February 6, 2015

ENERGY ANALYSIS
FOR
MANHATTAN WEST RESIDENTIAL TOWER
NEW YORK CITY

Based on the GMP Set dated
December 15, 2014
With Revisions

Submitted by:
Viridian Energy & Environmental
A Vidaris, Inc. Company
50 Washington Street
Norwalk, CT 06854
Adrian Tuluca, RA
Senior Principal
Phone: 203-299-1411
Fax: 203-299-1656
E-mail: atuluca@vidaris.com

Prepared for:
Brookfield Office Properties
250 Vesey Street, 15th Floor
New York, NY 10281
Megan Brothers
Phone: 212-417-7297
E-mail: megan.brothers@brookfield.com

TABLE OF CONTENTS

REPORT OVERVIEW

The Manhattan West SW Residential building, located in New York City, has approximately 790,000 ft^2 and 63-stories. The building has a mechanical bulkhead and a single-story basement.

The annual energy cost of the building and the savings of its energy efficient measures were estimated with DOE-2.1E energy analysis software.

The building as designed saves 10.2% in regulated energy costs compared to the NYC Energy Conservation Code 2011 baseline. Compliance with the NYC Energy Code is demonstrated by compliance with LL 48/2010 and LL 1/2011, and via the 2010 NYS Energy Construction Conservation Code, Section 506. **The building complies with the NYC Energy Code requirements.**

The tables below give a summary of results.

DESIGN BUILDING ENERGY PERFORMANCE

NYC Energy Conservation Code 2011	Total Annual Energy Cost [$]	Regulated Annual Energy Cost [$]	Savings Vs. Code Case [$]	Savings Vs. Code Case [%]	Code Compliant (Y/N)
Code Case: Based on NYCECC 2011	1,818,819	1,255,514			
Design case for Code	1,674,676	1,127,204	128310	10.2%	Y

Note:
This report is developed for the purpose of calculating the energy performance as per modeling requirements. Actual energy use and cost will be greater, since the modeling rules do not account for many real-life issues, such as quality of construction, equipment functionality, building operation and other factors. Reasons include, but are not limited to the following:

- The code baseline assume perfection, as noted in the bullets below, so the Proposed Design model also must assume perfection:
  - The HVAC equipment is manufactured as per standards. The design of the HVAC systems is such that the each individual piece of equipment performs optimally. The installation is flawless, and the operation optimum.
  - Lighting and lighting controls are perfectly manufactured/installed and function as such.
  - The insulation is installed perfectly. There are no gaps and no rips caused by pipes and wiring. The windows are put in place with perfect caulking.
- Certain real-life effects are not included in the baseline calculations, and therefore are not included in the design calculations either. For instance, the three-dimensional heat loss effect that occurs at the roof parapet
- Occupant behavior is idealized
- Other effects, such as uncertainties in equipment (plug load) operation.

COMPARISON OF BUILDING DESIGN TO ENERGY CODE

The following table shows the comparison of the Proposed Design Case and the NYC Energy Code Case:

Design case	NYC Energy Code	Design Source
Walls, Above Grade *Exterior Wall Construction, Spandrel Panel* *Spandrel Wall Component* • Insulated Glass Assembly (W/Mullions) • 5" Mineral Fiber Insulation (R-4.2/Inch), Derated To R-3.25 Per Therm Analysis • Air Gap • 4" Foil Faced Batt Insulation (R-13 Batts), Derated To R-1.75 Per Therm Analysis • Backing Board • Gypsum Board *Slab Edge Component* • Insulated Glass Assembly (W/Mullions) • Air Gap • 1-1/2" Mineral Fiber Insulation (R-4.2/Inch), Derated To R-1.42 Per Therm Analysis • 1-3/8" Firestopping (R-3.8/Inch) , Derated Per Therm Analysis • Concrete Slab Total Wall • Overall U-Value = 0.178 Btu/hr-ft^2-R	Walls, Above Grade *Exterior Wall Construction, Spandrel Panel* *Spandrel Wall Component* • Insulated Glass Assembly (W/Mullions) • 5" Mineral Fiber Insulation • Air Gap • 4" Foil Faced Batt Insulation • Backing Board • Gypsum Board *Slab Edge Component* • Insulated Glass Assembly (W/Mullions) • Air Gap • 1-1/2" Mineral Fiber Insulation • 1-3/8" Firestopping • Concrete Slab Total Wall Overall U-Value = 0.064 Btu/hr-ft2-R	A-314.00 Output Report LV-I

<table>
<tr><td>Walls, Above Grade

Exterior Wall Construction, Metal Panel
• Metal Panel
• Air Gap
• 1-5/8" Mineral Fiber Insulation (R-4.2/Inch), Derated To R-1.02 Per Therm Analysis
• 1-3/8" Firestopping (R-3.8/Inch), Derated Per Therm Analysis

Total Wall
• Overall U-Value = 0.374 Btu/hr-ft²-R</td><td>Walls, Above Grade

Exterior Wall Construction, Metal Panel
• Metal Panel
• Air Gap
• 1-5/8" Mineral Fiber Insulation
• 1-3/8" Firestopping

Total Wall
• Overall U-Value = 0.064 Btu/hr-ft²-R</td><td>A-341
Output Report LV-I</td></tr>
<tr><td>Walls, Above Grade

Exterior Wall Construction, Solid Wall
Solid Wall Component
• Insulated Glass Assembly (W/Mullions)
• 5" Mineral Fiber Insulation (R-4.2/Inch), Derated To R-3.85 Per THERM Analysis
• Air Gap
• 18” Concrete Wall

Slab Edge Component
• Insulated Glass Assembly (W/Mullions)
• 5" Mineral Fiber Insulation (R-4.2/Inch), derated To R-4.02 Per THERM Analysis
• 1-3/8" Firestopping (R-3.8/Inch) , derated Per THERM Analysis
• Concrete Slab

Total Wall
• Overall U-Value = 0.159 Btu/hr-ft²-R</td><td>Walls, Above Grade

Exterior Wall Construction, Solid Wall
Solid Wall Component
• Insulated Glass Assembly (W/Mullions)
• 5" Mineral Fiber Insulation
• Air Gap
• Concrete Wall

Slab Edge Component
• Insulated Glass Assembly (W/Mullions)
• 5" Mineral Fiber Insulation
• 1-3/8" Firestopping
• Concrete Slab

Total Wall (mass)
• Overall U-Value = 0.090 Btu/hr-ft²-R</td><td>A-320
Output Report LV-I</td></tr>
<tr><td>Vertical Glazing

53.4% vertical glazing</td><td>Vertical Glazing

40% vertical glazing</td><td>A-200
Output Report LV-D</td></tr>
</table>

Hybrid Window Wall (53.1%) • Solar heat gain coefficient (SHGC) = 0.23 • Visible Light Transmittance = 0.31 • U-factor (assembly) = U-0.49 Storefront Window (0.3%) • Solar heat gain coefficient (SHGC) = 0.82 • Visible Light Transmittance = 0.76 • U-factor (assembly) = U-1.25	Metal glazing, all other (39.8%) • Solar heat gain coefficient (SHGC) = 0.40 • U-factor (assembly) = U-0.55 Metal glazing, storefront (0.2%) • Solar heat gain coefficient (SHGC) = 0.40 • U-factor (assembly) = U-0.50	
Roofs *Terrace Roof Construction* • 2" Pavers R = 0.3, degraded 50% • Air Space R=0.82 • Filter Fabric • (R-20) 4" Extruded Polystyrene Insulation (Continuous) • Drainage Mat • Reinforced Cold Fluid Applied Membrane • 2“ Lightweight Concrete Topping Slab • Structural Concrete Deck • U-factor = U-0.044	Roofs *Insulation entirely above deck* • 2" Pavers • Air Space • Filter Fabric • (R-20) 4" Extruded Polystyrene Insulation (Continuous) • Drainage Mat • Reinforced Cold Fluid Applied Membrane • Topping Slab • Structural Concrete Deck • U-factor = U-0.048	A-320 through A-325 Output Report LV-I
Roofs *Mechanical Roof Construction* • Gravel Ballast • Filter Fabric • (R-20) 4" Extruded Polystyrene Insulation (Continuous) • Drainage Mat • Reinforced Cold Fluid Applied Membrane • 2” Lightweight Concrete Topping Slab • Structural Concrete Deck • U-factor = U-0.046	Roofs *Insulation entirely above deck* • Gravel Ballast • Filter Fabric • (R-20) 4" Extruded Polystyrene Insulation (Continuous) • Drainage Mat • Reinforced Cold Fluid Applied Membrane • Topping Slab • Structural Concrete Deck • U-factor = U-0.048	A-320 through A-325 Output Report LV-I

Underground wall construction • 1.5" Polystyrene insulation (R-7.5) • 14" Concrete • C-0.119 (wall only; without soil), per ASHRAE 90.1-2007 Table A4.2 • U = 0.110 including interior air-film	Underground wall construction • 14" Concrete • C-1.140 (wall only; without soil) • U = 0.642 including interior air-film	A-306 LV-I output report
Slab-on-grade construction • Soil • Gravel • Concrete slab • Unheated • F-factor = F-0.730	Slab-on-grade construction • Soil • Gravel • Concrete slab • Unheated • F-factor = F-0.730	A-310 No output verification available
Lighting <u>Lighting Power Density</u> Apartments Owner-provided 0.6[1] W/ft^2 Tenant-provided 0.7 W/ft^2 Amenity 0.4 W/ft^2 Basketball court 0.4 W/ft^2 Cafeteria 0.6 W/ft^2 Corridor 0.6 W/ft^2 Electrical 0.5 W/ft^2 EMR 0.7 W/ft^2 Lobby 0.6 W/ft^2 Locker 0.5 W/ft^2 Lounge 0.4 W/ft^2 Mail room 0.3 W/ft^2 Mechanical 0.6 W/ft^2 Office 0.4 W/ft^2 Retail 1.5 W/ft^2 Stairwells 0.8 W/ft^2 Storage 0.4 W/ft^2 General BOH 0.4 W/ft^2	Lighting <u>Lighting Power Density</u> Whole Building, Excluding Retail 0.7 W/ft^2 Retail 1.5 W/ft^2	E-200.00, E-202.00, E-204.00, E206.00, E-208.00 thru E217.00, E-402.00 LV-B Output report

[1] 43% of the apartment area has owner-provided lighting (i.e. kitchens, baths, and hallways). The rest of the apartment has tenant-provided lighting which is the same as the Baseline.

<table>
<tr><td></td><td></td><td></td></tr>
<tr>
<td>Occupancy sensors

Occupancy sensors for lighting control in stairwells, corridors, office, storage, lounge, gym, and cafe.
In the BOH corridors, offices, storage rooms and stairwells the lighting usage is reduced by 10%.</td>
<td>Occupancy sensors

Vacancy sensors in office</td>
<td>E-200.00, E-202.00, E-204.00, E206.00, E-208.00 thru E217.00, E-402.00</td>
</tr>
<tr>
<td>Exterior Lighting
Tradable Lighting
<table>
<tr><th>Category</th><th>Area</th><th>Wattage</th></tr>
<tr><td>Plaza</td><td>6430</td><td>592</td></tr>
<tr><td>Other Door</td><td>9</td><td>120</td></tr>
<tr><td>Total</td><td></td><td>712 W</td></tr>
</table></td>
<td>Exterior Lighting
Lighting Zone 2
Tradable Lighting
<table>
<tr><th>Category</th><th>Area</th><th>Wattage</th></tr>
<tr><td>Plaza</td><td>6430</td><td>900.2</td></tr>
<tr><td>Other Door</td><td>9</td><td>180</td></tr>
<tr><td>Base Site Allowance</td><td></td><td>600</td></tr>
<tr><td>Total</td><td></td><td>1680.2 W</td></tr>
</table></td>
<td>E-217, E219
Note- Temporary parking lighting on E-202 is not included</td>
</tr>
<tr>
<td>Energy Star appliances in apartments (based on MFHR guidelines)
<table>
<tr><th>Appliances</th><th>Energy Use kWh/year</th></tr>
<tr><td>Refrigerator</td><td>423</td></tr>
<tr><td>Dishwasher</td><td>164</td></tr>
<tr><td>Clothes washer</td><td>57</td></tr>
<tr><td>Clothes dryer</td><td>535</td></tr>
</table>
An additional plug load of 1.05 annual kWh/ft^2 for miscellaneous equipment in apartments

Gas cooking at 4.5 Million-Btu annually per apartment.</td>
<td>Energy Star appliances in apartments (based on MFHR guidelines)

Same as Design</td>
<td>Assumed- Unregulated
LV-B output report</td>
</tr>
<tr>
<td>Plug loads (other than apartments) based on MFHR guidelines

Corridors, restrooms, stairs, and support areas: 0.7 annual kWh/ ft^2</td>
<td>Plug loads (other than apartments) based on MFHR guidelines

Same as design</td>
<td>Assumed- Unregulated
LV-B output report</td>
</tr>
</table>

Other Multifamily Public & Common Areas: 1.6 annual kWh/ ft² Office: 4.9 annual kWh/ ft²		
Heating Schedule Heating temperature is set for 72°F during the hours of operation with a 65°F setback during unoccupied hours between January 1 thru May 15 and October 1 thru December 31	Heating Schedule Same as design	Assumed- Unregulated No output report
Cooling Schedule Cooling temperature is set at 75°F for corridors. Cooling in apartments is set at 75F during occupancy hours, with an 80°F setback during unoccupied hours from April 15 thru October 31. Cooling is available in common areas all year.	Cooling Schedule Same as design	Assumed- Unregulated No output report
HVAC – Low-rise corridors (AC-4-1) • Packaged DX unit with Dry Cooler • Cooling EER = 14.2 • Total cooling capacity = 848 MBH • Steam heating coils (boiler thermal efficiency = 82%) • 13,000 cfm outside air • Supply CFM = 13,000 • Supply BHP = 11.2 HP • Return BHP = 11.2 HP • Exhaust air heat recovery via enthalpy heat recovery wheel. Recovery efficiency = 85.4%	HVAC – Low-rise corridors (AC-4-1) • System #4: Packaged VAV with reheat • Cooling EER=9.5 (>760 MBH) • Cooling IPLV = 9.3 • Total cooling capacity = 1062 MBH • Hot water heating coils (boiler combustion efficiency = 82%) • 13,000 cfm outside air • Supply CFM = 13,000 • Supply BHP 11.2 HP • Return BHP = 11.2 HP • Exhaust air heat recovery with recovery efficiency = 50%	M-401 SV-A output report Note- boiler flue heat recovery is not modeled for compliance

• VFD drives • MERV 13 filters • Boiler flue heat recovery • Fan bhp/cfm per design documents	• VAV fan control • MERV 13 filter credit allowed • Fully ducted return air credit • Heat recovery pressure drop credit • No boiler flue heat recovery • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	
HVAC – High-rise corridors (AC-63-1, ACC-64-1) • Split air-cooled packaged DX unit • Cooling EER=10.1 • Total cooling capacity = 693 MBH • Natural gas furnace • Heating thermal efficiency 85.5% • 13,000 cfm outside air • Supply CFM = 13,000 • Supply Fan BHP = 16 HP • Return Fan BHP = 10 HP • Heat recovery with enthalpy heat recovery wheel. Recovery efficiency = 57% • VFD Drives • MERV 13 filters • Fan bhp/cfm per design documents	HVAC – High-rise corridors (AC-63-1) • System #4: Packaged VAV with reheat • Cooling EER=9.5 (>760 MBH) • Cooling IPLV = 9.3 • Total cooling capacity = 990 MBH • Hot water heating coils (boiler combustion efficiency = 80%) • 13,000 cfm outside air • Supply CFM = 13,000 • Supply fan BHP =16 HP • Return BHP = 10 HP • Heat recovery with recovery efficiency = 50% • VAV fan control • MERV 13 filters • Fully ducted return air credit • Heat recovery pressure drop credit • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401
Heating & Cooling for Apartments Heating and cooling is provided to each room by packaged terminal air conditioners with steam heating coils. The PTAC unit efficiency is as follows: Capacity [Btuh] EER Qty cfm 9,700 12.0 672 350 12,800 11.4 729 380	Heating & Cooling for Apartments System #10: Packaged terminal air conditioners with hot water coils. Capacity [Btuh] EER Qty cfm 9130 10.5 672 328 12,044 9.9 729 356	M-401

14,000 10.5 246 660 The weighted average EER of the PTAC units = 11.44 Total cooling capacity = 19293 MBH Total supply cfm = 674,580 cfm Fan bhp/cfm is per ASHRAE 90.1-2007, G3.1.2.9 (0.3 W/cfm).	13,173 9.7 246 618 The weighted average EER of the PTAC units = 10.1 Total cooling capacity = 18,200 MBH Total supply cfm = 632,386 cfm Fan energy is same as design.	
HVAC – Lobby (AC-3-2, RF-3-2) • Packaged DX unit with Dry Cooler • Cooling Capacity = 432 MBH • Cooling EER=14.6 • Baseboard hot water heating coils (boiler thermal efficiency = 82%) • Constant volume (VFD for balancing) • No economizer controls • OA CFM = 4,000 (8,000 CFM during heating season) • Supply CFM = 8,000 • Supply fan BHP = 6.55 HP • Return fan BHP = 3.9 HP • MERV 13 filters • Fan bhp/cfm per design documents, complying with the NYSECCC 2010, Section 503.2.10.1 requirements for VAV systems	HVAC - Lobby (AC-3-2, RF-3-2) • System #11: Packaged rooftop AC • Total cooling capacity = 432 MBH • Cooling EER=9.8 (240-760 MBH) • Cooling IPLV = 9.5 • Heating from 80% efficient furnace coils • Heating capacity = 389 MBH • Constant volume • Enthalpy controlled airside economizer • OA cfm = 4,000 (8,000 CFM during heating season) • Supply CFM = 8,000 • Fan BHP = 6.55 HP • Return fan BHP = 3.9 HP • MERV 13 filters • Fan bhp/cfm same as design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401
HVAC – Gym (AC-3-4, RF-2-1) • Packaged DX unit with Dry Cooler • Total Cooling Capacity = 825 MBH • Cooling EER = 14.0	HVAC – Gym (AC-3-4) • System #4: Packaged VAV with reheat • Total cooling capacity = 790 MBH • Cooling EER=9.5 (>760 MBH) • Cooling IPLV = 9.2	M-401

• Hot water heating coils (boiler thermal efficiency = 82%) • Additional air distribution via fan powered boxes • No economizer controls • OA cfm = 6,500 • Supply CFM = 15,000 • Supply fan BHP = 13.6 HP • Return fan BHP = 5.39 HP • MERV 13 filters • Fan bhp/cfm per design documents	• Hot water heating coils (boiler combustion efficiency = 82%) • Enthalpy controlled airside economizer • OA cfm = 6,500 • Supply CFM = 15,086 • Supply fan BHP = 13.6 HP • Return fan BHP = 5.39 HP • MERV 13 filters • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	
HVAC – Basketball court (AC-4-2, RF-3-4) • Packaged DX unit with Dry Cooler • Cooling capacity = 461 MBH • Cooling EER = 14.4 • Hot water heating coils (boiler thermal efficiency = 82%) • Variable volume fan • No airside economizer controls • OA cfm = 2,100 • Supply CFM = 11,000 • Supply Fan BHP = 8.94 HP • Return Fan BHP = 4.25 HP • MERV 13 filters • Fan bhp/cfm per design documents	HVAC – Basketball court (AC-4-2) • System #11: Packaged rooftop AC • Total cooling capacity = 359 MBH • Cooling EER=9.8 (240-760 MBH) • Cooling IPLV = 9.5 • Heating from 80% efficient furnace coils • Heating capacity = 300 MBH • Constant volume fan • Enthalpy controlled airside economizer • OA cfm = 2,100 • Supply CFM = 8,023 • Supply Fan BHP = 6.52 HP • Return Fan BHP = 3.1 BHP • MERV 13 filters • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401
HVAC – Amenity (AC-4-3, RF-3-5) • Packaged DX unit with Dry Cooler • Cooling capacity = 461 MBH • Cooling EER=14.4	HVAC – Amenity (AC-4-3) • System #4: Packaged VAV w/ reheat • Cooling capacity = 467 MBH • Cooling EER=9.8 (240-760 MBH) • Cooling IPLV = 9.5	M-401

• Hot water heating coils (boiler thermal efficiency = 82%) • No airside economizer controls • • OA cfm = 1,700 • Supply CFM = 10,000 • Supply fan BHP = 7.72 HP • Return fan BHP = 4.01 HP • MERV 13 filters • Fan bhp/cfm per design documents	• Hot water heating coils (boiler combustion efficiency = 82%) • Enthalpy controlled airside economizer • OA cfm = 1,700 • Supply CFM = 10,539 • Fan BHP = 8.13 • Return Fan BHP = 4.23 • MERV 13 filters • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	
HVAC – Lounge (AC-63-2, ACC-64-2, RF-63-1) • Split Air-cooled packaged DX unit • Cooling capacity = 520 MBH • Cooling EER=9.8 • Heating from 80% efficient furnace • Heating capacity = 480 MBH • No airside economizer controls • OA cfm = 3,000 • Supply CFM = 14,000 • Supply fan BHP = 16 HP • Return fan BHP = 4.5 HP • Fan bhp/cfm per design documents	HVAC – Lounge (AC-63-2) • System #11: Packaged rooftop AC • Cooling capacity = 757 MBH • Cooling EER=9.8 (240-760 MBH) • Cooling IPLV = 9.5 • Heating from 80% efficient furnace • Heating capacity = 588 MBH • Airside economizer controls • OA cfm = 3,000 • Supply CFM = 21,835 • Supply fan BHP = 24.9 HP • Return fan BHP = 7.0 HP • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401, M-402
HVAC – Back-Of-House (AC-3-1, RF-3-1) • Packaged DX unit with Dry Cooler • Cooling capacity = 535 MBH • Cooling EER=13.6 • Hot water heating coils (boiler thermal efficiency = 82%) • No airside economizer controls	HVAC – Back-Of-House (AC-3-1) • System #4: Packaged VAV w/ reheat • Cooling capacity = 815 MBH • Cooling EER=9.5 (>760 MBH) • Cooling IPLV = 9.2 • Hot water heating coils (boiler combustion efficiency = 82%) • Enthalpy controlled airside economizer • OA cfm = 2,800	M-401, M-402

• OA cfm = 2,800 • Supply CFM = 14,000 • Supply fan BHP = 13.7 HP • Return fan BHP = 6.52 HP • MERV 13 filter • Fan bhp/cfm per design documents	• Supply CFM = 22,167 • Supply fan BHP = 21.7 HP • Return fan BHP = 10.3 HP • MERV 13 filter • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	
HVAC – Retail • Air-cooled packaged DX unit • Cooling capacity = 94 MBH • Cooling EER=11.0 (65-135 MBH) • Heating from 80% efficient furnace • Heating capacity = 151 MBH • Constant volume • Enthalpy controlled airside economizer • OA cfm = 562 • Supply CFM = 2,808 • Fan BHP = 3.8 HP • Fan bhp/cfm per NYSECCC 2010, Section 503.2.10.1 requirements	HVAC – Retail • System #11: Packaged rooftop AC • Cooling capacity = 94 MBH • Cooling EER=11.0 (65-135 MBH) • Heating from 80% efficient furnace • Heating capacity = 151 MBH • Constant volume • Enthalpy controlled airside economizer • OA cfm = 562 • Supply CFM = 2,808 • Fan BHP = 3.8 HP • Fan bhp/cfm per NYSECCC 2010, Section 503.2.10.1 requirements	Assumed, tenant fit-out
HVAC – Cellar support spaces (AC-B1-1 thru 5, EF-B-2, EF-B-3, EF-3-1) • Packaged water cooled DX unit with Dry Cooler • Total cooling capacity = 535 MBH • Average cooling EER=13.67 • No heating • Constant volume • Water-side economizer when CW temp is below 44F • OA cfm = 0 (total) • Supply CFM = 22,815 • Supply fan BHP = 18.2 HP • Return fan BHP = 1.75 HP • Fan bhp/cfm per design documents	HVAC – Cellar support spaces (AC-B1-1 thru 5) • System #11: Packaged rooftop AC • Total Cooling capacity = 210 MBH (5 units) • Cooling SEER=13.0 (<65 MBH) • Heating from 80% efficient furnace • Heating capacity = 415 MBH • Constant volume • No economizer control • OA cfm = 0 (total) • Supply CFM = 21,323 (total) • Supply fan BHP = 17.0 HP • Return bhp = 1.6 HP kW • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401

HVAC – 36th floor support spaces (AC-36-1 thru 4 (AC-36-2 & 4 standby)) • Packaged water cooled DX unit with Dry Cooler • Total cooling capacity = 137 MBH (active units only) • Average cooling EER=12.69 • No heating • Constant volume • Water-side economizer when CW temp is below 44F • OA cfm = 0 (total) • Supply CFM = 5,850 • Fan HP = 4.0 HP • Fan hp/cfm per design documents	HVAC – 36th floor support spaces (AC-36-1 thru 4) • System #11: Packaged rooftop AC • Total Cooling capacity = 17.8 MBH (2 units) • Cooling SEER=13.0 (<65 MBH) • Heating from 80% efficient furnace • Heating capacity = 26.8 MBH • Constant volume • Constant volume • No economizer control • OA cfm = 0 (total) • Supply CFM = 1,358 • Fan HP = 0.9 HP • Fan hp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401
HVAC – EMR (AC-65-1 thru 4, ACC-64-1 thru 4, ACC-64-2&4 standby) • Split air-cooled Packaged DX unit • Total cooling capacity = 144.3 MBH • Average cooling EER=11.08 • Electric heating • Constant volume • OA cfm = 0 (total) • Supply CFM = 5850 • Fan HP = 7 HP • Fan hp/cfm per design documents	HVAC – EMR (AC-65-1 thru 4) • System #9: Packaged rooftop HP • Total Cooling capacity = 121 MBH (2 units) • Cooling SEER = 13 (<65 MBH) • Heating capacity = 260 MBH • Heating HSPF = 7.7 (<65 MBH cooling cap) • Constant volume • OA cfm = 0 (total) • Supply CFM = 8863 • Fan BHP =10.6 HP • Fan hp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-401
HVAC-Security (AC-1-1) • Packaged water cooled DX unit with Dry Cooler • Cooling capacity = 57.3 MBH • Average cooling SEER = 13	HVAC-Security (AC-1-1) • System #11: Packaged rooftop AC • Cooling capacity = 25 MBH • Cooling SEER=13.0 (<65 MBH) • Heating from 80% efficient furnace	M-401

• Heating via hot water baseboards • Water-side economizer when CW temp is below 44F • Constant volume • OA cfm = 0 (total) • Supply CFM = 2,500 • Supply fan HP = 2.0 HP • Fan hp/cfm per design documents	• Heating capacity = 94 MBH • No economizer control • Constant volume • OA cfm = 0 (total) • Supply CFM = 3,178 • Supply fan BHP = 2.5 HP • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	
HVAC- Sally Port (AC-S-1thru3, SF-1-1, EF-1-2) • Split air-cooled Packaged DX unit • Average cooling EER=10.7 • Electric heating • Constant volume • OA cfm = 500 (total) • Supply CFM = 3730 • Supply Fan BHP = 1.53 HP • Exhaust fan BHP = 1.33 • Fan hp/cfm per design documents	HVAC- Sally Port (AC-S-1thru3, SF-1-1, EF-1-2) • System #9: Packaged rooftop HP • Cooling capacity = 42.5 MBH • Cooling SEER = 13 (<65 MBH) • Heating HSPF = 7.7 (<65 MBH) • Heating capacity = 45 MBH • Constant volume • OA cfm = 500 (total) • Supply CFM = 5741 • Supply fan BHP = 2.0 kW • Fan bhp/cfm equal to design case, within the NYSECCC 2010, Section 503.2.10.1 requirements	M-402
Heating Plant Heating is provided by two 8,368 MBH and one 4,184 MBH low pressure steam boilers. The boiler thermal efficiency is 82%. The boilers have modulating flame burner. There is heat recovery from the boiler flue for the lower residential corridors outside air supply and DHW heating. (EC-1, EC-2, EC-3)	Heating Plant Heating is provided by two 9,670 MBH hot water boilers. The boiler combustion efficiency is 82%. The boilers have ON-OFF flame burner.	M-401 PS-H Output report * Proposed modeled as (3) 6973 MBH boilers. DOE2.1E does not allow different boiler sizes. Boiler flue heat recovery is not modeled for compliance
Hot Water Pumps (HWP-4-1/2, GWP-4-4/5, HWP-63-1/2, one stand-by for each type, 3 active) • Total flow = 265 gpm	Hot Water Pumps • Total flow = 772 gpm	M-402

• Hot water pumps = 37.8 W/gpm • Variable speed drives with minimum turndown ratio of 50%	• Hot water pumps = 37.8 W/gpm • Variable speed drives with minimum turndown ratio of 50%	
Steam Condensate Pumps • 23 W/gpm • 400 gpm • Variable speed drives with minimum turndown ratio of 50%	Steam Condensate Pumps N/A	M-402
Dry Coolers • Three Dry Coolers 100 Tons each • One Dry Cooler of 20 Tons • Fan Power: 15 hp for each 100-Ton units; 3 hp for the 20-Ton unit • Pump: 12.7 bhp for each 100-Ton units; 5.9 bhp for the 20-Ton unit	Cooling Towers N/A	M-402 Note- Dry-cooler energy is accounted for in the efficiency of the air conditioning units. Please see calculations following table.
Domestic Hot Water • Condensing boilers with 97% efficiency, modulating flame burner. • Heat recovered from the low pressure steam HW boiler flue is used to pre-heat DHW.	Domestic Hot Water • Gas fired hot water heater with 80% efficiency, on/off control	P-401 Note- boiler flue heat recovery is not modeled for compliance

Dry Cooler Efficiency Modifications for Energy Model

	Dry Cooler Set 1	Dry Cooler Set 2
	AC-DC-1thru3	AC-DC-64-1
Cooling capacity Served (MBH)	3824.7	136.8
Cooling capacity Served (tons)	300	20
Dry Cooler Pump Power (BHP)	38.1	5.9
Pump Efficiency	93%	92%
Dry Cooler Pump Power (kW)	30.6	4.8
Dry Cooler Fan Power (HP)	1.5	1.5
# Dry Cooler Fans	15	2
Total Dry Cooler Fan Power (HP)	45	3
Fan motor efficiency	86.5%	86.5%
Total Fan Power (kW)	38.8	2.6
Total Dry Cooler Power (kW)	69.4	7.4
Dry Cooler kW/ton	0.231	0.369

Proposed Case Modeled Cooling Efficiency with Dry Cooler Adjustments

DOE 2.1 System	Proposed Unit	Cooling Capacity (MBH)	EER	EER w/o Fans per ASHRAE 90.1-2010 Addendum bl	Cooling Eff. w/o fans, kW/ton	Dry Cooler serving Unit	Dry Cooler Adjustment (kW/ton)	Total Efficiency (kW/ton)	Modeled EIR
AC-1-1	AC-1-1	57.3	12.3	14.37	0.8349	AC-DC-1thru3	0.231	1.0659	**0.3031**
AC-3-4	AC-3-4	825	14	19.24	0.6239	AC-DC-1thru3	0.231	0.8549	**0.2431**
AC-36-1-4	AC-36-1, 2	79.5	11	12.92	0.9288	AC-DC-64-1	0.369	1.2978	
AC-36-1-4	AC-36-3, 4	57.3	12.3	14.37	0.8349	AC-DC-64-1	0.369	1.2039	
AC-36-1-4, All Units								1.2585	**0.3578**
AC-4-2	AC-4-2	461	14.4	18.38	0.6528	AC-DC-1thru3	0.231	0.8838	**0.2513**
AC-4-3-AMENITY-S	AC-4-3	450	14.4	18.34	0.6543	AC-DC-1thru3	0.231	0.8853	**0.2517**
AC-63-2	AC-63-2	520	9.8	12.67	0.9475			0.9475	**0.2694**
AC-B1-1-5	AC-B1-1, 2	161.6	11.1	13.28	0.9035	AC-DC-1thru3	0.231	1.1345	
AC-B1-1-5	AC-B1-3, 4	22.9	12.4	14.38	0.8347	AC-DC-1thru3	0.231	1.0657	
AC-B1-1-5	AC-B1-5	31.9	13.4	15.57	0.7708	AC-DC-1thru3	0.231	1.0018	
AC-B1-1-5, All Units								1.1077	**0.3150**
BOH-SYS	AC-3-1	535	13.6	17.63	0.6806	AC-DC-1thru3	0.231	0.9116	**0.2592**
CORR-SYS	AC-4-1	848	14.2	19.60	0.6123	AC-DC-1thru3	0.231	0.8433	**0.2398**
EMR-SYS	AC-65-1, 2	83.9	11.2	13.17	0.9113			0.9113	
EMR-SYS	AC-65-3, 4	60.4	11.2	13.10	0.9162			0.9162	
EMR-SYS, All Units								0.9134	**0.2597**
LOBBY-SYS	AC-3-2	432	14.6	18.52	0.6478	AC-DC-1thru3	0.231	0.8788	**0.2499**
RF-CORR-SYS	AC-63-1	693	10.1	13.52	0.8876			0.8876	**0.2524**
SALLY-SYS	AC-S-1	20.9	9.0	10.43	1.1506			1.1506	
SALLY-SYS	AC-S-2, 3	27.4	11.3	13.11	0.9150			0.9150	
SALLY-SYS, All Units								1.0169	**0.2892**

APPENDIX A - UTILITY RATES

The energy model uses the following utility rates to calculate the building's energy cost.

1.1. Electricity

ConEdison PSC-9, SC-8, Rate II (Large Multiple Dwelling - Redistribution), low tension

NY Sales Tax: 8.875 %

Time Period	Demand Charge			Energy Charge	
	M-F, 8am-6 pm	M-F, 8am-10pm	All hours	M-F 8am-10pm	Other hours
	per kW	*per kW*	*per kW*	*per kWh*	*per kWh*
January	$26.60	$19.56	$9.53	$0.1150	$0.0984
February	$26.60	$19.56	$9.53	$0.0979	$0.0908
March	$26.60	$19.56	$9.53	$0.1073	$0.0963
April	$26.60	$19.56	$9.53	$0.1051	$0.0925
May	$35.15	$28.11	$18.09	$0.1122	$0.0895
June	$60.80	$41.65	$26.54	$0.1188	$0.0853
July	$60.80	$41.65	$26.54	$0.1395	$0.1009
August	$60.80	$41.65	$26.54	$0.0843	$0.0615
September	$60.80	$41.65	$26.54	$0.1108	$0.0935
October	$35.76	$28.73	$18.70	$0.0764	$0.0605
November	$26.60	$19.56	$9.53	$0.1048	$0.0926
December	$26.60	$19.56	$9.53	$0.0941	$0.0841

1.2. Gas

ConEdison PSC-9 Gas, SC-3 (Residential and Religious - Heating Firm Sales)

Monthly customer charge: $18.60
NY Sales Tax: 8.875 %

Time Period	Energy Charge		
	First 90 therms	Next 2,910 therms	over 3000 therms
	per therm	*per therm*	*per therm*
January	$1.369	$1.185	$1.050
February	$1.325	$1.141	$1.006

March	$1.344	$1.159	$1.025
April	$1.197	$1.013	$0.878
May	$1.142	$0.958	$0.824
June	$1.416	$1.232	$1.097
July	$1.444	$1.259	$1.125
August	$1.443	$1.259	$1.124
September	$1.413	$1.228	$1.094
October	$1.351	$1.167	$1.032
November	$1.363	$1.179	$1.044
December	$1.396	$1.212	$1.077

Note: Cooking gas rates will be different but have not been modeled separately at this stage in the design. The results will not be significantly different since we are not taking any credit for cooking gas use in the design.