EA PREREQUISITE 2: MINIMUM ENERGY PERFORMANCE

Project # 1000004974 The New School University Center Points Attempted 0

All fields and uploads are required unless otherwise noted.

THRESHOLD ATTEMPTED

Points Attempted: 0

ALL OPTIONS

TARGET FINDER

The following fields are required, but the values have no bearing on EA Prerequisite 2 compliance. Use the Target Energy Performance Results calculator on the ENERGY STAR website to generate the values. If using prescriptive compliance paths (Options 2 or 3), leave the Design energy consumption and cost values blank in the Target Finder website, and set the Design values equal to the Target values in this form.

	Design	Target
Energy performance rating:	0	0
CO_2-eq emissions:	0 metric tons/year	0 metric tons/year
CO_2-eq emissions reduction:	%	%

Upload EAp2-1. Provide the Target Finder Energy Performance Results for the project building (a screen capture or other documentation containing the same information).(Optional)

Upload *Files: 0*

☒ The building is not able to get a Target Finder score because the tool does not support the primary building type of the project building.(Optional)

PREREQUISITE COMPLIANCE

Total gross square footage: 374,182 sf

Principal project building activity: Core Learning Space: College/University

Select a compliance path:

- **Option 1. Whole Building Energy Simulation.** The project team will document improvement in the proposed building performance rating as compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2007 or California Title 24-2005 Part 6.

○ **Option 2. Prescriptive Compliance Path: ASHRAE Advanced Energy Design Guide.** The project team will document compliance with the ASHRAE Advanced Energy Design Guide.

○ **Option 3. Prescriptive Compliance Path: Advanced Buildings Core Performance Guide.** The project team will document compliance with the Advanced Buildings™ Core Performance™ Guide.

OPTION 1. WHOLE BUILDING ENERGY SIMULATION

Complete the following sections:

Section 1.1A - General Information
Section 1.1B - Mandatory Requirements
Section 1.2 - Space Summary
Section 1.3 - Advisory Messages
Section 1.4 - Comparison of Proposed Design Versus Baseline Design Energy Model Inputs
Section 1.5 - Energy Type Summary
Section 1.6 - On-Site Renewable Energy (if applicable)
Section 1.7 - Exceptional Calculation Measure Summary (if applicable)
Section 1.8 - Performance Rating Method Compliance Report
Section 1.9A - Total Building Performance Summary
Section 1.9B - Reports & Metrics

SECTION 1.1A - GENERAL INFORMATION

☒ **Compliant energy simulation software:** The energy simulation software used for this project has all capabilities described in EITHER section "G2 Simulation General Requirements" in Appendix G of ASHRAE 90.1-2007 OR the analogous section of the alternative qualifying energy code used.

☒ **Compliant energy modeling methodology:** Energy simulation runs for both the baseline and proposed building use the assumptions and modeling methodology described in EITHER ASHRAE 90.1-2007 Appendix G OR the analogous section of the alternative qualifying energy code used.

Simulation program:	eQuest
Principal heating source:	Fossil Fuel
Energy code used:	ASHRAE 90.1-2007

List the ASHRAE addenda used in the modeling assumptions, if any.

Zip/Postal Code:	10011
Weather file:	TMY3\NY_New_York_Central_Prk_O.bin
Climate zone:	4A

List the climatic data from ASHRAE Standard 90.1-2007 Table D-1. Specify if another source is referenced for HDD & CDD data.

Heating Degree Days:	4,805
Cooling Degree Days:	3,634
HDD and CDD data source, if other than ASHRAE: (Optional)	

New construction gross square footage:	374,182
Existing, renovated gross square footage:	0
Existing, unrenovated gross square footage:	0
Total gross square footage:	374,182
New construction percent:	100 %
Existing renovation	0 %
Existing unrenovated	0 %

Gross square footage used in the energy model, if different than gross square footage above: (Optional)	369,211

SECTION 1.1B - MANDATORY REQUIREMENTS

For all elements included in the architect's scope of work for the project building, the project building design complies with all ASHRAE Standard 90.1-2007 mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4), and the information provided regarding the Proposed Case energy model in Section 1.4 is consistent with the Building Design.

Signatory: Mauricio Ulloa;Architect; January 25, 2012

REQUIRED SIGNATORY	
Initial here:	MU
ARCHITECT	

For all elements included in the mechanical engineer's scope of work for the project building, the project building design complies with all ASHRAE Standard 90.1-2007 mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4), and the information provided regarding the Proposed Case energy model in Section 1.4 is consistent with the Building Design.

Signatory: David Leo;MEP Engineer; January 18, 2012

REQUIRED SIGNATORY	
Initial here:	dl
MECHANICAL ENGINEER	

For all elements included in the electrical engineer's scope of work for the project building, the project building design complies with all ASHRAE Standard 90.1-2007 mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4), and the information provided regarding the Proposed Case energy model in Section 1.4 is consistent with the Building Design.

Signatory: David Leo;MEP Engineer; January 18, 2012

REQUIRED SIGNATORY	
Initial here:	dl
ELECTRICAL ENGINEER	

Upload the following Interactive Compliance Forms: (Optional)

- ☐ **Upload EAp2-2.** Building Envelope Compliance Documentation
- ☐ **Upload EAp2-3.** HVAC Compliance Documentation
- ☐ **Upload EAp2-4.** Lighting Compliance Documentation
- ☐ **Upload EAp2-5.** Service Water Heating Compliance Documentation

SECTION 1.2 - SPACE SUMMARY

Table EAp2-1. Space Usage Type

Space Name / Description	Space Usage Type	Space Size	Regularly Occupied GSF	Unconditioned GSF	Typical Hours in Operation (per week)
Auditorium	Audience/Seating Area: F	7,512	7,512	0	45
Classroom	Classroom/Lecture/Trainin	66,778	66,778	0	60
Corridor	Corridor/Transition	38,850	0	0	0
Dining	Dining Area	9,906	9,906	0	40
Dormitory	Dormitory - Living Quarter	103,851	103,851	0	168
Fitness	Exercise Area	1,375	1,375	0	50
Kitchen	Food Preparation	1,882	1,882	0	40

Space Name / Description	Space Usage Type	Space Size	Regularly Occupied GSF	Unconditioned GSF	Typical Hours in Operation (per week)
Laundry	Laundry-Washing	855	855	0	40
Lecture Hall	Classroom/Lecture/Trainin	6,668	6,668	0	60
Library - Reading	Reading Area	4,714	4,714	0	40
Library - Stacks	Stacks	1,458	1,458	0	0
Lobby	Lobby	5,356	5,356	0	60
Lounge	Lounge/Recreation	2,887	2,887	0	60
Meeting	Conference/Meeting/Mult	2,001	2,001	0	40
Electrical/Mechanical	Electrical/Mechanical	33,823	0	7,670	0
Office	Office	10,430	10,430	0	40
Restroom	Restrooms	10,700	0	0	0
Retail	Retail	9,029	9,029	0	80
Shafts	Shafts	22,866	0	22,866	0
Stair	Stairs-Active	20,235	0	20,235	0
Storage	Active Storage	8,035	0	8,035	0
	Total	369,211	234,702	58,806	
	Percentage of total (%)		63.57	15.93	

Add Row Delete Row

SECTION 1.3 - ADVISORY MESSAGES

Complete Table EAp2-2 based on information from the energy simulation output files.

Table EAp2-2. Advisory Messages

	Baseline Design (0° Rotation)	Proposed Design
Number of hours heating loads not met[1]	253	231
Number of hours cooling loads not met[1]	0	49
Total	253	280
Difference[2] (Proposed design minus baseline design)	27	
Number of warning messages	13	15
Number of error messages	0	0
Number of defaults overridden	0	0

Unmet load hours compliance	Y

[1]*Baseline design and proposed design unmet load hours each may not exceed 300*

[2]*Unmet load hours for the proposed design may not exceed the baseline design by more than 50 hours.*

SECTION 1.4 - COMPARISON OF PROPOSED DESIGN VERSUS BASELINE DESIGN ENERGY MODEL INPUTS

Download, complete, and upload "EAp2 Section 1.4 table.xls" (found under "Credit Resources") to document the Baseline and Proposed design energy model inputs for the project.

Documentation should be sufficient to justify the energy and cost savings numbers reported in the Performance Rating Table.

Upload EAp2-7. Provide the completed EAp2 Section 1.4 Tables available under "Credit Resources."

Upload *Files: 2*

SECTION 1.5 - ENERGY TYPE SUMMARY

List the energy types used by the project (i.e. electricity, natural gas, purchased chilled water or steam, etc.) for the Baseline and Proposed designs.

If revising the values in Table EAp2-3, reselect energy type in all affected rows in Table EAp2-4 and Table EAp2-5 to ensure that the revised values from Table EAp2-3 are propogated and that Table EAp2-4 and Table EAp2-5 calculations are refreshed.

Table EAp2-3. Energy Type Summary

Energy Type	Utility Company Name	Utility Rate and Description of rate structure[1]	Baseline Virtual Rate[2] ($ per unit energy)	Proposed Virtual Rate[2] ($ per unit energy)	Units of Energy	Units of Demand
Electricity	ConEdison	General Large Comme	0.1967	0.2421	kWh	kW
Natural Gas	ConEdison	From NYS Public Servic	1.2851	1.2699	therms	kBtuh
			0	0		

[1]*Describe the rate structure and list the local utility rate/s for the energy type. Per ASHRAE 90.1-2007 G2.4, project teams are allowed to use the state average energy prices published by DOE's EIA for commercial building customers, readily available on EIA's website (www.eia.doe.gov). If project uses backup energy for on-site renewable energy, please specify the rate of backup source energy.*

[2]*List the virtual energy rate from the baseline and proposed design energy model results or from manual calculations. This rate is defined as defined as the total annual charge divided by the metered energy from the plant for each resource. Provide a narrative explaining demand reduction if the Proposed and Baseline rates vary significantly.*

Add Row Delete Row

If the Proposed and Baseline rates vary significantly, describe the building input parameters (e.g. demand reduction measures) leading to the variation in energy rates, and provide detailed information regarding the utility rate structure including all demand and energy charges, and the seasonal and time-of-use structure of the utility tariff. (Required when Proposed & Baseline Rates vary by more than 10%)

The virtual electricity rates above vary by more than 10%. This difference in electricity rate is caused by the cogeneration systems serving the building.

Building with cogeneration -
Electricity Consumption: 2,147,461 kWh/yr
Electricity Cost: 519,865 $/yr
Virtual Rate: 0.24084 $/kWh

Building without cogeneration -
Electricity Consumption: 4,472,809 kWh/yr
Electricity Cost: 879,360 $/kWh

Upload EAp2-8. Provide any documentation to support the proposed/baseline rate variance narrative. (Optional) Upload *Files: 0*

SECTION 1.6 - PERFORMANCE RATING METHOD COMPLIANCE REPORT

In Table EAp2-4, list each energy end use for the project (including all end uses reflected in the baseline and proposed designs). Then check whether the end-use is a process load, select the energy type, and list the energy consumption and peak demand for each end-use for all four Baseline Design orientations.

Fill out the Proposed Design energy consumption and peak demand for each end use in Table. Performance Rating - Performance Rating Method Compliance.

Table EAp2-4. Baseline Performance - Performance Rating Method Compliance

End	Process	Baseline Design Energy Type	Units of Annual Energy & Peak Demand		Baseline (0° rotation)	Baseline (90° rotation)	Baseline (180° rotation)	Baseline (270° rotation)	Baseline Building Results
Interior Lighting		Electricity	Energy Use	kWh	971,180	971,180	971,180	971,180	971,180
			Demand	kW	281.74	281.74	281.74	281.74	281.74
Exterior			Energy Use						
			Demand						
Space		Natural	Energy Use	therms	157,820	161,070	159,370	156,160	158,605
			Demand	kBtuh	12,000	12,000	12,000	12,000	12,000
Space Cooling		Electricity	Energy Use	kWh	1,373,961	1,371,848	1,371,985	1,383,634	1,375,357
			Demand	kW	728.09	722.58	723.61	733.23	726.88
Pumps		Electricity	Energy Use	kWh	839,117	844,828	843,046	847,205	843,549
			Demand	kW	126.9	127.75	126.76	127.55	127.24
Heat Rejection		Electricity	Energy Use	kWh	35,094	35,115	35,183	35,371	35,190.75
			Demand	kW	80	80.57	80.49	80.79	80.46
Fans-Interior		Electricity	Energy Use	kWh	1,336,590	1,332,314	1,340,411	1,338,326	1,336,910
			Demand	kW	207.09	201.15	203.17	206.55	204.49

Fans - Parking Garage	☒		Energy Use						
			Demand						
Service Water Heating		Natural Gas	Energy Use	therms	55,910	55,910	55,910	55,910	55,910
			Demand	kBtuh	1,600	1,600	1,600	1,600	1,600
Receptacle Equipment	☒	Electricity	Energy Use	kWh	815,139	815,139	815,139	815,139	815,139
			Demand	kW	187.46	187.46	187.46	187.46	187.46
Interior Lighting - Process	☒		Energy Use						
			Demand						
Refrigeration Equipment	☒		Energy Use						
			Demand						
Cooking	☒		Energy Use						
			Demand						
Industrial Process	☒		Energy Use						
			Demand						
Elevators and Escalators	☒	Electricity	Energy Use	kWh	159,080	159,080	159,080	159,080	159,080
			Demand	kW	69	69	69	69	69
Space		Electricity	Energy Use	kWh	0	0	0	0	0
			Demand	kW	0	0	0	0	0
Baseline Energy Totals			Total Energy Use (mBtu/yr)		40241.91	40564.67	40416.91	40143.38	40341.72
					Annual Process Energy (mBtu/yr)				3324.04
					Process Energy Modeling Compliance[1]				N

1. Annual process energy costs must be at least 25% of the total energy costs for the proposed design. This form determines compliance using cost calculations from Section 1.9. Process Energy Costs should be modeled to accurately reflect the proposed building. Process Energy must be the same in the baseline and proposed cases, unless an exceptional calculation is used. Process energy costs must be at least 25% of the total baseline energy costs. Any exceptions must be supported by a narrative and/or other supporting documentation.

Add Row Delete Row

Note: Compliance is determined correctly after Section 1.9A is complete. If the project does not comply, explain any exceptions in the narrative below.

Explain any exceptions, special circumstances or modeling difficulties that occurred relating to the process energy noncompliance.

The proposed building process energy does comply but because there is no separate section to report the electricity generation and gas consumed by the cogeneration system this form is not picking up the correct numbers. An explanation is given below to show that the process energy cost in the proposed building is at least 25%:
Proposed building total annual energy cost (with cogeneration): $943,077
Proposed building total process energy:
Proposed building virtual energy rate: $0.242084/kWh
Proposed building total process energy cost: $235,842
% process energy cost: 25%

Note: Table EAp2-11 reports the energy consumption and cost for both the baseline and proposed building with cogeneration. Table Eap2-5 reports the energy consumption for the proposed building without cogeneration.

Upload EAp2-9. Provide any documentation to support the process energy noncompliance narrative. (Optional)

Upload *Files: 0*

Table EAp2-5. Performance Rating - Performance Rating Method Compliance

End Use	Process	Baseline Building Units		Baseline Building Results	Proposed Design Energy Type	Units of Annual Energy & Peak Demand		Proposed Building Results	Percent Savings
Interior Lighting		Energy Use	kWh	971180		Energy Use	kWh	827,074	
		Demand	kW	281.74	Electricity	Demand	kW	267.17	14.84
Exterior Lighting		Energy Use				Energy Use		0	
		Demand				Demand		0	0
Space Heating		Energy Use	therms	158605		Energy Use	therms	80,482	
		Demand	kBtuh	12000	Natural Gas	Demand	kBtuh	6,590	49.26
Space Cooling		Energy Use	kWh	1375357		Energy Use	kWh	915,014	
		Demand	kW	726.88	Electricity	Demand	kW	520.8	33.47
Pumps		Energy Use	kWh	843549		Energy Use	kWh	639,635	
		Demand	kW	127.24	Electricity	Demand	kW	167.16	24.17
Heat Rejection		Energy Use	kWh	35190.75		Energy Use	kWh	71,333	
		Demand	kW	80.46	Electricity	Demand	kW	74.86	-102.7
Fans-Interior		Energy Use	kWh	1336910.2		Energy Use	kWh	1,036,644	
		Demand	kW	204.49	Electricity	Demand	kW	215.12	22.46
Fans - Parking Garage	X	Energy Use				Energy Use		0	
		Demand				Demand		0	0
Service Water Heating		Energy Use	therms	55910		Energy Use	therms	4,670	
		Demand	kBtuh	1600	Natural Gas	Demand	kBtuh	150	91.65
Receptacle Equipment	X	Energy Use	kWh	815139		Energy Use	kWh	815,139	
		Demand	kW	187.46	Electricity	Demand	kW	187.46	0
Interior Lighting - Process	X	Energy Use				Energy Use		0	
		Demand				Demand		0	0
Refrigeration Equipment	X	Energy Use				Energy Use		0	
		Demand				Demand		0	0
Cooking	X	Energy Use				Energy Use		0	
		Demand				Demand		0	0
Industrial Process	X	Energy Use				Energy Use		0	
		Demand				Demand		0	0
Elevators and Escalators	X	Energy Use	kWh	159080		Energy Use	kWh	159,080	
		Demand	kW	69	Electricity	Demand	kW	69	0

Save Form

Space Heating		Energy Use	kWh	0		Energy Use	kWh	5665	
		Demand	kW	0	Electricity	Demand	kW	4.13	0
Baseline Total Energy Use				40341.72	Proposed Total Energy Use			23765.42	MBtu/yr
Baseline Process Energy				3324.04	Proposed Process Energy			3324.04	MBtu/yr

Table EAp2-6. Section 1.6 Energy Use Summary & Energy Savings

Energy Type	Units	Baseline Design	Proposed Design
Electricity	kWh	5,536,406	4,469,584
Natural Gas	therms	214,515	85,152
		0	0
Totals	MMBtu	40,341.72	23,765.42

SECTION 1.7 - EXCEPTIONAL CALCULATION MEASURE SUMMARY

Select one of the following

- ○ The energy analysis includes exceptional calculation method(s) (ASHRAE 90.1-2007, G2.5).
- ◉ The energy analysis does not include exceptional calculation methods.

SECTION 1.8 - ON-SITE RENEWABLE ENERGY

Select one of the following

- ○ The project uses on-site renewable energy produced on-site.
- ◉ The project does not use on-site renewable energy.

SECTION 1.9A - TOTAL BUILDING PERFORMANCE SUMMARY

Table EAp2-10. Energy Use Summary: Total Building Energy Use Performance

Energy Type	Units	Baseline Case		Proposed Case			
Section 1.6 Energy Use		Process	Section 1.6 Energy Use	Section 1.6 Energy Use	Section 1.7 Energy Savings	Section 1.8 Ren Energy Savings	Total Energy Use
Electricity	kWh	974,219	5,536,406	4,469,584	0	0	4,469,584
Natural Gas	therms	0	214,515	85,152	0	0	85,152
		0	0	0	0	0	0
Totals	MMBtu	3,324.04	40,341.72	23,765.42	0	0	23,765.42
						Energy use savings	41.09 %

Save Form

Table EAp2-11. Energy Cost Summary: Total Building Energy Cost Performance (Baseline Case)

Energy Type	Baseline Cost ($) (0° rotation)	Baseline Cost ($) (90° rotation)	Baseline Cost ($) (180° rotation)	Baseline Cost ($) (270° rotation)	Baseline Building Performance
Electricity	1,087,783	1,087,653	1,088,936	1,091,672	1,089,011
Natural gas	274,664	278,841	276,656	272,531	275,673
Totals	1,362,447	1,366,494	1,365,592	1,364,203	1,364,684

Table EAp2-12. Energy Cost Summary: Total Building Energy Cost Performance (Manual Cost Input)

Energy Type	Units	Baseline Case		Proposed Case			
Section 1.6 Energy Use		Process	Section 1.6 Energy Use	Section 1.6 Energy Use	Section 1.7 Energy Savings	Section 1.8 Ren Energy Savings	Total Energy Cost
Electricity	$	0	1,089,011	519,116	0	0	519,116
Natural Gas	$	0	275,673	420,315	0	0	420,315
	$	0		0	0	0	0
Totals	$	0	1,364,684	939,431	0	0	939,431
Baseline process energy costs as percent of total energy costs (%)			0	Energy cost savings			31.16 %
EA Credit 1 points documented							10

Use the Automatic Cost Calculation path if the project uses automatic cost calculation under Section 1.7 or Section 1.8.

☐ **Automatic Cost Calculation**: The project will generate the energy cost values using the virtual energy rate from Section 1.5: Energy Use Summary.

Section 1.9B - REPORTS AND METRICS

Table EAp2-14. Energy Use Intensity

	Baseline EUI	Proposed EUI
Electricity (kWh/sf)		
Interior Lighting	2.595	2.21

Save Form

Space Heating	0	0
Space Cooling	3.676	2.445
Fans - Interior	3.573	2.77
Service Water Heating	0	0
Receptacle Equipment	2.178	2.178
Miscellaneous	2.774	2.342
Total	14.796	11.945
Natural Gas (kBtu/sf)		
Space Heating	42.387	21.509
Service Water Heating	14.942	1.248
Total Energy Use Intensity (kBtu/sf)		
Total	107.813	63.513

Table EAp2-15. End Use Energy Percentage

	Baseline Case	Proposed Case	End Use Energy Savings (%)
Interior Lighting	8.212	11.872	2.965
Space Heating	3,931.53	3,386.551	4,712.867
Space Cooling	11.634	13.135	9.481
Fans - Interior	11.308	14.881	6.185
Service Water Heating	1,385.918	196.495	3,091.196
Receptacle Equipment	6.893	11.7	0
Miscellaneous	8.779	12.582	3.327

Input & Output Summaries from the Energy Model

Upload the summary report from the simulation program.

- (●) **Upload EAp2-11.** If the project used DOE2, eQuest & Visual DOE, provide the Input summary and the BEPS, BEPU, & ES-D reports.
- ( ) **Upload EAp2-12.** If the project used EnergyPlus, provide the Input summary and the Annual Building Utility Performance Summary (ABUPS), System Summary, and the file that shows the annual energy cost by fuel source.
- ( ) **Upload EAp2-13.** If the project team used EnergyPro, provide the Input summary and the Title 24 reports: PERF-1, ECON-1, & UTIL-1.
- ( ) **Upload EAp2-14.** If the project team used HAP, provide the Input summary and the Annual Cost Summary, Unmet Load reports for all plants and systems (Building Zone Temperature Report), and Systems Energy Budget by Energy Source.

Upload *Files: 6*

○ **Upload EAp2-15.** If the project team used Trace, provide the Input summary as well as the the Energy Consumption Summary, Energy Cost Budget/PRM Summary report, and Performance Rating Method Details.

○ **Upload EAp2-16.** For all other modeling software, upload supporting documents of similar scope and detail (input and output summaries.)

ADDITIONAL DETAILS

☒ Special circumstances preclude documentation of prerequisite compliance with the submittal requirements outlined in this form.

SPECIAL CIRCUMSTANCES

Describe the circumstances limiting the project team's ability to provide the submittals required in this form. Be sure to reference what additional documentation has been provided, if any. Non-standard documentation will be considered upon its merits.

The following documents have been modified and/or added to the supporting documentation in response to the GBCI design review comments:

1. Clarification narrative: 120710 The New School Resubmission Narative.pdf
2. Revised Energy Model Report: 120710 The New School_100 CD_Energy Analysis Report_REV03.pdf
3. Baseline and Proposed BEPS, BEPU, ES-D reports: 120710 The New School BEPS, BEPU, ES-D REV01.pdf
4. Baseline and Proposed PS-H Reports For DHW Heaters and Co-generation Equipment: 120710 The New School PS-H.pdf
5. EAp2 Section 1.4 table revised: EAp2+Section+1.4+tables REV01.xls

All original support documentation submitted during the preliminary design review has been kept for comparison purposes.

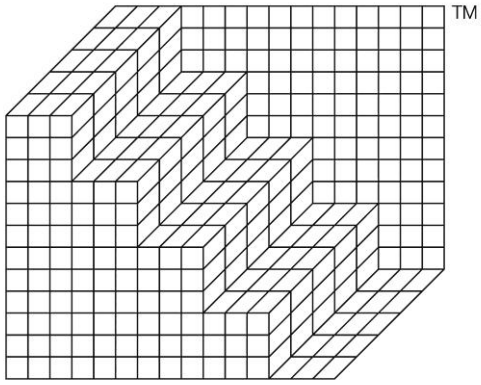
Upload EAp2-SC. Provide any additional documentation that supports the claim to special circumstances. (Optional) Upload *Files: 1*

☐ The project team is using an alternative compliance approach in lieu of standard submittal paths.

SUMMARY

EA Prerequisite 2: Minimum Energy Performance Compliance Documented: Y Check Compliance

Note: *Click "Check Compliance" to validate that the form meets the requirements. "Check Compliance" must be run after any changes are made to the form to ensure that "Compliance Documented" is accurate. Always press "Check Compliance" before saving the form.Fields are highlighted in red after "Check Compliance" is pressed are incomplete required fields. After entering information in those fields and pressing "Check Compliance" once more, the fields should return to their normal color*



Buro Happold

The New School University Center

Energy Analysis Study (based on 100% CD submittal)

July 10, 2012
Revision 3

Revision	Description	Issued by	Date	Checked
1	Energy Analysis Study	MS	05-16-2011	SB
2	Energy Analysis Study	MS	09-15-2011	SB
3	Energy Analysis Study	KW	07-10-2012	SB

This report has been prepared for the sole benefit, use and information of DURST and The New School for the purposes set out in the report or instructions commissioning it. The liability of Buro Happold Limited in respect of the information contained in the report will not extend to any third party.

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author	**M.Sajjal/ K.Wiebe**
signature	
date	**July 10, 2012**
approved	**S.Baumgartner**
signature	
date	**July 10, 2012**

Team

Owner: The New School

Architect: SOM LLP

MEP: Cosentini Associates

Energy/LEED: Buro Happold

Contents

1 Executive Summary

1.1 Whole Building Energy Analysis

The New School's University Center has been designed to achieve a LEED Gold rating using the LEED 2009 Tool. To aid in the design process and document the predicted energy savings to satisfy the LEED requirements, Buro Happold built an energy model using eQuest simulation tool to represent the architectural and HVAC systems. According to this whole-building simulation, the facility will perform **31.2% (in energy cost)** better than the ASHRAE/IESNA 90.1-2007 baseline requirements using the Performance Rating Method (Appendix G). It should be noted that this percentage savings is for the entire building annual energy cost by using the likely utility rate in the region. Changes in these rates will affect the percentages of energy cost savings.

To maximize the energy savings over baseline building, a list of energy conservation measures was investigated. This report summarizes the cumulative energy savings from the agreed upon energy conservation measures. The building will comply with all mandatory requirements under 90.1-2007 and comply with the prerequisite of ASHRAE 90.1-2007. The 31.2% estimated energy cost reduction equates to **10 LEED points** under EA Credit 1 (9 for 28%, 10 for 30%, and 11 for 32%)

2 Project Brief

The proposed University Center is located at the corner of 5th Avenue and 14th Street in Manhattan. The project consists of a base of academic, retail and theater space, and a tower on the base of dormitories. Working from the construction document drawings, we calculated a total gross sq footage of 369,210 sq. ft. as follows:

Space Name	Space Size (sf)	Regularly Occupied (sf)	Unconditioned (sf)
Auditorium	7,512	7,512	0
Classroom	66,778	66,778	0
Corridor	38,850	0	0
Dining	9,906	9,906	0
Dormitory	103,851	103,851	0
Fitness	1,375	1,375	0
Kitchen	1,882	1,882	0
Laundry	855	855	0
Lecture Hall	6,668	6,668	0
Library - Reading	4,714	4,714	0
Library - Stacks	1,458	1,458	0
Lobby	5,356	5,356	0
Lounge	2,887	2,887	0
Meeting	2,001	2,001	0
Electrical/Mechanical	33,823	0	7,670
Office	10,430	10,430	0
Restroom	10,700	0	0
Retail	9,029	9,029	0
Shafts	22,866	0	22,866
Stair	20,235	0	20,235
Storage	8,035	0	8,035
Total	369,210	234,702	58,806

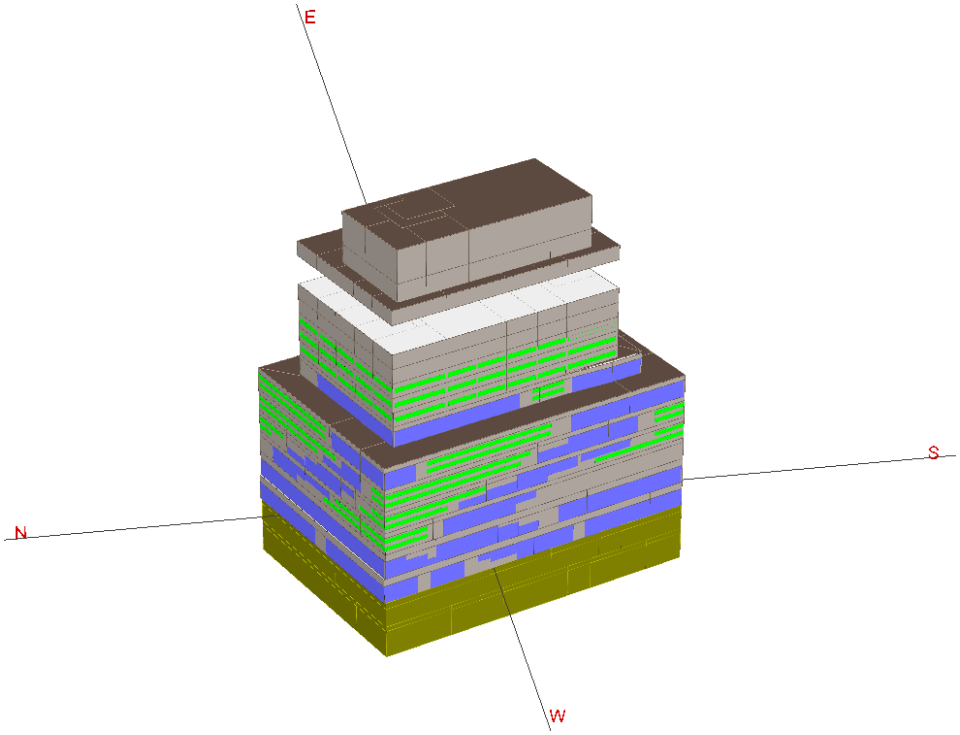

Fig1: 3D view of University Center, the New School

3 Introduction

The New School is committed to develop a sustainable project to the greatest extent. The project is pursuing a LEED Gold rating, through well insulated building shell, lighting reduction and additional HVAC efficiency measures. To assist in this goal, Buro Happold evaluated the performance of the building using energy analysis tools.

The goal of the analysis is to minimize the annual energy consumption of the building without compromising the thermal and visual comfort in the space. Design strategies are provided in terms of effectiveness of energy conservation measures.

This report illustrates the inputs and outputs of this process in the following terms:

- Building location
- Building geometry
- Building use schedules
- Internal loads
- Energy Analysis summary
- LEED Energy and Atmosphere credit 1 summary.

4 Methodology

For the whole building energy analysis, electricity and thermal load assessments the following methods of analysis were used.

4.1 Energy Modelling

An energy model of the proposed building was built to accurately represent the current architectural plans to match both geometry and resolution. This model was constructed using the eQuest v3.64. The eQuest software uses DOE 2.2 as the computational engine to predict the various energy flows in building during a Typical Meteorological Year (called as TMY). Most recent weather data for New York, NY is defined by the National Renewable Energy Laboratory (NREL) in TMY3 format. For detailed information refer to http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/
The energy model was based on US climate zone 4A for New York, NY (Table B-1 of ASHRAE 90.1-2007), and the building envelope requirements prescribed in Table 5.5-4 of ASHRAE/IESNA 90.1- 2007. TMY3 weather file for New York Central Park, NY was used for this analysis.

eQuest software was used to generate a 3D model of the building with the internal space split into a number of control zones. The software then uses annual weather data to calculate the various energy flows into and out of each zone, including solar gains, people, lighting and equipment gains, the energy stored within the building fabric (envelope), and wind-driven infiltration. The energy model is capable of calculating variations of temperature in each control zone for every hour of the year, in addition to system's and thermal zones outside air and supply ventilation requirements.

For the purpose of LEED EA credit 1 compliance, two models are built in eQuest and whole building simulation is done in order to compare the resulting annual energy cost of the two building models.

- The first model, "Proposed Design Building," represents the current design (100%CD) as per the current architectural and systems set.
- The second model "Baseline Building" represents the same building, but is based on the minimum requirements of ASHRAE/IESNA Standard 90.1-2007, Appendix G.

Electricity rates used for both baseline and proposed cases was based on information provided by ConEdison website http://www.coned.com/documents/elec/271-281a.pdf for a general-large commercial (SC.9) with Rate III (Voluntary Time-of-Day, Low Tension service) tariff.

Charge Type		*Electricity Rate*
Supply Charge	Market Supply Charge	**$ 0.0888 per kWh**
	Markey Supply Charge	**$ 14.16 per kW**
	Monthly Adjustment Clause	**$ 1.035 per kW**
Delivery Charge	**Consumption**	**$ 0.0071 per kWh**
	Summer Demand (June – Sept) *	
	Monday through Friday, 8 AM to 6 PM	**$7.08 per kW**
	Monday through Friday, 8 AM to 10 PM	**$15.16 per kW**
	All hours – all days	**$ 14.50 per kW**
	Winter Demand (Oct – May)*	
	Monday through Friday, 8 AM to 10 PM	**$9.82 per kW**
	All hours – all days	**$ 4.15 per kW**

***:** The demand charge for each time period will be determined by multiplying the maximum demand for the respective time period by the rate applicable to the demand for that time period. The total demand charge will be the sum of the charges for each of the time periods.

Natural gas rates used for both baseline and proposed cases was based on information provided by NYS Public Service Commission (http://www.dps.state.ny.us/TypicalBills.htm) for ConEdison's typical summer and winter rates.

Period	*Natural Gas Rate*
Winter Rates (between October and May)	**$ 1.305 per therms**
Summer Rates (between June and September)	**$ 1.183 per therms**

Results are reported as a comparison of energy consumption between the improved design and baseline building.

5 DTM – Building Energy Conservation Measures

The following energy efficiency measures have been incorporated into the architecture and HVAC design as of the issue date of this report:

- External glazing: Insulated low e glass with a glazing assembly U value ~ 0.40 Btu/hr·ft²·˚F, SHGC – 0.59 (20% fritting = SHGC-0.49) compared to a U value of 0.55 Btu/hr·ft²·˚F, SHGC – 0.40 for the external glazing in base case
- External wall: Steel Frame building with closed-cell extruded polystyrene (R 20), U value – 0.043 Btu/hr·ft²·˚F compared to base case U value – 0.064 Btu/hr·ft²·˚F
- External roof with extruded polystyrene insulation (R 20), U value – 0.043 Btu/hr·ft²·˚F compared to base case U value – 0.048 Btu/hr·ft²·˚F
- Efficient lighting design to reduce the overall lighting power density in the building by 18%
- Daylighting strategies to reduce artificial lights in the spaces in select academic perimeter spaces
- Variable frequency drives (VFD) control for chilled-water, hot-water and condenser pumps.
- Variable frequency drives (VFD) control for cooling tower fans.
- Modular, multi-stage with magnetic bearing (frictionless) high efficiency centrifugal chiller.
- Water-side economizer will provide free-cooling for HVAC system, especially for cooling loads during mild or cold weather.
- Fan-coils units with ECM motors in the dormitory would provide conditioning to the spaces with cycling fans to meet thermal loads as compared to the constant fan flow PTAC units in the base case.
- An on-site cogeneration plant will generate electricity for the facility use and recovered thermal energy as a by-product for DHW utilization on the site (200 kW and 65 kW systems)
- Energy recovery ventilation units will be used to pre-condition the fresh outside air year-around.
- An ice-storage unit with a dedicated chiller will be used to lower the chiller's cooling capacity requirement during summer days by storing ice during the night, when the electricity demand cost is cheaper.

6 DTM - Model Inputs and Assumptions

When developing thermal models it is necessary to make certain assumptions as to the levels of internal heat gains from equipment, people, and also properties of the building such as construction material and infiltration rate. The input data for the model are as follows:

1.4.1A -ASHRAE 90.1 Section 5: Building Envelope (Construction Assemblies)

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	Insulation entirely above deck	R-20	U-0.048 Btu/hr·ft²·˚F	4'' Extruded polystyrene board	R-20	U-0.043 Btu/hr·ft²·˚F
Roof SRI	0.30 reflectivity	NA	NA	0.30 reflectivity	NA	NA
Walls - Above Grade	Steel framed building	R-13 + R7.5ci	U-0.064 Btu/hr·ft²·˚F	Closed-cell 4'' extruded polystyrene, 1'' air space, Gypsum board	R-20	U-0.043 Btu/hr·ft²·˚F
Walls - Below Grade	ASHRAE table 5.5-4	R-0	C-1.14 Btu/hr·ft²·˚F	8" concrete w insulation	R-10	C-0.092 Btu/hr·ft²·˚F
Semiheated Exterior Envelope	NA	NA	NA	NA	NA	NA
Floors	Steel joist	R-30	U-0.038 Btu/hr·ft²·˚F	Steel joist	R-30	U-0.038 Btu/hr·ft²·˚F
Slab-On-Grade Floors	unheated	R-0	F-0.73 Btu/hr·ft·˚F	unheated; vertical 12"	R-7.5	F-0.60 Btu/hr·ft·˚F
Opaque doors	Swinging Nonswinging	NA NA	U-0.700 Btu/hr·ft²·˚F U-1.500 Btu/hr·ft²·˚F	Swinging Nonswinging	NA NA	U-0.500 Btu/hr·ft²·˚F U-1.000 Btu/hr·ft²·˚F
Other	NA	NA	NA	NA	NA	NA

1.4.1B - ASHRAE 90.1 Section 5: Fenestration and Shading

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Vertical fenestration Area (% of Wall area)	31.50%	31.50%
Vertical Glazing Description	metal framing, all other	metal framing double glazed windows
Vertical Glazing U-factor	U-0.55 Btu/hr·ft²·°F (assembly)	U-0.40 Btu/hr·ft²·°F (assembly)
Vertical Glazing SHGC - North	SHGC-0.40	SHGC-0.49 (bronze-frit) SHGC-0.59 (no-frit)
Vertical Glazing SHGC Non-North	SHGC-0.40	SHGC-0.49 (bronze-frit) SHGC-0.59 (no-frit)
Shading Devices	None	None
Fenestration Visual Light Transmittance	VLT-0.90	VLT-0.62 (bronze-frit) VLT-0.78 (no-frit)
Skylight Fenestration Area (percent of roof area)	NA	NA
Skylight Description	NA	NA
Skylight U-factor	NA	NA
Skylight SHGC	NA	NA
Building Self-Shading Description	None	None
Building Orientation & Shape	north; rectangular	north; rectangular
Other	NA	NA

1.4.2 - ASHRAE 90.1 Section 6: HVAC (Air-Side)

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Primary HVAC Type	System#7 - VAV w reheat (School & Retail)	VAV fan powered boxes
Other HVAC Type	System#1 - PTAC (Dormitory)	FCU (Dormitory); Heat Recovery Units (HRU) serving school spaces
Semi-conditioned Space HVAC Type	NA	NA
Semi-conditioned Area (Gross SF)	NA	NA
Semi-conditioned Heating Capacity (Btuh)	NA	NA
Total Cooling Capacity	Building Total: 21,388 kBtu/h AHU C2-1: 1,542 kBtu/h AHU C2-2: 404 kBtu/h AHU C2-3: 1,446 kBtu/h AHU C2-4: 872 kBtu/h AHU C2-5: 163 kBtu/h AHU 2-1: 1,173 kBtu/h AHU 2-2: 948 kBtu/h AHU 3-1: 1,596 kBtu/h AHU 4-1: 1,905 kBtu/h AHU 5-1: 1,881 kBtu/h AHU 6-1: 1,953 kBtu/h AHU 7-1: 1,165 kBtu/h AHU 7-3: 590 kBtu/h AHU 7-4: 874 kBtu/h AHU 16-1: 344 kBtu/h	Building Total: 15,473 kBtu/h AHU C2-1: 1,143 kBtu/h AHU C2-2: 232 kBtu/h AHU C2-3: 764 kBtu/h AHU C2-4: 543 kBtu/h AHU C2-5: 128 kBtu/h AHU 2-1: 764 kBtu/h AHU 2-2: 666 kBtu/h AHU 3-1: 1,217 kBtu/h AHU 4-1: 1,503 kBtu/h AHU 5-1: 1,492 kBtu/h AHU 6-1: 1,520 kBtu/h AHU 7-1: 956 kBtu/h AHU 7-3: 270 kBtu/h AHU 7-4: 571 kBtu/h AHU 16-1: 159 kBtu/h

	AHU 16-2: 588 kBtu/h PTAC 8th Flr: 447 kBtu/h PTAC 9th Flr: 456 kBtu/h PTAC 10th Flr: 451 kBtu/h PTAC 11th Flr: 418 kBtu/h PTAC 12-14th Flr: 1,544 kBtu/h PTAC 15th Flr: 426 kBtu/h PTAC 16th Flr: 202 kBtu/h	AHU 16-2: 165 kBtu/h FCU 8th Flr: 392 kBtu/h FCU 9th Flr: 404 kBtu/h FCU 10th Flr: 398 kBtu/h FCU 11th Flr: 366 kBtu/h FCU 12-14th Flr: 1,372 kBtu/h FCU 15th Flr: 373 kBtu/h FCU 16th Flr: 75 kBtu/h HRU-1: 3,346 kBtu/h HRU-2: 3,346 kBtu/h HRU-3: 3,346 kBtu/h
Unitary Cooling Capacity Ranges	Individual PTAC size: 13.85 kBtu/h	NA
Unitary Cooling Efficiency	9.55 EER Calculated per Table 6.8.1D Adjusted for Fan Power: 11.25 EER	NA
Total Heating Capacity	Building Total: 16,200 kBtu/h AHU C2-1: 1,370 kBtu/h AHU C2-2: 260 kBtu/h AHU C2-3: 965 kBtu/h AHU C2-4: 489 kBtu/h AHU C2-5: 95 kBtu/h AHU 2-1: 808 kBtu/h AHU 2-2: 529 kBtu/h AHU 3-1: 950 kBtu/h AHU 4-1: 1,316 kBtu/h AHU 5-1: 1,256 kBtu/h AHU 6-1: 1,438 kBtu/h AHU 7-1: 920 kBtu/h AHU 7-3: 349 kBtu/h	Building Total: 11,000 kBtu/h AHU C2-1: 1,037 kBtu/h AHU C2-2: 259 kBtu/h AHU C2-3: 778 kBtu/h AHU C2-4: 651 kBtu/h AHU C2-5: 16 kBtu/h AHU 2-1: 691 kBtu/h AHU 2-2: 648 kBtu/h AHU 3-1: 1,210 kBtu/h AHU 4-1: 413 kBtu/h AHU 5-1: 385 kBtu/h AHU 6-1: 475 kBtu/h AHU 7-1: 357 kBtu/h AHU 7-3: 185 kBtu/h

	AHU 7-4: 596 kBtu/h AHU 16-1: 453 kBtu/h AHU 16-2: 446 kBtu/h PTAC 8th Flr: 452 kBtu/h PTAC 9th Flr: 460 kBtu/h PTAC 10th Flr: 456 kBtu/h PTAC 11th Flr: 423 kBtu/h PTAC 12-14th Flr: 1,530 kBtu/h PTAC 15th Flr: 429 kBtu/h PTAC 16th Flr: 212 kBtu/h	AHU 7-4: 812 kBtu/h AHU 16-1: 172 kBtu/h AHU 16-2: 170 kBtu/h FCU 8th Flr: 319 kBtu/h FCU 9th Flr: 326 kBtu/h FCU 10th Flr: 323 kBtu/h FCU 11th Flr: 299 kBtu/h FCU 12-14th Flr: 1,070 kBtu/h FCU 15th Flr: 304 kBtu/h FCU 16th Flr: 102 kBtu/h HRU-1: 2,226 kBtu/h HRU-2: 2,226 kBtu/h HRU-3: 2,226 kBtu/h
Unitary Heating Capacity Ranges	NA	NA
Unitary Heating Efficiency	NA	NA
Fan System Operation	Variable Speed (System#7); Continuous when occupied, Cycling to meet thermal loads when unoccupied (System#1)	Variable Speed (VAV); Cycling to meet thermal loads when occupied or unoccupied (FCU)
Outdoor Air Design Min Ventilation	Building Total: 136,850 cfm AHU C2-1: 12,000 cfm AHU C2-2: 3,000 cfm AHU C2-3: 6,000 cfm AHU C2-4: 8,000 cfm AHU C2-5: 550 cfm AHU 2-1: 10,000 cfm AHU 2-2: 4,500 cfm AHU 3-1: 10,500 cfm AHU 4-1: 12,000 cfm	Building Total: 136,850 cfm AHU C2-1: 12,000 cfm AHU C2-2: 3,000 cfm AHU C2-3: 6,000 cfm AHU C2-4: 8,000 cfm AHU C2-5: 550 cfm AHU 2-1: 10,000 cfm AHU 2-2: 4,500 cfm AHU 3-1: 10,500 cfm AHU 4-1: 12,000 cfm

	AHU 5-1: 12,000 cfm AHU 6-1: 12,000 cfm AHU 7-1: 7,500 cfm AHU 7-3: 2,000 cfm AHU 7-4: 7,000 cfm AHU 16-1: 9,000 cfm AHU 16-2: 9,000 cfm PTAC 8th Flr: 1,400 cfm PTAC 9th Flr: 1,400 cfm PTAC 10th Flr: 1,400 cfm PTAC 11th Flr: 1,300 cfm PTAC 12-14th Flr: 4,000 cfm PTAC 15th Flr: 1,300 cfm PTAC 16th Flr: 1,000 cfm	AHU 5-1: 12,000 cfm AHU 6-1: 12,000 cfm AHU 7-1: 7,500 cfm AHU 7-3: 2,000 cfm AHU 7-4: 7,000 cfm AHU 16-1: 9,000 cfm AHU 16-2: 9,000 cfm FCU 8th Flr: 1,400 cfm FCU 9th Flr: 1,400 cfm FCU 10th Flr: 1,400 cfm FCU 11th Flr: 1,300 cfm FCU 12-14th Flr: 4,000 cfm FCU 15th Flr: 1,300 cfm FCU 16th Flr: 1,000 cfm
HVAC Air-side Economizer Cycle	NA	NA
Economizer High-Limit Shutoff	NA	NA

Design Airflow Rates (Conditioned Space)	Building Total: 479,686 cfm AHU C2-1: 27,786 cfm AHU C2-2: 8,571 cfm AHU C2-3: 30,060 cfm AHU C2-4: 18,025 cfm AHU C2-5: 3,494 cfm AHU 2-1: 20,926 cfm AHU 2-2: 19,065 cfm AHU 3-1: 31,359 cfm AHU 4-1: 36,078 cfm AHU 5-1: 35,784 cfm AHU 6-1: 36,600 cfm AHU 7-1: 21,807 cfm AHU 7-3: 11,045 cfm AHU 7-4: 16,265 cfm AHU 16-1: 16,759 cfm AHU 16-2: 28,788 cfm PTAC 8th Flr: 13,223 cfm PTAC 9th Flr: 13,522 cfm PTAC 10th Flr: 13,360 cfm PTAC 11th Flr: 12,302 cfm PTAC 12-14th Flr: 47,079 cfm PTAC 15th Flr: 12,522 cfm PTAC 16th Flr: 5,266 cfm	Building Total: 373,530 cfm AHU C2-1: 24,000 cfm AHU C2-2: 6,000 cfm AHU C2-3: 18,000 cfm AHU C2-4: 16,000 cfm AHU C2-5: 3,000 cfm AHU 2-1: 16,000 cfm AHU 2-2: 15,000 cfm AHU 3-1: 28,000 cfm AHU 4-1: 32,000 cfm AHU 5-1: 32,000 cfm AHU 6-1: 32,000 cfm AHU 7-1: 20,000 cfm AHU 7-3: 4,000 cfm AHU 7-4: 15,000 cfm AHU 16-1: 9,000 cfm AHU 16-2: 9,000 cfm FCU 8th Flr: 10,913 cfm FCU 9th Flr: 11,264 cfm FCU 10th Flr: 11,095 cfm FCU 11th Flr: 10,166 cfm FCU 12-14th Flr: 38,878 cfm FCU 15th Flr: 10,397 cfm FCU 16th Flr: 1,817 cfm HRU-1: 35,000 cfm HRU-2: 35,000 cfm HRU-3: 35,000 cfm

Total System Fan Power (Conditioned)	Building Total: 539.7 kW AHU C2-1: 40 kW AHU C2-2: 12.6 kW AHU C2-3: 40.9 kW AHU C2-4: 26.1 kW AHU C2-5: 4.7 kW AHU 2-1: 32.1 kW AHU 2-2: 25.9 kW AHU 3-1: 43.3 kW AHU 4-1: 49.4 kW AHU 5-1: 49.4 kW AHU 6-1: 50.1 kW AHU 7-1: 30.1 kW AHU 7-3: 15 kW AHU 7-4: 23.6 kW AHU 16-1: 22.5 kW AHU 16-2: 38.3 kW PTAC 8th Flr: 4 kW PTAC 9th Flr: 4.1 kW PTAC 10th Flr: 4.1 kW PTAC 11th Flr: 3.8 kW PTAC 12-14th Flr: 14.3 kW PTAC 15th Flr: 3.8 kW PTAC 16th Flr: 1.6 kW	Building Total: 383.2 kW AHU C2-1: 30.9 kW AHU C2-2: 5.6 kW AHU C2-3: 20.5 kW AHU C2-4: 14.9 kW AHU C2-5: 3.7 kW AHU 2-1: 20.6 kW AHU 2-2: 20.6 kW AHU 3-1: 33.6 kW AHU 4-1: 46.3 kW AHU 5-1: 46.3 kW AHU 6-1: 46.3 kW AHU 7-1: 30.8 kW AHU 7-3: 5.6 kW AHU 7-4: 14.9 kW AHU 16-1: 11.2 kW AHU 16-2: 11.2 kW FCU 8th Flr: 2.3 kW FCU 9th Flr: 2.4 kW FCU 10th Flr: 2.4 kW FCU 11th Flr: 2.2 kW FCU 12-14th Flr: 8.3 kW FCU 15th Flr: 2.2 kW FCU 16th Flr: 0.4 kW HRU-1: 85.8 kW HRU-2: 85.8 kW HRU-3: 85.8 kW
Total Supply Fan Power	NA	HRU-1: 56 kW HRU-2: 56 kW HRU-3: 56 kW

Total Return / Relief Fan Power	NA	NA
Total Exhaust Fan Power (tied to AHUs)	NA	HRU-1: 29.8 kW HRU-2: 29.8 kW HRU-3: 29.8 kW
6.5.3.1.1B Pressure Drop Adjustments	For all AHU's except AHU 7-4, 16-1, & 16-2: Fully ducted return and/or exhaust systems - 0.5 Return and/or exhaust airflow control devices - 0.5 Exhaust filters, scrubbers, or other exhaust treatment - 0.47 Particulate Filtration Credit: MERV 13 through 15 - 0.9 Heat recovery device - 0.8 Total - 3.17 For AHU 7-4, 16-1, & 16-2: Fully ducted return and/or exhaust systems - 0.5 Return and/or exhaust airflow control devices - 0.5 Exhaust filters, scrubbers, or other exhaust treatment - 0.47 Total - 1.47	NA
Zone Terminal Boxes Fan Power	NA	0.00015 kW/cfm
Unconditioned Total Fan Power	NA	NA

Unconditioned Total Fan Flow	NA	NA
Semi-conditioned Total Fan Power	NA	NA
Semi-conditioned Total Fan Flow	NA	NA
Exhaust Air Energy Recovery	NA	% of Building Served: 60% Effectiveness: 85% Operation - OA Delta Enthalpy (1 Btu/lb) Operating Mode- Heating/Cooling Make-up Air Temp Ctrl – Mixed Air-Rst Capacity Control – Modulate HX
Demand Control Ventilation	None	None
Supply Air Temperature Reset Parameters	Reset higher by 5°F under minimum cooling load conditions	Reset higher by 5°F under minimum cooling load conditions
Thermal Energy Storage	NA	NA
Other	NA	NA

1.4.3 - ASHRAE 90.1 Appendix G: HVAC (Water-side)

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
The Project Has District Heating (Y/N)	N	N
The Project Has District Cooling (Y/N)	N	N
Number of Chillers	2 water-cooled centrifugal	3 (2 centrifugal water cooled; 1 screw for ice storage)
Chiller Part-Load Controls	None	frictionless; 2 compressor per circuit
Chiller Capacity (Per Chiller)	2x750 tons (1500 tons total)	2x390 tons; 1x425 tons (1200 tons total)
Chiller Efficiency	6.1 COP @ AHRI	6 COP @ AHRI; 5.9 COP @ AHRI
Chilled Water Loop Supply Temp	44°F	42°F
Chilled Water (CHW) Loop Delta-T	12°F	11°F
CHW Loop Temp Reset Parameters	OA Reset (per ASHRAE section G3.1.3.9)	Load Reset
CHW Loop Configuration	Primary/Variable Secondary	Primary/Variable Secondary
Number of Primary CHW Pumps	1	2
Primary CHW Pump Power	9 W/gpm (40 HP)	17 W/gpm (50 HP)
Primary CHW Pump Flow	2,905 gpm	2,160 gpm
Primary CHW Pump Speed Control	Constant Speed	Variable Speed
Secondary CHW Pump Power	13 W/gpm (50 HP)	35 W/gpm (100 HP)
Secondary CHW Pump Flow	2,905 gpm	2160 gpm

Secondary CHW Pump Speed Control	Variable Speed	Variable Speed
Number of Cooling Towers / Fluid Coolers	1	3
Cooling Tower Fan Power	38.2 gpm/hp (80 kW)	33.75 gpm/hp (90 kW; 40 hp each)
Cooling Tower Fan Control	two-speed	variable speed
Condenser Water Leaving Temperature	85°F (leaving cooling tower)	85°F (leaving cooling tower)
Condenser Water (CW) Loop Delta-T	10°F	12°F
CW Loop Temp Reset Parameters	Fixed	Load Reset
CW Loop Configuration	Constant Primary	Primary/Variable Secondary
Number of CW Pumps	1	2
CW Pump Power	19 W/gpm (100 HP)	55 W/gpm (200 HP)
CW Pump Flow	4,057 gpm	2,700 gpm
CW Pump Speed Control	Constant Speed	Variable Speed
Number of Boilers	2 Hydronic Boilers	3 Steam Boilers
Boiler Part-Load Controls	NA	NA
Boiler Capacity (Per Boiler)	2x 8,353 kBtu/h (16,700 kBtu/h total)	2x8368 kBtu/h; 1x4184 kBtu/h (20,900 kBtu/h total)
Boiler Efficiency	82% Ec (~80% Et)	82% Et
Boiler Water Loop Supply Temperature	180°F	250°F; (180°F supply on steam-to-how HX)
Hot Water or Steam (HHW) Loop DT	50°F	20°F
HHW Loop Temp Reset Parameters	OA Reset (per ASHRAE section G3.1.3.4)	Load-Reset
HHW Loop Configuration	Primary Only Variable	Primary Only Variable

Number of Primary HHW Pumps	1	3
Primary HHW Pump Power	19 W/gpm (17 HP)	37 W/gpm (30 HP)
Primary HHW Pump Flow	670 gpm	600 gpm
Primary HHW Pump Speed Control	Variable Speed	Variable Speed
Secondary HHW Pump Power	NA	NA
Secondary HHW Pump Flow	NA	NA
Secondary HHW Pump Speed Control	NA	NA
Thermal Energy Storage Capacity	NA	2,800 ton-hr
Thermal Energy Storage Control Sequence	NA	10 hrs charge; 14 hrs discharge (Charge between 10 PM-8AM)
Thermal Energy Storage Charge Temp	NA	25°F
Thermal Energy Storage Chiller Efficiency	NA	4.8 COP
Water-side Economizer	NA	350 ton capacity; 80% effectiveness plate HX
Water-side Energy Recovery	NA	NA
Cogeneration	NA	200 kW & 65 kW cogeneration systems
Electricity Generation Efficiency	NA	33% & 29%
Exhaust Heat Recovery Efficiency	NA	50% (serving only DHW loop)

1.4.4 - ASHRAE 90.1 Section 7: Service Water Heating

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
SHW Equipment Type	Gas-fired Storage Water Heater	Gas-fired Storage Water Heater
SHW Storage Tank Capacity	DHW Heater 1: 1,000 Gals DHW Heater 2: 900 Gals	DHW Heater 1: 1,000 Gals DHW Heater 2: 900 Gals
SHW Heating Input Capacity[1]	DHW Heater 1: 797 kBtu/h DHW Heater 2: 1,455 kBtu/h	DHW Heater 1: 797 kBtu/h DHW Heater 2: 1,455 kBtu/h
Equipment Efficiency[1]	DHW Heater 1: 80% Et, SL 4,475 Btu/h DHW Heater 2: 80% Et, SL 5,119 Btu/h	DHW Heater 1: 80% Et, SL 4,475 Btu/h DHW Heater 2: 80% Et, SL 5,119 Btu/h
Temperature Controls	140°F Supply	140°F Supply
SHW Energy Recovery	NA	NA
Other	No improvements on DHW equipment	No improvements on DHW equipment

1.4.5 - ASHRAE 90.1 Section 9: Lighting

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Automatic Lighting Shutoff Method	Lighting schedules used are understood to reflect mandatory control requirements (table G3.1.6)	Lighting schedules used are understood to reflect mandatory control requirements (table G3.1.6)
Gross Lighted Floor Area	346,344 sf	346,344 sf
Interior Lighting Power Calc Method	Space-by-Space Method	Space-by-Space Method
Interior Lighting Power Density (Average)	1.14 W/sf	0.93 W/sf
Interior LPD per space (Space-by-Space)	Stair - 0.6 W/sf Dorm - 1.1 W/sf Storage - 0.8 W/sf Corridor - 0.5 W/sf Laundry - 1.9 W/sf MER - 1.5 W/sf Dining - 0.9 W/sf Office - 1.1 W/sf Restroom - 0.9 W/sf Fitness - 0.6 W/sf Kitchen - 1.2 W/sf Meeting - 1.3 W/sf Lecture - 1.4 W/sf Classroom - 1.4 W/sf Lobby - 1.3 W/sf Lounge - 1.2 W/sf Library Reading - 1.2 W/sf Auditorium - 2.6 W/sf	Stair - 0.42 W/sf Dorm - 0.58 W/sf Storage - 0.62 W/sf Corridor - 0.82 W/sf Laundry - 0.87 W/sf MER - 0.97 W/sf Dining - 0.98 W/sf Office - 1.07 W/sf Restroom - 1.13 W/sf Fitness - 1.15 W/sf Kitchen - 1.22 W/sf Meeting - 1.27 W/sf Lecture - 1.3 W/sf Classroom - 1.35 W/sf Lobby - 1.39 W/sf Lounge - 1.42 W/sf Library Reading - 1.21 W/sf Auditorium - 1.51 W/sf

	Library Stacks - 1.7 W/sf Retail - 1.7 W/sf	Library Stacks - 1.58 W/sf Retail - 1.7 W/sf
Additional Lighting Power Allowance	NA	NA
Automatic Interior Space Shutoff Control in Required Spaces (Section 9.4.1.2)	Classrooms, meeting rooms, break areas	Classrooms, meeting rooms, break areas
Interior Lighting Power Adjustments (Table G3.2)	None	None
Daylight Dimming Controls	None	Perimeter spaces in academic spaces; 50% of space lighting controlled using continuous dimming
Automatic Exterior Lighting Control	NA	NA
Total Exterior Lighting Power	NA	NA
Tradable Surface Exterior Lighting Power	NA	NA

Non-Tradable Surface Exterior Lighting Power	NA	NA
Other	NA	NA

1.4.6 – Miscellaneous

Model Input Parameter / Energy Efficiency Measure	Baseline Case	Proposed Case
Receptacle equipment	Auditorium(Assembly) – 1.0 W/sf Classrooms – 1.0 W/sf Mechanical / Electrical – 0.5 W/sf Restrooms – 0.0 W/sf Kitchen – 1.0 W/sf Dormitory (Living Quarters) – 0.5 W/sf Lounge – 0.5 W/sf Office – 1.0 W/sf Fitness - 2.0 W/sf Storage - 0 W/sf Laundry - 1.0 W/sf Retail - 0.5 W/sf Dining - 1.0 W/sf	Auditorium(Assembly) – 1.0 W/sf Classrooms – 1.0 W/sf Mechanical / Electrical – 0.5 W/sf Restrooms – 0.0 W/sf Kitchen – 1.0 W/sf Dormitory (Living Quarters) – 0.5 W/sf Lounge – 0.5 W/sf Office – 1.0 W/sf Fitness - 2.0 W/sf Storage - 0 W/sf Laundry - 1.0 W/sf Retail - 0.5 W/sf Dining - 1.0 W/sf
Escalators and Elevators	132 kW	132 kW
Refrigeration equipment	NA	NA
Cooking	NA	NA
Data Center & Server Room Loads	NA	NA
Process loads	NA	NA
Other	NA	NA

7 Energy Summary by End use (Proposed design vs. baseline building)

End Use	Energy Type	Proposed Building Energy	Baseline Building Energy	Proposed / Baseline Energy %
Lighting - Conditioned	Electricity, kWh	827,074	971,180	85%
Space Cooling & Heat Rejection	Electricity, kWh	986,347	1,410,548	70%
Space heating	Electricity, kWh	5,665	0	-
Space heating	Natural Gas, therms	80,482	158,605	51%
Pumps & Aux	Electricity, kWh	639,635	843,549	76%
Fans	Electricity, kWh	1,036,644	1,336,910	78%
Office Equipment/Elev	Electricity, kWh	974,219	974,219	100%
DHW	Natural Gas, therms	4,670	55,910	8%
Cogeneration Gas Consumption	Natural Gas, therms	245,830	N/A	N/A
Cogeneration Electricity Generation	Electricity, kWh	-2,324,545	N/A	N/A
TOTAL BUILDING CONSUMPTION (MMBtu)		40,414.389	40,341.717	**100.2%**

Type	Proposed Energy Use [kWh], [therms]	Proposed Cost [$]	Baseline Energy Use [kWh]	Baseline Cost [$]	Proposed / Baseline Energy %	Proposed / Baseline Cost %
Total Electricity	2,144,223	$519,119	5,536,406	$1,089,011	39%	48%
Total Natural Gas	330,983	$420.315	214,515	$275,673	154%	152%
Total Energy Cost		$939,432		$1,362,447		69%
				Percent Cost Savings =		**31.16%**

Results of whole building simulation show that the improved proposed design, with agreed upon energy conservation measures, and performs **31.2%** better energy cost savings than the baseline building.

8 Conclusion

8.1 Energy Analysis

The building is designed with an aim to reduce the energy consumption by incorporating efficiency gains in the form of high performance envelope, reduced lighting loads, on-site electricity generation, waste heat recovery and efficient mechanical system operation. The results of energy analysis show that the proposed design consumes 2,144 MWh of electricity and 330,983 therms of natural gas annually. The total estimated annual energy cost for the proposed case is about $939,432.

The calculation for LEED EA credit 1, using Performance Rating Method, show that the proposed building designs performs **31.2% better** than the baseline building.

It is essential that the building performs as intended for less energy operation. Thus, it is recommended that building automation controls be installed to optimize the building energy use, with manual override.

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