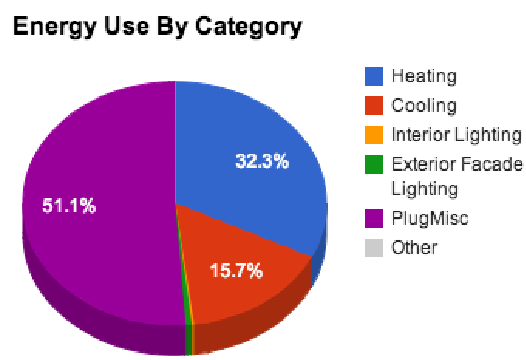
Baseline Comparison

To compare the simulated loads and energy uses of 201 Rouse Boulevard against a national baseline of building performance I choose the 2003 Commercial Building Energy Consumption Survey (see Appendix G). In Figure 9 below you see that 201 Rouse outperforms the industry average for a office building (92.9 kBTU/sqft) and a building in the 50,000 to 100,000 sqft category (88.8 kBTU/sqft).

	Total Energy [kBTU]	Energy Per Total Building Area [kBTU/sqft]
Total Site Energy	**1,874,668.53**	**22.20**
Net Site Energy	**1,874,668.53**	**22.20**
Total Source Energy	**6,150,792.85**	**72.84**
Net Source Energy	**6,150,792.85**	**72.84**

Figure 9: 201 Rouse Site and Source Energy Usage

Energy Use By Subsystem



201 Rouse's systems in this analysis ran entirely upon electricity, the only natural gas usage in the system may be an un-specced hot water heater for domestic hot water and any gas appliances.
This is useful in the analysis of the building as the subsystems are easily broken down and it becomes easier to judge the efficiencies and performance of individual systems for redesign. From the Energy+ results (Figures 10 and 11) the heating system is the single most consumptive system (the interior equipment includes the Heating and Cooling loads so the real Misc. Plug load is 56,774.24 kBTU). The building's simulation does show an abnormally low

interior lighting load (though this maybe due to energy+'s run of a daylighting simulation congruent to the energy simulation and the ample windows could have lead to this reduction in lighting load). With these results in mind there is great potential in on site electrical generation or heat pumps to reduce this high heating load.

Category	Subcategory	Electricity [kBTU]
Heating	General	**605,920.53**
Cooling	General	**294,704.78**
Interior Lighting	General	**4,540.04**
Exterior Lighting	Exterior Facade Lighting	**11,781.37**
Interior Equipment	PlugMisc	**957,399.55**
Exterior Equipment	General	**0.00**
Fans	Fan-Powered Terminal Fan	**331.74**

Figure 10: Energy use By Subsystem

	Electricity Intensity [KBTU/sqft]
Lighting	**2.08**
HVAC	**114.81**
Other	**122.00**
Total	**238.89**

Figure 11: Utility user Per Condition Floor Area

Zone Performance

See Appendix H for a breakdown of the performance and simulated loads of 201 Rouse per zone. A note, the 2x multiplier on floor two is to simulate the 2nd and 3rd floor which are identical in zones and have the same air and thermal transfer rates.

Utility Cost

PECO is the electric utility that supplies 201 Rouse Boulevard. In line with the heating HVAC load being the largest, January (Philadelphia's coldest month) is the most energy intensive month, with May having the least cost due to reduced HVAC loads.
See Appendix I for Data about 201 Rouse's peak demand. Peak Load for 201 Rouse occurs at 5:30 on January 2nd, with a demand of 686,227 W.

	Sum	Max
EnergyCharges ($)	87696.21	12491.34
DemandCharges ($)	0	0
ServiceCharges ($)	105.72	8.81
Basis ($)	87801.93	12500.15
Adjustment ($)	0	0
Surcharge ($)	0	0
Subtotal ($)	87801.93	12500.15
Taxes ($)	7024.15	1000.01
Total ($)	94826.08	13500.16

Figure 12: Total Utility Use

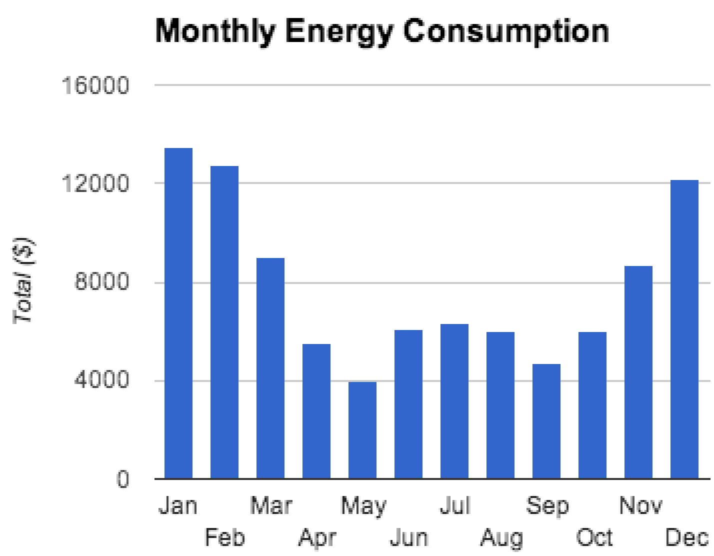


Figure 13: Monthly Utility Cost

Pollution

201 Rouse Boulevard is in a Corporate Office center in a Mixed used development on the outskirts of Philadelphia. In such a location, and with the rising codes and laws pertaining to building efficiencies, a building's emissions are a growing concern. While there is little site activity that generates any kind of greenhouse gas emission, beyond the standard population impact, however the source emissions must always be accounted for. Luckily the Philadelphia region is powered , in a substantial portion by nuclear power, and as such the source emissions for 201 Rouse Boulevard are lower than standards for 2003's CBECS survey for medium office buildings. See Figure 14 for the month by month carbon dioxide emissions and Appendix J for further emission

results. As can be seen in the CO2 results below and the NOX and SO2 results in Appendix J, the emissions follow the monthly patterns of energy use, but with less variance and a higher base level.

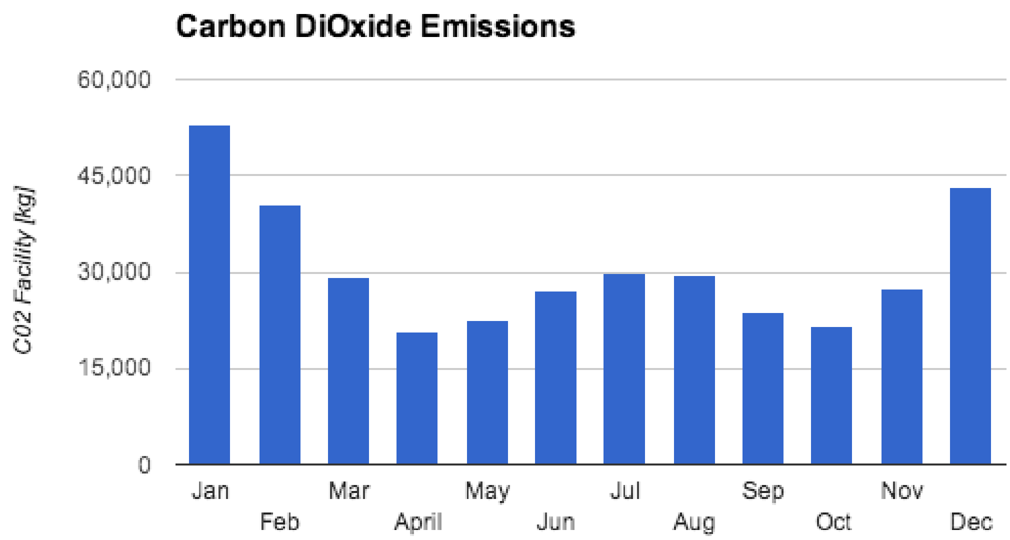


Figure 14: CO2 Emissions

Professional Simulation

A team from In:Posse was responsible for the construction and simulation of an energy model for 201 Rouse. The team at In:Posse had a head start on the energy model for this building as they had done a similar building at 150 Rouse Boulevard (that achieved LEED Gold) with the same team of architects and engineers. With this previous similar project they were able to quickly make future predictions of energy use as soon as 50% schematic design. With this early start and with LEED objectives, they were able to help make product choices to compensate for the roughly 45% glass exterior that violates LEED energy baselines. In addition they had to keep adjusting the model and make new envelope and window changes to keep the peak load of the building under the capacity of the two primary air handling units. The team at In:Posse did all this with the aid of Trane Trace and eQuest. With the recent completion of permit drawings and the breaking ground of construction, the team at In:Posse is starting their final phase of energy modeling, where they will create their LEED models and to check actual simulated energy performance and reduction strategies.

Appendix

Appendix A: Weather Data from epw file for Philadelphia, PA

Monthly Standard Heating/Cooling Degree Days/Hours

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
HDD base 10°C	292	220	134	26	0	0	0	0	0	9	76	215
HDD base 18.3°C	547	451	371	193	62	6	0	1	21	140	286	467
CDD base 10°C	3	3	23	89	238	383	482	456	316	139	41	7
CDD base 18.3°C	0	0	1	6	41	139	223	198	86	12	1	0
CDH base 23.3°C	0	0	12	72	393	1208	2127	1694	552	69	3	0
CDH base 26.7°C	0	0	2	22	128	439	882	621	142	8	0	0

Monthly Statistics for Dry Bulb temperatures °C

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	17.8	15.6	23.9	28.9	32.2	33.3	36.7	36.1	33.9	25	22.2	20
Day:Hour	26:14:00	20:16:00	26:15:00	19:16:00	4:14:00	16:13:00	7:15:00	4:15:00	6:15:00	1:13:00	14:15:00	4:15:00
Minimum	-13.9	-11.7	-2.8	-2.8	7.2	12.2	12.8	13.3	10	1.7	-7.2	-7.8
Day:Hour	23:06:00	10:06:00	23:03:00	5:06:00	7:05:00	27:04:00	4:04:00	25:02:00	24:05:00	31:01:00	24:06:00	29:06:00
Daily Avg	-1.6	0.5	7.3	12.5	18	22.2	25.3	23.9	20.8	12.3	7.4	3.5

Appendix B : Occupancy Density

Space	Area (sqft)	Persons	People Density (ppl/100 sqft)
Office Space Floor 4	19,645	197	1.00
Office Space Floor 3	19,645	197	1.00
Office Space Floor 2	19,645	197	1.00
Office Space Floor 1	3,880	39	1.01
Office Space Floor 1	9,912	100	1.01
Total	**72,727**	**730**	**1.00**

Appendix C: Lighting Power Loads and Densities

Type	Panel Board	VA	V
Emergency Lighting	EL1	10,760	277/480
Elevator Emergency	EP1	1,000	120/208
Outdoor Lighting	HL1	8,720	277/480
Common Area Lighting	HL1	13,530	277/480
Area of Occupancy Area	72,727	sqft	
Perimeter of Building	636	ft	
Indoor Lighting Intensity	0.35	W/sqft	
Outdoor Lighting Intensity	13.71	W/ft	

Appendix D: Equipment and HVAC Loads and Densities

Equipment

Type	Panel Board	VA	V
Fire Alarm Controls	EP1	1600	120/208
Genset battery Charger	EP1	200	120/208
Toilet Valves	HP1	5600	120/208
HVAC Controls	HP1	500	120/208
Door Operator	HP1	2360	120/208
Water Coolers	HP1	3600	120/208
Fire Door	HP1	860	120/208
Genset Block/Battery/Strip HTR	HP1	7000	120/208
Area of Occupancy Area	72727	sqft	
Perimeter of Building	636	ft	
Equipment Density	0.2986511199417	W/sqft	

HVAC

Type	Panel Board	VA	V
Exhaust fan (EF2)	HP1	1180	120/208
Sump Pump	HP1	1180	120/208
Transfer Fans	HP1	1520	120/208

Exhaust Fan (EF1)	HH1	3980	277/480
Space Unit Heaters	HH1	14010	277/480
AHU Unit HEaters	HH1	10000	277/480
Fan Terminal Unit B	HH1	10180	277/480
VAV Terminal Unit	HH1	6000	277/480
Fan Terminal Unit A	HH1	3540	277/480
Area of Occupancy Area	72727	sqft	
Perimeter of Building	636	ft	
HVAC Intensity	0.70936516011935	W/sqft	

Total

Total Equipment and HVAC Intensity	**1.104 W/sqft**

Appendix E: Internal Loads by Zone

Lighting Load

Zone	Lighting Level (W)	Fraction Radiant	Fraction Visible
Exterior N/S	**28.207**	**0.2**	**0.2**
Exterior E/W	**9.151**	**0.2**	**0.2**
Interior	**101.8**	**0.2**	**0.2**

People

Zone	People Per 100 sqft	Fraction Radiant	Carbon dioxide Generate Rate (ft^3/min/Btu/h)
Exterior N/S	**0.2821**	**0.3**	**0.000023733**
Exterior E/W	**0.0915**	**0.3**	**0.000023733**
Interior	**1.0185**	**0.3**	**0.000023733**

Electrical Equipment

Zone	Design Level (W)	Fraction Latent	Fraction Radient	Fraction Lost
Exterior N/S	**2530**	**0**	**0**	**0**
Exterior E/W	**820**	**0.5**	**0.5**	**0.5**
Interior	**9130**	**0**	**0**	**0**

Appendix F: HVAC Zone and System Sizing

Field	Units	Obj1
AirLoop Name		PVAV_PFP-BOXES
Type of Load to Size On		Sensible
Design Outdoor Air Flow Rate	ft3/min	autosize
Minimum System Air Flow Ratio		0.3
Preheat Design Temperature	F	44.6
Preheat Design Humidity Ratio	lbWater/lbDryAir	0.008
Precool Design Temperature	F	55.04
Precool Design Humidity Ratio	lbWater/lbDryAir	0.008
Central Cooling Design Supply Air Temperature	F	55.04
Central Heating Design Supply Air Temperature	F	62.06
Sizing Option		NonCoincident
100% Outdoor Air in Cooling		No
100% Outdoor Air in Heating		No
Central Cooling Design Supply Air Humidity Ratio	lbWater/lbDryAir	0.0085
Central Heating Design Supply Air Humidity Ratio	lbWater/lbDryAir	0.008
Cooling Design Air Flow Method		DesignDay
Cooling Design Air Flow Rate	ft3/min	0
Heating Design Air Flow Method		DesignDay
Heating Design Air Flow Rate	ft3/min	0
System Outdoor Air Method		ZoneSum
Zone Maximum Outdoor Air Fraction	dimensionless	1

HVAC System Sizing

Field	Units	Obj1
Zone or ZoneList Name		ZN_1_FLR_1_SEC_
Zone Cooling Design Supply Air Temperature Input Met		SupplyAirTemperatu
Zone Cooling Design Supply Air Temperature	F	57.2
Zone Cooling Design Supply Air Temperature Difference	deltaF	
Zone Heating Design Supply Air Temperature Input Met		SupplyAirTemperatu
Zone Heating Design Supply Air Temperature	F	104
Zone Heating Design Supply Air Temperature Differenc	deltaF	
Zone Cooling Design Supply Air Humidity Ratio	lbWater/lbDryAir	0.0085
Zone Heating Design Supply Air Humidity Ratio	lbWater/lbDryAir	0.008
Design Specification Outdoor Air Object Name		ZN_1_FLR_1_SEC_
Zone Heating Sizing Factor		
Zone Cooling Sizing Factor		
Cooling Design Air Flow Method		DesignDay
Cooling Design Air Flow Rate	ft3/min	
Cooling Minimum Air Flow per Zone Floor Area	ft3/min-ft2	
Cooling Minimum Air Flow	ft3/min	
Cooling Minimum Air Flow Fraction		0
Heating Design Air Flow Method		DesignDay
Heating Design Air Flow Rate	ft3/min	0
Heating Maximum Air Flow per Zone Floor Area	ft3/min-ft2	

HVAC Zone Sizing, showing N/S Perimeter Zone

Appendix G: CBECS Survey Data

Revised: December, 2008

Table E2A. Major Fuel Consumption (Btu) Intensities by End Use for All Buildings, 2003

	Major Fuel Energy Intensity (thousand Btu/square foot)										
	Total	Space Heating	Cooling	Ventilation	Water Heating	Lighting	Cooking	Refrigeration	Office Equipment	Computers	Other
All Buildings	91.0	33.0	7.2	6.1	7.0	18.7	2.7	5.3	1.0	2.2	7.9
Building Floorspace (Square Feet)											
1,001 to 5,000	99.0	30.7	6.7	2.7	7.1	13.9	7.1	19.9	1.1	1.7	8.2
5,001 to 10,000	80.0	30.1	5.5	2.6	6.1	13.6	5.2	8.2	0.8	1.4	6.6
10,001 to 25,000	71.0	28.2	4.5	4.1	4.1	14.5	2.3	4.5	0.8	1.6	6.5
25,001 to 50,000	79.0	29.9	6.8	5.9	6.3	14.9	1.7	3.9	0.8	1.8	7.1
50,001 to 100,000	88.7	31.6	7.6	7.6	6.5	19.6	1.7	3.4	0.7	2.0	8.1
100,001 to 200,000	104.2	39.1	8.2	8.9	7.9	22.9	1.1	2.9	Q	3.2	8.7
200,001 to 500,000	100.2	38.2	7.8	7.4	9.2	22.7	1.3	1.3	1.1	2.6	8.2
Over 500,000	118.2	38.2	11.8	8.8	10.6	28.7	2.3	2.4	Q	3.2	11.1
Principal Building Activity											
Education	83.1	39.4	8.0	8.4	5.8	11.5	0.3	1.6	0.4	3.3	4.0
Food Sales	199.7	28.9	9.8	5.9	2.9	36.7	8.3	94.8	1.6	1.5	9.1
Food Service	258.3	43.1	17.4	14.8	40.4	25.4	63.5	42.1	1.0	1.0	9.5
Health Care	187.7	70.4	14.1	13.3	30.2	33.1	3.5	2.6	1.2	3.2	16.1
Inpatient	249.2	91.8	18.6	20.0	48.4	40.1	5.3	2.0	1.1	3.6	18.1
Outpatient	94.6	38.1	7.2	3.3	2.5	22.6	Q	3.5	1.3	2.6	13.2
Lodging	100.0	22.2	4.9	2.7	31.4	24.3	3.2	2.3	Q	1.2	7.0
Mercantile	91.3	24.0	9.9	6.0	5.1	27.5	2.3	4.4	0.7	1.0	10.3
Retail (Other Than Mall)	73.9	24.8	5.9	3.7	1.1	25.7	0.3	5.0	0.6	0.9	5.6
Enclosed and Strip Malls	102.2	23.6	12.4	7.5	7.7	28.6	3.4	4.0	0.8	1.1	13.2
Office	92.9	32.8	8.9	5.2	2.0	23.1	0.3	2.9	2.6	6.1	9.0
Public Assembly	93.9	49.7	9.6	15.9	1.0	7.0	0.3	2.2	Q	Q	6.5
Public Order and Safety	115.8	49.9	8.9	9.5	14.0	16.5	1.3	2.9	0.6	1.5	10.6
Religious Worship	43.5	26.2	2.9	1.4	0.8	4.4	0.3	1.7	0.1	0.2	4.9
Service	77.0	35.9	3.8	6.0	1.0	15.6	Q	2.1	0.3	0.8	11.4
Warehouse and Storage	45.2	19.3	1.3	2.0	0.6	13.1	Q	3.5	0.2	0.5	4.8
Other	164.4	79.4	10.5	6.1	2.1	34.1	Q	6.0	Q	2.9	18.9
Vacant	20.9	14.4	0.6	0.4	0.1	1.7	Q	Q	Q	0.0	3.1
Year Constructed											
Before 1920	80.2	47.7	1.8	2.9	4.4	9.1	4.4	4.4	0.5	0.9	3.9
1920 to 1945	90.4	45.5	3.8	4.4	6.2	13.2	2.9	3.7	0.4	1.2	9.1
1946 to 1959	80.9	39.1	4.5	4.9	6.3	12.9	1.9	3.7	0.6	1.5	5.7
1960 to 1969	91.5	40.8	5.6	6.1	7.8	14.7	1.7	4.8	0.8	2.2	6.9
1970 to 1979	97.0	32.3	7.9	7.0	8.3	21.6	2.5	5.2	1.1	2.3	8.6
1980 to 1989	100.0	28.8	9.8	6.6	8.2	23.9	2.7	6.0	1.3	3.1	9.6
1990 to 1999	90.2	25.2	9.2	7.2	6.0	21.0	2.9	6.5	1.3	2.6	8.4
2000 to 2003	81.6	19.4	8.8	5.9	6.3	21.7	3.3	6.5	0.7	1.6	7.4
Census Region and Division											
Northeast	99.8	48.2	3.9	5.4	6.7	17.1	2.7	4.5	0.9	2.3	8.1
New England	99.8	53.9	3.0	4.5	5.8	16.0	1.9	6.0	0.7	2.0	6.0
Middle Atlantic	99.7	46.3	4.2	5.7	7.0	17.4	3.0	4.0	1.0	2.4	8.7

Energy Information Administration
2003 Commercial Buildings Energy Consumption Survey: Energy End-Use Consumption Tables

Appendix H: Zone Performance

Zone	Area [sqft]	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume [ft^3]	Multipliers	Gross Wall Area [sqft]	Window Glass Area [sqft]	Lighting [W/sqft]	Plug and Process [W/sqft]
ZN_1_FLR_1_SEC_1	3,372.29	Yes	Yes	50,542.01	1.00	3,597.07	1,438.83	0.97	86.83
ZN_1_FLR_2_SEC_1	3,372.29	Yes	Yes	50,542.01	2.00	3,597.07	1,438.83	0.97	86.83
ZN_1_FLR_3_SEC_1	3,372.29	Yes	Yes	50,542.01	1.00	3,597.07	1,438.83	0.97	86.83
ZN_1_FLR_1_SEC_2	1,094.08	Yes	Yes	16,397.77	1.00	1,318.85	553.92	0.97	86.83
ZN_1_FLR_2_SEC_2	1,094.08	Yes	Yes	16,397.77	2.00	1,318.85	553.92	0.97	86.83
ZN_1_FLR_3_SEC_2	1,094.08	Yes	Yes	16,397.77	1.00	1,318.85	553.92	0.97	86.83
ZN_1_FLR_1_SEC_3	3,372.29	Yes	Yes	50,542.01	1.00	3,597.07	1,438.83	0.97	86.83
ZN_1_FLR_2_SEC_3	3,372.29	Yes	Yes	50,542.01	2.00	3,597.07	1,438.83	0.97	86.83
ZN_1_FLR_3_SEC_3	3,372.29	Yes	Yes	50,542.01	1.00	3,597.07	1,438.83	0.97	86.83
ZN_1_FLR_1_SEC_4	1,094.08	Yes	Yes	16,397.77	1.00	1,318.85	553.92	0.97	86.83
ZN_1_FLR_2_SEC_4	1,094.08	Yes	Yes	16,397.77	2.00	1,318.85	553.92	0.97	86.83
ZN_1_FLR_3_SEC_4	1,094.08	Yes	Yes	16,397.77	1.00	1,318.85	553.92	0.97	86.83
ZN_1_FLR_1_SEC_5	12,177.09	Yes	Yes	182,501.93	1.00	0.00	0.00	0.97	86.83
ZN_1_FLR_2_SEC_5	12,177.09	Yes	Yes	182,501.93	2.00	0.00	0.00	0.97	86.83
ZN_1_FLR_3_SEC_5	12,177.09	Yes	Yes	182,501.93	1.00	0.00	0.00	0.97	86.83
Total	84,439.42			1,265,525.24		39,326.72	15,941.69	0.97	86.83
Conditioned Total	84,439.42			1,265,525.24		39,326.72	15,941.69	0.97	86.83

Appendix I: Peak Demand

	ELECTRICITY:FACILITY [J]	ELECTRICITY:FACILITY {Maximum}[W]	ELECTRICITY:FACILITY {TIMESTAMP}
Jan	284903000000	686,227	02-JAN-05:30
Feb	217918000000	699,072	21-FEB-05:15
Mar	156965000000	542,196	08-MAR-05:15
Apr	110292000000	378,949	03-APR-04:30
May	121201000000	110,980	15-MAY-14:00
Jun	146013000000	192,805	26-JUN-05:30
Jul	160281000000	189,567	10-JUL-05:15
Aug	158040000000	179,658	14-AUG-05:15
Sep	127016000000	129,095	11-SEP-13:30
Oct	115972000000	458,471	30-OCT-04:30
Nov	147144000000	593,011	20-NOV-05:30
Dec	232135000000	629,810	11-DEC-05:30

	HEATING:ELECTRICITY {AT MAX/MIN} [W]	COOLING:ELECTRICITY {AT MAX/MIN [W]
Jan	660004.118	0
Feb	672848.858	0
Mar	515973.029	0
Apr	352725.58	0
May	0	53616.501
Jun	0	167428.871
Jul	0	164178.171
Aug	0	153463.574
Sep	0	71731.427
Oct	432248.375	0
Nov	566788.334	0
Dec	603586.801	0

Appendix J: Emissions

	CO2:FACILITY [kg]	NOX:FACILITY [kg]	SO2:FACILITY [kg]	HG:FACILITY [kg]	WATER ENVIRONMENTAL FACTORS:FACILITY [L]	CARBON EQUIVALENT:FACILITY [kg]
Jan	53,106	104.4738	318.8062	0.001	158716.1477	15185.9112
Feb	40,620	79.9105	243.8503	0.0007	121399.71	11615.4861
Mar	29,258	57.5589	175.6434	0.0005	87443.2655	8366.5442
April	20,558	40.444	123.4166	0.0004	61442.3998	5878.7895
May	22,592	44.4444	135.6239	0.0004	67519.7226	6460.2659
Jun	27,217	53.5429	163.3885	0.0005	81342.1868	7782.7949
Jul	29,876	58.7752	179.355	0.0005	89291.0361	8543.3383
Aug	29,459	57.9533	176.847	0.0005	88042.4485	8423.8738
Sep	23,676	46.5768	142.1309	0.0004	70759.2128	6770.2193
Oct	21,617	42.527	129.7729	0.0004	64606.829	6181.5611
Nov	27,428	53.9577	164.6542	0.0005	81972.3291	7843.0867
Dec	43,270	85.124	259.7594	0.0008	129319.9849	12373.2956

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