Technical Report III

201 Rouse Boulevard

The Navy Yard

Philadelphia, PA 19112

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Executive Summary

Technical Report III provides an analysis of the existing conditions of the heating, ventilation, and air conditioning system to be installed at 201 Rouse Boulevard. Part of this analysis entails an understanding of the design objectives, criteria, and influences that went into building the mechanical systems and the building as a whole. Additionally the mechanical system's performance, cost, space, and contribution to a LEED accreditationwill be weighed in a final determination of the system's merits within the larger building scope.

201 Rouse is a 84,000 square foot office building being constructed in Philadelphia, PA. Comprised of class A office space, and a glass heavy facade, the designers had to build a mechanical system that helped achieve a LEED Gold rating and meet strict indoor conditions.

With every square foot of space taken up by building service systems being another square foot unable to be rented, maximizing the mechanical system's performance per for was critical. Yet sacrifices could not be made to the comfort of the occupants, so the system still had to be able to meet all of the load conditions the occupants and the weather could create.

The mechanical system achieved a usable space footprint of 1, 177 ft^2 while exceeding the ventilation requirements by providing 16,000 SCFMs of outside air and both the heating and cooling elements provided a greater capacity than the peak simulated load of 2,905 kBTU/hr and 1,921 kBTU/hr respectively.

Comprised of three rooftop packaged units, variable air volume terminals, and terminal fan units; the whole mechanical system is controlled by a BACnet based building automation system that runs in four primary modes: warm up, cool down, occupied and unoccupied.

Overall the system cost $46 per square foot and consumed 31.6 kBTU per square foot for an average monthly utility cost of $10,000; all of which are below baseline comparisons giving this mechanical system a good price per performance factor.

Many of the space and energy saving techniques and equipment used in 201 Rouse were to achieve the desired LEED accreditation, and the system yielded 24 points toward the designer's target of 60 for the whole project.

As with any project the system is a work in progress and there are significant changes that could create a more efficient, cheaper, or more sustainable system.

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 Space, Cafe, Fitness Center

Size:

84,500 square feet

Construction:

September 2013 to 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 four 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 an economizer system balancing the return air and outside air based upon outside air (OA) requirements and relative humidity. The third rooftop unit is a smaller 1,600 SCFM packaged unit that conditions 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 layout of the office spaces has yet to be finalized.

Ventilation

Building ventilation is handled by providing over 16,000 SCFMs of outside air during occupied times. Additional exhaust is handled by two rooftop exhaust fans, with additional localized 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) respectively. The smaller (~400 SCFM) transfer fans handle the ventilation from the electric closets and machine rooms and are 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 riser shaft as the return system and is integrated in the AHUs with air side economizers.

Controls

201 Rouse Boulevard has a web accessed native BACnet 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.

Design Influences

Speculative Office Building

The initial planning for 201 Rouse was as a speculative office building, and although Liberty Property Trust (the owner) has extensive experience in property development and has history with the design team, the initial design objectives had to be based around generalized predictions of future occupants. While building a speculative building does give you a blank slate for design of building systems, there are many considerations that have to be made so that any future tenants can be accommodated. As such the mechanical system had to be size to handle the maximum office occupancy of one person per 100 sq. ft., had to provide more than the minimum ventilation as required by ASHRAE 62.1, and have additional vertical risers for expansion of the HVAC system (and was utilized with the additional exhaust for the kitchen).

LEED Accreditation

The only other initial design influence was the owner championed goal to achieve Gold Level of LEED Certification. As as holistic rating system based upon energy efficiency and sustainability; the efficiency measures and equipment requirements of LEED drove many of the future decisions. For more on the LEED accreditation and a scoring of 201 Rouse's Mechanical System see the "LEED Analysis" section on page 25.

Additional

One of the largest influences on the design of 201 Rouse's mechanical system was the architectural decision to have approximately 44% of the building's facade be windows. Not only is this percentage over the 40% recommended in ASHRAE 90.1 it significantly increased both solar load and the heat transfer of the building envelope. This architectural decision required an increase in the mechanical system's capacity and multiple design changes in windows selection.

Design Conditions

Weather

Design Outdoor Conditions:

- Summer: 90.6 ^{oF} Dry Bulb and 74.3^{oF} Wet Bulb
- Winter:16.9^{oF}

Desired Indoor Conditions:

- 75^{oF} for cooling and 70^{oF} for heating and 54% Relative Humidity (RH)

Occupancy

Room Number	Name	Area (sq. ft.)	Function	Floor Area per Occupant	Design Occupancy
101	Lobby	1,300	Lobby	100 sq. ft.	13 people
116	Tennant	3,700	Office Space	100 sq. ft.	37 people
115	Tenant	9,700	Office Space	100 sq. ft.	97 people
201	Tenant	18,900	Office Space	100 sq. ft.	189 people
300	Tenant	18,900	Office Space	100 sq. ft.	189 people
401	Tenant	18,900	Office Space	100 sq. ft.	189 people

Table 1: 201 Rouse Occupancy

Schedules

201 Rouse is a standard corporate office building, as such its weekday schedules are based around regular business hours. See Figures 1 through 4 for 201 Rouse's weekday occupancy, lighting, equipment, and HVAC schedules. On weekends the building will face a heavily reduced occupancy (and corresponding loads) on Saturday, and on Sunday the building is assumed to be unoccupied and the HVAC and lights go into an unoccupied mode (for more information on the mechanical system's unoccupied mode see page 26).

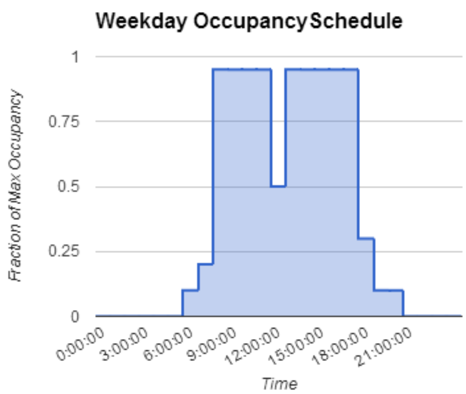


Figure 1:Weekday Occupancy Schedule

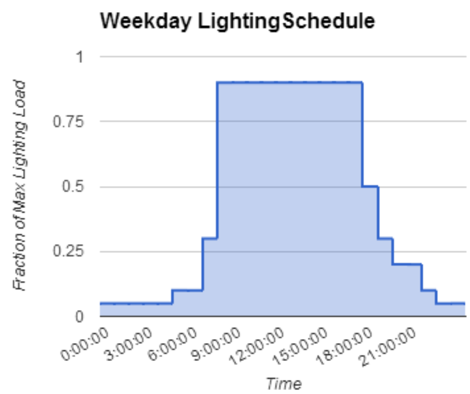


Figure 2: Weekday Lighting Schedule

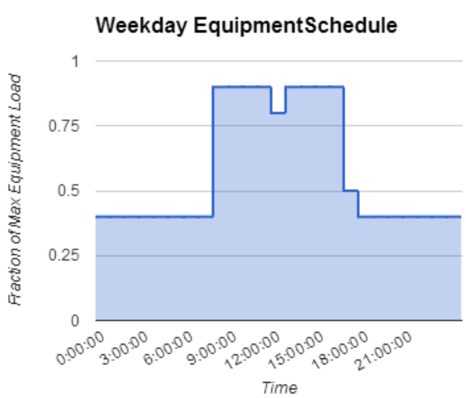


Figure 3: Weekday Equipment Schedule

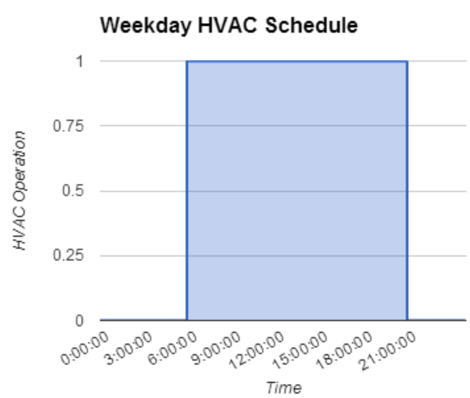


Figure 4: Weekday HVAC Schedule

Materials

Roof:

The roof of 201 Rouse is standard gravel on asphalt with five inches of rigid insulation on metal deck.

Floors:

The 3 above ground floors of 201 Rouse utilizes a five inch normal weight slab on metal deck floor construction.

Facade:

201 Rouse's facade is a zinc clad steel frame with rigid insulation. The facade has man fenestrations on each side, with the south oriented side have inset windows, while the east and west sides have vertical fins; both of which act as sun shading devices.

Loads & Ventilation

The primary purposes of a building's mechanical equipment are to meet the thermal loads of the building and maintain indoor air quality.

Loads

201 Rouse's spaces will house 60,000+ sqft of office space, reception area, and has the potential to hold a fitness center and cafe. With those facilities and use in mind the primary loads will come from equipment, HVAC machinery, lights, and people. Table 2 below lists the equipment loads in 201 Rouse.

Equipment Loads	
Electrical Plug Density	0.75W/ft^2
Lighting Intensity	1.0 W/ft^2
Equipment Density	0.229 W/ft^2
HVAC	0.709 W/ft^2

Table 2: Equipment Loads

Table 3 below lists the peak simulated load (using Energy+) for the heating and cooling elements. For more information on these and other simulated building results see Technical Report 2. The design capacity of the system to be installed at 201 Rouse adequately cover the peak simulated load (simulation shows only ~30 hrs of unmet conditions) and has room changes in the building function that might require a higher heating or cooling capacity.

	Peak Simulated Load (1000 Btu/hr)	Designed Capacity (1000 Btu/hr)
Heating	2,905	1,562.5 at Packaged Unit + 10-42 at each VAV box
Cooling	1,921 (sensible), 2,642 (total)	2,222.4 (sensible), 3,051.6 (total)

Table 3: Heating and Cooling Loads

Ventilation Requirements

Integral for a well functioning building is the ability to have a high level of indoor air quality. With that in mind, ASHRAE Standard 62.1 creates a minimum volume of outside air based upon a space's size and its occupation density. Table 4 below details the ventilation requirements for all the spaces in 201 Rouse and that the current mechanical system provides more than the minimum requirements of outside air with the ASHRAE standard. For more information on compliance with ASHRAE Standard 62.1 and the ventilation capabilities of 201 Rouse see Technical Report 1.

Room Number	Room Name	Function	Size (sqft)	Min outside air flow (CFM)	Min Provided Outside Air (CFM)	Meets ASHRAE 62.1 Requirement
101	Lobby	Lobby	1,300	71	184	Y
116	Tennant	Office Space	3,700	192	1,519	Y
115	Tenant	Office Space	9,700	492	1,519	Y
201	Tenant	Office Space	18,900	957	4,123	Y
300	Tenant	Office Space	18,900	963	4,123	Y
401	Tenant	Office Space	18,900	969	4,386	Y

Table 4: Ventilation Requirements

Space

In today's day and age, a building's mechanical system is a critical component; it is what makes a building uninhabitable. However all this equipment tends to take up valuable occupiable floor space. With a well thought out design and the use of the unoccupied roof for the majority of equipment, the mechanical footprint in 201 Rouse is relatively small; see Table 5 and Figure 5 and 6 for breakdowns of Mechanical Spaces and its impact use of occupiable area. Figure 7 highlights these areas on the floor plans.

Total Usable Space Lost	1,177	sqft
Total Building Space	84,730	sqft
% Lost	1.39	%

Table 5: Occupiable Building Space Lost

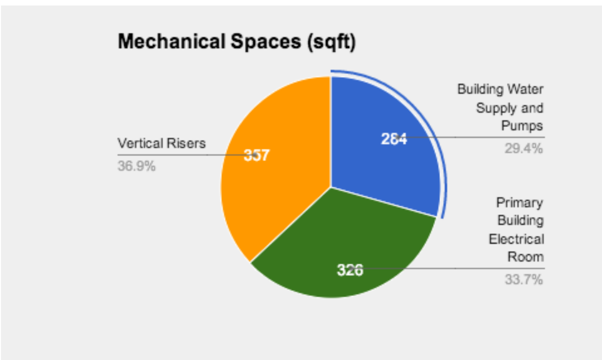


Figure 5: Mechanical Spaces

Figure 6: Occupiable Building Space Lost

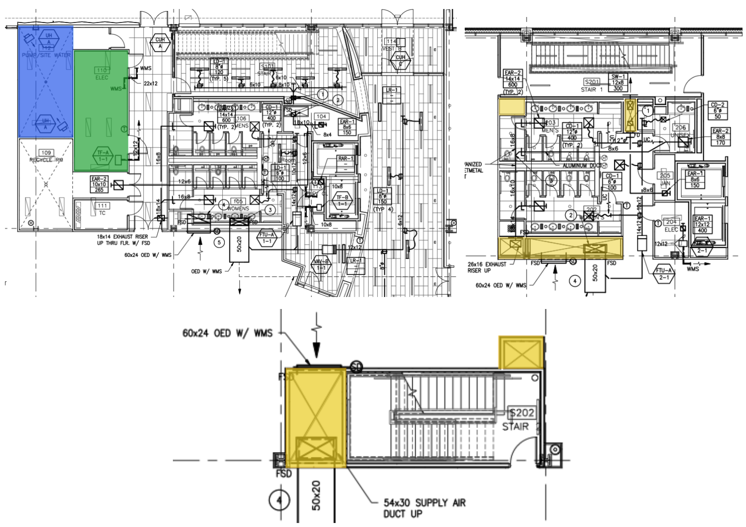


Figure 7: Highlighted Floor Plans Showing Mechanical Spaces

Equipment and Schematics

Packaged Units

201 Rouse has three rooftop packaged HVAC units that handle the conditioning and airflow for the building. Pictured to the right in the McQuay RPS130D, one of the two different specified units for 201 Rouse. Table 6 details the main components of the two different types of rooftop units specified.

Packaged Unit	Airflow (Max/Min) [SCFM]	Cooling Capacity (MBH)	Heating Capacity (MBH)	Unit Specified
1 & 2	33,600/8,230	1501.5	748.5	McQuay RPS130D
3	1,600/165	48.6	65.5	McQuay MHSH04B

Table 6 : Packaged Unit Specifications

Electric Unit Heaters

Tag	KW	Total Amperage	Volt/Phase
CUH-A	3	10.8	277/1
CUH-B	4	14.4	277/1
CUH-C	5	18.2	277/1
US-A	5	6	460/3

Table 7: Electric Unit Heaters

Fans

Service	Type	Airflow (SCFM)	Static Pressure (wc)	Motor Size
Toilet Exhaust	Power Exhaust	5,310	1.5	3 HP
Janitor's Closet	Power Exhaust	865	1.5	0.5 HP
Electric Closets	Inline	400	0.25	217 W
Elevator Machine Room	Inline	300	0.25	135 W

Table 8 : Fan Schedule

Variable Air Volume Terminals

Unit	Inlet Dia. (in)	Primary Air (Max/Min) (CFM)	Electric Reheat Coil Capacity (BTU/hr)	Electric Reheat Coil KW
A	6	420/210	10239	3
B	8	800/400	20478	6
C	10	1400/700	34310	10
D	12	1800/900	42663	12.5

Table 9 : Variable Air Volume Boxes

Fan Terminals

Tag	Type	Inlet Dia. (in)	Primary Air Valve		Fan	Electric Reheat	Coil
			Max Flow (CFM)	Min Flow (CFM)	Motor Size	Capacity (1000 BTU/hr)	KW
A	Series	8	1,000	400	0.5 HP	-	-
B	Series	8	1,000	400	0.5 HP	30.7	9

Table 10: Fan Terminals

Grills, Diffusers, & Registers

Tag	Service	Type	Max Normally Closed	Face Size (in) or Slot WIdth
CD-1	Supply	Square Plaque	30	24x24
CD02	Supply	Square Plaque	30	12x12
LD-1	Supply	Linear Slot	30	1 1" Slot
SW-1	Supply	35 Deg Fixed Louver	30	-
RAR-1	Return	35 Deg Fixed Louver	30	-
LR-1	Return	Linear Slot	30	1 1" Slot
ER-1	Exhaust	35 Deg Fixed Louver	30	12x12
ER-2	Exhaust	35 Deg Fixed Louver	30	24x24

Table 10: Grills, Diffusers, and Registers

Pumps

Pump	GPM	Pressure (psi)	Motor Size	Amps
Building Water Supply	130	40	(2) 3 HP	11

Table 11: Domestic Water Pump

Schematics

Figure 8 below depicts the a rooftop packaged air handling unit, typical of the three that are used at 201 Rosue.

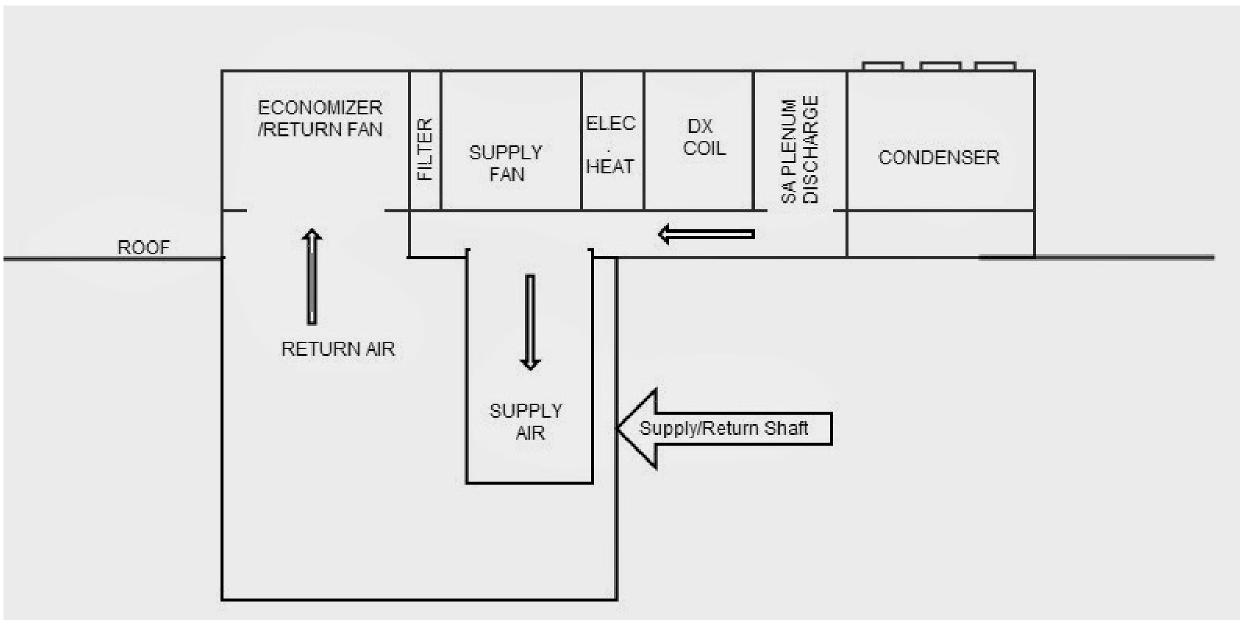


Figure 8: Diagram of Rooftop Air Handling Unit

The following flow diagram, Figure 9, depicts the airflow of the mechanical system of 201 Rouse; while Figure 10 depicts a typical exhaust system that is implemented twice in 201 Rouse.

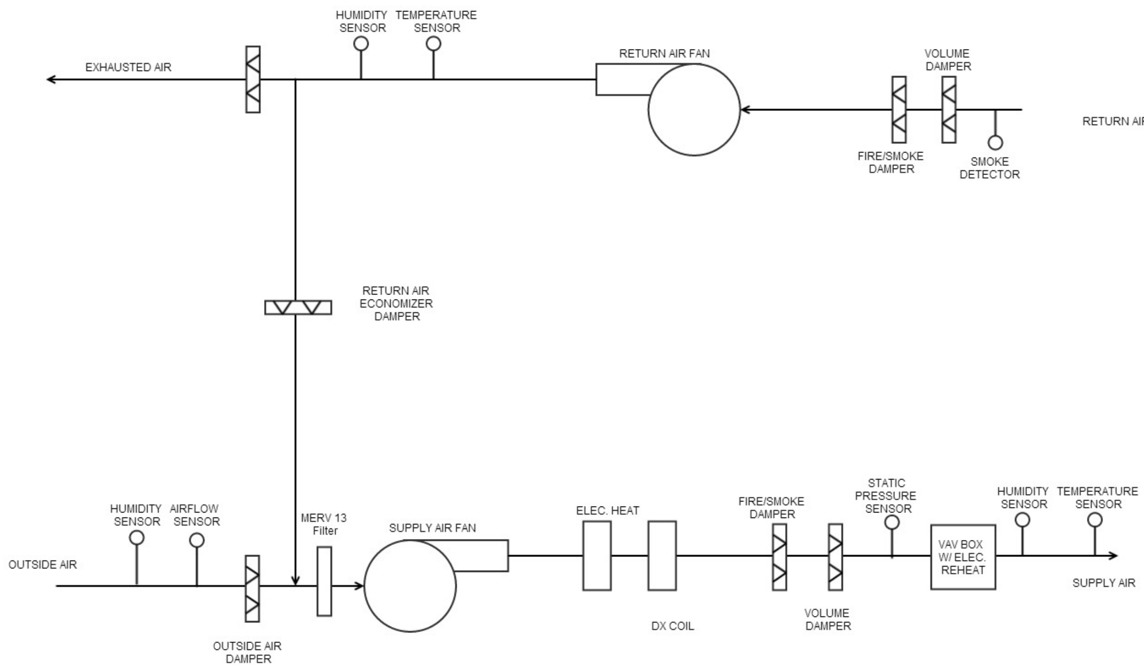


Figure 9: Airflow Diagram of Mechanical System

Figure 10: Exhaust System

System Operation

HVAC

201 Rouse's space conditioning and ventilation are handled by three rooftop packaged air handling units that contain the return fan, filter, supply fan, electric heating coils, D/X cooling coils, and the condenser. See Figure 8 on page 15 for a schematic of a typical rooftop packaged unit from 201 Rouse. These packaged units are integral to the whole HVAC system for 201 Rouse.

Return air is collected from the building spaces and pulled into one of two vertical risers in the two core structures of the building. This air travels through both a fire and smoke/fire damper and up to the roof. Once at the roof the air will either be mixed with fresh outside air, or exhausted into the atmosphere (for more on this see the following Control section). Pulled through a MERV 13 filter by the supply fan, the air then passes through the heating and D/X cooling coils (see the Control section for when these are active). Once the air is properly conditioned it discharges the AHU into the supply ducts, where from it passes through another set of volume and smoke/fire damper and is monitored by a static pressure gauge. Once delivered to each zone, the air is then reheated (if necessary) by variable air volume boxes that have reheat capabilities and diffused into the occupiable spaces.

Certain spaces in 201 Rouse (stairs, kitchen, bathrooms, mechanical rooms) have additional exhaust capabilities, which are handled by two rooftop exhaust fans, Figure 10 in the previous section is a schematic representation of the typical exhaust system used in 201 Rouse.

Control

201 Rouse implements a BACnet based web accessible building automation system (BAS) that monitors the implemented sensors and executes the control programming. 201 Rouse's mechanical system operates in any one of four different modes based upon occupancy and the programed time schedule: morning cool-down, morning warm-up, occupied, and unoccupied.

During morning warm-up the outside air damper closes and the heating coils and ahu are energized. All of the flow terminals (FTU) and Variable air volume (VAV) boxes are to open all the way and then begin to close themselves off once their zones reach the desired occupied setpoints. The BAS estimates the time of morning warm-up based upon occupancy times, the desired occupied setpoint and the current outdoor conditions.

During morning cool-down the rooftop packaged unit will energize and maintain max cooling until the space temperature sensors readings matching the occupied setpoint. During this time the outside air damper will be closed unless the outside air enthalpy is less than that of the return air enthalpy, the BAS is able to do this using the temperature and humidity sensors installed in the return air duct and outside the packaged units (these can be seen in Figure 9, the system flow diagram).

During the occupied mode the BAS monitors temperature, humidity and static pressure and modulates the HVAC system. The BAS has access to each of the zone's temperature sensors (which control VAVs and FTUs) and uses them to determine its temperature control. If some of the sensors are reading above or below the occupied setpoint then the system will modulate 1^{oF} hotter or cooler until one of the terminals is fully open and starts calling for cooling/heating respectively. During cooling scenarios the system utilizes the air based economizer (as seen in Figure 9) when the return air enthalpy (monitored by the temperature and humidity sensors) is greater than the enthalpy of the outside air the outside air damper will open greater than its minimum occupied setting and the return air damper will close and the mechanical cooling system will shut off till the setpoints are no longer maintained. During all these processes the outside air is kept above its set minimum value (see Ventilation) using the mounted flow monitoring station. The variable fan drives of the AHUs (see Packaged Units and Figure 9) are controlled by the BAS which utilizes the downstream static pressure sensors shown in Figure 9 to maintain the system air balance.

During the unoccupied mode the BAS will keep the outside air damper closed and the air handling unit shall cycle to maintain the unoccupied temperature setpoint as monitored by the zone's temperature sensors.

Variable air volume terminals in 201 Rouse have electric reheat capabilities (see Variable Air Volume Terminals for more technical information on these). These VAVs will be controlled by wall mounted temperature sensors in each zone and will modulate open to meet the design conditions and will energize the electric reheat in stages when the zone temperature is more than 2^{oF} less than the setpoint.

Energy

Consumption

201 Rouse is an all electric building, the primary reasons for this are the availability of cheap energy in the Philadelphia region, the use of electricity from renewable resources yield the building points towards its LEED Certification (see Energy and Atmosphere), and with the Navy Yard being on a independent micro grid there is the future possibility of locally generated green power sources. Table 12 below shows the buildings total Site and Source energy use while Table 13 and Figure 11 display breakdown of the building's energy use by category.

	Total Energy [kBTU]	Energy Per Total Building Area [kBTU/sqft]
Total Site Energy	2,668,664.40	31.60
Net Site Energy	2,668,664.40	31.60
Total Source Energy	8,755,877.69	103.69
Net Source Energy	8,755,877.69	103.69

Table 12: Total Site and Source Energy

Category	Electricity [kBTU]
Heating	382,473
Cooling	572,681
Interior Lighting	541,801
Exterior Lighting	11,781
Interior Equipment	957,400
Exterior Equipment	0
Fans	202,530
Total	**2,668,664.40**

Table 13: Building Energy Consumption

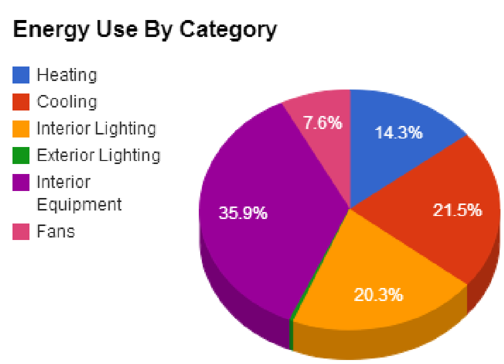


Figure 11: Building Energy Use by Category

Benchmark

To benchmark 201 Rouse the Department of Energy's Commercial Prototype Building Models were used. These models are based upon commercial building survey data in the United States and are built according to ASHRAE Standard 90.1-2010 and simulated in Energy+ (the same simulation software used to analyze 201 Rosue). To compare against 201 Rouse the medium office building in Baltimore, MD was used based on the criteria of similar size (53,000 ft^2) and in the same ASHRAE Climate Zone (4A). The results are normalized to be by square foot to adjust for differences in building size. As Table 14 shows, 201 Rouse currently outperforms the baseline energy model, though this could be subject to change once additional loads are put upon the system by the tenants.

	Energy Use- 201 Rouse [kBTU/sqft]	**Energy Use - Baseline [kBTU/sqft]**
Total Site Energy	**31.60**	**36.55**
Net Site Energy	**31.60**	**36.55**
Total Source Energy	**103.69**	**101.93**
Net Source Energy	**103.69**	**101.93**

Table 14: Total Energy Baseline

For a more indepth look into 201 Rouse's energy consumption and its comparison to industry standards read Technical Report 2.

Costs

Initial

201 Rouse has an initial project cost of ~$21 Million dollars for the 84,500 ft^2 four story office space building in a corporate office complex at the Philadelphia Navy Yard. Table 15 below details the total and per square foot costs of both the whole building and the mechanical system. The costs of the mechanical system components is roughly 19% of the total building's costs. This percentage may lower as the interior spaces are designed and constructed, which will raise the total project cost.

	Total Cost	Cost per ft^2
Building	$21,064,000	$249
Mechanical System	$4,027,769	$48

Table 15: Initial Costs

Monthly

201 Rouse has general electric service from PECO Energy Company. Table 16 below details the simulated total and max monthly cost for electricity from PECO for operating 201 Rouse Boulevard. Figure 12 provides a further breakdown of service costs by month; in this it is evident that january is the most energy intensive month and October the most efficient.

	Yearly Total	Monthly Max
Energy Charges ($)	**111673.14**	**15257.39**
Demand Charges ($)	**0**	**0**
Service Charges ($)	**105.72**	**8.81**
Basis ($)	**111778.86**	**15266.2**
Adjustment ($)	**0**	**0**
Surcharge ($)	**0**	**0**
Subtotal ($)	**111778.86**	**15266.2**
Taxes ($)	**8942.31**	**1221.3**
Total ($)	**120721.17**	**16487.5**

Table 16: Energy Cost, Sum and Max

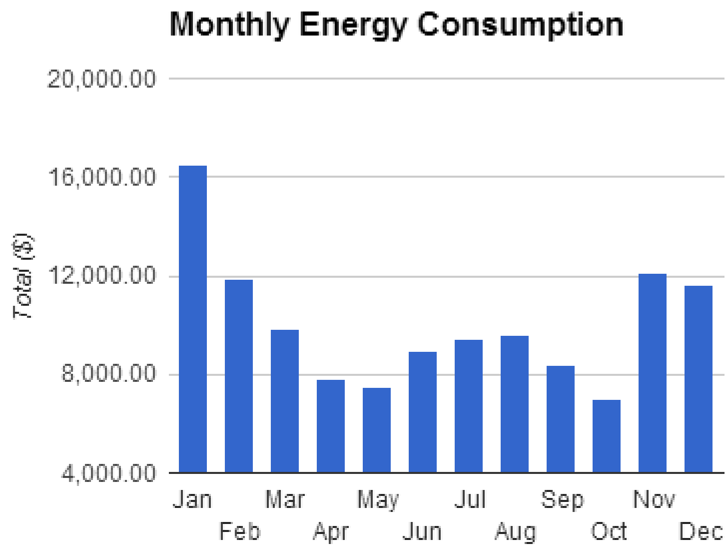


Figure 12: Monthly Electricity Cost

LEED Analysis

Since 1998 the US Green Building Council (a nonprofit that promotes sustainability in building design, construction and operation) has released the Leadership in Energy & Environmental Design (LEED) suite of ratings systems. These ratings provide a standard upon which to build "green" buildings and achieve a recognized level of accreditation.

The LEED ratings for new construction are based around seven categories: sites, water efficiency, energy and atmosphere, materials and resources, indoor air quality, innovation in design, and regional priorities.

Following the guidelines set out by LEED can yield substantial energy savings and minimize environmental impact. If that wasn't incentive enough, LEED rated sustainable properties produce a higher demand and lead toward comparably higher rents. WIth these factors in mind the team from Liberty Property Trust set the design team in motion to achieve Gold level certification for 201 Rouse. On the project team Re:Vision Architecture is the leader of the sustainability team in charge of achieving the LEED certification. With LEED Gold Certification entailing getting at least 60 of the 110 LEED checklist points broad integration between the teams was paramount.

To achieve the Gold level of certification, sustainability features would have to be utilized in many building systems along with its overall construction. With respect to 201 Rouse's mechanical system, the LEED categories of Energy and Atmosphere and Indoor Environmental Quality are most pertinent. To analyze the systems of 201 Rouse the 2009 LEED Standard for New Construction and Major Renovations were used.

Energy and Atmosphere

Credit	Description	Intent	Execution	Points
Prerequisite 1	Fundamental Commissioning of Building Energy Systems	To verify the project's energy-related systems are installed and calibrated to perform according to the Owner's project requirements, basis of design and construction documents.	The owner will document and monitor the Project Requirements while Bala Engineers will do the commissioning based off the Construction Documents	Required
Prerequisite 2	Minimum Energy Performance	Establish the min. level of energy efficiency for the building and systems.	Initial designs were based on AHSRAE Standard 90.1-2010 (see Tech. Report 1) and Energy models were performed during various phases of design by In-Posse to check compliance.	Required
Prerequisite 3	Fundamental Refrigerant Management	To reduce stratospheric ozone depletion by controlling CFCs.	The HVAC systems of 201 Rouse use R-410A, a CFC free refrigerant.	Required
Credit 1	Optimize Energy Performance	To increase the levels of energy efficiency beyond those of the latest baseline performance standards.	Using the Whole Building Energy Simulation option, the In-Posse model predicts more than 16% energy savings than the the baseline.	3 of 19
Credit 2	On-Site Renewable Energy	To promote the utilization of on-site renewable energy generation.	N/A	0 of 7
Credit 3	Enhanced Commissioning	To begin commissioning process early in design and execute additional activities post verification.	The integrated project team began commissioning and modeling from early stages in design.	2 of 2
Credit 4	Enhanced Refrigerant Management	Reduce Ozone depletion due to refrigerants	The building uses HVAC equipment that eliminates the emission of refrigerants.	2 of 2
Credit 5	Measurement and Verification	Promote ongoing accountability of building energy consumption over time.	The base building will be metered and monitored and fed back to check and calibrate the energy model.	3 of 3
Credit 6	Green Power	Encourage development and use of green power sources	201 Rouse has a contract to provide at least 35% of its baseline usages from green power sources.	2 of 2

Table 17 :Leed Energy & Atmosphere

Indoor Air Quality

Credit	Description	Intent	Execution	Points
Prerequisite 1	Minimum Indoor Air Quality Performance	Establish min. indoor air quality performance	201 Rouse meets the ventilation requirements of AHSRAE Standard 62.1-2010 (see Tech.Report 1)	Required
Prerequisite 2	Environmental Tobacco Smoke Control	Prevent/Minimize occupant exposure to tobacco smoke.	Smoking is prohibited in 201 Rouse	Required
Credit 1	Outdoor Air Delivery Monitoring	Provide ventilation system monitoring for occupant comfort	201 Rouse has a outdoor air monitoring station that controls OA flow and monitors CO2 concentrations.	1 of 1
Credit 2	Increased Ventilation	Provide OA ventilation beyond the minimum requirements	201 Rouse has a HVAC system with a min. of 24% outdoor air, more than 30% greater than the ASHRAE 62.1 standard (see Tech Report 1)	1 of 1
Credit 3.1	Construction Indoor Air Quality Management Plan- During Construction	Reduce Indoor Air Quality (IAQ) due to construction.	Met IAQ guidelines from SMACNA	1 of 1
Credit 3.2	Construction Indoor Air Quality Management Plan- Before Occupancy	Reduce Indoor Air Quality (IAQ) due to construction.	There will be a flush-out once construction ends.	1 of 1
Credit 4.1	Low-Emitting Materials - Adhesives and Sealants	Reduce Indoor Air Contaminants.	All adhesives were selected based on LEED Action Plan and VOC Limits	1 of 1
Credit 4.2	Low-Emitting Materials - Paints and Coatings	Reduce Indoor Air Contaminants.	All paints were selected based on LEED Action Plan and VOC Limits	1 of 1
Credit 4.3	Low-Emitting Materials - Flooring Systems	Reduce Indoor Air Contaminants.	All flooring systems were selected based on LEED Action Plan and VOC Limits	1 of 1
Credit 4.4	Low-Emitting Materials - Composite Wood and Agrifiber Products	Reduce Indoor Air Contaminants.	All wood products were selected based on LEED Action Plan and VOC Limits	1 of 1
Credit 5	Indoor Chemical and Pollutant Source Control	Minimize occupant exposure to hazardous particulates and chemical pollutants	Building entrances trap incoming particles, and there is ample exhaust and ventilation to deal with IAQ	1 of 1
Credit 6.1	Controllability of Systems - Lighting	Provide high level of lighting system control	Each floor and the exterior has independent daylighting sensors	1 of 1
Credit 6.2	Controllability of Systems - Thermal Comfort	Provide subzone control of HVAC systems	N/A	0 of 1
Credit 7.1	Thermal Comfort - Design	Provide a comfortable thermal environment	The HVAC system is compliant with ASHRAE 55	1 of 1
Credit 7.2	Thermal Comfort - Certification	Assessment of building occupant thermal comfort over time	N/A	0 of 1
Credit 8.1	Daylight and Views - Daylight	Provide occupants connection to outdoors and natural light	N/A	0 of 1
Credit 8.2	Daylight and Views - Views	Provide occupants connection to outdoors and natural light	201 Rouse has large perimeter windows on all faces and floors	1 of 1

Table 18:Leed Indoor Air Quality

Summary

Even without complicated, expensive and next-generation mechanical equipment, 201 Rouse was able to employ an energy efficient mechanical system that meet the thermal and indoor air quality needs of the occupants. This mechanical system yielded 24 points toward 201 Rouse's LEED certification goal of Gold. The latest tally by the LEED consultants at Re:Vision Architecture have the building's project totals at 54 points, which is a Silver level certification. There are still many points on the table and they are adjusting the design and construction to become a more sustainable building and reach Gold Certification.

System Evaluation

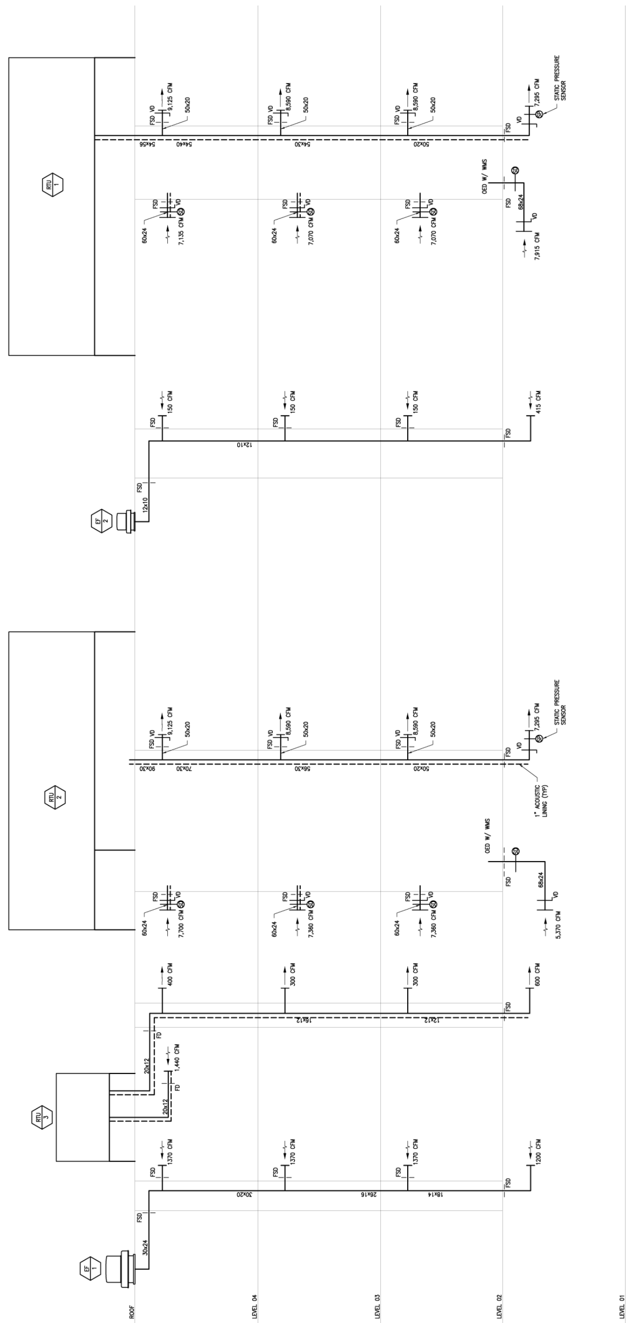
From the onset, designing the mechanical system of 201 Rouse was an exercise in contradictions, being both simple and difficult. Being built as a speculative office building, the design team only had a core of a building to plan on and had to predict and accommodate for a variety of tenants. Additionally the owner wanted to pursue Gold level LEED certification.

With all these requirements in mind the system as currently designed is passable. With only a cost of $\$45/\text{ft}^2$ initially and a average monthly electric cost of \$10,000 the system met its load criteria, the local and national standards that are required and contributed significantly to its pending LEED accreditation.

However there are a few issues that could be addressed to lower initial and monthly cost. Firstly the minimum outdoor air intake is an order of magnitude higher than is required (9% vs 24%), creating a system that is closer to the ASHRAE 62.1 Standard will lower energy and equipment cost. Additionally the Cooling capacity of the condenser and D/X coil was oversized based the simulated building usage and is another avenue to consider in downsizing. Lastly there are more LEED points on the table that a more efficient and tightly designed mechanical system could obtain to help achieve the Gold level accreditation.

Appendix

Appendix A:Mechanical Air Riser Diagram



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