XXXX COLLEGE NEW RESIDENCE HALL
Yyyyy, MA

Small Building Program
Energy Savings Analysis

Final Report
March 20, 2017

PREPARED FOR

Eversource Electric
National Grid Gas

PREPARED BY

ABC, Inc.
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EXECUTIVE SUMMARY

Background

The XXXX College in Yyyyy, MA is constructing a new 45,000 sf Residence Hall. The New Residence Hall project is participating in the utilities incentive program under *Small Building* approach which is offer to new construction or major renovation projects with building floor area between 20,000 and 100,000 sf.

Eversource and NGrid retained ABC, Inc. (ABC) to perform the Technical Assistance (TA) study for this project in accordance with the incentive program requirements. This includes participation in the design charrette in an early design phase, review of design documents at mid design phase[1], and conducting an energy savings analysis based on the final design (100% CDs). This is a final report that presents the final energy savings based on the most recent set of design documents and project information that was made available to us as described in the Analysis section below.

Analysis

To assess potential energy savings for this project two eQUEST energy consumption simulation models were created, one representing the *as designed* building and the other representing a comparable *baseline* building. The *as designed* model was constructed using information obtained from the 100% CD set dated March 31, 2017. Information on the design is included in the *Facility Description* section starting on page __ of this report. The *baseline* building elements (building shell construction, mechanical systems performance, lighting system performance, etc) were selected according to ASHRAE Standard 90.1-2013 with applicable MA Energy Code addenda and the utilities *Baseline Document*. A more detailed description of the methodology can be found in the *Analysis Methodology and Baseline Design Description* section on page __. Please note that the modeling procedure used for this analysis is different (at the utilities request) from the standard TA utility analysis methodology where each measure is analyzed individually.

Results

The *as designed* building achieves **30.8%** energy cost savings and **38.9%** site energy savings over a comparable *baseline* building. The electric energy savings amount to **132,806 kWh/year** ($22,230) and natural gas savings amount to **15,775 therms/year** ($20,813). Table 1a on the following page summarizes the results of this study. Additionally, table 1b provides information on electric energy and demand savings in periods required for a custom incentive application. Table 1c lists any other significant cost savings or increases for the owner that may result from the measure implementation. Table 2 provides energy savings information by end use.

Main energy efficiency features (energy conservation measures) that contribute to the reported overall energy savings are listed in the *Energy Efficiency Measures Incorporated Into Building Design* section on page 11. The approximate incremental cost of these measures is estimated at $100,000.

In addition to custom energy conservation measures included in this report the project is expected to apply for prescriptive incentives for the following energy efficiency features:

- LED exterior lighting fixtures
- High efficiency kitchen appliances (electric and natural gas)

[1] The reviewed design documents are typically between 100% Design Development (DD) set and approximately 60% Construction Documents (CDs).

Table 1a – Overall Energy Savings Summary

	Electric		Natural Gas		Site Energy	Source Energy	Total Cost
	kWh	$	Therms	$	kBtu	kBtu	$
Baseline Energy Consumption	635,949	$98,836	30,518	40,851	5,222,274	9,411,290	139,687
Baseline Energy Consumption/Area (Building Area: 45,000 sf)	14.1	2.20	0.68	0.91	116	209	3.10
Combined Run Energy Consumption	503,143	76,606	14,743	20,038	3,191,511	6,505,730	96,644
Combined Run Consumption/Area	11.2	1.70	0.33	0.45	71	145	2.15
Savings	132,806	$ 22,230	15,775	$ 20,813	2,030,763	2,905,560	$ 43,043
Savings (percentage)	20.9%	22.5%	51.7%	50.9%	38.9%	30.9%	30.8%

Table 1b – On Peak and Off Peak Electric Energy Savings and Demand Reduction

	kWh				Total Percent Energy Savings on Peak ***	
	Summer		Winter			
Peak Energy		kWh		kWh		%
Off-Peak Energy		kWh		kWh		
				Total Estimated Annual kWh Savings**		kWh

	kW				
	June	July	August	December	January
Average Peak*					

* **Average Peak kW:**
Example: Assume the demand savings is 10 kW whenever a plant is in operation and the plant shuts down at 6pm, then the average demand reduction in winter is 5 kW (10 kW ÷ 2 hours = 5 kW)

** **Total Estimated Annual kWh Savings:** The sum of all the Summer and Winter Peak and Off-Peak kWh Savings

*** **Total Percent Energy Savings on Peak:** The sum of the Summer and Winter Peak kWh divided by the Total Annual kWh Savings

Table 1c – Non-Electric and Non-Gas Impacts

Non-Electric, Non-Gas Benefits (Impacts)					
Oil (MMBtu)	Propane (MMBtu)	Water (Gallons)	Sewer (Gallons)	Annual O&M / Labor / Materials ($)	Other One-Time ($)

Table 2 – Summary of Energy Consumption Comparison by End Use

End Use	Baseline Design Energy Type	Units of Annual Energy & Peak Demand		Baseline Building Results	As Design	Percent Savings
Area Lights	Electric	Energy Use	kWh	248,396	118,312	52.4 %
Misc Equip	Electric	Energy Use	kWh	209,873	209,873	0.0 %
Space Heating	Electric	Energy Use	kWh	0	1,540	0.0 %
Space Cooling	Electric	Energy Use	kWh	72,713	53,390	26.6 %
Pump & Aux	Electric	Energy Use	kWh	3,781	18,489	-389.0 %
Vent Fans	Electric	Energy Use	kWh	101,186	101,014	0.2 %
HT Pump Supplement	Electric	Energy Use	kWh	0	525	0.0 %
Dom. Hot Water	Gas	Energy Use	Therms	6,600	5,678	14.0 %
Exterior Usage	Electric	Energy Use	kWh	0	0	0.0 %
Space Heating 2	Gas	Energy Use	Therms	23,918	9,065	62.1 %
Total Energy Use (kBtu/year)				5,222,274	3,191,511	38.9 %

Energy Type			Baseline Design	As Design	Percent Savings
Electric	Usage	kWh	635,949	503,143	20.9 %
Electric	Cost	$	$ 98,836	$ 76,606	22.5 %
Gas	Usage	Therms	30,518	14,743	51.7 %
Gas	Cost	$	$ 40,851	$ 20,038	50.9 %
Total Energy Use (kBtu/year)			5,222,274	3,191,511	38.9 %
Total Energy Cost ($)			$ 139,687	$ 96,644	**30.8%**

FACILITY DESCRIPTION

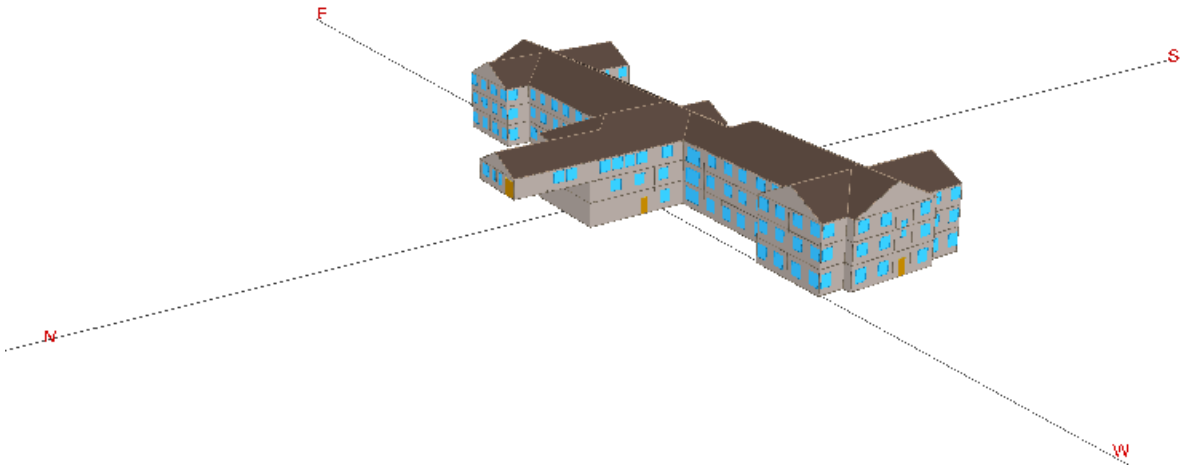

Figure 1: eQuest model of XXXX College New Residence Hall

General

XXXX College's New Residency Hall will be located within the Yyyyy Massachusetts campus. The residence will consist of a 3-story high, 45,000 sf facility housing 168 students. The building occupancy pattern assumed in this analysis is based on information provided by the project architect and is consistent with a higher education dormitory facility. The facility will follow the college's academic schedule and will close during recesses and breaks, all other times the facility will be operated continuously. The following are the anticipated recesses and breaks.

- Thanksgiving break: November 28 through December 1
- Winter break: December 22 through January 19
- Spring Break: March 8 through March 16
- Summer Break: May 13 through June 8
- Yearly Cleaning: August 9 through August 16

Electric service for the building is purchased from XYZ and provided by Eversource. The natural gas is purchased from MNO and provided by National Grid (NGrid).

Architectural

The building is a three story building. The total facility area will be 45,000 sf. The floor plans are repetitious with two "mirrored" wings containing the living quarters of the residents and a central core area which provides community space and other building facilities that differ slightly floor to floor. The central core area houses the mechanical and electrical rooms on the first floor, the residence director's apartment on the second floor and a classroom learning space on the third floor.

The building envelope components of the project are briefly described below.

Wall Constructions:

- Brick veneer wall: brick, air space cavity, 2.5" of rigid insulation (R-12.5 total), liquid applied air and vapor barrier, 8" CMU block wall. Overall U-0.063. This is the predominant wall type.
- Clapboard siding wall: cement board siding, vertical block metal strapping at 16" o.c., 2.5" horizontal "Z" clip @ 24" o.c., 2.5" of rigid insulation (R-12.5 total), liquid applied air and vapor barrier, 8" CMU block wall. Overall U-0.07. This is used only on the 2nd and 3rd floor of West and North west elevation
- Stone veneer wall: real stone veneer set in mortar, 5/8" cement board, 2.5" horizontal "Z" clip @ 24"

o.c., 2.5" of rigid insulation (R-12.5 total), liquid applied air and vapor barrier, 8" CMU block wall. Overall U-0.068. This is used only on the 1st floor of West and North west elevation.

Roof Construction:

The proposed roof constructions, is an asphalt shingle roof over a self-adhering ice/water shield membrane, roof deck, wood trusses and 8" of spray applied closed cell insulation. Overall U-0.031

Windows:

Single hung windows are the predominant window type for the proposed building. The project also contains curtain walls in limited areas. The overall window U-value and SHGC that are used in the proposed model are listed below.

Window Type	Frame Type	Center of Glass U-value (winter)	Overall Assembly U-value	Solar Heat Gain Coefficient (SHGC)	Visible Transmittance (Vt)
Single Hung fixed windows	Peerless GSH3/GDH3 Aluminum framed	0.29; Solarban 60 clear, air space	0.35 (from submittal)	0.36	63%
Curtain wall	Kawneer series 1600 aluminum curtain wall system	0.29; Solarban 60 clear, air space	0.46 (based on Kawneer look up tables)	0.36	63%

Overall, windows will constitute approximately 30% of the total wall area.

Mechanical Systems

According to the mechanical drawings dated June 6, 2017, submittals and information from the mechanical engineer, the proposed building has the following HVAC systems and features:

- A 80-ton high efficiency split system air cooled Trane chiller model# RAUJC80EP, with a full load EER of 11.0 and a part load IEER of 15.4 at rated conditions. The chiller will provide the chilled water to the fan coil units serving the building.
- A boiler plant with two gas-fired condensing boilers. Each boiler (Lochinvar Knight XL, model KBN 601) has input capacity of 600 MBH and full-load thermal efficiency of 94% at 80°F return water temperature. The boiler plant will provide hot water to fan coil units serving the building. Each boiler has a primary pump associated with it (BP-1 and BP-2). Each pump is sized at 38 gpm and 2/5 hp motor.
- The dual temperature building loop will be served by two secondary pumps (one is spare), P-1 and P-2, each sized at 200 gpm, 10 hp and both will have VFDs for pump capacity control. According to the control sequence, the dual loop is expected to operate based on a scheduled change over. More information on the controls and setpoints is listed below.
- Two identical 100% OA constant volume units will provide conditioned makeup air to corridors, showers and bathrooms. Each unit includes an enthalpy wheel for exhaust air energy recovery, Dx cooling (split system with remote air cooled condenser) and gas fired furnace. The energy recovery effectiveness, EER, supply air (SA) flow, and exhaust air (EA) flow of each unit are listed below.

Unit #	Heat recovery eff.*	SA/EA flow, cfm	EER**
ERV-1	67.6%/74.4%	3,300/3,000	11.7
ERV-2	67.6%/74.4%	3,300/3,000	11.7

* at design conditions from submittals based on outdoor air/exhaust air wheel effectiveness
** at ARI conditions (condensing unit only, excluding the heat recovery effectiveness)

- Space heating and cooling for most spaces (including all dorm units) are served by 2-pipe vertical fan coil units (FCU) with chilled water (CHW)/hot water (HW) heating coils. Each unit is provided with electronic commutated (EC) motors for the supply fan. Each unit has a design supply air (SA) flow of 300 or 400 cfm, cooling capacity of 5.9 or 8.7 MBH, and heating capacity of 13.5 or 19.9 MBH. Spaces served by FCUs do not have mechanical ventilation. The only ventilation air included in the model is through infiltration. Please note that opening of windows by the occupants is not explicitly accounted in the analysis presented in this report.
- Two small ductless split units with remote air-cooled condenser serve the elevator machine room 104 and IDF room 202. The units have cooling capacity of 9.0 and 12.0 MBH respectively. The units are Panasonic model number CS-S9NKUA (EER of 12.0) and CS-S12NKUA (EER of 12.0) respectively.
- An air to air heat pump with supplemental electric heat is provided for the classroom on the third floor. It is a Rheem unit model number RHSL-HM3617JA sized for 3 tons. The submittal data provided to us for the unit did not include information on the unit-specific efficiency rating. Therefore in the analysis presented in this report it was assumed that the unit has efficiency ratings that meets the ASHRAE 90.1-2007 Standard with cooling rated efficiency of 13.0 SEER and heating efficiency of 7.7 COP. It was assumed in this analysis that 10 cfm of outside air per occupant (32 occupants total) will be provided by the unit to the space.
- Hot water cabinet unit heaters are provided for vestibules, entryways, and stairwells.

The main features related to the HVAC controls, set-points, and fan power for different systems are listed below along with some assumptions used when actual information was not available:

- Dual temperature loop control and the 2-pipe change over
    - Scheduled change over: mid-May to mid-September cooling available, the remainder of the year heating is available.
    - Hot water loop set-points: design HW supply temperature of 140°F will be reset based on the outdoor air temperature as follows: at ≤ 30°F OA temperature the HW setpoint will be 140°F and at ≥ 60°F OA temperature the setpoint will be 110°F. The design HW supply and return temperature difference is assumed to be approximately 20°F (120°F design HW return temperature).
    - Chilled water loop set-points: design CHW supply temperate of 45°F with a 10°F ΔT, constant supply temperature set-point
    - The dual temperature loop is a variable flow loop provided with two pumps (P-1 and P-2 where one is a spare) with associated VFDs. In the analysis presented in this report it is assumed that the minimum flow through the loop is 20% of the loop's design flow; the design flow is the CHW flow at approximately 200 gpm; the minimum flow through the loop is 40 gpm. Please note that it is assumed that when the chiller operates (the loop is in cooling mode) the minimum flow is 100 gpm (or approximately 50% of the design flow); this is done to account for possible limitations that the chiller may have on the minimum evaporator flow. The dual loop operates continuously year round.
- FCU fan power selections and control

- Each proposed Whalen FCU is provided with 1/2 hp electronically commutated (EC) motor for the supply fan. The average fan power of 0.3 W/cfm is used for each fan based on fan power provided in the submittal.
- In the analysis presented in this report it is assumed that the units cycle on as needed when cooling or heating is required (fan on and the control valve on the heating/cooling coil modulates to maintain room temperature). At other times the fan is off and the control valve is closed.
- The room temperature setpoints are assumed as follows:

	Heating setpoint	Cooling setpoint
Normal occupancy	72°F	75°F
School breaks/recess periods	68°F	78°F

- Control of ERV-1 and ERV-2.
  - The units are assumed to operate continuously year round.
  - According to the control sequence provided by the installing contractor, the units will operate at constant supply and exhaust air flow.
  - According to information provided by the installing contractor each unit will be controlled by a field mounted room temperature sensor. The user can input the desired room temperature and the unit will adjust the discharge air temperature to maintain the room temperature setpoint. We were not able to obtain information on where the room temperature sensor will be located (specific room, return duct, etc). Consequently, we have assumed in the analysis presented in this report that each unit will operate to at fixed discharge air temperature of 68°F. Such discharge air temperature should allow for maintaining the space temperature approximately between 68°F and 72°F.
  - We were not provided with a control sequence for the energy recovery wheel operation. In absence of the actual detailed sequence we assumed that the enthalpy wheel speed will modulate to maintain the proper discharge air temperature. During periods when full energy recovery is not desired (air-side economizer cycle) the energy wheel will be slowed down or stopped to avoid overheating of the fresh air.
- Control of AHU-1/HP-1 serving 3rd floor classroom.
  - This unit is assumed to operate on the following schedule: Monday thru Friday from 8.00 am till 8.00 pm and OFF on weekends and holidays (inlcuding breaks). During scheduled occupied hours the unit operates continuously to maintain room temperature. During scheduled unoccupied hours the unit is off and cycles on as needed to maintain unoccupied room temperature setpoint.
  - The assumed classroom temperature setpoints are as follows:

	Heating setpoint	Cooling setpoint
Occupied	70°F	75°F
Unoccupied	65°F	80°F

- Control of split cooling units serving the elevator machine room 104 and IDF room 202. It is assumed in the analysis presented in this report that the units cycle as needed to maintain room temperature of 70°F.

Interior Lighting Systems and Equipment Loads

The interior lighting system for the proposed building will consist mainly of a variety of LED and fluorescent fixtures. The average lighting power density (LPD) for the proposed building is 0.502 W/sf. Per electrical drawings, dated 10-20-17, interior lighting controls include:

- Occupancy sensors in common areas such corridors, lounge and in classroom 305
- Automatic daylight responsive controls in ___.

Miscellaneous equipment loads are assumed to be as follows:

- 1.5 W/sf for the dorm rooms, lounges, offices, classroom
- 2.0 W/sf for the laundry facility; no gas load is assumed at this time
- 0.2 W/sf for spaces such as lobby, corridors, mechanical room, lounges, etc.
- 0.0 W/sf for stairs and vestibules.
- The elevator machine room 104 and IDF room 202 (served by AC-1 and AC-2) are assumed to have equipment loads ranging between 0.79 kW and 1.05 kW. This is assumed based on approximately 30% of the design cooling capacity of the units serving these spaces.

Equipment loads comprise all non-HVAC equipment plugged into convenience outlets, including computers, printers, monitors, kitchen appliances in lounges and in the 3rd floor kitchen, washers and dryers in the laundry room, vending machines, etc.

Exterior Lighting System

The proposed exterior lighting consists of LED lamps. Please note that in accordance with the incentive program guidelines, exterior lighting system has not been included in the analysis presented in this report.

Domestic Hot Water System

The domestic hot water (DHW) loads are expected to include lavatory sinks, shower and laundry. Water heating will be provided by a two gas-fired water heaters, Lochinvar model number AWN-701-PM. The schedule units are high efficiency condensing water heaters with thermal efficiency of 93%, an input capacity of 700 MBH each and storage tanks with a capacity of 175 gallons each. According to the ENERGY STAR MFHR simulation guidelines, section 3.9.2, the energy consumption associated with domestic hot water heating presented in this report was estimated based on average daily hot water use per person of 12 gallons (168 total occupants). This water use accounts for everything including laundry. In the analysis presented in this report no reduction in hot water usage due to proposed low flow shower heads and faucets is accounted for.

ANALYSIS METHODOLOGY AND BASELINE DESIGN DESCRIPTION

To analyze future energy consumption patterns of XXXX College's New Residence Hall and the impact of various energy conservation measures incorporated into the building design, a computer model of the facility was developed and building consumption simulations were performed using the eQUEST building analysis program. eQUEST uses the latest DOE-2.2 building energy analysis software as its calculating engine. This very flexible program permits modeling of variety of building types and components including complex building geometry, lighting systems, HVAC systems, central plant equipment, and utility rate structure.

The *as designed* and the *baseline* building eQUEST models were compiled from information contained in the construction document set dated March 31, 2017. Boston, MA weather data (in TMY2 format) was used in the analysis. Electric utility cost and cost savings were calculated using Eversource's electric G-2 rate and an electricity purchase price of $0.08 per kWh from XYZ. The natural gas cost and cost savings were calculated using NGrid G-43 rates and a natural gas purchase price of $0.849 per them from MNO. The resultant virtual[2] electric rate is approximately $0.150 per kWh and the virtual gas rate is $1.35 per therm.

The comparison of the *baseline* and the *as designed* buildings was performed following the analysis methodology prescribed by the utilities. The baseline building meets the requirements of MA energy code using the ASHRAE Standard 90.1-2013 path with applicable amendments as well as the utilities Baseline Document. A separate spreadsheet document has been provided with this report to show a side-by-side comparison of the major components of the *as designed* and *baseline* building models. Any components not mentioned in the table are identical in both models.

[2] Virtual rate refers to the overall blended utility cost per unit for the project over the given year, when accounting for both the cost of the commodity and the distribution rate structure.

ENERGY EFFICIENCY MEASURES INCORPORATED INTO BUILDING DESIGN

Measures

Several energy efficiency measures and technologies are incorporated into the building design according to information that was made available to us. These are included in the *as designed* building model presented in this report. A brief description of each measure is provided below.

- Enhanced window performance
- Reduced lighting power density (LPD) and lighting controls
    - Occupancy sensors
    - LPD of 0.50 W/sf
- Heat recovery devices for ERV-1 and 2.
- VFDs on the dual temperature water loop pumps
- High efficiency chiller
- High efficiency condensing boilers with optimized hot water supply temperature with outside air reset control
- High efficiency condensing domestic hot water heaters

Incremental Cost

The approximate incremental cost for these measures is estimated at $100,000 based on information provided by the design team (for windows and HVAC measures) and based on information from past projects (for lighting).

APPENDIX

- Comparison of Baseline design versus Proposed design
- eQuest BEPU and ES-D output reports for Baseline and As Designed energy models
- Other:
    - Copies of selected submittals and project correspondence related to building systems
    - Chiller performance data furnished by the manufacturer

Comparison of Baseline Design Versus Proposed Design

Opaque Building Envelope

Model Input Parameter / Energy Efficiency Measure	Baseline Case			Proposed Case		
	Description	Insulation R-value	Assembly U-factor/ C-factor/ F-factor	Description	Insulation R-value	Assembly U-factor/ C-factor/ F-factor
Roofs	*Same as proposed but with less insulation*	*R-20ci*	*U-0.48*	*asphalt shingle roof over a self-adhering ice/water shield membrane, roof deck, wood trusses and 8" of spray applied closed cell insulation.*	*R-40*	*U-0.031*
Walls - Above Grade - Type 1	*Same as proposed but with more insulation*	*R-13+7.5ci*	*U-0.064*	*Cement board siding, vertical block metal strapping, 2.5" of rigid insulation (assuming R-5 per inch), liquid applied air and vapor barrier, 8" CMU block wall.*	*R-12.5ci*	*U-0.089*
Walls - Above Grade - Type 2	*Same as proposed but with more insulation*	*R-13+7.5ci*	*U-0.064*	*Real stone veneer, 5/8" cement board, 2.5" of rigid insulation (assuming R-5 per inch), liquid applied air and vapor barrier, 8" CMU block wall*	*R-12.5ci*	*U-0.089*
Walls - Below Grade						
Floors						
Slab-On-Grade Floors						
Opaque Doors						

Fenestration and Shading

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Vertical fenestration Area (% of Wall area)	*29.00%*	*29.00%*
Vertical Glazing Description	*Metal framed other*	*Metal framed other*
Vertical Glazing U-factor/SHGC	*0.55/.40*	*0.55/.40*
Fenestration Visual Light Transmittance	*70%*	*70%*

HVAC (Air-Side)

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
HVAC Sytem Type		
RTU-1	*Same as proposed*	*Packed DX VAV single zone, gas furnace*
AHU-1	*Same as proposed*	*VAV system with chilled wqter cooling coil and hot water heating coil serving multiple zones with shut off type VAV boxes with HW reheat*
Design Supply Air Flow		
RTU-1	*Same as proposed*	*5,000 cfm*
AHU-1	*Same as proposed*	*20,000 cfm*
Total System Fan Power		
RTU-1	*5.7 kW*	*5.3 kW*
AHU-1	*21.3 kW*	*20.7 kW*
Total Supply Fan Power		
RTU-1		
AHU-1		
Total Return/Exhaust Fan Power (tied to AHUs)		
RTU-1		
AHU-1		
Total Cooling Capacity		
RTU-1	*Same as proposed*	*112,500 Btu/hr*
AHU-1	*Same as proposed*	*450,000 Btu/hr*
Unitary Cooling Efficiency		
RTU-1	*EER of 12.5*	*EER of 14.0*
AHU-1	*Same as proposed*	*Not applicable*
Total Heating Capacity		
RTU-1	*Same as proposed*	*100,000 Btu/hr*
AHU-1	*Same as proposed*	*450,000 Btu/hr*
Unitary Heating Efficiency		
RTU-1	*Same as proposed*	80%
AHU-1	Same as proposed	Not applicable
Fan System Operation		
RTU-1	*VAV, min unit flow 50% of the design flow (limited by ventilation flow)*	*VAV, min unit flow 40% of the design flow*
AHU-1	*Same as proposed*	*VAV, min unit flow 25% of the design flow*
Outdoor Air Design Min Ventilation		
HVAC Air-side Economizer Cycle		
Economizer High-Limit Shutoff		
Exhaust Air Energy Recovery		
RTU-1	*Yes, 50% effectiveness*	*Yes, 75% effectiveness*
AHU-1	*Yes, 50% effectiveness*	*Yes, 75% effectiveness*
Controls		
Discharge air temperature		
Demand controlled ventilation		
Other		
Terminal units		
Min flow		
RTU-1	*Same as proposed*	*Not applicable*
AHU-1	*30% or based on ventilation requirements, whichever is greater*	*30% of the design flow with CO2-based override*
Other controls		
RTU-1		
AHU-1		
Other Systems		
Miscellaneous Building Exhaust Fans		
Garage Fans		

HVAC (Water-side)

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Number of Chillers		
Chiller Capacity (Per Chiller)		
Chiller Efficiency		
Chilled Water (CHW) Loop		
Configuration		
Design Delta-T		
Temperature Control		
Flow Control		
Primary CHW pumps		
Number of Pumps		
Pump Power		
Pump Flow		
Speed Control		
Secondary CHW Pumps		
Number of Pumps		
Pump Power		
Pump Flow		
Pump Speed Control		
Cooling Tower		
Type		
Number		
Size		
Power		
Control		
Condenser Water(CW) Loop		
Configuration		
Design Delta-T		
Temperature Control		
Flow Control		
CW Pumps		
Configuration		
Number of Pumps		
Pump Power		
Pump Flow		
Pump Speed Control		
Number of Boilers		
Boiler Capacity (Per Boiler)		
Boiler Efficiency At AHRI conditions		
Hot Water (HW) Loop		
Configuration		
Design Delta-T		
Temperature Control		
Flow Control		
HW Pumps		
Configuration		
Number of Pumps		
Pump Power		
Pump Flow		
Pump Speed Control		
Other Hydronic Loops		
Other Pumps		
Other HVAC Equipment		

HVAC (Other)

Duct Insulation		
Air Leakage		
Piping Insulation		
Other		

Domestic (Service) Water Heating

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
SHW Equipment Type	*Same as proposed*	*Two gas fired condensing DHW heaters.*
SHW Storage Tank Capacity	*Same as proposed*	*Storage tank: (2) 175-Gallon*
SHW Heating Input Capacity	*Same as proposed*	*600,000 Btu/hr.*
Equipment Efficiency	*80% Thermal Efficiency*	*93% Thermal Efficiency*
Temperature Controls	*Same as proposed*	*120°F DHW setpoint*

Lighting

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Interior Lighting Power Calc Method	*Same as proposed*	*Building Method -Dormitory*
Interior Lighting Power Density (Average)	*1.0 W/sf*	*0.75 W/sf*
Interior Lighting Controls		
Exterior Lighing Power		
Exterior Lighting Controls		

Other/Miscellaneous

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Elevators		
Receptacle Equipment		
Kitchen Equipment		
Refrigeration Equipment		