GreenLight LLC
an energy conservation company

New York City Local Law 87 Energy Efficiency Report

[redacted]

[redacted]

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Table of Contents

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List of Figures

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List of Tables

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Energy Efficiency Report Author Information

Abro Management, the firm responsible for the above mentioned property hired Green Light Energy Conservation LLC (Green Light) as their 3rd party contractor to prepare this combined Energy Efficiency Report that includes both of the required RCx and ASHRAE Level 2 Energy Audit. Green Light is a vertically integrated sustainability contracting and consulting firm based in Lakewood, NJ that provides energy and water efficiency services to its clients throughout the NYC metropolitan area.

Green Light hired Altanova Energy + Sustainability (Altanova), an engineering consulting firm based in Queens, NY to provide oversight and review of the enclosed analysis and reporting. Altanova's Emily Hoffman, served as the lead engineer on this project and her signature affirming compliance with NYC Local Law 87 is included below.

I, Emily Hoffman, PE, of Altanova Energy + Sustainability, affirm that the enclosed analysis complies with the requirements of NYC Local Law 87 and that I personally was involved in the production of this analysis as per the requirements of NYC Local Law 87.

____

Emily Hoffman, PE

____

Date

Table 1: Energy Efficiency Report Author Information

Energy Efficiency Report Staff Information	
Lead Audit & RCx Engineer:	[redacted]
Company:	
Company Address:	
Company Phone:	
NYS PE License Number:	
CEM Certification Number:	
RCx Certification Type and Number:	
Junior Audit & RCx Engineer:	[redacted]
Company:	Green Light Energy Conservation
Company Address:	216 River Ave Lakewood, NJ 08701
Company Phone:	732-312-5550
BPI MFBA Certification Number:	[redacted]

Executive Summary

The New York City (NYC) Council and Mayor's office passed Local Law 87 (LL87) in 2009 in order to reduce the energy (electricity and natural gas, and fuel oil) consumption of buildings that are larger than 50,000 square feet. The law requires covered buildings to hire a 3rd party contractor with the requisite qualifications to complete an analysis of how the facility's base-building systems use energy and propose recommendations for reducing the energy consumption of these base-building systems.

The recommendations are mandated under LL87 to fall into 2 categories:

1) Retro-Commissioning (RCx) – which entails a review of the maintenance and operation of the base building systems with a focus on energy efficiency. The specific points on the base building systems that most be included in the RCx scope of work are detailed in LL87. The RCx recommendations must be followed completely in order for the building owner to comply with LL87.

2) Energy Efficiency Audit – which entails a review of the existing equipment and recommendations for capital improvements that will save energy in a cost-effective manner. The Energy Efficiency Audit is required to meet the standards of an American Society of Heating and Refrigeration Engineers (ASHRAE) Level 2 Energy Audit. The Energy Efficiency recommendations are for the edification of the building owner and are not mandated by LL87 to be implemented. The law does state however that the energy efficiency recommendations may be mandated for implementation in future legislation depending on a measure-by-measure basis.

This report is concerned with the property at 845 Gerard Avenue, Bronx, NY 10451 that is listed on the NYC Department of Buildings (DOB) LL87 Covered Buildings list as the entry tabulated below:

Table 2: LL87 Covered Building List information

BBL	Boro	Block	Lot	Building Square Footage *	Number of Buildings	Tax Class	Street Number	Street Name	Boro	Zip	Year Due
[redacted]											

Nathan Winkler, from Green Light, visited the facility on June 19, 2013 and met with the building superintendent to review the base-building systems. The results of the site visit and requisite analysis are included in the enclose report. The required RCx measures and optional Energy Efficiency measures are tabulated in the tables below:

Table 3: RCx Summary

Retro-Commissioning Measures						
RCM	Description	Annual Savings Utility Bill [$]	Implementation Cost [$]	Rebate Program	Rebate [$]	Simple Payback [Yrs]
1	Boiler Tune Up	$362.42	500.00	ConEd Multifamily	$250.00	0.69

The selection of RCx measures was based on the mandates in LL87 and must be implemented in order to comply with LL87.

Table 4: Energy Efficiency Measure Summary

Energy Efficiency Measures						
ECM	Description	Annual Savings Utility Bill [$]	Implementation Cost [$]	Rebate Program	Rebate [$]	Simple Payback [Yrs]
1	Water Efficient Fixtures	$2,722.82	$6,600.00	None	$0.00	2.42
2	LED Exterior Lighting	$411.94	$1,700.00	None	$0.00	4.13
3	Condensing DHW Heaters	$5,098.35	$25,800.00	ConEd Multifamily	$9,000.00	3.30
4	Thermostatic Radiator Valves	$1,087.25	$29,700.00	ConEd Multifamily	$22,770.00	6.37
5	Roof Cavity Insulation	$1,113.78	$14,250.00	ConEd Multifamily	$2,850.00	10.24

The energy efficiency measures were selected based on an assessment of not only the energy cost savings, but also their impact on the building's maintenance, durability, comfort, and the health of the occupants. Green Light recommends that all of the above measures be implemented.

General Building Information

The multifamily building at 845 Gerard Avenue in Bronx, NY was built in the 1930s and has 66 units ranging from studio apartments to 3 bedrooms. All of the units are rentals and the facility is owned and managed by Aaron Kushner of Abro Management, based in Woodmere, NY. The facility has a central steam heating system with 1-pipe steam radiators. There is no central cooling and most residents use window AC units. There a total of 7 stories including the basement and the gross conditioned space is 71,700 square feet.

Table 5: General Building Information

Building Information	
Building Address:	[redacted]
Property Manager:	
Property Manager Address:	
Property Manager Phone:	
Number of Stories Including Basement:	7
Number of Units:	66
Year Built:	1937
Gross Area [SqFt]:	71,700
Number of Elevators:	2
Central Heating System:	1-Pipe Steam Radiators
Central Cooling System:	None

The tenants pay for their own electricity and gas for cooking. Abro Management pays for the common electric, gas, and oil accounts that supply the common area lighting, elevator, heating system, domestic hot water system, and miscellaneous equipment required for the maintenance of the facility. The single steam boiler was recently converted to run on gas at all times.

Table 6: 2012 Water Bills

2012 Water Rates						
Meter Dates	**Low Flow Dial [CF]**	**High Flow Dial [CF]**	**Total Water Charge [$]**	**Total Sewer Charge [$]**	**Total Charge [$]**	**Notes**
3/19/2012 to 9/17/12	1,500	560,100	$23,696.39	$37,677.26	$61,373.65	Billing fixed to flat rate per Apartment based on NYC DEP Multifamily Conservation Program
9/17/2012 to 3/18/13	2,100	514,700				
Total Annual Water Consumption [Gallons]:						**8,066,432.0**

Table 7: 2012 Energy Bills

2012 Energy Consumption					
Month	Electricity			Gas	
	kW	kWh	$	Therms	$
January	16.30	6,930	$1,108.80	6,000	$6,600.00
February	15.80	7,578	$1,212.48	5,500	$6,050.00
March	14.70	5,706	$912.96	5,000	$5,500.00
April	11.80	5,742	$918.72	4,000	$4,400.00
May	12.70	5,562	$889.92	800	$880.00
June	11.10	5,778	$924.48	800	$880.00
July	11.50	5,652	$904.32	800	$880.00
August	12.00	5,500	$880.00	800	$880.00
September	12.70	5,600	$896.00	4,000	$4,400.00
October	11.80	5,652	$904.32	5,000	$5,500.00
November	14.70	5,724	$915.84	5,500	$6,050.00
December	14.20	7,254	$1,160.64	6,000	$6,600.00
Total:	**16.30**	**72,678**	**$11,628.48**	**44,200**	**$48,620.00**

Table 8: Estimated Utility Rates

Utility Rates	
$/Therm	$1.20
$/kWh	$0.19

Energy Usage Analysis

Abro management purchased this building in early 2013 and a complete utility bill history was not available at the time of preparing this report. The energy usage was **estimated** based on bills for 2013 as they became available as well as comparison to a similar building in the neighborhood, 831 Gerard Avenue, operated by Abro Management.

The electricity consumption and demand remain relatively constant throughout the year, which confirms that all air conditioning and other climate-sensitive equipment is being operated solely on the tenants' accounts. The relative contribution of different pieces of equipment to the electricity consumption and demand on the common area accounts was estimated based on nameplate data and the operating frequency indicated by the building maintenance staff.

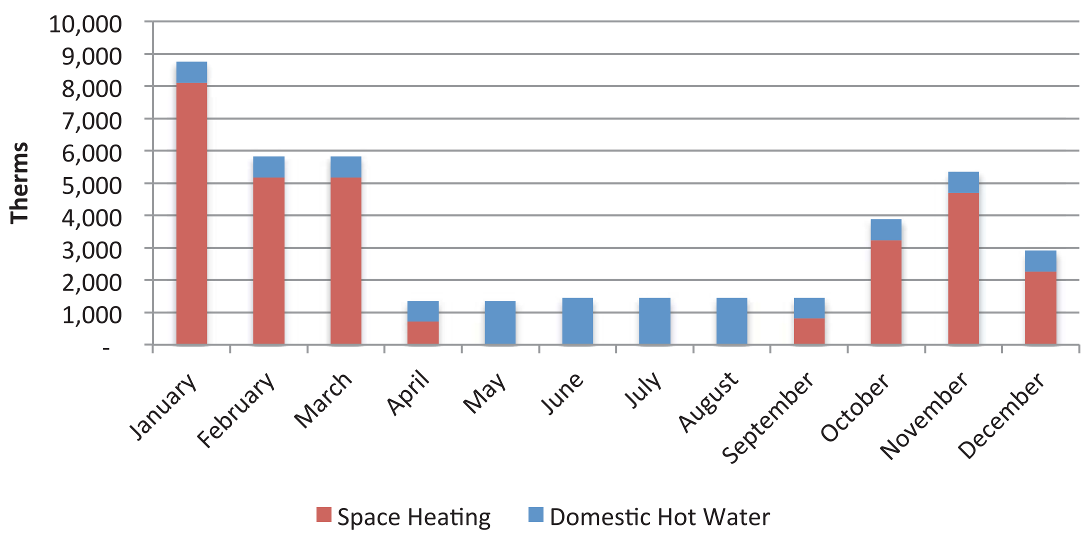

Figure 1: 2012 Domestic Hot Water & Space Heat Fuel Consumption

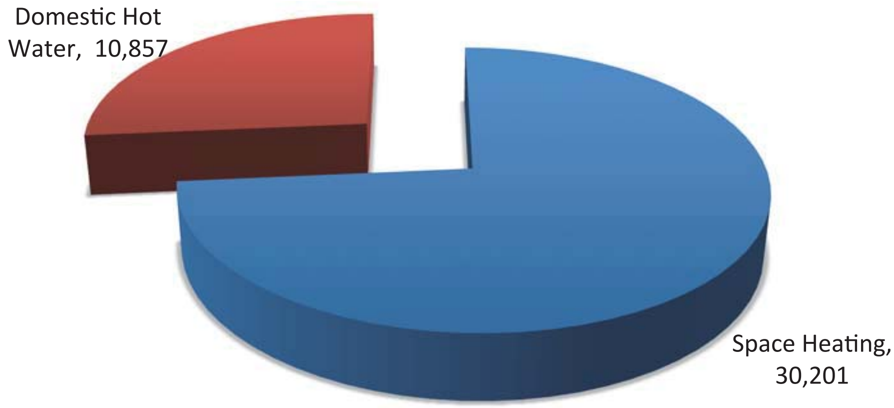

Figure 2: 2012 Fuel Consumption Sources in Therms

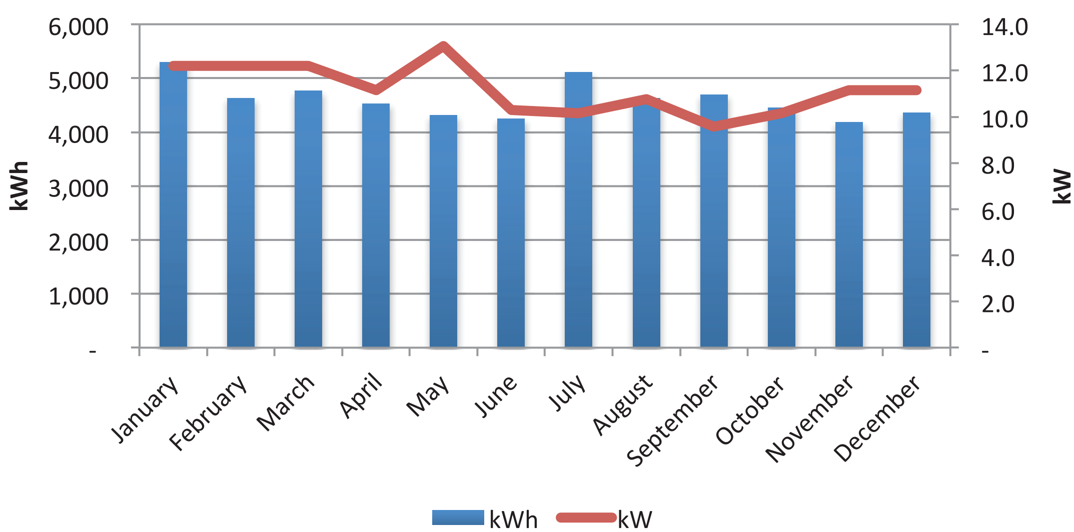

Figure 3: 2012 Electricity Usage

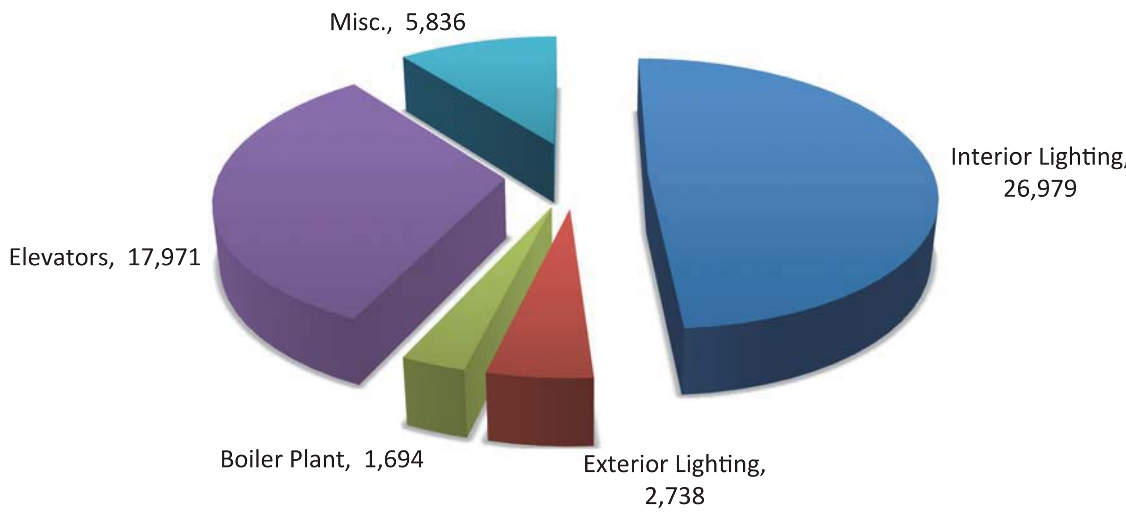

Figure 4: 2012 Electricity Consumption Sources in kWh

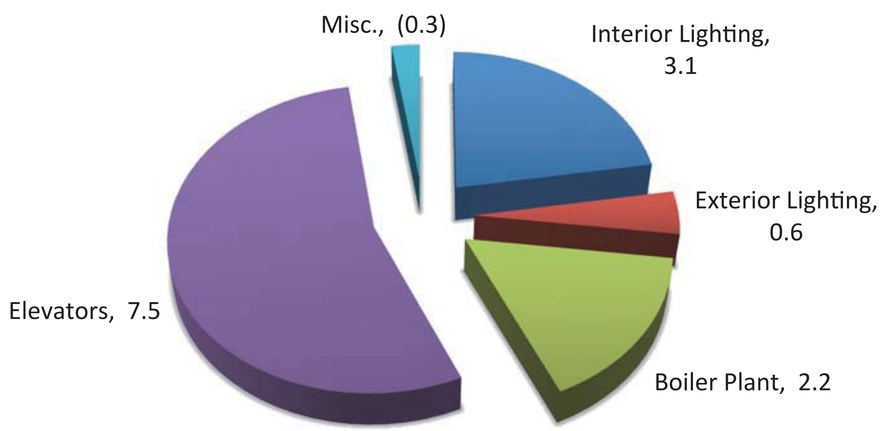

Figure 5: 2012 Electricity Demand Sources in kW

Building Description

Building Envelope

Roof

The roof of the building is composed of concrete base covered with rubber sheeting that is painted silver. There are numerous penetrations for waste vent pipes and the bases of all penetrations appear to be in good order. A single brink penthouse in the center houses the elevator motors. According to the facility staff, the roof cavity between the tope ceiling and the concrete roof deck has not been opened since the initial construction but is believed to be un-insulated because puddles often form on the roof in the winter when the side walks around the building are covered in snow and ice, thus indicated significant heat losses through the roof deck. The combination of roof materials was estimated to equate to a thermal resistance value of R-11 for the purposes of this analysis. No water leaks or significant air leaks were observed on the roof during the site visit.

Walls and Fenestrations

The building is enclosed on all sides with a white masonry façade. No major issues were observed with the wall structure during the site visit. The windows are all double pane, normal glass, with vinyl frames and thermal breaks. All of the windows are operable by the inhabitants to provide ventilation and comfort.

Figure 6: Exterior Wall

Heating System

Space Heating and Domestic Hot Water (DHW) are supplied by a single 5,320 MBH, gas-fired, low-pressure steam boiler. The boiler was installed approximately 28 years ago and is good operating condition as the burners were replaced and upgraded in the past year for using natural gas. All condensate is returned to the boiler via a gravity feed system and Hartford loop. Operation of the boiler is controlled with automatic digital controls by US Energy Group that update boiler operation in realtime based on temperature sensors deployed throughout the facility. Boiler Logs and inspection reports are included in Appendix C.

Table 9: Steam Boiler Specifications

Boiler Plant	
Boiler Operator License:	TBD
Input MBH:	5,320
Output MBH:	3,248
Boiler Type:	Steam
Boiler Installation Date:	1985
Steam Pressure:	5
Fuel Type:	Gas
Stack Temperature:	TBD
Steam Temperature:	TBD
Domestic Hot Water Pump Qty:	0
Domestic Hot Water Pump HP:	0
Domestic Hot Water Temperature:	TBD
Domestic Hot Water System Type:	Tankless Coil
LWCO Gauge Glass Reading:	TBD
Operater Pressure Switch Reading:	TBD
Firing Rate Pressure Modulation Reading:	TBD
High Limit Pressure Switch:	TBD
Pressure Gauge Reading:	TBD
Condensate Return System Type:	Gravity Fed Hartford Loop
Condensate Pump HP:	0
Condensate Pump Qty:	0
Condensate Pump Demand [kW]	0
Condensate Pump Annual Electric [kWh]:	0
Burner HP:	3
Boiler Nameplate Information:	US Energy Group Digital Steam Boiler Controls, A Eastmond & Sons Inc, Heating System 625FS, Input MBH 5320, Net Input MBH 4184, Out MBH 3248, Serial# 3056, Steam SqFt 13535
Condensate Pump Nameplate Information:	TBD
Domestic Hot Water System Nameplate Information:	TBD
Rated Boiler Efficiency:	78%
Boiler Burner Demand [kW]:	2.238
Boiler EFLH	757
Boiler Annual Electric [kWh]:	1694.166
Summer DHW Efficiency:	35%
Winter DHW Efficiency:	78%
Boiler Heating Temperature Setpoint:	TBD
Boiler Operating Schedule:	TBD
Boiler Control Operation Description:	TBD

Figure 7: Steam Boiler Plant

Space Heating

Space heating is provided by 5 PSI steam supplied to 1-pipe steam radiators. The air valves are replaced on a regular 3 year cycle according to facility staff as well as whenever tenants complain of faulty operation.

Table 10: Radiator Survey

Heating System Balancing		
Estimated Total Number of Radiators:	198	
% Radiators Sampled:	TBD	
Apartment Number	*Radiator Temperature [F]*	*Radiator Condition (Leaks, noise, etc)*
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD
TBD	TBD	TBD

Figure 8: Typical Steam Radiator

Domestic Hot Water (DHW)

Domestic hot water is currently supplied by a recirculating loop that passes through a coil in the steam boiler and mixes with the domestic water line at the terminal units to provide hot water for showers, faucets, and other applicable fixtures.

Figure 9: DHW Steam Boiler HX Coil

Ventilation System

There is no active ventilation system in the facility. Operable windows and exhaust vents through the roof that rely on the stack effect to circulate stale air to the outside supply all fresh air.

Cooling System

All cooling is paid for by the tenants' electric account and consists of tenant-owned window AC units.

Lighting

Interior Lighting

The interior lighting in the common areas consists of 8' linear fluorescent lighting.

Table 11: Interior Hallway Lighting

Interior Lighting	
Hallway Fixture Type:	8' 2LampT8F96-59W
Hallway Fixture Qty:	30
Hallway Fixture Wattage:	102.66
Common Area Fixture Type:	n/a
Common Area Fixture Qty:	0
Common Area Fixture Wattage:	0
Interior Lighting Demand [kW]:	3.0798
Interior Lighting Annual Burn Hours:	8760
Interior Lighting Annual Energy [kWh]:	26979.048

Exterior Lighting

The exterior lighting consists of 100W Mercury Vapor Lamp Wallpack fixtures installed on the roof as well as around the building at the street level.

Table 12: Exterior Lighting

Exterior Lighting	
Exterior Fixture Type:	100W-MV Wallpack w/Photo Cell Control
Exterior Fixture Qty:	5.00
Exterior Fixture Wattage:	125.00
Exterior Lighting Demand [kW]:	0.63
Exterior Lighting Annual Burn Hours:	4,380.00
Exterior Lighting Annual Energy [kWh]:	2,737.50

Lighting Controls

All of the interior lighting is controlled with manual switches. The hallway & stairwell lights are on continuously throughout the year and the laundry room lights are turn off at the discretion of the tenants. Exterior lighting is controlled by photos cells and was observed to be off during the site visit, which took place during daylight hours.

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Miscellaneous Equipment

Elevators

One geared traction elevator serves the facility and its motor generator drive motor appeared to be in excellent working condition at the time of the site visit.

Table 13: Elevator Specifications

Elevator	
Elevator Type:	Geared Traction
Elevator Qty:	1
Motor Drive Type:	Motor Generator (MG)
Motor HP:	10
Elevator Peak Demand [kW]	7.46
Estimated Annual Run Hours	2,409
Elevator Annual Electric [kWh]	17,971

Figure 10: Elevator Motor

Retro-Commissioning (RCx)

The details of LL87 stipulate the exact points that must be assessed for the RCx portion of compliance and are copied below with an accompanying discussion of the relevance of each point to the facility at 845 Gerard Avenue, Bronx, NY.

Local Law 87 RCx Checklist

Retro commissioning should ensure the items listed in section 28-308.3 of the legislation are met. This includes the following items:	Status for 845 Gerard Avenue, Bronx, NY
1. Operating protocols, calibration, and sequencing:	
1.1. HVAC temperature and humidity set points and setbacks are appropriate and operating schedules reflect major space occupancy patterns and the current facility requirements.	The only piece of equipment that has temperature set points is the boiler and space heating system. All items were observed to be in order during the site visit, please refer to the boiler plant section earlier in this report for details. There is no humidification equipment in the building.
1.2. HVAC sensors are properly calibrated.	The only piece of equipment that has HVAC sensors is the boiler and space heating system. All items were observed to be in order during the site visit, please refer to the boiler plant section earlier in this report for details.
1.3. HVAC controls are functioning and control sequences are appropriate for the current facility requirements.	The only piece of equipment that has HVAC controls/sequences is the boiler and space heating/DHW system. All items were observed to be in order during the site visit, please refer to the boiler plant section earlier in this report for details.
1.4. Loads are distributed equally across equipment when appropriate (i.e. fans, boilers, pumps, etc. that run in parallel).	There is only 1 boiler and thus the load is distributed as designed, by definition.
1.5. Ventilation rates are appropriate for the current facility requirements.	All ventilation rates are compliant with the NYC Housing Code (See Appendix A).
1.6. System automatic reset functions are functioning appropriately, if applicable.	Not applicable
1.7. Adjustments have been made to compensate for oversized or undersized equipment so that it is functioning as efficiently as possible.	Not applicable
1.8. Simultaneous heating and cooling does not occur unless intended.	Not applicable
1.9. HVAC system economizer controls are properly functioning, if applicable.	Not applicable
1.10. The HVAC distribution systems, both air and water side, are balanced.	Not applicable
1.11. Light levels are appropriate to the task.	All light levels are in compliance with the NYC Housing Code (See Appendix A)
1.12. Lighting sensors and controls are functioning properly according to occupancy, schedule, and/or available daylight, where applicable.	Not applicable
1.13. Domestic hot water systems have been checked to ensure proper temperature settings.	The domestic hot water system was observed to be delivering at a temperature that provides hot water and addresses potential health risks, please refer to the boiler plant section earlier in this report for details.
1.14. Water pumps are functioning as designed.	The domestic hot water circulator pump was observed to be operating on a constant basis at the time of the audit.
1.15. System water leaks have been identified and repaired.	There were no system water leaks observed during the audit.
2. Cleaning and repair:	
2.1. HVAC equipment (vents, ducts, coils, valves, soot bin, etc.) is clean.	The only HVAC equipment observed consisted of the boiler plant and the steam radiators. The condition of the boiler plant is detailed in the boiler plant section earlier in this report and the radiator survey is included in the space heating section earlier in this report.

Retro commissioning should ensure the items listed in section 28-308.3 of the legislation are met. This includes the following items:	**Status for 845 Gerard Avenue, Bronx, NY**
2.2. Filters are clean and protocols are in place to replace, as appropriate.	Not applicable
2.3. Light fixtures are clean.	During the site walk through the light fixtures were observed for cleanliness and no issues were noted during the survey.
2.4. Motors, fans, and pumps, including components such as belts, pulleys, and bearings, are in good operating condition.	The only pump in the facility consisted of the DHW circulator, which was observed and is detailed with the rest of the boiler plant earlier in this report.
2.5. Steam traps have been replaced as required to maintain efficient operation, if applicable.	The facility staff indicated a regular radiator air-valve replacement schedule for maintaining optimum system efficiency.
2.6. Manual overrides on existing equipment have been remediated.	Not applicable
2.7. Boilers have been tuned for optimal efficiency, if applicable.	A recommendation for a boiler tune up was given at the time of the audit.
2.8. Exposed hot and chilled water and steam pipes three (3) inches or greater in diameter with associated control valves are insulated in accordance with the standards of the New York city energy conservation code as in effect for new systems installed on or after July 1, 2010.	A recommendation for insulating 3" steam piping was given at the time of the audit.
2.9 In all easily accessible locations, sealants and weather stripping are installed where appropriate and are in good condition.	Weather stripping and air sealing was observed to be installed appropriately
3. Training and documentation:	
3.1. Permits for all HVAC, electrical and plumbing equipment are in order.	All boiler documentation and licenses were observed to be displayed on the wall next to the boiler in the boiler room.
3.2. Critical operations and maintenance staff have received appropriate training, which may include labor/management training, on all major equipment and systems and general energy conservation techniques.	The superintendent was interviewed at the time of the audit to confirm awareness of proper energy conservation techniques for boiler operation. Details on the boiler operation schedule are included in the boiler plant section earlier in this report. All boiler licenses and documentation were observed to be displayed on the wall next to the boiler in the boiler room.
3.3. Operational and maintenance record keeping procedures (log books, computer maintenance records, etc.) have been implemented.	All logs of boiler plant water quality, cleaning, and other parameters were displayed on the wall next to the boiler in the boiler room.
3.4. The following documentation is on site and accessible to the operators: the operations and maintenance manuals, if such manuals are still available from the manufacturer, the maintenance	The boiler operation manual was observed on site next to the boiler.

RCx Equipment Testing Summary

The following equipment was tested as part of the RCx portion of LL87 compliance:

1) Steam Boiler – The steam boiler was tested and tuned for optimal combustion efficiency according to the EPA Boiler Tune Up Guidelines included in Appendix A and the Boiler Tune Up Report, which details the points and equipment used to test the system is included in Appendix C.

2) Exterior Lighting Controls – The photocell that controls the exterior lighting was adjusted during the site visit in order to verify that it operates as designed. The photocell controller was observed to operate properly when it was adjusted during the visit.

RCx Integrated Systems Testing and Boiler System Balancing

The steam boiler, radiators, and distribution system is the only integrated system that requires testing in this building to comply with LL87. The digital steam boiler controls by US Energy Group provide a real time monitoring of system balance and performance through the utilization of temperature sensors deployed throughout the building. The US Energy Group temperature readouts from the past winter heating season were analyzed to verify proper and uniform space heating performance across the facility. In addition, a walkthrough of the building during the heating seasons was conducted to test a sample of radiators for heating performance and uniformity. The radiator testing results are tabulated in the space heating section included earlier in this report.

RCx Measures (RCMs)

The table below summarizes the energy/cost savings, and associated expenses for implementing the observed issues that are included in the RCx scope of work.

Table 14: RCx Measures Summary

Retro-Commissioning Measures							
RCM	Description	Annual Savings		Implementation Cost [$]	Rebate Program	Rebate [$]	Simple Payback [Yrs]
		Fuel Consumption [Therms]	Utility Bill [$]				
1	Boiler Tune Up	302.01	$362.42	500.00	ConEd Multifamily	$250.00	0.69

Energy Rates	
$/kWh	0.19
$/Therm	1.2

RCM 1: Boiler Tune Up

According to facility staff the boiler has not received a tune up in the past year and thus this measure for improving the overall durability and combustion efficiency of the boiler is included in the RCx scope of work. The savings resulting from tuning the boiler were estimated to equal 1% of its current fuel usage. The baseline efficiency that the boiler should achieve after tuning is estimated at 79% as per the nameplate data.

Energy Efficiency Opportunities

There are cost effective opportunities for reducing the energy consumption of the facility's base building systems and thereby reduce utility costs. Because LL87 leaves the adoption of these measures to the discretion of the building manager, where they may choose to implement, all, some, or none of the proposed improvements, the energy savings in this analysis have been calculated independently and interactive effects between the measures have not been taken into account. The savings analysis was based on nameplate information, industry standards, as well as conservative assumptions. An attempt to incorporate potential changes in the building operating conditions, occupancy, or other unforeseen factors has been made as much as possible when preparing this analysis.

The estimated energy and cost savings for each of the six Energy Efficiency Measures (EEMS) are detailed in the tables below.

Table 15: Energy Efficiency Measure Energy Savings

Energy Efficiency Measures				
ECM	Description	Annual Savings		
		Electric Demand [kW]	Electric Usage [kWh]	Fuel Usage [Therms]
1	Water Efficient Fixtures	-	-	2,269.01
2	LED Exterior Lighting	0.50	2,168.10	-
3	Condensing DHW Heaters	-	-	4,248.62
4	Thermostatic Radiator Valves	-	-	906.04
5	Roof Cavity Insulation	-	-	928.15

Utility Rates	
Gas Rate [$/Therm]	$1.10
Electricity Rate [$/kWh]	$0.16

Table 16: Energy Efficiency Measure Economics

Energy Efficiency Measures						
ECM	Description	Annual Savings Utility Bill [$]	Implementation Cost [$]	Rebate Program	Rebate [$]	Simple Payback [Yrs]
1	Water Efficient Fixtures	$2,722.82	$6,600.00	None	$0.00	2.42
2	LED Exterior Lighting	$411.94	$1,700.00	None	$0.00	4.13
3	Condensing DHW Heaters	$5,098.35	$25,800.00	ConEd Multifamily	$9,000.00	3.30
4	Thermostatic Radiator Valves	$1,087.25	$29,700.00	ConEd Multifamily	$22,770.00	6.37
5	Roof Cavity Insulation	$1,113.78	$14,250.00	ConEd Multifamily	$2,850.00	10.24

Energy Efficiency Measures

EEM 1: Water Efficient Fixtures

It is recommended to install water efficient faucet aerators and showerheads in all of the units to reduce both water and fuel consumption. The existing water fixtures include NYC Building code-compliant 2.4 Gallon per Minute (GPM) showerheads and 2.0 GPM faucet aerators installed by the building manager as well as tenant installed replacements that often use water at rates that exceed code requirements. In addition to reducing water usage in the building, the efficient water fixtures will reduce fuel consumption through decreasing the domestic hot water load. The energy and water savings analysis for this measure is based on the methodology in the New York State Energy Saving Calculation Protocols included in Appendix A and the key calculation results are tabulated below.

The product design basis for this measure is the Green Light Water Conservation vandal-resistant shower head and flow restrictor described in Appendix B. The total annual resource savings are estimated at 2,269.01 Therms, which equates to annual cost savings of $2,722.82. The total installation cost is estimated at $6,600.00, which yields a simple payback of just over 2.42 years.

Table 17: Water Efficient Fixtures Analysis

Water Efficient Fixture Analysis	
Shower Heads	
Baseline [GPM/Fixture]	2.40
Green Light Proposed [GPM/Fixture]	1.75
Throttle Factor	0.75
Minutes per Shower	8.00
Showers per Day	2.00
Days per Year	365.00
Shower Water Temp. [F]	105.00
City Supply Water Temp. [F]	62.50
Water Mean Heat Capacity [Btu/Gal-F]	8.30
Btu/Therm	100,000.00
Gas Heater Eff	57%
Aerators	
Baseline [GPM/Fixture]	2.00
Green Light Proposed [GPM/Fixture]	1.00
Duration of Use [Minutes]	0.50
Number of Uses per Day	30.00
Days per Year	365.00
Faucet Temperature [F]	80.00
Summary	
Total Number of Apartments	66.00
Number of Sinks per Apartment	2.00
Number Showers per Apartment	1.00
Total Baseline Gallons/Yr	1,604,394.00
Total Proposed Gallons/Yr	921,442.50
Total Water Savings Gallons/Yr	682,951.50
Total Utility Bill Water Consumption Gallons/Yr	8,066,432.00
Total % Water Consumption Composed by Showers and Sinks	20%
Total Baseline Shower/Sink DHW Therms/Yr	6,024.21
Total Proposed Shower/Sink DHW Therms/Yr	3,755.20
Total Utility Bill DHW Therms/Yr	10,856.94
Total % DHW Energy Composed by Showers and Sinks	55%
DHW - DW Bills Calibration Factor	75%
Total Installation Cost per Apartment [$]	$100.00

EEM 2: High Efficiency Condensing DHW Heaters

It is proposed to valve-off the existing steam-heated domestic hot water coil and install 3 new 400MBH gas fired condensing hot water heaters piped into a single manifold and operated in stages to provide domestic hot water to the building. The existing hot water system experiences extremely low efficiencies during times when space heating is not required of as little as 35% in the summer, as is detailed in the DHW efficiency study attached in Appendix A. The poor efficiency is a result of the necessity to fire a steam boiler designed to handle the heating load of the entire building and thus is vastly oversized to the task of domestic hot water heating. This results in frequent cycling and poor overall system performance. During the winter heating season the domestic hot water system efficiency remains limited by the boiler itself, which is estimated at approximately 78%. The weighted average system efficiency for the current season based on the annual winter and summer hours was calculated to be 57%.

The proposed system of (3) 400MBH hot water heaters provides the turndown required to match the relatively insignificant load during most of the day as well as the peak loads during the morning and evening when many people take showers, wash dishes, etc. It is anticipated that the proposed system will supply heat to the domestic hot water loop on average at 125F and thus the return water temperature will be within the condensing range. This will result in an estimated average system efficiency of 93%, which represents a significant improvement over the existing equipment.

The design basis for this measure is the Turbomax 109 Domestic Hot Water Heater, which is detailed in Appendix B. The total annual energy savings from implementing this measure are estimated at 4,248.62 Therms, which equates to annual cost savings of $3,058.80. The estimated installation cost is $25,800.00 and is eligible for a $3,000 rebate per water heater from the Con Edison Multifamily Program totaling $9,000.00. When accounting for the rebate, the simple payback is just over 3 years. The Con Edison Multifamily Program is detailed in Appendix D.

Table 18: High Efficiency DHW System Analysis

Condensing DHW System ECM	
Estimated Baseline DHW Summer Efficiency [%]	35%
Estimated Baseline DHW Winter Efficiency [%]	78%
Estimated Summer Hours	4,320.00
Estimated Winter Hours	4,440.00
Weighted Average Annual DHW Baseline Efficiency [%]	57%
Proposed Instantaneous Condensing Gas DHW Efficiency with Standby Losses at 140F Return Water Temperature [%]	93%
Number of Units	66
Average Number of People per Unit	3
Generation and Storage System Flow Rate [Gallon/Hr]	1,148.40
Generation and Storage System Storage Volume [Gallons]	2,178.00
DHW System Heater Capacity [Btu/Hr]	906,268.93
Turbomax 109 Flow Rate at 140 Supply Temp [Gal/Hr]	531.00
Number of Turbomax Units Required	3
Installation Cost [$]	$25,800.00
Rebate [$]	$9,000.00
Baseline DHW Energy [Therms/Yr]	10,856.94
Proposed DHW Energy [Therms/Yr]	6,608.32
Total DHW Energy Savings [Therms/Yr]	4,248.62

EEM 3: LED Exterior Lighting

It is proposed to replace the Mercury Vapor wall packs that provide exterior lighting to the facility with LED wall packs. The existing fixtures use approximately 125 watts per fixture and are recommended for an LED replacement that uses 26 watts per fixture. The existing fixtures are controlled by a photocell that helps prevent them from operating during daylight hours. It is recommended the proposed fixtures utilize built-in photocells to ensure that the fixtures are never on during daylight hours. The design basis for this measure is the RAB WPLED26 and the specifications are detailed in Appendix B. The total annual energy savings for this measure are estimated at 2,168 kWh, which equates to annual utility bills savings of $411.94. The cost to implement this measure is estimated at $1,700.00.

Table 19: Exterior LED Lighting Analysis

Exterior Lighting ECM	
Exterior Fixture Type:	100W-MV Wallpack w/Photo Cell Control
Exterior Fixture Qty:	5
Exterior Fixture Wattage:	125
Exterior Lighting Demand [kW]:	0.63
Exterior Lighting Annual Burn Hours:	4,380
Exterior Lighting Annual Energy [kWh]:	2,738
Proposed Exterior Fixture Type:	26W LED
Proposed Exterior Fixture Qty:	5
Proposed Exterior Fixture Wattage:	26
Proposed Exterior Lighting Demand [kW]:	0.13
Proposed Exterior Lighting Annual Burn Hours:	4,380
Proposed Exterior Lighting Annual Energy [kWh]:	569
Exterior Lighting Demand Savings [kW]:	0.50
Exterior Lighting Annual Electric Savings [kWh]:	2,168
Proposed Lighting Installation Cost [$]:	$1,700.00

EEM 4: Thermostatic Radiator Valves

The one pipe steam radiators in the facility are currently regulated by air standard air valves that enable the radiators to be filled with steam regardless of the space heating demands of the occupants. The installation of thermostatic radiator valves will control the steam entry into the radiators based on the temperature of the space. There are an estimated 198 radiators installed across the multi-building complex. The design basis for this measure is the Danfoss 1-pipe steam thermostatic radiator valve specified in Appendix B. The savings estimate of 3% of the total space heating fuel consumption was based on a study completed by EME Group with NYSERDA that is included in Appendix A. The total energy savings from this measure are estimated at 906.04 Therms per year and the accompanying annual cost savings are $1,087.25. The cost to implement this measure is estimated at $150 per radiator valve and a rebate from the Con Edison Multifamily Program equal to $115 per valve is available and detailed in Appendix D.

Table 20: Thermostatic Radiator Valve Savings Analysis

Thermostatic Radiator Valve Analysis	
Estimated Number of Radiators	198.00
Installation Cost per Radiator [$]	$150.00
ConEd Multifamily Program Rebate per Radiator [$]	$115.00
Estimated % Fuel Savings Based on NYSERDA EME Analysis	3%
Baseline Fuel Usage [Therms/Yr]	30,201.33
Proposed Fuel Usage [Therms/Yr]	29,295.29
Fuel Savings [Therms/Yr]	906.04

EEM 5: Roof Cavity Insulation

It is proposed to insulate the cavity between the top floor ceiling and the roof deck with blown densely packed cellulose. This will improve the energy efficiency of the building and result in a direct cost savings to the property manager by reducing heat loss through the roof in the winter and thus the overall load on the boiler.

This measure will also improve the comfort of the tenants by reducing the heating load gradient between the lower floor apartments and upper floor apartments, such that when the boiler provides comfortable temperatures on the top floor it doesn't overheat the first floor and vise versa. Tenants will also benefit directly from a reduced cooling load on their air conditioners due to reduced heat transfer from the roof into the building during the summer.

The savings analysis for this measure was based on the NY Energy Savings Protocols detailed in Appendix A. The total annual energy savings for the property manager are estimated at 928 Therms, which equates to cost savings of approximately $1,113.78. The estimated total implementation cost is $14,250.00 and with the Con Edison Multifamily Program Rebate of $2,850.00 the simple payback is just less than 10 years. The Con Edison Multifamily Program is detailed in Appendix D.

Table 21: Roof Insulation Analysis

Air Sealing & Insulation of Roof Cavity	
Building Foot Print SqFt	9,500
Baseline R-Value [Concrete base, Rubber covering, wood/plaster ceiling/ fiber glass batts]	11
Proposed R-Value (Air sealing & Insulation with dense pack cellulose)	38
NY Tech (Multifamily High Rise) Manual Annual Savings Estimate [Therms/kSF]	97.7
Total Annual Savings [Therms]	928.15
Installation Cost per Square Foot	$1.50
Installation Cost [$]	$14,250.00
ConEd Roof Insulation Rebate [$/SqFt]	$0.30
Rebate [$]	$2,850.00

Interactive Measures and Effects

Local Law 87 allows building managers to install some, all, or none of the proposed measures. In order to adjust for this fact, all of the above measure savings have been calculated independently and interactive effects have not been considered. EEMs 1 and 3 in particular will both impact the domestic hot water consumption and the installation of both measures together will result in total gas savings that are estimated to be about 75% of the sum of the above listed savings. EEMs 4 and 5 both impact the total space heating fuel consumption and the installation of them together will similarly result in approximately 75% of the sum of the above listed savings. There are no other significant interactive effects in the recommended scope of work.

Conclusions and Recommendations

Energy costs represent a constant and growing financial liability for the management of 845 Gerard Avenue in Bronx, NY and the enclosed recommendations when taken as a package are expected to cut the overall fuel and electricity usage of the common area accounts by 21% and 4% respectively. This equates to an annual total energy cost savings of $10,797. The total estimated project cost to implement all of the recommended measures is $78,550 after accounting for rebates from the Con Edison Multifamily Program and thus a simple payback of approximately 4 years.

Table 22: Total Project Energy Savings Opportunity

Total Project Summary	Annual Savings			
	Electricity Demand [kW]	Electricity Consumption [kWh]	Fuel Consumption [Therms]	Utility Bill [$]
Baseline	13.07	55,218	41,058	$59,761
Proposed	12.57	53,050	32,404	$48,965
Savings	0.49	2,168	8,654	$10,797
Percent Savings	4%	4%	21%	18%
Total Base Project Cost [$]	**Total Rebates [$]**			**Simple Payback [Yrs]**
$78,550.00	$34,870.00			4.05

In addition to the rebates listed above, low-interest financing paid through utility bills for energy efficiency improvements to multifamily buildings in New York City are made available through the New York Energy Efficiency Corporation (NYCEEC) and case study detailing how that process work is included in Appendix D.

While the Con Edison Multifamily Program is the simplest and fastest path to attaining financial incentives for funding the enclosed recommendations, more comprehensive incentives and financing is available through the New York State Energy Research and Development Authority (NYSERDA) Multifamily Performance Program (MPP). The NYSERDA MPP involves comprehensive energy modeling of all of the building's energy usage to define a required scope of work and subsequent measurement and verification of energy savings post installation. The process for obtaining incentives takes place over a considerably longer time scale but is open to all types of measures such as the rooftop ventilator replacement and LED exterior lighting that are included in this analysis but are ineligible for funding through the Con Edison program. In addition, the NYSERDA MPP has a mechanism for low-interest financing to pay for the scope of work. Details on the NYSERDA MPP are included in Appendix D. It is recommended to proceed with the NYSERDA MPP should the management decide to implement the majority of the measures included in this report.

Disclaimer

The information contained in this report is intended to guide the building owner in the process of selecting capital improvements that will improve the building's overall performance. Green Light does not guarantee any energy savings, cost savings, installation pricing, or building conditions detailed in this report. Commodity markets, occupancy patterns, weather patterns, and maintenance regimes constantly change in ways that affect a building's performance and will impact the results of implementing any of the enclosed recommendations. The building manager may proceed with changes to the facility at their own risk and Green Light assumes no financial, legal, or material obligation for financial, legal, material, or human losses incurred as a result of the enclosed recommendations. None of the enclosed recommendations should be implemented without the direct management of a licensed contractor and/or engineer and Green Light bares no responsibility for disappointing results stemming from faulty construction, neglect, or mismanagement.

Appendix A: Standards & Guidelines

New York City Housing Code Lighting and Ventilation Requirements

HOUSING MAINTENANCE CODE
CHAPTER 2

SUBCHAPTER 3
PHYSICAL AND OCCUPANCY STANDARDS FOR DWELLING UNITS

ARTICLE 1
Lighting and Ventilation

Section

Sec. 27-2057 Lighting and Ventilation in Multiple Dwellings; General Requirements

a. No multiple dwelling shall be so altered as to diminish the light and ventilation of any room in any way not approved by the department.
b. Every required window shall be so located as to light properly all portions of the room.
c. Any obstruction of required light and ventilation shall be unlawful.

[Back to top]

Sec. 27-2058 Lighting and ventilation of living rooms in multiple dwellings erected after 1929

a. Required windows. Every living room in a multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine, shall have at least one window opening on:

1. a street;
2. a lawful yard or court on the same lot;
3. a partially enclosed balcony or space above a setback, which opens directly to a street, yard or court, if the area of the front of such balcony or space open to the outer air is at least equal to seventy-five percent of the floor area of such balcony or space;
4. a completely enclosed balcony or space above a setback in a fireproof multiple dwelling, if: the enclosure is not more, than one story in height; the outer enclosing walls and roof are of incombustible materials; an area glazed with clear plate glass or plastic equivalent on the outer enclosing walls, if at least fifty percent of the area of the interior enclosing walls and at least fifty percent of such glazed area opens on a street, legal yard or court. One-half of such glazed area shall be openable. A living room does not include a kitchen under this paragraph.

b. No required window of a living room shall open on an offset or a recess of less, than six feet in width.

c. Size of windows

1. The total area of all windows in the room shall be at least one-tenth the floor area of such room, except that when a room opens solely on a balcony or space above a setback, the total area of such opening shall be one-tenth the combined floor area of the room and that portion of the balcony or space directly in front of such room. In determining the ratio of windows to floor area, the combined glazed area of windows and doors opening on a balcony or a space above a setback may be used.
2. Every required window shall be at least twelve square feet.
3. At least one-half of every required windows shall open, except that for a mullioned casement window a minimum of five and one-half square feet is sufficient. In a room, where a centralized mechanical ventilating system provides forty cubic feet of air per minute, twenty-five percent of the window area or five and one-half square feet of such area, whichever is greater, shall be openable.
4. The top of one required window in every room shall be at least seven feet above the floor, except that in dwellings erected pursuant to plans filed after April twenty-third, nineteen-hundred fifty-nine and prior to June fourteenth, nineteen-hundred sixty-seven this requirement shall not apply.

d. Through ventilation

1. No part of any living room with windows or doors in lieu thereof opening on a balcony or space above a setback shall be more, than thirty feet from the exterior face of the outer enclosing wall.
2. In any dwelling unit in a non-fireproof multiple dwelling or in a dwelling unit of three rooms or less in a fireproof multiple dwelling no part of any room shall be more, than thirty feet from a window opening on a street or yard, unless such room also opens on a legal court.

e. Openings on lot line. Every window and its assembly in a wall situated on a lot line, except a street line, shall be fireproof; the assembly shall have a fire resistive rating of at least three-quarters of an hour; and the window shall be glazed with wire glass at least one-quarter of an inch thick. Every such window shall be of automatic self-closing construction, whenever it is less, than fifty feet above the non-fireproof roof of another structure located thirty feet or less from the lot line.

f. Dining space. A dining space shall have a window, which:

1. complies with the provisions of subdivision (a) of this section and
2. has an area at least one-eighth the floor area of such dining space.

[Back to top]

Sec. 27-2059 Lighting and ventilation of living rooms in converted dwellings

a. Required windows. Except as provided in subdivision (c), every living room in a converted dwelling shall have at least one window opening on:

1. a street
2. a yard or outer court, which complies with the provisions of section one-hundred seventy-two of the Multiple Dwelling Law or
3. an inner court or shaft with minimum dimensions of three feet, nine inches in width and eight feet in length. For a room located on the top storey a skylight of the dimensions required in subdivision (b) may be substituted for a window.

b. Size of windows

1. The total area of all windows in the room shall be at least one-tenth the floor area of such room.
2. Every required window or skylight shall be at least twelve square feet, except that if the total area of windows in the room is one-eighth of the floor area, this requirement shall not apply.
3. At least one-half of every required window shall open. One-half of the skylight shall have ventilating openings, unless (a) the skylight is equipped with a minimum of one-hundred and forty-four square inches of ventilation and (b) there is at least one window in the room and (c) the combined glazed area of the skylight and window is at least one-eighth of the floor area.
4. The top of every required window shall be at least seven feet above the floor, except that on the top storey it shall be a minimum of six feet above the floor.

c. Non-complying rooms

1. A room, which is non-complying with the minimum room size requirements of subdivision (b) of section 27-2074 of article four of this subchapter or with the requirements of subdivisions (a) and (b) of this section, may not be occupied, unless it has a single or unbroken opening of not less, than thirty-two and one-half square feet into an immediately adjoining room. Such adjoining room shall have a window on a street or a yard, which complies with the provisions of section one-hundred seventy-two of the Multiple Dwelling Law, except that if the dwelling is two storeys or less in height, the window of such adjoining room may open on an outer court or a court not less, than four feet in width extending from street to yard.
2. No room may be subdivided in any manner, unless each subdivided portion meets the requirements of paragraph one of this subdivision or of subdivision (a) of this section.

[Back to top]

Sec. 27-2060 Lighting and ventilation of living rooms in new law tenements

a. Required windows

Every living room in a new law tenement shall have a window opening on:

1. a street or
2. a lawful yard or court

b. Size of windows

1. The total area of all windows in the room shall be at least one-tenth the floor area of such room.
2. Every required window shall be at least twelve square feet.
3. At least one-half of every required window shall open.
4. The top of one required window in a room shall be at least seven feet six inches above the floor.

c. Through ventilation

1. Every part of a dwelling unit of three rooms or less shall be either within eighteen feet of a street or yard, or have a window opening upon a lawful court.
2. If the window of any room opens on an inner court with a width of less, than ten feet between the exterior wall of the dwelling and the lot line, there shall be a sash window connecting such room to an adjoining room within the dwelling unit. The sash window shall have at least ten square feet of glazed

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area, one-half of which shall open.

d. Dining space. A dining space shall have at least one window:

1. that complies with the provisions of subdivision (a) and
2. that has an area not less, than one-eighth the floor area of such dining space.

[Back to top]

Sec. 27-2061 Lighting and ventilation of living rooms in old law tenements

a. Required windows. Every living room in an old law tenement shall either have a window opening:

(1) on a street or

(2) on a yard at least four feet in depth or

(3) on a court or shaft at least twenty square feet in area open to the sky without a roof or skylight or

(4) Above the roof on an adjoining building or it shall meet the requirements of the Multiple Dwelling Law. In the event that a window opens above the roof of an adjoining building and the light and air from the adjoining lot is thereafter diminished in any way, the department may determine that such a room is a non-complying room and require compliance with the requirements of the Multiple Dwelling Law. For a room located on the top storey a ventilating skylight opening to the outer air may be substituted for a window. At least one-half of every required window shall open.

b. Dining space. A dining space shall have at least one window, which:

(1) opens on a street, yard or legal court and

(2) Has an area not less, than one-eight the floor area of such dining space.

[Back to top]

Sec. 27-2062 Lighting and ventilation in one- and two-family dwellings

a. Required windows. Every living room shall have at least one window open to a street, public place or an open and unobstructed yard, court or other required open space on the same lot as the dwelling.

b. Size of windows, substitutes for windows

1. The total area of all windows in the room shall be at least one-tenth the floor area of such room or twelve square feet, whichever is greater.
2. Skylights opening directly to the outer air, transparent or translucent panels or doors or other natural light-transmitting media may be substituted for window openings, subject to the approval of the department, if they provide an equivalent amount of light to that transmitted through the window area required in paragraph one of this subdivision.
3. At least forty-five percent of the required window area, skylight or other openings shall be openable to provide natural ventilation. If a mechanical ventilation system provides forty cubic feet of air per minute, the openable area may be reduced to twenty-five percent.

c. Non-complying rooms

1. >A living room in a one- or two-family dwelling constructed after January first, nineteen-hundred thirty-eight, which meets the minimum room-size requirements of article four of this subchapter, but does not comply with subdivision (a) of this section, may not be occupied, unless it has a single unbroken opening of not less, than sixty square feet into an immediately adjoining room. The adjoining room shall have at least one window opening to the outer air and such window shall be not less, than one-tenth of the combined floor area of the room.
2. In a one- or two-family dwelling constructed prior to January first, nineteen-hundred thirty-eight an opening shall be required between a room without a window and an immediately adjoining living room with at least one window. Such opening shall have a minimum size of thirty-two and one-half square feet.

[Back to top]

HOUSING MAINTENANCE CODE
CHAPTER 2

SUBCHAPTER 3
PHYSICAL AND OCCUPANCY STANDARDS FOR DWELLING UNITS

ARTICLE 3
Kitchens and Kitchenettes

Section

Sec. 27-2070 Facilities and equipment

a. The owner of a multiple dwelling shall provide every kitchen and kitchenette therein with gas or electricity or both for cooking.

b. The owner of a multiple dwelling shall provide every kitchen and kitchenette therein with a sink with running water equipped with a waste and trap at least two inches in diameter.

c. Every kitchenette in a multiple dwelling shall be surrounded by partitions extending from the floor to the ceiling, except for entrances to such kitchenette. When located within a room, such kitchenette, except for entrances, shall be designed so that it is separated from said room. However, a kitchenette existing on December ninth, nineteen-hundred fifty-five shall be deemed to be in compliance with this subdivision, if it is maintained in accordance with prior acceptance or approval by the department.

[Back to top]

Sec. 27-2071 Lighting and ventilation

The following requirements shall govern in multiple dwellings:

a. The lighting and ventilation of kitchens shall be governed by the provisions on lighting and ventilation in article one of this subchapter.

b. A kitchenette constructed after July first, nineteen-hundred forty-nine, shall have a window opening upon a street, a yard, court, shaft, any partially enclosed balcony or space above a setback, as described in paragraph three of subdivision (a) of section 27-2058 of article one of this subchapter or an offset or recess less, than six feet in width. Such window shall be at least one foot wide, have a total area of at least three square feet and be at least ten percent of the floor area of such kitchenette. In lieu of such window such kitchenette may have mechanical ventilation to provide at least six changes per hour of the air volume of such kitchenette or when such kitchenette is on the top storey, may have a skylight of at least one foot wide with a total area of at least four square feet or one-eighth of the area of the kitchenette, whichever is greater and shall have ventilating openings of at least one-half of the area of the skylight.

c. A kitchenette constructed after July first, nineteen-hundred forty-nine, may have a door or doors, if the lower portion of each door has a metal grille containing at least forty-eight square inches of clear openings or in lieu of such grille there are two clear open spaces, each of at least twenty-four square inches, one between the bottom of the door and the floor and the other between the top of the door and the head jamb.

d. A kitchenette shall be deemed to be in compliance with this section, if it was accepted, approved by the department on or before July first, nineteen hundred fifty-two and if it was maintained in accordance with such acceptance or approval.

[Back to top]

Sec. 27-2072 Fire protection

a. In a multiple dwelling the owner shall fire-retard in every kitchen and kitchenette all combustible material immediately underneath or within one foot of any apparatus used for cooking or warming food or shall cover such combustible material with asbestos of at least three-sixteenths of an inch in thickness and twenty-six gauge metal or with fire resistive material of equivalent rating, except where such cooking or warming apparatus is installed in accordance with requirements established by the department in conformity with generally accepted safety standards. There shall be at least two feet of clear space above the exposed cooking surface of any such apparatus.

b. In a multiple dwelling the owner shall in every kitchenette either fire-retard the ceilings and walls, exclusive of doors, or install one or more sprinkler heads to fuse at a temperature not higher, than two-hundred and twelve degrees Fahrenheit. Such heads shall be connected to the water supply through a pipe of at least one-half inch in diameter. Any kitchenette, which was accepted or approved by the department on or before July first, nineteen-hundred fifty-two and maintained in accordance with such acceptance or approval, shall be deemed to be in compliance with this subdivision.

[Back to top]

Sec. 27-2073 Requirements for kitchens and kitchenettes in one- and two-family dwellings

The following requirements shall govern one- and two-family dwellings:

a. The lighting and ventilation of kitchens constructed on or after July fourteenth, nineteen-hundred sixty-seven shall be governed by the provisions on lighting and ventilation of section 27-2062 of article one of this subchapter.

b. Every kitchenette constructed on or after July fourteenth, nineteen-hundred sixty-seven shall be provided with a window opening upon a street, yard or court. Such window shall be at least one foot wide, have a total area of at least three square feet and be at least ten percent of the floor area of such kitchenette. However, when a kitchenette is on the top storey, it may have in lieu of such window a skylight at least one foot wide with a total area of at least four square feet or one-eighth of the area of the kitchenette, whichever is greater and which shall have ventilating openings of at least one-half of the area of the skylight. In lieu of a window a kitchenette may have mechanical ventilation to provide at least six changes per hour of the air volume of such kitchenette.

c. Every kitchenette may be equipped with a door or doors, if the lower portion of each such door has a metal grille containing at least forty-eight square inches of clear openings or in lieu of such a grille there are two clear open spaces, each of at least twenty-four square inches, one between the bottom of the door and the floor and the other between the top of the door and the head jamb.

d. In every kitchen and kitchenette constructed on or after July fourteenth, nineteen-hundred sixty-seven all combustible material immediately underneath or within one foot of any permanent apparatus used for cooking or warming food shall be fire-retarded or covered with asbestos at least three-sixteenths of an inch in thickness and twenty-six gauge metal or with fire-resistive material of equivalent rating, except where such permanent cooking or warming apparatus is installed in accordance with requirements established by the department in conformity with generally accepted safety standards. There shall always be at least two feet of clear space above any exposed cooking surfaces of such apparatus.

e. The owner shall in every kitchenette constructed on or after July fourteenth, nineteen-hundred sixty-seven, fire-retard the ceilings and walls, exclusive of doors.

f. The owner of a dwelling shall provide every kitchen and kitchenette with gas or electricity or both for cooking and with a sink with running water, equipped with a waste and trap at least two inches in diameter.

[Back to top]

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HOUSING MAINTENANCE CODE
CHAPTER 2

SUBCHAPTER 3
PHYSICAL AND OCCUPANCY STANDARDS FOR DWELLING UNITS

ARTICLE 2
Sanitary Facilities

Section

Sec. 27-2063 Location of water closets

a. Water closets are prohibited in any yard, court or other open space. The owner shall remove any such existing water closet or other similar receptacle and under the direction of the department disinfect the area, where such receptacle was located.

b. Water closets are prohibited in a cellar or basement, unless they are either provided for lawful cellar and basement dwelling units, or are supplementary to water closets required under the provisions of this article.

c. In any apartment a water closet may be placed in a separate compartment or in a bathroom.

d. In any apartment no more, than one water closet shall be placed within a single compartment.

e. In a class A multiple dwelling a general toilet room containing more, than one water closet is prohibited, unless such water closets are supplementary to the facilities required for each apartment or serve the nonresidential portions of the premises.

f. In a multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine no water closet located within a compartment or bathroom may open into any kitchen or kitchenette.

[Back to top]

Sec. 27-2064 Size and construction of water closet compartments

a. Every water closet compartment shall be at least two feet, four inches in clear width.

b. The walls enclosing every water closet compartment shall extend from floor to ceiling, except in general toilet or bathrooms.

c. The walls of every water closet compartment and general toilet or bathroom shall be plastered, tiled or covered with similar materials approved by the department.

d. The floor of every water closet compartment, bathroom or general toilet room shall be waterproofed with material approved by the department. Such waterproofing shall extend at least six inches above the floor, except at the doors.

e. Drip trays are prohibited.

f. No water closet or other plumbing fixture shall be enclosed with any woodwork.

[Back to top]

Sec. 27-2065 Light and ventilation of water closet compartments

a. In every water closet compartment, bathroom and general toilet room one of the following requirements for light and ventilation shall be met:

1. There shall be a window opening upon a street, yard, court, partially enclosed balcony or space above a setback on an offset or recess, which may be less, than six feet in width. Every such window shall be at least three square feet in area and one-half of its area shall open.
2. If the water closet compartment, bathroom or general toilet room is either located on the top storey or is underneath the bottom of a lawful shaft or court, it may be lighted and ventilated by a skylight in the roof. Such skylight shall contain three square feet of glazed area and shall open.
3. There shall be a system of mechanical ventilation approved for construction and arrangement by the department. In a multiple dwelling such system of ventilation shall be maintained and operated continuously to provide at least four changes per hour of the air volume of each water closet, bathroom or general toilet room daily from six o'clock in the morning until midnight in all residential parts of a dwelling and from seven o'clock in the morning until seven o'clock at night in any non-residential parts of a dwelling. In a private dwelling the approved system of mechanical ventilation may be switch-operated.

b. Nothing in this section shall require any change to be made in the lighting or ventilation of water closets, bathrooms or general toilet rooms in any portion of any old law tenement or any converted dwelling, if such lighting or ventilation was lawful on July first, nineteen-hundred sixty-one and in one- or two-family dwellings, if such lighting or ventilation was lawful on August second, nineteen-hundred sixty-seven.

[Back to top]

Sec. 27-2066 Sanitary facilities in apartments

a. Multiple dwellings erected after nineteen-hundred twenty-nine:

1. Every apartment in a multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine shall contain a water closet and a bath.
2. In every such dwelling exceeding two storeys in height a water closet shall be accessible to every bedroom without passing through any other bedroom and such access shall be required in every dwelling of two storeys or less in height erected after July first, nineteen-hundred sixty-one.
3. In a multiple dwelling erected after July fourteenth, nineteen-hundred sixty-seven every apartment shall contain a washbasin.

b. Converted dwellings

1. Every apartment in a converted dwelling shall contain a water closet and a bath or shower and every apartment in a dwelling converted after July first, nineteen-hundred sixty-one shall also contain a washbasin.
2. In an apartment located in a dwelling converted after April thirteenth, nineteen-hundred forty there shall be access to a water closet from every bedroom without passing through any other bedroom.

c. New law tenements

1. Every apartment in a new law tenement shall contain a water closet and a bath.
2. In every apartment a water closet shall be accessible to every bedroom without passing through any other bedroom.

d. Old law tenements

1. In every old law tenement a water closet shall be provided for the exclusive use of the occupants of every apartment. If it is not located within the apartment, the water closet shall be located on the same storey, as the apartment and shall be equipped with lock and key.
2. Such water closet shall be constructed and ventilated as approved by the department.

e. New apartments in converted dwellings or tenements. After December ninth, nineteen-hundred fifty-five in any converted dwelling or tenement, in which:

1. the number of apartments in the dwelling is increased by any alteration, including the subdivision of existing apartments, the conversion of non-residential space or rooming units to apartments or the enlargement of the dwelling or
2. all apartments in the dwelling are vacated by the department or, except in a summer resort dwelling, are untenanted for sixty days or more, a new certificate of occupancy shall not be issued and a newly

created apartment shall not be occupied or a vacated apartment reoccupied, unless it contains a water closet, bath or shower and washbasin.

f. Requirements for all apartments in multiple dwellings effective January first, nineteen-hundred seventy-three: Effective January first, nineteen-hundred seventy-three there shall be provided for the exclusive use of the occupants of each apartment in a multiple dwelling a water closet, a bath or shower and a wash basin, except that in tenements no washbasin shall be required pursuant to this section, where there is a sink within the apartment.

[Back to top]

Sec. 27-2067 Sanitary facilities in rooming units

a. Every building containing rooming units and each individual apartment used for single-room occupancy shall contain at least one water closet, washbasin and bath or shower for each six persons lawfully occupying rooming units therein and for any remainder of less, than six persons. At least one water closet shall be located on any floor containing a rooming unit. If there are not more, than two rooms on the first storey above the basement in said rooming house, no water closet is required on such floor, but the occupants of the room shall be counted in determining the required number of facilities.

b. Every occupant of a rooming unit shall have access to each required water closet, washbasin and bath or shower without passing through any other rooming unit or portion of the dwelling reserved for other occupants.

c. Any additional water closet installed to comply with the requirements of subdivision (a) of this section shall be located in a compartment separate from any other water closet, bath or shower, except that a required washbasin may be provided in such compartment. Such additional baths or showers shall be located in compartments separate from every required water closet.

d. Sanitary facilities for the exclusive use of and accessible only to the occupants of one rooming unit may be combined in a bathroom. Neither the facilities, nor the occupants shall be counted in determining the number of the facilities required in subdivision (a) of this section.

[Back to top]

Sec. 27-2068 Sanitary facilities in certain multiple dwellings erected after 1929

a. Fireproof multiple dwelling. In a fireproof multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine, in which any living room opens directly upon a public hall without any intervening room, foyer or passage, or in which any suites of two living rooms open upon a foyer giving direct access to a public hall, there shall be one water closet for every three such living rooms on a storey. Every such water closet shall be accessible to one or more such rooms without passage through a public hall or bedroom. In a class B multiple dwelling, where any such living room does not have access to a water closet without passage through a public hall or bedroom, there shall be at least one water closet for every such fifteen living rooms or fraction thereof and every such living room shall have access to a water closet through a public hall.

b. Fireproof class B dwelling. In a fireproof class B multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine, in which every living room, excluding rooms occupied by management and maintenance personnel of the dwelling, opens directly to a public hall without passing through any other room, foyer or private hall, there shall be two water closets for the first twenty living rooms or fraction thereof and one additional water closet for each additional fifteen living rooms or fraction thereof. Such water closets may be located in compartments or in general toilet rooms accessible from every living room on the floor. A urinal may be substituted for a water closet on any storey, where seventeen or more rooms are occupied exclusively by males, but not more, than one-quarter of the required facilities may be urinals.

c. Non-fireproof class B dwellings. In a non-fireproof class B multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine there shall be one water closet and washbasin for every seven living rooms. One such water closet compartment with washbasin shall be accessible to every room on each floor.

d. Sanitary facilities for employees of tenants. If employees of the tenants occupy two or more rooms opening directly to the same public hall in a fireproof multiple dwelling erected after April eighteenth, nineteen-hundred twenty-nine, there shall be one water closet for the first four rooms or fraction thereof and one additional water closet for each additional seven rooms or fraction thereof. Such facilities shall be accessible either directly from such rooms, or through the public halls.

[Back to top]

[redacted]

Sec. 27-2069 Sanitary facilities in one- and two-family dwellings

The owner of a one- or two-family dwelling shall provide for the exclusive use of the occupants of each dwelling unit at least one water closet, one washbasin and one bath or shower. Such facilities shall be located on the same storey as each dwelling unit or on any of the storeys, to which a dwelling unit extends.

[Back to top]

New York State Energy Saving Calculation Protocols

High Efficiency Water Fixtures

Low Flow Showerheads

Measure Description

A low flow showerhead is a water saving showerhead rated at 2.5 gallons per minute (gpm) - the federal statutory standard for showerheads – or less. It reduces the amount of water flowing through the showerhead, compared with a standard showerhead, while maintaining similar water pressure.

Savings Estimation Approach – Method and Results[26]

Annual Energy Savings

Method

The savings estimations were derived through the following steps:

1. Develop estimate of annual gallons of water saved from the measure

Water Savings = ((GPM_{base} – GPM_{ee}) X (throttle factor) X (minutes/shower) X (#showers/day) X 365 (days/year))

Recommended values are shown in the Table below.

Parameter	Value	Source
GPM_{base}	3.25	LBNL study
GPM_{ee}		Program tracking data on rebated showerhead flowrate
Throttle factor	0.75	Used in LBNL study to adjust for occupant reduction in full flow rate
Minutes per shower	8	LBNL study
Showers per day	2	

2. Calculate the amount of heat required to heat that much water.

kWh Savings =((water savings x (temp to shower-temp to heater) x (8.3BTU per gallon) / (3414 Btu/kWh)) /water heater $efficiency_{elec}$

therm Savings =((water savings x (temp to shower-temp to heater) x (8.3BTU per gallon) / (100,000 Btu/therm)) /water heater $efficiency_{gas}$

The typical value for water temperature leaving the shower is 105 degrees F. Inlet water temperature by location is shown below.

[26] This methodology is derived from CL&P and UI Program Savings Documentation for 2008 Program Year, pp. 155-156.

[redacted]

City	Annual average outdoor temperature (°F)	T mains (°F)
Albany	48.2	54.2
Binghamton	46.9	52.9
Buffalo	48.3	54.3
Massena	44.7	50.7
Syracuse	48.6	54.6
Upstate average	47.3	53.3
NYC	56.5	62.5

Standard assumptions for water heater efficiency are listed below.

Water Heater Type	Water heater efficiency
Electric	0.97
Gas	0.75

Summary of Variables and Data Sources

Variable	Value	Notes
GPM_{ee}		From application
GPM_{base}	3.25	
Throttle factor	0.75	
Min/shower	8	
Shower/day	2	
T_{shower}	105	
T_{mains}		Avg T_{mains} based on upstate or downstate
Water heater effic	0.97	Electric
	0.75	Gas

Notes & References

1. Average hot water use per person taken from: Lutz, James D., Liu, Xiaomin, McMahon, James E., Dunham, Camilla, Shown, Leslie J.McCure, Quandra T; “Modeling patterns of hot water use in households;” LBL-37805 Rev. Lawrence Berkeley Laboratory, 1996..
2. Average annual outdoor temperature taken from the National Renewable Energy Laboratory TMY 3 long-term average weather data sets, processed with the DOE-2.2 weather data statistics package. www.nrel.gov
3. Water mains temperatures estimated from annual average temperature taken from: Burch, Jay and Craig Christensen; “Towards Development of an Algorithm for Mains Water Temperature.” National Renewable Energy Laboratory.

Revision Number

0

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Faucet Aerators

Measure Description

A faucet aerator is a water saving device that, by federal guidelines that went into effect in 1994, enables no more than 2.2 gallons per minute (gpm) to pass through the faucet. A low flow faucet aerator can reduce water flow to 1.5 gpm while maintaining appropriate water pressure and flow.

Savings Estimation Approach – Method and Results[27]
Annual Energy Savings

Method

The savings estimations were derived through the following steps:

1. Develop estimate of annual gallons of water saved from the measure

> Water Savings = ((Standard – low flow aerator GPM) X (duration/use) X (#uses/day) X (days/year))

The table below provides the baseline (standard) and low flow aerator water flows, related input assumptions, and the resulting water savings. Assumptions regarding average duration of use and number of uses per day are also presented. This is based on the CL&P and UI savings document, which itself relied on FEMP assumptions.[28]

Water Savings (Gallons/year)

Standard aerator (GPM)	2.2
Replacement low flow aerator (GPM)	1.5
Savings in GPM	0.7
Duration of use (minutes)	0.5
No. of uses/day	30
Days/year	365
Gallons of water saved/year	3,830

2. Calculate energy savings

> kWh Savings =((water savings x (temp faucet-temp to heater) x (8.3BTU per gallon) / (3413Btu/kWh)) /water heater efficiency$_{elec}$

[27] This methodology is derived from CL&P and UI Program Savings Documentation for 2008 Program Year, pp. 157-158.
[28] Federal Energy Management Program "Domestic Water Conservation Technologies" at http://www1.eere.energy.gov/femp/pdfs/22799.pdf and other sources.

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therm Savings =((water savings x (temp faucet-temp to heater) x (8.3BTU per gallon) / (100,000Btu/therm)) /water heater efficiency$_{gas}$

Typical value for water temperature leaving the faucet is 80 degrees F. Inlet water temperature by location is shown below.

City	Annual average outdoor temperature (°F)	T mains (°F)
Albany	48.2	54.2
Binghamton	46.9	52.9
Buffalo	48.3	54.3
Massena	44.7	50.7
Syracuse	48.6	54.6
Upstate average	47.3	53.3
NYC	56.5	62.5

Standard assumptions for water heater efficiency are listed below.

Water Heater Type	Water heater efficiency
Electric	0.97
Gas	0.75

Summary of Variables and Data Sources

Variable	Value	Notes
GPM_{ee}	2.2	
GPM_{base}	1.5	
Duration (minutes)	0.5	
Uses/day	30	
Days per year	365	
T_{faucet}	80	
T_{mains}		Avg T_{mains} based on upstate or downstate
Water heater effic	0.97	Electric
	0.75	Gas

Notes & References

1. Methodology derived from CL&P and UI Program Savings Documentation for 2008 Program Year, pp. 157-158.
2. See Federal Energy Management Program "Domestic Water Conservation Technologies" for water savings data. http://www1.eere.energy.gov/femp/pdfs/22799.pdf
3. Average annual outdoor temperature taken from the National Renewable Energy Laboratory TMY 3 long-term average weather data sets, processed with the DOE-2.2 weather data statistics package. www.nrel.gov
4. Water mains temperatures estimated from annual average temperature taken from: Burch, Jay and Craig Christensen; "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory.

Revision Number
1

Roof Cavity Insulation

Building: Multi-Family Highrise City: NYC HVAC: Steam Boiler Only Measure: Wall Insulation

Base	0			11			13			17			19		
Measure	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF
11	0.0	0.0	39.6												
13	0.0	0.0	51.5	0.0	0.0	11.9									
17	0.0	0.0	68.2	0.0	0.0	28.6	0.0	0.0	16.8						
19	0.0	0.0	74.1	0.0	0.0	34.5	0.0	0.0	22.6	0.0	0.0	5.8			
21	0.0	0.0	79.2	0.0	0.0	39.6	0.0	0.0	27.7	0.0	0.0	10.9	0.0	0.0	5.1
25	0.0	0.0	87.3	0.0	0.0	47.7	0.0	0.0	35.8	0.0	0.0	19.0	0.0	0.0	13.2
27	0.0	0.0	90.3	0.0	0.0	50.7	0.0	0.0	38.8	0.0	0.0	22.1	0.0	0.0	16.2

Building: Multi-Family Highrise City: NYC HVAC: Steam Boiler Only Measure: Roof Insulation

Base	0			11			19			30			38		
Measure	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF	kWh/ kSF	kW/ kSF	therm/ kSF
11	0.0	0.0	318.5												
19	0.0	0.0	371.5	0.0	0.0	52.9									
30	0.0	0.0	403.0	0.0	0.0	84.5	0.0	0.0	31.5						
38	0.0	0.0	416.2	0.0	0.0	97.7	0.0	0.0	44.7	0.0	0.0	13.2			
49	0.0	0.0	426.6	0.0	0.0	108.1	0.0	0.0	55.2	0.0	0.0	23.6	0.0	0.0	10.5
60	0.0	0.0	434.9	0.0	0.0	116.3	0.0	0.0	63.4	0.0	0.0	31.8	0.0	0.0	18.7

[redacted]

Steam Pipe Insulation

Pipe Insulation

This section covers pipe insulation in space heating and domestic hot water (DHW) system distribution system applications. The savings depend on the type and size of the pipe, insulation type and thickness, hot water temperature and piping system ambient temperature.

Method for Calculating Energy Savings

$$\Delta kW_S = L \times \frac{\left[(UA/L)_{base} - (UA/L)_{ee}\right]}{\eta_{heater} \times 3413} \times \Delta T_S \times CF_S$$

$$\Delta kWh = L \times \frac{\left[(UA/L)_{base} - (UA/L)_{ee}\right]}{\eta_{heater} \times 3413} \times \overline{\Delta T} \times hr$$

$$\Delta therm = L \times \frac{\left[(UA/L)_{base} - (UA/L)_{ee}\right]}{\eta_{heater} \times 100{,}000} \times \overline{\Delta T} \times hr$$

where:

ΔkW	= gross coincident demand savings
ΔkWh	= gross annual energy savings
L	= length of insulation installed
ΔT	= temperature difference between water within the pipe and air under peak conditions
$\overline{\Delta T}$	= average temperature difference between water within the pipe and air temperature (°F)
UA/L	= overall pipe heat loss coefficient per unit length (Btu/hr-°F-ft)
CF	= coincidence factor
3412	= conversion factor (Btu/kWh)
8760	= conversion factor (hr/yr)
100,000	= conversion factor (Btu per therm)
η_{heater}	= water heater or boiler efficiency

The ***overall heat transfer coefficient*** per foot of pipe for the base and improved (insulated) piping is shown in the tables below.

Baseline Uninsulated Pipe Heat Loss Coefficient (UA/L) in Btu/hr-°F-ft

Pipe Size (nominal) (in.)	Bare Copper Piping			Bare Steel Piping	
	Service Hot Water	Hot water heat	Steam heat	Hot water heat	Steam heat
0.75	0.40	0.45	0.49	0.73	0.78
1	0.50	0.56	0.61	0.89	0.95
1.25	0.59	0.67	0.72	1.10	1.18
1.5	0.68	0.78	0.83	1.24	1.33
2	0.86	0.98	1.05	1.52	1.63
2.5	1.04	1.18	1.26	1.81	1.94
3	1.21	1.37	1.47	2.16	2.32
4	1.54	1.75	1.88	2.72	2.92

Insulated Copper Pipe Heat Loss Coefficient (UA/L) in Btu/hr-°F-ft

Pipe Size (nominal) (in.)	Fiberglass				Rigid foam			
	0.5 in	1.0 in	1.5 in	2.0 in	0.5 in	1.0 in	1.5 in	2.0 in
0.75	0.17	0.11	0.09	0.08	0.12	0.08	0.06	0.05
1	0.21	0.13	0.10	0.09	0.15	0.09	0.07	0.06
1.25	0.24	0.15	0.11	0.10	0.17	0.10	0.08	0.07
1.5	0.27	0.16	0.13	0.11	0.20	0.12	0.09	0.08
2	0.34	0.20	0.15	0.12	0.24	0.14	0.11	0.09
2.5	0.41	0.23	0.17	0.14	0.29	0.17	0.12	0.10
3	0.47	0.26	0.19	0.16	0.34	0.19	0.14	0.11
4	0.60	0.33	0.24	0.19	0.43	0.24	0.17	0.14

Insulated Steel Pipe Heat Loss Coefficient (UA/L) in Btu/hr-°F-ft

Pipe Size (nominal) (in.)	Fiberglass				Rigid foam			
	0.5 in	1.0 in	1.5 in	2.0 in	0.5 in	1.0 in	1.5 in	2.0 in
0.75	0.20	0.12	0.10	0.08	0.14	0.09	0.07	0.06
1	0.23	0.14	0.11	0.09	0.17	0.10	0.08	0.07
1.25	0.28	0.17	0.13	0.11	0.20	0.12	0.09	0.08
1.5	0.31	0.18	0.14	0.12	0.22	0.13	0.10	0.08
2	0.37	0.21	0.16	0.13	0.27	0.15	0.12	0.10
2.5	0.44	0.25	0.18	0.15	0.32	0.18	0.13	0.11
3	0.52	0.29	0.21	0.17	0.38	0.21	0.15	0.12
4	0.65	0.36	0.26	0.21	0.47	0.26	0.18	0.15

The ***efficiency*** of an electric storage type water heater is assumed to be 0.97. The efficiency of a non-condensing storage type water heater is assumed to be 0.75. For space heating applications, the efficiency of a gas hot water boiler is assumed to be 0.80 and the efficiency of a gas steam heating boiler is assumed to be 0.75.

The ***ambient temperature difference*** between the water temperature and the ambient room temperature is used to calculate the pipe losses. Water heaters are generally located in conditioned or partially conditioned spaces to avoid freezing. A room temperature of 70°F is the default value. A water heater setpoint temperature of 130°F is the default value. Similarly, space heating boilers are generally located in conditioned or partially conditioned spaces to avoid freezing. A room temperature of 60°F is the default value.

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An average water temperature of 160°F is the default value for hot water boilers, and an average steam pipe temperature of 190°F is the default value for steam boilers.

The ***coincidence factor*** is defined as the average fraction of the peak savings for the measure that occurs at the time of system peak. Since the measure affects standby losses, water heater savings occur year-round. Boiler systems are assumed to be turned off in the summer, so there are no savings in the summer.

The recommended value for the coincidence factor is shown below.

Parameter	Recommended Values
Coincidence factor (water heater)	1.0
Coincidence factor (space heating boiler)	0.0

Baseline Efficiencies from which Savings are Calculated

The UA_{base} assumes uninsulated copper pipe for water heating applications, and uninsulated copper or steel pipes for space heating applications.

Compliance Efficiency from which Incentives are Calculated

The UA_{ee} for insulated pipes was calculated for fiberglass and rigid foam pipe insulation of various thicknesses.

Service hot water pipe insulation for non-recirculating systems common in single family buildings is limited to the first 12 feet of hot water supply pipe leaving the water heater. Recirculating systems common in multifamily buildings should use the full length of installed pipe insulation to calculate savings.

Space heating pipe insulation is limited to insulation installed in unheated spaces only.

Operating Hours

The water heater is assumed to be available during all hours.

Single family and multifamily low rise buildings should use the heating equivalent full-load hours as shown in Appendix G. Systems in high rise multifamily buildings should use 3240 operating hours per year.

Summary of Variables and Data Sources

Variable	Value	Notes
L	From application	
ΔT	60°F (service hot water) 100°F (hot water heat) 130°F (steam heat)	130°F hot water temp, 70°F room temp 160 °F hot water temp, 60°F room temp 190 °F steam temp, 60°F room temp
$\overline{\Delta T}$	60°F (service hot water)	130°F hot water temp, 70°F room temp

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	100°F (hot water heat) 130°F (steam heat)	160 °F hot water temp, 60°F room temp 190 °F steam temp, 60°F room temp
UA/L	From table above	Pick value based on pipe size, insulation type and insulation thickness
CF	1.0	
η_{heater}	0.97 (elec water heater) 0.75 (gas water heater) 0.80 (gas hot water heat) 0.75 (gas steam heat)	
hr	Service hot water: 8760hr Space Heat: $EFLH_{heat}$ (SF and MF lowrise) 3240 (MF highrise)	$EFLH_{heat}$ from Appendix G.

Notes & References

1. The uninsulated pipe losses were obtained from the 2001 ASHRAE Handbook of Fundamentals, Chapter 25, Tables 11A and 12.
2. Insulated pipe losses were calculated using a k value of 0.25 Btu-in/SF-°F for fiberglass and 0.18 Btu-in/SF-°F for rigid foam insulation. Pipe wall resistance and exterior film resistance were neglected.

Revision Number

1

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DOMESTIC HOT WATER CONSUMPTION AND EFFICIENCY

Researching Consumption and Demand in New York City Multifamily Apartment Buildings

Final Report

Prepared for

THE NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

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NYSERDA
Report 97-2

February 1997

Table 2-2
DHW System Efficiencies

System	Month	DHW Fuel Input (Btu/h)	DHW Energy Output (Btu/h)	Return Losses (Btu/h) % Fuel in	Marginal Output Efficiency e	Standby Losses B	(B)(e)	Off-Cycle Losses (Btu/h) % Fuel In	Average Efficiency	Regression Efficiency
	February	60,000	24,500	11,180	0.665	23,200	15,400	4,200	41.0%	
				18.0%				7.0%		
	April	61,800	22,600	11,350	0.620	27,400	17,000	5,640	37.0%	
				18.0%				10.0%		
Direct Fired	June	42,600	16,100	10,100	0.763	20,140	15,300	5,215	39.0%	
System				24.0%				13.0%		
	August	38,900	14,200	10,300	0.720	19,300	13,900	3,616	37.0%	
				26.0%				9.0%		
	All Months	53,700	19,200	10,750	0.680	26,363	18,000	7,250	36.6%	35.1%
				20.0%				13.5%		
Indirect Fired		44,205	16,455	10,035	0.865	25,054	21,660	7,250	37.7%	37.3%
System				22.7%				26.0%		
Tankless Coil		43,400	12,000	9,500	0.840	21,544	18,100	8,600	32.7%	33.5%
System				22.0%				20.0%		

DHW Efficiencies of the Indirect Fired System

In May, July and September no space heating occurred and all the gas energy flowing to the boiler was used for DHW (see Figure A2, Appendix A).

Following the same approach as outlined for the direct fired tank a regression efficiency of 37.3% is obtained for an average output energy of 16,455 Btu/h (820 Btu/h/unit). Figure 2-11 and Table 2-2 show the relevant regression analysis and data. Off-cycle losses for the indirect fired system are as high as 26% of the energy input.

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Try These On for Size: New Guidelines for Multifamily Water Heating

by Fredric S. Goldner

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ASHRAE has published new sizing guidelines for hot water systems, based on recent studies of water-heating use in apartment buildings. If adopted in practice, the new sizing method should prevent the costly oversizing that is now common.

Energy professionals have long been frustrated by the lack of reliable data for sizing domestic hot water (DHW) equipment in multifamily buildings. To be on the safe side, many designers oversize the equipment, resulting in systems with higher equipment costs, operating costs, and energy use. Now ASHRAE has incorporated data from recent studies into new guidelines for properly sizing DHW systems.

Using previous (pre-1995) ASHRAE guidelines resulted in serious undersizing (see Figure 1). In practice, however, DHW systems and combined heating/DHW boilers are often oversized by 30%-200%, according to the New York City Department of Housing Preservation and Development, Energy Conservation Division. Discussions with designers in other parts of the country revealed similar oversizing.

The 60-unit building in the photo above houses middle-income families. As part of a study conducted in New York City, researchers monitored the building's hot water consumption, which fell into the medium usage category under the 1995 ASHRAE guidelines.

What happens is that the individual responsible for installing a boiler will often size it with a what was there before, looks like ..., or other rule-of-thumb method. Even when they do try to calculate the loads, designers use enormous safety factors because they know the DHW demands estimated with the old methods tend to undersize (see Evolution of an Oversizing Rule). The safety factors cause considerable oversizing even when the space heating portion is calculated properly, which is rarely the case. I've seen factors that double the size of the boiler relative to the space heating load (a rule of thumb that is particularly inaccurate for the New York climate).

Evolution of an Oversizing Rule

A review of manufacturers' literature uncovered at least half a dozen different methods for sizing both combined heat/DHW units and stand-alone systems.

Many of these methods were initially based on the pre-1995 ASHRAE approach. I once sat down with the VP of marketing and one of the design engineers for a prominent manufacturer and asked them how the data sheets in their catalog determine system size. They replied the *ASHRAE Handbook* method. After running some calculations, we found that in fact their results were somewhere between two to three times greater than the results obtained using the *Handbook* method.

What probably happened was that the engineer who had written the sizing sheets (many years ago) started with the *Handbook* values as a base. But from his experience, he recognized that the numbers were not sufficient to meet a building's demand, so he added a safety factor based on that experience. Subsequently, as the catalog has been revised, each engineer given the responsibility to update the sheets has said to himself or herself, Well, *I'm* not going to be responsible for there not being enough hot water in a building and has added another safety factor on top of the previous one. And then the chief engineer in charge of the revision says, *I'm* not going to be responsible for there not being enough hot water . . . and adds yet another safety factor. Thus over time these values have in some cases become grossly inflated.

To aggravate this already bad situation, the contractor on the job may look at the data sheets and say, Well *I'm* not . . . and add another level of so-called safety factor. The job then gets sized out and a call is made to the warehouse, whose staff, feeling like all the other parties, applies the next-size-up approach before sending the heater/boiler out to the job site.

The 1995 ASHRAE Guidelines The new guidelines update the previous ASHRAE hot-water demand values. In part, the new values reflect changes in numbers of water-consuming devices, personal habits, lifestyles, and sanitation needs since the late 1960s, when the previous values were determined. In addition, sophisticated computers and monitoring equipment have enabled us to gather more extensive data on which to base sizing criteria.

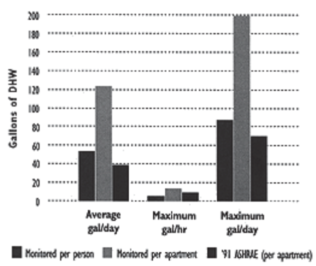


Figure 1. Comparison of monitored data to hot-water usage calculated with values from the *1991 ASHRAE HVAC Applications Handbook* Table 7. For these New York City buildings, using the 1991 ASHRAE guidelines would have resulted in severely undersized equipment.

The 1995 guidelines also take a new approach. Rather than a single value for volume of water used per apartment, they offer a range of values for different types of users. The residents or likely residents of a building are separated by their demographic characteristics into three usage categories: low, medium, or high (LMH). Additionally, the usage factors are provided *per capita* rather than per apartment. This reflects the fact that people, not apartments or square footage, use water.

To help in the design process, the new ASHRAE tables give more detailed levels of consumption for the peak 5 minutes and the peak 15 minutes (the old tables had only 60-minute peak values). These values more closely represent the instantaneous demand peak that a building will experience.

Using the New Method The first step in calculating DHW demand is to determine the demographic profile of the project and building occupants. Different types of building occupants consume hot water in fairly predictable patterns. Users can be lumped into one of the three typical LMH categories of water consumers.

Table 1 lists a variety of occupant classifications, one or a combination of which should describe the occupants of any particular multifamily building. For example, a luxury condominium in an area inhabited predominantly by young couples will tend to fall into the all occupants work category of low anticipated water consumption. By contrast, a low-income housing project will generally fall somewhere between the low income and no occupants work categories of high-volume water consumption. An abundance of hot-water-consuming appliances, such as clothes washers or dishwashers, will tend to increase hot-water consumption. If the condominium building example above intended, or allowed, the future installation of a clothes washer in each unit, the demographic category should be augmented from low to medium. It is up to the system's designer to determine this category.

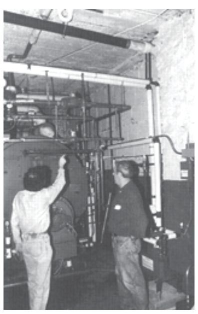
Once this LMH factor has been determined, values for hot-water consumption can be selected from Table 2. Values are indicated per capita in peak or maximum flows of 5 minutes, 15 minutes, one hour, two hours, three hours and one day, as well as average daily flow. From these values, anticipated demand can be determined for the estimated maximum building population.

Table 1. Demographic Characteristics Correlation to DHW Consumption

Demographic characteristics	Usage factor
No occupants work Public assistance and low income (mix) Family and single-parent households (mix) High percentage of children Low income	High
Families Public assistance Singles Single-parent households	Medium
Couples	

Couples Higher population density Middle income Seniors One person works, one stays home All occupants work	Low

Table 2. National DHW Sizing Guidelines (Low-Medium-High)				
Hot Water Demands and Use for Multifamily Buildings				
	Maximum hour	**Peak 15 minutes**	**Maximum day**	**Average day**
Low	2.8 gal (10.5 l)/person	1 gal (4 l)/person	20 gal (76 l)/person	14 gal (53 l)/person
Med	4.8 gal (18 l)/person	1.7 gal (6.4 l)/person	49 gal (185 l)/person	30 gal (114 l)/person
High	8.5 gal (32.5 l)/person	3 gal (11.5 l)/person	90 gal (340 l)/person	54 gal (205 l)/person
	Peak 5 minutes	**Peak 30 minutes**	**Maximum 2 hours**	**Maximum 3 hours**
Low	0.4 gal (1.5 l)/person	1.7 gal (6.5 l)/person	4.5 gal (17 l)/person	6.1 gal (23 l)/person
Med	0.7 gal (2.6 l)/person	2.9 gal (11 l)/person	8 gal (31 l)/person	11 gal (41 l)/person
High	1.2 gal (4.5 l)/person	5.1 gal (19.5 l)/person	14.5 gal (55 l)/person	19 gal (72 l)/person
Note: These volumes are for DHW delivered to the tap at 120oF.				
Sources: Data from Chapter 45: Service Hot Water, In 1995 ASHRAE Handbook: HVAC Applications, Atlanta: ASHRAE, 1995, and Goldner, F.S., and D.C. Price. Domestic Hot Water Loads, System Sizing and Selection for Multifamily Buildings. In 1994 ACEEE Summer Study on Energy Efficiency in Buildings Proceedings, 2.105-2.116. Berkeley: American Council for an Energy-Efficient Economy, 1994.				



Author Fredric Goldner discusses meter equipment with building superintendent John Perkins. The meter he is pointing to monitors hot water recirculation, and above it is a domestic hot water consumption meter.

The number of occupants per apartment should be estimated based on local standards or regulations. For example, in a given city, studios may accommodate two persons; one-bedroom apartments, three persons; two-bedroom apartments, three to five persons; and so on.

In buildings where corrective maintenance cannot be done, a safety factor of 20%-30% may be employed to compensate for poorly maintained fixtures and distribution piping. However, this should be done only in extreme cases.

The figures presented in Table 2 are for centrally fired systems; individual apartment water heater systems are likely to have lower levels of consumption because the resident usually pays for fuel directly, which encourages conservation. There isn't a set of values for individual systems in ASHRAE, but a suggested rule of thumb for sizing these would be to use a low-end estimate for a single-family home load.

ASHRAE based its 1995 guidelines (published in the 1995 *HVAC Applications Handbook*) on new research conducted in New York City (see Collecting Usage Data in New York City) as well as data from studies in seven other areas of the United States and Canada. Both research and practical experience in different areas of North America indicate that there are variances in DHW use among geographical locations. There is, however, no distinctive pattern that can be identified with the available data.

The joint ASHRAE/ASPE (American Society of Plumbing Engineers) *Domestic Hot Water Design Manual,* to be published this fall, will go into greater depth than the ASHRAE standards, including the patterns of consumption and demand derived from the New York study. Becoming familiar with these patterns can help designers choose the best equipment and help auditors troubleshoot related system problems.

Collecting Usage Data in New York City

In 1990-91, Energy Management & Research Associates (EMRA) gathered 14 months of real-time monitoring data in 30 New York City multifamily buildings. The New York State Energy Research and Development Authority sponsored the study.

The data were collected by computerized heating controllers, which monitored burner on-off times and the following temperatures: apartment air, outdoor air, boiler water (aquastat), and DHW. Eight buildings had additional monitoring equipment installed to record stack temperature, boiler makeup water flow, DHW flow in 15-minute increments, oil flow, and DHW temperature before and after the mixing valve and on the return line.

In 1993, we equipped a subset of three of the sites to record DHW flow in 5-minute increments and to

[redacted]

record recirculation flows. This was done to get a more precise picture of short-term/instantaneous demand peaks and to collect the missing information necessary to create an accurate simulation of real-time operations. We collected data in these three buildings for 100 days.

EMRA also collected building operation and tenant information from superintendents and property managers via questionnaires and interviews, and building and apartment occupancy records. We conducted energy audits to determine the type and condition of equipment and buildings.

Within the New York research, we tried to include a variety of building sizes, income levels, ethnic backgrounds, and locales. The study buildings are characteristic of the older and predominant stock of the over 120,000 New York City multifamily buildings. The buildings range in size from 17 to 103 apartments in either five or six above-ground stories. These buildings were built before 1902 or between 1902 and 1928. All have combination steam-space-heating and DHW-generating steel tube boilers, which use primarily #4 or #6 oil in air-atomizing burners. DHW is generated by a tankless coil just under the surface of the boiler water.

Energy Use Analysis

An evaluation of the energy used to produce DHW was conducted for the summer period, when the systems are used strictly for DHW purposes. This analysis revealed that an average of 150 gallons (ranging from 100 to 200 gallons) of DHW was produced and used at the tap for each gallon of #6 oil (or equivalent) consumed by the burner. Included in these figures are various levels of combustion efficiency, standby losses, pipe insulation, and other real-time factors that affect the operation of systems in occupied buildings. These numbers can be used as a check against results of energy savings predictions from audit calculations related to hot water conservation measures (such as low-flow showerheads).

For further details, a copy of Report No. 94-19, *Energy Use and Domestic Hot Water Consumption: Phase 1,* is available from NYSERDA. Tel:(518)465-6251, Ext. 250.

The Variations Behind the Values Seasonal and Daily Variations The multifamily buildings we studied show distinct seasonal variations of DHW consumption levels (see Figure 2). The average daily consumption rises 10% in the fall (from summer consumption), and rises 13% more in the winter. Consumption then drops slightly in the spring and drops significantly (19%) in the summer.

There is generally a slightly higher daily consumption on weekends than on weekdays. This holds true in all seasons. The average weekend daily consumption is 7.5% greater than the average weekday daily consumption.

Weekday and weekend hot-water consumption patterns have distinct differences (see Figure 3). Weekdays have little overnight usage; a morning peak; lower afternoon demand; and an evening or nighttime peak. Weekends have just one major peak, which begins later in the morning and continues until around 1 pm to 2 pm. The usage then tapers off fairly evenly through the rest of the day. The weekend peak is greater than any of the weekday peaks.

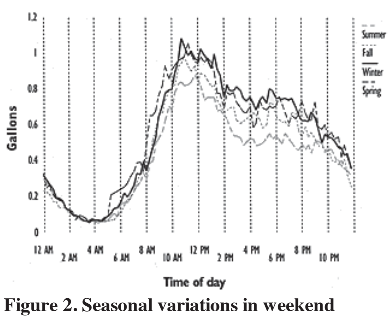
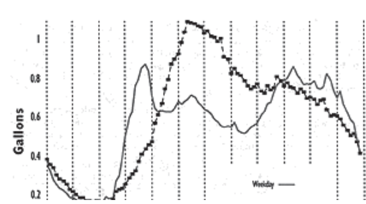


Figure 2. Seasonal variations in weekend consumption, gallons per person (composite of data from New York City apartment buildings).

The highest peaking level occurs during winter weekends. Thus, the best tactic for an engineer who has the time and money to custom-design a retrofit system is to monitor current consumption for two or three winter weekends to determine a building's actual peak usage, rather than estimating it with Table 2. A system designed to meet these draws should satisfy all other year-round requirements.



Two morning peaks occur on the weekdays, the first between 6 am and 8 am and the second between 9:30 am and noon. Individual buildings tend to exhibit one of these two peaks. Generally, the buildings with large numbers of working

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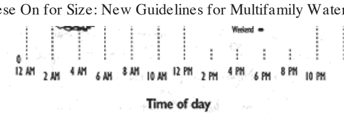


Figure 3. Weekday versus weekend consumption (composite of data from New York City apartment buildings). Research in New York City found that apartment residents use the most water between 10 AM and 12 noon during winter weekends.

numbers of working tenants and middle-income populations experience the early morning peak, while buildings with many children exhibit the later morning peak (especially during the summer period).

This knowledge of flow patterns can come in particularly handy when troubleshooting hot water complaints. For instance, a large fluctuation in water temperature at a time when the usage was extremely low recently helped me to identify a problem with a faulty hot water coil. If the fluctuation was observed only during a high usage period, the cause-perhaps an undersized coil or a problem with the mixing valve-would have been harder to determine.

Recirculation Systems DHW systems in multifamily buildings generally employ one of three types of return or recirculation system. The first option is to have no recirculation piping at all. This is most often found in the smallest end of the multifamily sector, where there are short runs between the supply source (boiler or heater) and the farthest tap. The second option is a gravity return system (thermosiphon circulation). The monitoring data indicate that these systems have a very small flow, ranging from 0 to 0.5 gpm. The third option is a forced recirculation system. These systems employ a small pump to keep water flowing, thus avoiding stagnation and the need for residents to run the tap for a long period (particularly on upper floors) to receive sufficiently hot water. The pumps either are run continuously or may be cycled on and off by an aquastat.

Although recirculation pumps should be sized to meet each individual building's requirements, common practice is one size fits all. Thus we found the same pump size at all sites. (A methodology for proper pump size selection can be found on page 45.5 of the 1995 ASHRAE *HVAC Applications Handbook*.)

Our monitoring showed that water consumption has an inverse relationship with recirculation flow. In the overnight period, when there is little or no consumption, the pump reaches its maximum capacity rate. Designers should consider this and the flow curves in Figure 3 when choosing between recirculation control strategies (see The Best Boiler and Water Heating Retrofits, *HE* Sept/Oct '95, p. 27, and Controlling Recirculation Loop Heat Losses, *HE* Jan/Feb '93, p. 9). A new study investigating three very low-cost approaches to reduce recirculation system losses while maintaining resident comfort and satisfaction should be completed in early 1997.

Peak Demands and Average Consumption In the New York City buildings, the average hourly consumption is only 42% of the consumption in the peak hour. Instead of sizing a system to be able to provide the peak demand, it's possible to generate and store hot water during the periods of average and below-average demand to meet the peak. This could be accomplished by installing a system with a heater designed to generate the average hourly load, running essentially continuously, and providing enough storage tank capacity to store unneeded hot water during the night and furnish it during periods of peak demand (such as morning shower time).

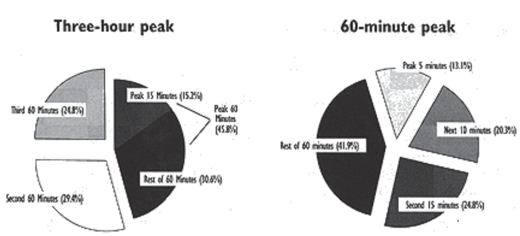


Figure 4. Parts of three-hour peak and 60-minute peak consumption.

Concurrence of Peaks Beyond the general usage patterns of a building, peaking times and flows are used to more closely identify demands on the boiler. Figure 4 shows how all of the peak volumes contribute to the one-hour and three-hour peak demands on the DHW generation and/or storage system. These relationships can be used to model various configurations of hot water supply systems (see A Sizing Example).

The 5-, 15-, 60-, 120-, and 180-minute peak demand times coincide with each other. These volumes should therefore be addressed as different (time length) measurements within the same peak DHW draw, so the system can be designed to satisfy this load. An instantaneous system designed to meet the peak 5-minute draw will have no problem meeting the rest of the load.

Generation and storage systems should be designed both to provide hot water for the average load and to meet the short, sharp peaks.

A Sizing Example

Let's take a 58-unit apartment building whose occupants are a mix of families, middle income couples, and some singles. Most adults work outside the home. There is a public laundry in the basement with a few washers, and the leases prohibit both clothes washers and dishwashers in the apartments (although conversations with the building superintendent have confirmed that a number of people have such appliances.)

[redacted]

Step 1. Compute the maximum potential occupancy, based on local standards and expectations, and conversations with the building owner or manager.

Maximum Total Apt size Apts people/apt people 3-bedroom 4 x 5 = 20 2-bedroom 14 x 4 = 56 1-bedroom 25 x 3.5 = 87.5 Studios 15 x 2.25 = 33.75 Building total 198

Step 2. Determine the Low, Medium, or High (LMH) usage factor of the building's occupants from Table 1, based on knowledge of the building, conversations with the building owner or manager, and observations. Consider the effect of either currently installed or potential future additions of appliances that might move a building up to a higher usage category.

Based on the information above, the Medium usage factor was selected.

Instantaneous Systems

For either an instantaneous DHW-only system or a tankless coil in a combination heat/DHW boiler, first find the system load (gallons per hour) based on the peak 5-minute demand. Next, convert this to a Btu/h rating. This rating can then be used to select equipment.

Step 3a. Compute the system load using the 5-minute peak demand values in Table 2.

Number Peak 5-min Peak LMH factor of people demand Periods/h system load Medium 198 x 0.7 gal/person x 12 = 1,663 gal/h *Step 4a*. Convert the system load to a Btu/h rating. (In New York City, the average year-round temperature rise required is about 90oF.)

1/Boiler System load Conversion Temp rise combustion efficiency DHW load 1,663 gal/hr x 8.33 lb/gal x 90oF x 1/0.8 (80% CE) = 1,558,439 Btu/h *Instantaneous DHW-Only Heater*. The 1,558,439 Btu/h should be the size of the DHW heater. (Note that a higher combustion efficiency should actually be used for sizing an instantaneous heater; use 85% or the efficiency specified in the equipment documentation.)

Combination Heat/DHW Boiler. When sizing a tankless coil in a combination heat/DHW system, the 1,663 gallons per hour is the coil size to be ordered. The 1,558,439 Btu/h is the additional load capacity for DHW to be added to the space-heating load to size the boiler. (In an existing steam heating distribution system, the space-heating load should be computed by the EDR-equivalent direct radiation-methodology.)

Generation and Storage System

For a system with a mix of generation and storage, calculate the generator size based on the peak 30-minute demand to get a Btu/h rating. Calculate the storage tank volume based on the maximum three-hour demand.

Step 3b. Compute the system load using the peak 30-minute and maximum three-hour hot water values in Table 2.

Number Peak 30-min LMH factor of people demand category Periods/h System load Medium 198 x 2.9 gal/person x 2 = 1,148 gal/h Number Maximum 3-hours LMH factor of people demand category Storage volume Medium 198 x 11 gal/person = 2,178 gal

Step 4b. Next, convert the load into equipment ratings.

1/Boiler System load Conversion Temp rise combustion efficiency DHW load 1,148 gal/h x 8.33 lb/gal x 90oF x 1/0.85 (85% CE) = 1,012,536 Btu/h The 1,012,536 Btu/h is the size of the hot-water heater. This heater should then be used to supply 2,100 gallons of unfired storage tanks.

[redacted]

Estimating Consumption in Existing Buildings

To estimate how much hot water is used in a building for energy consumption or savings calculations, use the LMH factor and the average day hot-water value in Table 2. In this calculation, replace the maximum potential occupancy from Step 1 with the actual current (or best-guess recent) occupancy level.

Step 3c. Calculate system load using the average day values in Table 2.

	Current number	Average day	LMH factor	of people	demand	System load	Medium
153	x	30 gal/person	=	4,590 gal/day			

Straighten Up and Size Right There seem to be as many different types of DHW heating systems as there are people who design them. What they all attempt to accomplish is to provide the correct mix of generation capacity and storage to satisfy both the peaks and the average load. One major concern during the development of the LMH approach was the acceptance and use of the new system. Because it results in higher load estimates than the old guidelines, it is important that the new method be used correctly.

If the current practice of defensive oversizing is applied to the new guidelines, this will only exaggerate the capital and energy inefficiencies experienced in the past. It is therefore important for the designer to recognize the inherent safety nets in the new approach. The most significant of these is that the method uses the building's maximum potential occupancy, which may never actually occur. Also, using the new guidelines, an engineer designs a system to satisfy the higher-volume but short-duration peaks (not delineated in the old guidelines), which occur only a few times during the year. Even if the system were not able to satisfy that load, the problems would probably be minor-for instance, the occupants might experience slightly lower temperature hot water at their taps a few times per year.

The main question concerning acceptance and use of the new guidelines is whether the designers and energy professionals are comfortable with their reliability and professional backing. ASHRAE's Technical Committee 6.6 (Service Hot Water) was the main force in the call for a new sizing tool based on the vast quantity of real-time data that has been collected. The new joint ASHRAE/ASPE *Domestic Hot Water Design Manual,* scheduled for publication this fall, should also provide substantial support for those who wish to size systems properly. It includes a how-to sizing guide for 17 different building types-from residential buildings to commercial, industrial, and recreational facilities.

Further Reading Chapter 45: Service Hot Water, In *1995 ASHRAE Handbook: HVAC Applications,* Atlanta: ASHRAE, 1995.

Goldner, F.S. DHW System Sizing Criteria for Multifamily Buildings. *ASHRAE Transactions* 100, No.1 (January 1994): 147-65.

Goldner, F.S. *Energy Use and DHW Consumption Research Project,* Report No. 94-19. Final Report: Phase 1. Prepared by Energy Management and Research Associates for New York State Energy Research and Development Authority, November 1994.

Goldner, F.S., and D.C. Price. Domestic Hot Water Loads, System Sizing and Selection for Multifamily Buildings. In 1994 *ACEEE Summer Study on Energy Efficiency in Buildings Proceedings,* 2.105-2.116. Berkeley, CA: American Council for an Energy-Efficient Economy,1994.

Boiler Tune-up Guide

National Emission Standards for Hazardous Air Pollutants for Area Sources:
Industrial, Commercial, and Institutional Boilers

40 CFR Part 63 Subpart JJJJJJ

The purpose of this Guide is to provide the boiler owner the knowledge base to appropriately direct boiler tune-up activities to comply with the requirements of the Boiler Area Source Rule. This will allow the boiler owner to clearly define the scope of work the tuning technician will be tasked to accomplish.

What is a boiler tune-up?

- A *boiler tune-up* refers to many aspects of improving boiler operations. In this Guide, the term *boiler tune-up* specifically refers to the activity to meet the requirements in the Boiler Area Source Rule (**40 CFR Part 63 Subpart JJJJJJ).**
- The tune-up activity is the act of reestablishing the air-fuel mixture for the operating range of the boiler. Oxygen and unburned fuel (carbon monoxide is generally the indicative measurement) are balanced to provide safe and efficient combustion. Carbon monoxide (CO) concentrations are also measured to ensure proper burner operation.
- A primary goal of a boiler tune-up is to improve boiler efficiency with respect to combustion operations.

What are the tune-up requirements under the Boiler Area Source Rule?

- See §63.11223(b) for the actual requirements.
- See the **Tune-up Guidance and Example Recording Form – Area Sources** posted at http://www.epa.gov/ttn/atw/boiler/boilerpg.html for information on compliance dates, recordkeeping, and reporting requirements.

Who should perform the actual tune-up?

- **All boiler adjustments and modifications should be completed by qualified, experienced technicians.**
  - Boiler operations in general and tune-up activities in particular are hazardous and require the skill and knowledge of experienced technicians.
  - The tune-up technician should be skilled in the evaluation and adjustment of the specific boiler and burner equipment in use.

What are the basic activities and minimum requirements associated with a boiler tune-up?

The following is a simple checklist that highlights the basic activities and requirements associated with a boiler tune-up to comply with the requirements of the Boiler Area Source Rule. The checklist is intended to be a time ordered tool to aid in planning and conducting boiler tune-ups.

1) Preparation

a) Clearly identify the target equipment along with the intent and goals of the tune-up.

b) Assemble boiler drawings and data sheets.

c) Assemble burner drawings and data sheets.

d) Assemble combustion control information.

e) Identify environmental regulations and limitations.

i) Typically nitrogen oxides (NOx) and combustible material (often identified as CO) are specifically addressed in the emission limits.

f) Identify steam production control strategy that will be used during the tune-up.

g) Identify in-situ instrumentation and verify calibration.

h) Identify measurement locations and verify access.

i) The most common flue gas measurement location is immediately downstream of the steam generation section of a water-tube type boiler. For a fire-tube type boiler the flue gas sample is most commonly taken as the exhaust gases exit the boiler proper.

i) Establish tune-up timeframe.

2) As-found observation

NOTE: Identification of the as-found conditions centers on measurement of the operating parameters of the combustion process that will be modified during the tune-up process. The primary measurements required under the Boiler Area Source Rule are flue gas oxygen content and flue gas carbon monoxide content at the high-fire or typical operation load.

a) Examine the combustion control components (i.e., the system controlling the air-to-fuel ratio) and ensure it is functioning properly.

b) Examine the burner internal components and identify any defects, if applicable.

c) Examine the general boiler conditions and identify any defects.

d) Measure and record the following for each operating position of the combustion control system.

i) Observe flame pattern, flame dimensions, and burner condition.

ii) Flue gas oxygen content.

iii) Flue gas carbon monoxide (CO) content.

iv) Flue gas emissions content (NOx, if appropriate).

(1) Additional flue gas component analysis is required when the environmental permit specifies limits on emission components. A common regulated emission component is nitrogen oxides (NOx).

v) Emissions control settings.

(1) Flue Gas Recirculation flow settings (if applicable).

vi) Final flue gas temperature.

e) Document any modifications completed at this point.

3) Tune-up

The tune-up activity is the act of ensuring the burners are properly mixing the air and fuel and of reestablishing the most appropriate amount of excess air throughout the operating range of the boiler.

a) Tune-up each operating position of the combustion control system (from high-fire through low-fire).

NOTE: The rule [63.11223(b)(4)] only requires that the tune-up be conducted at high-fire or the typical operating load.

i) Establish steady operation for the target operating point.

ii) Adjust combustion control position relationship to achieve desired combustion characteristics.

(1) Flue gas oxygen content - target will generally be the manufacturer's specifications.

(2) CO content - target will generally be the manufacturer's specifications.

(3) NOx content, if applicable – target will generally be the limit specified in the environmental permit.

(a) Adjustments for emissions control are generally completed after combustion adjustments are established.

iii) Measure and record the following for each operating position of the combustion control system.

NOTE: Only the high-fire or typical operating load need to be recorded to comply with the rule [63.11223(b)(6)].

(1) Observe flame pattern, flame dimensions, and burner condition.

(2) Flue gas oxygen content.

(3) Flue gas CO content.

(4) Flue gas emissions content (NOx and others).

(5) Final flue gas temperature.

iv) Document any modifications completed at each point.

4) Document tune-up.

a) Document the tune-up including the following.

i) As-found conditions.

ii) Post tune-up conditions.

iii) Modifications and repairs completed.

iv) Recommended investigations and modifications.

v) Identified shortcomings of the equipment.

Additional Guidance

What if manufacturer's specifications are not available?

The appropriate range within which to manage excess oxygen depends on the fuel type and the method of monitoring and controlling flue gas oxygen content. The following table provides some general information of the typical control limits for steam boilers. The data represented in this table indicates the _expected_ operating range for boilers.

The numerical values in the table represent the amount of oxygen (O_2) in the flue gas as it exits the combustion zone. This is the actual field measurement for most boilers and it is the common control parameter. The oxygen concentrations noted in the table are "wet basis" measurements and "dry basis" measurement). The rule [§63.11223(b)(5)]) allows measurements on either a dry or wet basis as long as it is the same before and after the adjustments are made.

The two designations in the table are *automatic control* and *positioning control*. *Positioning control* is generally not equipped with continuous flue gas oxygen measurement. The more efficient control is *automatic control*. *Automatic control* (or *continuous automatic control*) continually monitors oxygen content and combustion air flow is trimmed to maintain required oxygen limits, sometimes referred to as *oxygen trim control*.

Typical Flue Gas Oxygen Content Control Parameters

Fuel	Automatic Control Flue Gas O_2 Content				Positioning Control Flue Gas O_2 Content			
	Minimum		Maximum		Minimum		Maximum	
	Wetl Gas Sample [%]	Dry Gas Sample [%]	Wetl Gas Sample [%]	Dry Gas Sample [%]	Wet Gas Sample [%]	Dry Gas Sample [%]	Wet Gas Sample [%]	Dry Gas Sample [%]
Natural Gas	1.5	1.8	3.0	3.6	3.0	3.6	7.0	8.0
No. 2 Fuel Oil	2.0	2.2	3.0	3.3	3.0	3.3	7.0	7.6
No. 6 Fuel Oil	2.5	2.8	3.5	3.8	3.5	3.8	8.0	8.5
Pulverized Coal	2.5	2.7	4.0	4.3	4.0	4.3	7.0	7.4
Stoker Coal	3.5	3.7	5.0	5.3	5.0	5.3	8.0	8.4
Stoker Biomass-Wet	4.0	5.2	8.0	9.7	5.0	6.4	8.0	9.7
Stoker Biomass-Dry	4.0	4.4	8.0	8.6	5.0	5.5	8.0	8.6

Additionally, it should be noted that flue gas oxygen content targets may be influenced by environmental controls; such as, nitrogen oxides (NO_x) control. When a boiler is equipped with NO_x control the minimum oxygen concentrations are sometimes higher than if the boiler was equipped with a standard burner without NO_x control.

What tools or methods can be used to measure oxygen and CO?

The primary tool required to complete a boiler combustion tune-up is a flue gas analyzer. The required measurements for an appropriate flue gas analysis are flue gas oxygen content, combustibles content, and any components that are managed as a part of environmental compliance (NOx for example). These measurements are typically obtained with a portable combustion analyzer.

NOTE: This Guide is in no way intended to advise a departure from the boiler or burner manufacturer's instructions and recommendations.

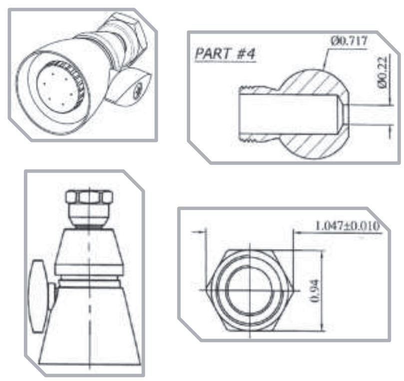
What if I need more detailed information on performing a boiler tune-up?

- ***For More Information:*** Boiler Tune-up Guide for Area Source Boiler Owners is based on the Boiler Tune-up Guide for Natural Gas and Light Fuel Oil Operation, prepared by Greg Harrell, DOE's Energy Management Services which presents:
  - A general discussion of boiler efficiency and the influence combustion control has on efficiency.
  - The basic combustion control methods.
  - The typical field activities associated with tuning a boiler.
  - The methods for evaluating the economic impact associated with tuning a boiler.
  - A basic discussion of the environmental impacts that can be expected with a boiler tune-up activity.
  - General reference data that can be useful in boiler tune-up evaluations
  - A list of general references that may prove useful in tune-up activities.
- This Guidebook can be found at: http://www.epa.gov/ttn/atw/boiler/boilerpg.html

Appendix B: Equipment Cut-Sheets

High Efficiency Water Fixtures – Green Light

GreenLight
a water conservation company

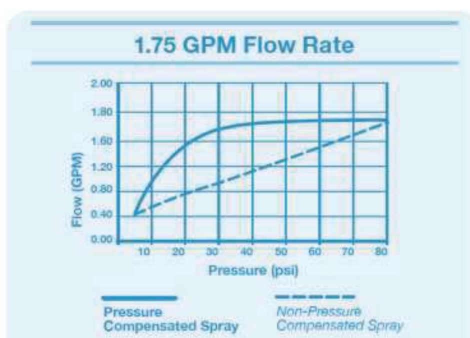


GLWCVPSH-1.75

Vandal Resistant Brass Showerhead and restrictor combination

Green Light Water Conservation strives to ensure a comfortable shower while using 30% less water than other showerheads currently on the market. Additionally, Green Light places a 1.75 GPM restrictor behind the shower arm to guarantee that the savings achieved will not be tampered with. The combination of the behind the wall restrictor, coupled with our brass vandal resistant shower head, will ensure to achieve a comfortable distribution. The pressure compensating technology generates an adequate velocity while using less water.

- 1.75 gallon per minute flow rate (6.6 liter per minute)
- Green Lights non-removable vandal resistance pressure compensating restrictor provides a constant output of water regardless of pressure
- Non-aerated spray means less temperature loss with maximum energy savings
- Easy installation
- 5 year warranty



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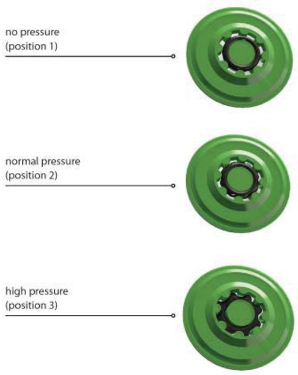
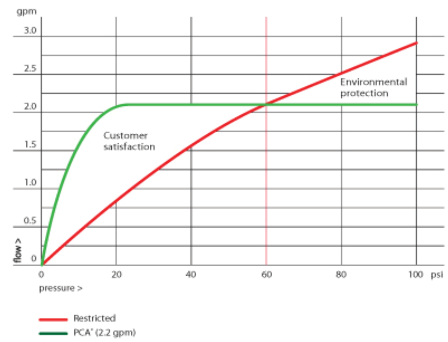
Pressure Compensating Technology





Working Principle of Pressure Compensating Aerators

Static conditions (no flow):
The o-ring is relaxed (position 1).

Dynamic conditions (flow):
The o-ring subjected to the line pressure is compressed into the seating area which reduces the water passage (position 2). As the pressure increases the o-ring is compressed further into the seating area and reduces the water passage further (position 3). As the pressure decreases the o-ring relaxes and reopens the water passage (return to position 2 and 1). Pressure compensating flow regulators are not recommended for use in non-pressurized applications.

Pressure Compensating Aerators (PCA®)

There are two options to control the flow. The more common option is a fixed orifice designed to allow a predetermined flow at a specified pressure (e.g. 60 psi for the US standard) - such products are referred to as «restricted».

The other option is to compensate for variations in pressure to achieve a constant flow rate with the Pressure Compensating Aerator (PCA®) technology. The pressure compensating flow regulator produces – by means of its o-ring – a constant flow rate regardless of pressure fluctuations.
Restricted devices tend to provide insufficient flow at low pressure and excess flow at high pressure. In many markets and applications it is preferable to select the PCA® technology. The fields of application include: markets with a standard defining the maximum flow rate, water conservation, and plumbing systems where an even distribution of water between various points of use is needed.

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LED Wallpack Exterior Lighting Fixture – RAB

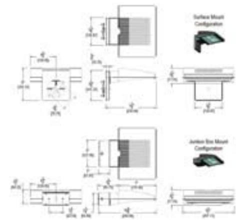
Created: 06/26/2013

WPLED26

26 Watt LED Wallpack. Equivalent to 175W MH wallpack . Includes both junction box and surface mount for recessed box. IESNA Full Cutoff, Fully Shielded optics. 5 Year warranty.

Color: Bronze

Weight: 7.5 lbs



LED Info

Watts:	26W
Color Temp:	5000K (Cool)
Color Accuracy:	66
L70 Lifespan:	100000
LM79 Lumens:	1,816
Efficacy:	61 LPW

Driver Info

Type:	Constant Current
120V:	0.26 A
208V:	0.16 A
240V:	0.14 A
277V:	0.12 A
Input Watts:	30W
Efficiency:	87%

Technical Specifications

UL Listing:
Suitable for wet locations. Suitable for mounting within 1.2m (4ft) of the ground.

Lumen Maintenance:
100,000-hour LED lifespan based on IES LM-80 results and TM-21 calculations.

IP Rating:
Ingress Protection rating of IP66 for dust and water.

Finish:
Chip and fade resistant polyester powder coat finish.

Color Stability:
LED color temperature is warrantied to shift no more than 200K in CCT over a 5 year period.

Color Uniformity:
RAB's range of CCT (Correlated color temperature) follows the guidelines of the American National Standard for Specifications for the Chromaticity of Solid State Lighting (SSL) Products, ANSI C78.377-2008.

Ambient Temperature:
Suitable for use in 40°C ambient temperatures.

Fixture Efficacy:
61 Lumens per Watt.

Color Accuracy:
66 CRI.

Color Temperature (Nominal CCT):
5000K.

Driver:
Multi-chip 26W high output long life LED Driver Constant Current, 720mA, Class 2, 6 KV Surge Protection, 100V-277V, 50-60 Hz, 100-240V .4 Amps.

Cold Weather Starting:
The minimum starting temperature is -40°C.

Thermal Management:
Cast aluminum Thermal Management system for optimal heat sinking. The LPACK is designed for cool operation, most efficient output and maximum LED life by minimizing LED junction temperature.

California Title 24:
WPLED complies with California Title 24 building and electrical codes.

Equivalency:
The WPLED26 is Equivalent in delivered lumens to a 175W Metal Halide Wallpack.

HID Replacement Range:
The WPLED26 can be used to replace 150 - 200W Metal Halide Wallpacks based on delivered lumens.

Green Technology:
RAB LEDs are Mercury, Arsenic and UV free.

Patents:
The WPLED design is protected by U.S. PATENT D608,040 and patents pending in the U.S., Canada, China, Taiwan and Mexico.

For use on LEED Buildings:
IDA Dark Sky Approval means that this fixture can be used to achieve LEED Credits for Light Pollution Reduction.

Dark Sky Approved:
The International Dark Sky Association has approved this product as a full cutoff, fully shielded luminaire.

[redacted]

WPLED26 - continued

Country of Origin:
Designed by RAB in New Jersey and assembled in Taiwan.

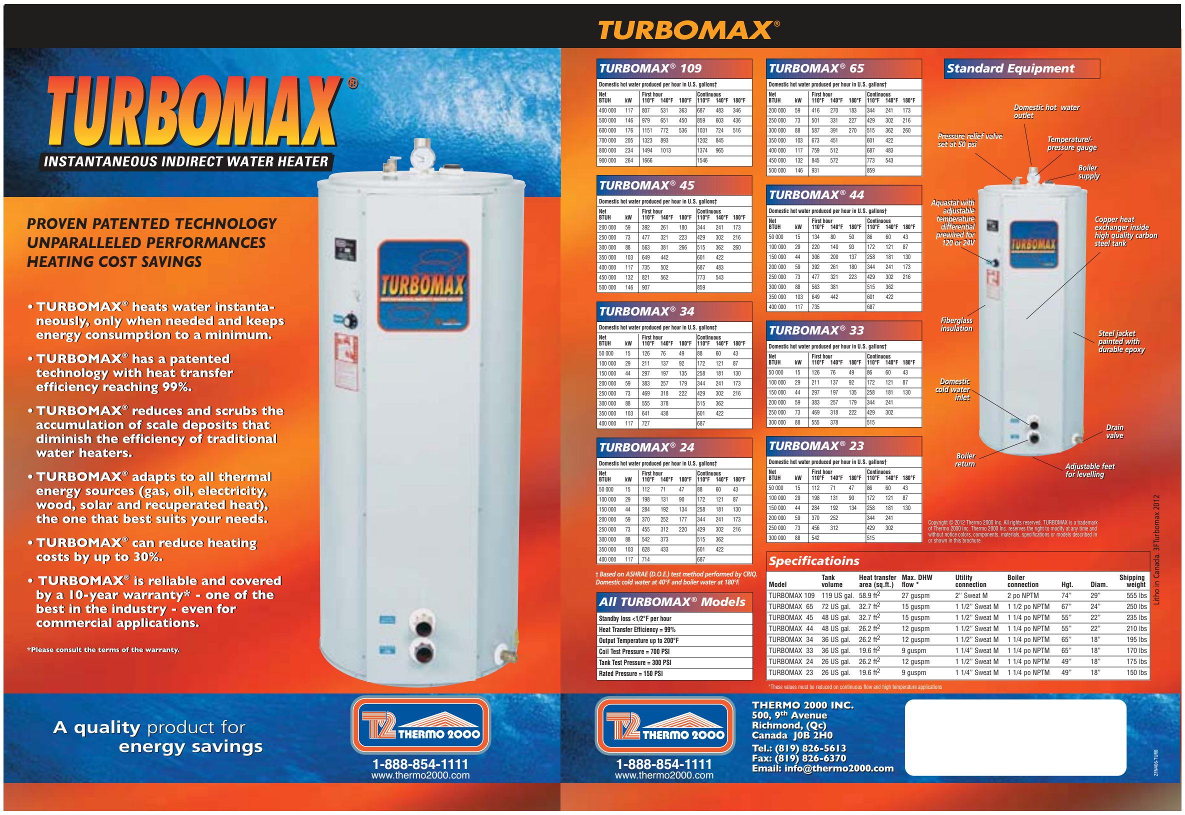
Trade Agreements Act Compliant:
This product is a product of Taiwan and a "designated country" end product that complies with the Trade Agreements Act.

GSA Schedule:
Suitable in accordance with FAR Subpart 25.4.

DLC Listed:
This product is on the Design Lights Consortium (DLC) Qualified Products List and is eligible for rebates from DLC Member Utilities.

[redacted]

High Efficiency DHW Heater – Turbomax



TURBOMAX®

INSTANTANEOUS INDIRECT WATER HEATER

PROVEN PATENTED TECHNOLOGY
UNPARALLELED PERFORMANCES
HEATING COST SAVINGS

- **TURBOMAX® heats water instantaneously, only when needed and keeps energy consumption to a minimum.**
- **TURBOMAX® has a patented technology with heat transfer efficiency reaching 99%.**
- **TURBOMAX® reduces and scrubs the accumulation of scale deposits that diminish the efficiency of traditional water heaters.**
- **TURBOMAX® adapts to all thermal energy sources (gas, oil, electricity, wood, solar and recuperated heat), the one that best suits your needs.**
- **TURBOMAX® can reduce heating costs by up to 30%.**
- **TURBOMAX® is reliable and covered by a 10-year warranty* - one of the best in the industry - even for commercial applications.**

*Please consult the terms of the warranty.

A quality product for energy savings

THERMO 2000
1-888-854-1111
www.thermo2000.com

TURBOMAX®

TURBOMAX® 109

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
400 000	117	807	531	363	687	483	346
500 000	146	979	651	450	859	603	436
600 000	176	1151	772	536	1031	724	516
700 000	205	1323	893		1202	845	
800 000	234	1494	1013		1374	965	
900 000	264	1666			1546		

TURBOMAX® 45

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
200 000	59	392	261	180	344	241	173
250 000	73	477	321	223	429	302	216
300 000	88	563	381	266	515	362	260
350 000	103	649	442		601	422	
400 000	117	735	502		687	483	
450 000	132	821	562		773	543	
500 000	146	907			859		

TURBOMAX® 34

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
50 000	15	126	76	49	88	60	43
100 000	29	211	137	92	172	121	87
150 000	44	297	197	135	258	181	130
200 000	59	383	257	179	344	241	173
250 000	73	469	318	222	429	302	216
300 000	88	555	378		515	362	
350 000	103	641	438		601	422	
400 000	117	727			687		

TURBOMAX® 24

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
50 000	15	112	71	47	88	60	43
100 000	29	198	131	90	172	121	87
150 000	44	284	192	134	258	181	130
200 000	59	370	252	177	344	241	173
250 000	73	455	312	220	429	302	216
300 000	88	542	373		515	362	
350 000	103	628	433		601	422	
400 000	117	714			687		

† Based on ASHRAE (D.O.E.) test method performed by CRIQ. Domestic cold water at 40°F and boiler water at 180°F.

All TURBOMAX® Models

Standby loss <1/2°F per hour
Heat Transfer Efficiency = 99%
Output Temperature up to 200°F
Coil Test Pressure = 700 PSI
Tank Test Pressure = 300 PSI
Rated Pressure = 150 PSI

TURBOMAX® 65

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
200 000	59	416	270	183	344	241	173
250 000	73	501	331	227	429	302	216
300 000	88	587	391	270	515	362	260
350 000	103	673	451		601	422	
400 000	117	759	512		687	483	
450 000	132	845	572		773	543	
500 000	146	931			859		

TURBOMAX® 44

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
50 000	15	134	80	50	86	60	43
100 000	29	220	140	93	172	121	87
150 000	44	306	200	137	258	181	130
200 000	59	392	261	180	344	241	173
250 000	73	477	321	223	429	302	216
300 000	88	563	381		515	362	
350 000	103	649	442		601	422	
400 000	117	735			687		

TURBOMAX® 33

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
50 000	15	126	76	49	86	60	43
100 000	29	211	137	92	172	121	87
150 000	44	297	197	135	258	181	130
200 000	59	383	257	179	344	241	
250 000	73	469	318	222	429	302	
300 000	88	555	378		515		

TURBOMAX® 23

Domestic hot water produced per hour in U.S. gallons†

Net BTUH	kW	First hour 110°F	140°F	180°F	Continuous 110°F	140°F	180°F
50 000	15	112	71	47	86	60	43
100 000	29	198	131	90	172	121	87
150 000	44	284	192	134	258	181	130
200 000	59	370	252		344	241	
250 000	73	456	312		429	302	
300 000	88	542			515		

Standard Equipment

Specificatioins

Model	Tank volume	Heat transfer area (sq.ft.)	Max. DHW flow *	Utility connection	Boiler connection	Hgt.	Diam.	Shipping weight
TURBOMAX 109	119 US gal.	58.9 ft^2	27 guspm	2'' Sweat M	2 po NPTM	74''	29''	555 lbs
TURBOMAX 65	72 US gal.	32.7 ft^2	15 guspm	1 1/2'' Sweat M	1 1/2 po NPTM	67''	24''	250 lbs
TURBOMAX 45	48 US gal.	32.7 ft^2	15 guspm	1 1/2'' Sweat M	1 1/4 po NPTM	55''	22''	235 lbs
TURBOMAX 44	48 US gal.	26.2 ft^2	12 guspm	1 1/2'' Sweat M	1 1/4 po NPTM	55''	22''	210 lbs
TURBOMAX 34	36 US gal.	26.2 ft^2	12 guspm	1 1/2'' Sweat M	1 1/4 po NPTM	65''	18''	195 lbs
TURBOMAX 33	36 US gal.	19.6 ft^2	9 guspm	1 1/4'' Sweat M	1 1/4 po NPTM	65''	18''	170 lbs
TURBOMAX 24	26 US gal.	26.2 ft^2	12 guspm	1 1/2'' Sweat M	1 1/4 po NPTM	49''	18''	175 lbs
TURBOMAX 23	26 US gal.	19.6 ft^2	9 guspm	1 1/4'' Sweat M	1 1/4 po NPTM	49''	18''	150 lbs

*These values must be reduced on continuous flow and high temperature applications

Litho in Canada. 3FTurbomax 2012

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Tel.: (819) 826-5613
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Email: info@thermo2000.com

ZFN406-TURB

GreenLight LLC
an energy conservation company

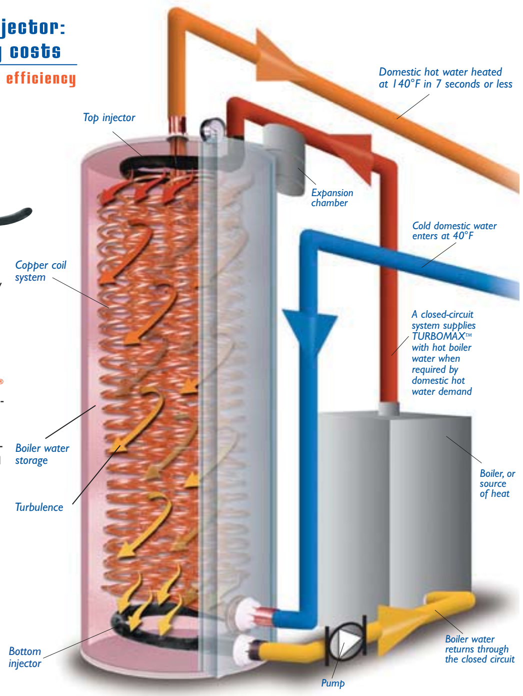
TURBOMAX®

Our patented injector: reduces heating costs
99% heat transfert efficiency

The secret of the TURBOMAX®'s exceptional performance is in its patented injector, which provides optimum heat transfer. In simpler words the TURBOMAX® water heaters can produce more hot water, more rapidly. Money-wise it reduces the cost of heating by reducing the running time of the boiler or the need for a bigger water heater to do the same work.

Both ends of the TURBOMAX® contain an injector with perforated walls. The top injector creates multiple jets of boiler water swirling (creating turbulence) all over the copper coil and spreading boiler water evenly throughout the tank.

The turbulence produces convection, i.e., activates the instantaneous passage of the boiler water heat through the copper coil walls and then to the domestic water inside the coils.



Patented in USA No 5,165,472 and in Canada No 2,038,520

Visit our website at www.thermo2000.com

How does it work?

The principle behind the TURBOMAX® is based on the use of boiler water to heat the fresh domestic water instantly when required.

BOILER WATER
In order to maintain the domestic water temperature, the system supplies hot boiler water to the TURBOMAX® tank. The boiler water enters the top of the tank through a patented injector, which creates turbulence for an even water temperature around the copper coils, ensuring maximum thermal exchange. As the boiler water descends in the tank it transfers thermal energy to the copper coils in the TURBOMAX®®.

The boiler water arrives at the bottom of the tank to be collected by a second patented injector and is redirected to the boiler to be re-heated until the system has returned to its initial state.

DOMESTIC WATER
In contrast to the boiler water, fresh domestic water is forced up through the coil system from the bottom of the tank. As it rises, the domestic water in the coils draws energy from the ambient heat of the pre-heated tank water. This process allows domestic water to be heated from 40°F to 140°F in 7 seconds or less.

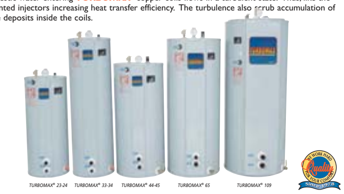
COUNTERFLOW MOTION
As you will note, firstly the flow of boiler water is from the top of the tank to the bottom and secondly the flow of fresh domestic water inside the copper coils is from the bottom of the heater to the top. The counterflow motion of both fluids increases the efficiency of heat transfer and prevents domestic hot water temperature swings.

HEAT STORAGE
The boiler water in TURBOMAX® tank constitutes a store of heat energy ready to heat fresh domestic water. The volume of boiler water stored in TURBOMAX® tank provides enough heat to keep your domestic water hot while the boiler heats up. In fact, it acts as a buffer which prevents domestic hot water or boiler water temperature swings.

COPPER COILS
Copper is the metal by which heat from the boiler water contained in the tank is transferred to domestic water in the coils. Copper is an excellent conductor of heat (17 times more so than stainless steel), which increases thermal efficiency. Also, copper is known to be the metal most resistant to corrosion by household water.

Copper offers great resistance to thermal stress (expansion and contraction of material due to temperature changes in the water). TURBOMAX® uses the expansion and the contraction of copper to prevent the accumulation of scale inside the tube. The copper tubes are made into coils to take advantage of the radial expansion-contraction motion of copper. This constant motion changes inner surface tension and prevents scale deposits from attaching to the inner side of the copper coils.

TURBULENCE
Turbulence reduces heating costs. TURBOMAX® water heaters operate at an unparalleled 99% heat transfer efficiency. TURBOMAX® uses turbulence to produce more hot water, more rapidly. First, TURBOMAX® patented injectors, provide turbulence inside the tank. Second, domestic water entering TURBOMAX® copper coils flows in a turbulent state. Thus, like the patented injectors increasing heat transfer efficiency. The turbulence also scrub accumulation of scale deposits inside the coils.



TURBOMAX® units are available in several sizes to fit your needs

THERMOSTATIC RADIATOR VALVE (TRV) DEMONSTRATION PROJECT

Final Report

Prepared for

THE NEW YORK STATE
ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

Project Manager
Norine Karins

Prepared by

EME GROUP
135 Fifth Avenue
New York, NY 10010

Project Manager
Michael McNamara

1545-EEED-BES-91

NYSERDA
Report 95-14

September 1995

MASTER

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SUMMARY

Space heating in multifamily buildings with low pressure steam boilers is often controlled with a central indirect monitoring control (IMC) system that uses an outdoor temperature sensor and time clock. IMC systems operate on a limited number of inputs and will overheat apartments if not properly calibrated and adjusted, leading to the classic open-window syndrome often seen in the winter months in New York City. Thermostatic Radiator Valves (TRVs) have been used to control steam flow in radiators for decades; however, most steam-heated multifamily buildings in New York City are not outfitted with TRVs.

This three year research project investigated the use of TRVs on one-pipe low pressure steam systems. The project determined TRVs effectiveness in eliminating overheated apartments, resultant energy savings, and cost effectiveness. EME also assessed occupant reception to TRVs and identified pitfalls in their installation and maintenance. US Energy Control Fuel computers recorded apartment temperatures, boiler fuel consumption and hot water use in eight low- and middle- income buildings ranging in size from 15 to 26 units. Three sets of twin buildings were monitored: two pairs in Brooklyn, and one pair in Manhattan. Another two buildings monitored in the Bronx, although not twins, were similar in construction and located near each other. The data were collected and stored by the fuel computer hourly and downloaded through a modem to EME's office.

To participate in the project, each building owner had to upgrade the heating plants and maintain them in good condition throughout the three-year project. Upgrades included insulating bare steam pipes, tuning burners, making minor repairs to the steam distribution system, and replacing inoperative or undersized air vents on radiators and steam mains. After installing these measures, the building's fuel consumption, domestic hot water use and apartment temperatures were recorded for 12 months. This became the base year for comparing TRV energy savings.

The research project encompasses three phases. Phase-1 determined each building's base year energy use after the installation of low-cost energy conservation measures. In phase-2 four buildings were outfitted with TRVs with a 72°F setpoint in half of the apartments ("partial installation"). In phase-3, three of the four buildings were outfitted with TRVs in the remaining apartments ("full installation"), and a fifth building was outfitted with TRVs in half of the apartments.

The average room temperature of an overheated apartment using TRVs was reduced, and the building's space heating energy use decreased an average of 9.45% with partial installation and 15.5% with full installation. The higher the average apartment temperature before TRV installation, the greater the energy savings. This research showed that if an apartment's average winter temperature was already

[redacted]

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maintained at 72°F by the existing boiler control system no energy savings would be achieved through the installation of TRVs.

During the two years the TRV apartments were monitored, there were only a few complaints. Most occurred during phase-2, and came from tenants accustomed to average room temperatures ranging from 74°F to 78°F before TRV installation. The TRVs had no mechanical problems. The main problem, as in most steam systems, occurred with wet steam distorting air vents. This occurred in one building and was repaired by attaching a different manufacturer's air vent to the TRV.

Many factors influence a multifamily building's energy use, including the condition of the boiler and burner, upkeep and maintenance of the boiler and steam distribution system, and the building's DHW load. The researchers conclude that TRVs are a cost effective energy conservation measure, and that comfortable room temperatures and reduced fuel use are achievable when properly installed.

[redacted]

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Danfoss Thermostatic Radiator Valves

Data sheet

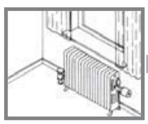
RA 2000 1PS Thermostatic Radiator Valve For Use on One-Pipe Low-Pressure Steam Systems

Danfoss

Typical Installation

Dial / Operator / Sensor + Valve

FREE STANDING RADIATORS
The free-standing one-pipe low-pressure steam radiator is positioned where air continually passes freely over the operator



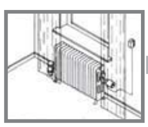
Use standard or tamper resistant model with combined dial/operator/ sensor. Always install the operator horizontally

Use air vent

PLUS

1/8" one-pipe steam valve

FREE STANDING RADIATORS
The free-standing one-pipe low-pressure steam radiator is accessible, but air cannot continually pass freely over the operator



Use dial / operator with remote sensor. The sensor and capillary tube may be extended up to 6' and can be easily wall mounted.

Use air vent

PLUS

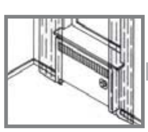
1/8" one-pipe steam valve

CONVECTORS
The one-pipe low-pressure steam convector is inaccessible; room air cannot continually pass freely over the valve

Use operator with combined remote dial / sensor. The dial/sensor and capillary tube may be extended up to 6' and are wall mounted.

Use air vent
PLUS
Two 45° elbows
PLUS
1/8" one-pipe steam valve

ENCLOSED RADIATORS
The cabinet enclosed radiator configuration requires that the dial and sensor be mounted separately, away from the valve



Use operator with separate remote dial and remote sensor. Place the remote sensor beneath the element or on a draft-free wall. The remote dial mounts on the enclosure or wall.

Use air vent

PLUS

1/8" one-pipe steam valve

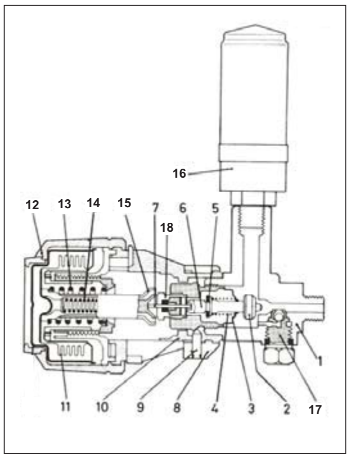
[redacted]

Data sheet

RA 2000 1PS Thermostatic Radiator Valve For Use on One-Pipe Low-Pressure Steam Systems

Danfoss

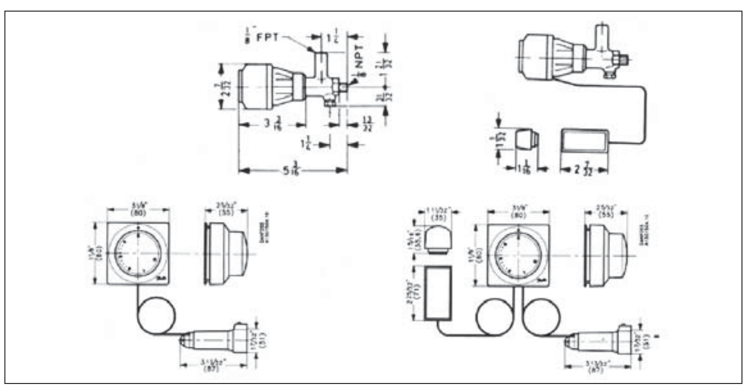
Design & Function



Part	Material
1. Valve	Nickel plated brass
2. Valve Disc	EPDM
3. Spindle guide	Phosphor bronze
4. Spring	Stainless steel
5. Back seat washer	EPDM
6. Valve spindle	Brass
7. Pressure pin	Stainless steel
8. Clamping band	Al. alloy
9. Allenscrew	Steel
10. Socket	Zytel Nylon
11. Bellows	Phosphor bronze
12. Handle	ABS
13. Adjustment spring	Steel
14. Safety spring	Steel
15. Pressure spindle	Polyamide No. 6
16. Air vent	-
17. Retainer	Brass
18. Packing gland	-
Capillary Tube	Steel

- Danfoss' RA 2000 1PS one-pipe steam thermostatic radiator valve provides accurate temperature control and quite operation.
- The movement of air across the thermostatic operator effects the modulation control in regulating the venting of air from the radiator or convector.
- Based on the set temperature on the operator, the 1PS regulates the amount of steam allowed into the emitter by controlling the amount of air allowed to vent out.
- The venting action occurs during each system (boiler) on-cycle only when heat is required. Air will re-enter the system during the boiler off-cycle via a patened "across the seat" vacuum breaker. This eliminates condensate buildup and allows natural system aspiration to take place.
- The RA 2000 1PS assembly is specifically designed for low pressure steam systems. The system pressure should not be constant preventing air to get back into the system.
- Thermostatic radiator valve assembly- valve, thermostatic operator and air vent- can be used for free standing radiators, convectors, and enclosed radiators. 1PS is not recommended for copper fin tube radiators.

Dimensions



[redacted]

Data sheet

RA 2000 1PS
Thermostatic Radiator Valve
For Use on One-Pipe Low-Pressure Steam Systems

Danfoss

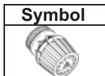
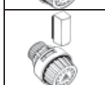
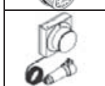
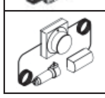
Technical Data

Type	Maximum Temperature	Maximum Pressure
RA 2000 1PS	250°F	15psig

RA 2000 Operators

Temp. Range: 45°F-86°F

Max. Sensor Temp.: 140°F

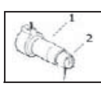
Symbol	Code No.	Description	Sensor	Capillary
	013G8250	Valve mounted dial & sensor	Built-in	-
	013G8252	Valve mounted dial with remote sensor	Remote	6'
	013G8240	Valve mounted dial and sensor, tamper-resistant	Built-in	-
	013G2922	Valve mounted dial with remote sensor, tamper-resistant	Remote	6'
	013G8562	Combined remote mounted dial & sensor	-	6'
	013G8565	Combined remote mounted dial & sensor	-	16'
	013G8568	Combined remote mounted dial & sensor	-	26'
	013G8564	Separate remote mounted dial and sensor	Remote	6' + 6'

Parts & Accessories For RA 2000 Operators:

013G8250
013G8252
013G8240
013G2922

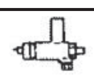
Code No.	Description
013G1236	Screwdriver tool set
013G1215	Limitation pins for RA 8250/52 (30 pcs)
013G1237	Limitation pins for tamper resistant operators RA 8240 / 2922 (30 pcs)
013G5245	Anti-theft protection clips for RA 8250/52 (20 pcs)
013G1232	Locking screw plugs for tamper resistant operators RA 8240 / 2922 (50 pcs).
013G1672	Cover plate for scale window of tamper resistant operators (20 pcs)

013G8562
013G8565
013G8568
013G8564



Position No.	Description	Code No.
1	Socket Body for RA 2000	013G5191
2	Bellows Holder (set of 2 pcs)	013G5503

RA2000 1PS Valve

Design	Code no.	Valve Size	Pattern	Connections Inlet x Outlet
	013G0140	1/8"	1PS	MPT x FTP

Parts & Accessories For RA2000 1PS Valve

Code No.	Description
013L8011	1-pipe steam air vent
013L8300	Brass 45° street elbow for convector
013G0290	Packing gland for valves

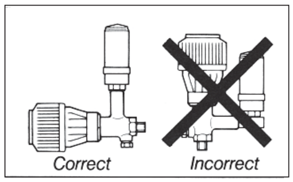
[redacted]

RA 2000 1PS Thermostatic Radiator Valve For Use on One-Pipe Low-Pressure Steam Systems

Data sheet

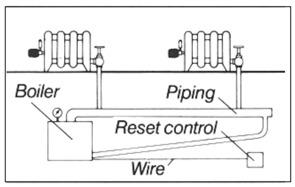
Danfoss

How To Avoid Problems

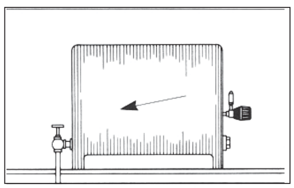


The operator with valve-mounted dial and sensor must be mounted horizontally.

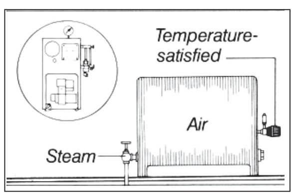
IMPORTANT
In one-pipe steam systems sufficient pitch is required to permit condensate return. Condensate should not be trapped in the valve or vent. The vent (when not supplied) should be checked to assure it is properly working.



Boiler/steam supply must not run at constant pressure. This prevents the ability for air to enter back into the system.

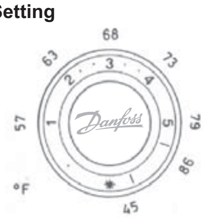


Make sure that free-standing radiators or cast iron convectors are properly pitched and that hand valves are FULLY open.



To aid in preventing overheating of rooms that are temperature satisfied, boiler steam pressure must be kept low, recommended normally at or below 2psig. Otherwise air will be compressed in the radiator, allowing steam to enter when not required.

Setting



The user can easily set room temperature by turning the dial clockwise or counterclockwise. The diagram to the right shows the appropriate relationship between dial scale numbers and room temperature.

At its lowest setting, the RA 2000-1PS provides frost protection and maintains room temperature at approximately 45Deg.F.
At its highest setting, the RA 2000-1PS maintains room temperature at approximately 85Deg.F.

The temperature on all RA 2000-1PS models may be limited or locked.

Danfoss Inc.
6711 Mississauga Road, Suite 410
Mississauga, ON, L5N 2W3
Tel.: 905-285-2050, Fax: 905-285-2055
www.na.heating.danfoss.com

Danfoss Inc.
7941 Corporate Drive
Baltimore, MD 21236 USA
Tel.: 443 512 0266, Fax: 443 512 0270
www.na.heating.danfoss.com

VDSXA122 ©Danfoss 07/07
FEDGRA

Appendix C: Steam Boiler Documentation

NYC DEP Inspection Report

NYC Buildings DEP

BO9: DOB Boiler Inspection Report and DEP Boiler Renewal Request

DOB Boiler Inspection Report: Sections 1-7 and 9; DEP Boiler Renewal: Sections 1-3 and 8-9
You may fulfill filing requirements for both agencies by completing the entire form.

1 Premises *Address where the Boiler is Physically Located*

Borough Bronx | Block 2483 | Lot 53 | BIN | Special Place Name
House No. 845 | Street Name GERARD AVENUE | Zip 10451-2211

2 Building Occupancy and Exempt Status

☑ Multiple Dwelling ☐ Commercial ☐ Mixed Use ☐ Other: | Total Number of Residential Units:

If Fee Exempt, check type of acceptable proof: ☐ Real Estate $0.00 tax bill ☐ Verification Letter from Department of Finance

3 Owner Information ☑ *Check here if change in owner since last filing*

Name Abro Management Corp.; | Day Phone 516-569-4119
Address 845 Gerard Ave | City Bronx | State NY | ZIP 10451-2211 | E-mail
Contact Person Abro Management Corp.; | Relationship to owner | Day Phone 516-569-4119
Address 845 Gerard Ave | City Bronx | State NY | ZIP 10451-2211 | E-mail

4 DOB Inspection Report Information | **Inspection Completed On: 03/07/2013**

Boilers must be inspected in accordance with requirements of NY State Labor Law Sections 204, NY State Department of Labor Rules and Regulations 12 NYCRR 4, New York City Code, Article 303 of Title 28 of the Administrative Code, and RCNY §§ 101-07 and 103

DOB Boiler Number #####-##	Boiler Make & Model	Pressure Hi/Lo	PSI	BTUs	Floor	Inspection I = Internal E = external
2221-01	Built In: 1985 Federal	Lo	15	4315000	Bas	E

Are Defects Identified in Sec. 5a below? ☑ No (Inspection Passes) ☐ Yes (BO13 must be filed within 45 days of insp. date)

5a Boiler Inspection Defect Summary-Correction Required *see Boiler Defect Code Key -Instruction Manual*

BOILER PART															
VIOLATION CONDITION															
REMEDY															

5b Boiler Inspection Defect Summary-Correction Recommended *see Boiler Defect Code Key -Instruction Manual*

BOILER PART															
VIOLATION CONDITION															
REMEDY															

5c Boiler Inspection Defect Notes/Comments/Other

6 Boiler Insurance Company *Complete only if insurance company performs inspection.*

Insurance Company Travelers Ins. Co. | Contact Person Ginger Hartney | Business Phone 516.933.3922
Policy Holder Name | Certificate/Policy No. | Expiration Date
Address | City | State | ZIP

INTERNAL USE ONLY -- DO NOT WRITE BELOW

DOB Audit - Inspector's Initials | Badge Number | Inspection Date
☐ Violation issued ☐ No Violation Found | Comments

4/09

BO9 PAGE 2

7 Authorized NYC Boiler Inspector (Check the appropriate type)

SEAL

Name: Andrew Keane License No.: NY05326

☑ Insurance Company Representative

Authorized to perform low pressure inspections only:

☐ Master Plumber ☐ Oil Burner Installer ☐ High Pressure Boiler Operator

The Department of Buildings' Boiler Division must receive this form within 45 days of the inspection date. If the report is not filed prior to deadline, the owner shall be liable for a civil penalty, pursuant to Section 103-01 (c) of Subchapter C of Chapter 100 of Title 1 of the Official Compilation of the Rules of the City of New York.

Falsification of any statement is a misdemeanor and is punishable by a fine or imprisonment, or both. It is unlawful to give to a city employee, or for a city employee to accept, any benefit, monetary or otherwise, either as a gratuity for properly performing the job or in exchange for special consideration. Violation is punishable by imprisonment or fine or both. I understand that if I am found after hearing to have knowingly or negligently form, signed statement, application, report or certification of the correction of a violation required under the made a false statement or to have knowingly or negligently falsified or allowed to be falsified any certificate, provisions of this code or of a rule of any agency, I may be barred from filing further applications or documents with the Department.

Signature Andrew Keane Date 03/07/2013

8 Department of Environmental Protection

*Owner/Agent: Complete **only** in expiration year. Insurance Companies: Do **not** complete this section.*

Select one: ☐ Renew Registration ☐ Renew Certificate to Operate *(PE/RA Seal & Signature Required below)*

Installation #_____ Expiration Date _____ # of Identical Units _____ Fee Enclosed $_____

(Enter Fee in section 9, line b below)

If Fee Exempt, check type of acceptable proof ☐ Real Estate $0.00 tax bill ☐ Verification Letter from Department of Finance

Please provide contact information for the owner, superintendent, contractor or other authorized agent who can be contacted to schedule an inspection, provide access and operate equipment to demonstrate compliance.

Contact Person (if different than listed in section 3) Telephone Number ( )

Address Apt. No. City State ZIP

Fax Number ( ) E-mail

I request renewal of the Registration/Certificate to Operate for the equipment which is the subject of the above-referenced installation number and which has been inspected by the owner/owner's agent and is ready for inspection by DEP's Bureau of Environmental Compliance.

I am aware that if there is exposed friable asbestos in a damaged or deteriorated condition in the room/area where the equipment is located, the inspection will not be completed and a notice of disapproval will be issued.

"I hereby affirm, under penalty of perjury, that the information provided on this form is true to the best of my knowledge and belief and that the equipment will be operated in accordance with the requirements of the Air Pollution Control Code Chapter 1 of Title 24, New York City Administrative Code, and appropriate requirements of other agencies. I recognize that false statements are punishable as a misdemeanor pursuant to Section 24-190 of the Air Pollution Control Code and Section 210.45 of the Penal Law."

Owner/Representative Print name and Signature

Title

Date

P.E./R.A. Seal and Signature
(Required only if filing Renewal of Certificate to Operate)

9 Fee Calculation

a) DOB Total Fee $ 30	Enter "0" if filing only with DEP or if Fee Exempt. DOB Filing fee is $30.00.
b) DEP Total Fee $ 0	See section 9 above. Enter "0" if this is not the year of expiration or if form is filed by an insurance company.
c) Grand Total $ 30	**Make check or money order payable to NYC Department of Buildings for this amount.**

Submit to: Department of Buildings, 280 Broadway, 6th floor, Manhattan, New York 10007
Attention: CFB—Boilers

4/09

GreenLight LLC
an energy conservation company

Boiler Tune Up Report

Appendix D: Utility and State Incentive Program Information

Con Edison Multifamily Program

conEdison
GREEN TEAM
ENERGY EFFICIENCY EXPERTS

MULTIFAMILY ENERGY EFFICIENCY PROGRAM

Use less energy and **save money**

Con Edison is offering property owners and building managers ways to make properties with 5 to 75 units more energy efficient, reduce costs, save money, and help protect the environment.

The Green Team Offers:

- financial incentives for approved equipment upgrades
- energy surveys to show where your building could save energy and money through this program
- free "smart" power strips and CFLs and low-flow devices in apartment units

We'll Recommend:

- heating system upgrades to high-efficiency boilers
- heating-control installation, including energy-management systems, boiler reset controls, and programmable thermostats
- roof and heating-pipe insulation
- high-efficiency fluorescent lighting, occupancy sensors, and LED exit signs
- heating system cleaning and tuning to improve equipment performance
- thermostatic radiator valves for apartment radiators, bi-level-operation light fixtures for stairways and corridors

Is Your Building Eligible?

To participate, you must:

- own or manage a building with 5 to 75 units (includes rent-controlled, rent-stabilized, and market-rate rentals, as well as co-ops and condos); and
- receive a Con Edison bill and pay the System Benefits Charge (SBC)

For More Information:

Let the Green Team show you how your building can save energy and money.

- call us at 1-877-870-6118
- visit conEd.com/greenteam for a full list of eligible measures and incentives

conEdison
GREEN TEAM
ENERGY EFFICIENCY EXPERTS

Common Area (Gas)

Measure:	Incentive Detail:	Incentive $:
High-efficiency hot-water gas boilers (85-89% thermal efficiency)	≤ 300 MBH input capacity 301-499 MBH input capacity 500-999 MBH input capacity ≥1000 MBH input capacity	**$1,000** per boiler **$2,000** per boiler **$2,500** per boiler **$3,500** per boiler
High-efficiency, condensing hot-water gas boilers (≥90% thermal efficiency)	≤ 300 MBH input capacity 301-499 MBH input capacity 500-999 MBH input capacity ≥1000 MBH input capacity	**$2,000** per boiler **$3,000** per boiler **$5,000** per boiler **$15,000** per boiler
Gas steam boilers	≤ 300 MBH input capacity (AFUE ≥ 78%) >300 MBH input capacity (Thermal Efficiency ≥ 80%)	**$700** per boiler **$2** per MBH input, **up to $2,500**
Steam traps	n/a	**70%** of measure cost
Heating system clean and tune	n/a	**$225** per boiler
Heating controls	Energy-management system with in-unit temperature sensors Boiler reset controls (for existing hot water systems) In-unit programmable thermostats Thermostatic radiator valves (TRV's)	**70%** of total cost, **up to $20,000** **$500** **$30** per thermostat **$115** per valve
Pipe insulation (heating and DHW)	1" Fiberglass insulation 2" Fiberglass insulation 3" Fiberglass insulation	**$1** / linear foot **$2** / linear foot **$3** / linear foot
Building envelope	Roof and wall insulation R-11 added R-19 added R-38 added Door weatherstripping and sweeps	 **$0.15** / square foot **$0.20** / square foot **$0.30** / square foot **$25** / door

Common Area (Electric)

Measure:	Incentive Detail:	Incentive $:
Common area lighting	Linear fluorescent fixtures 1-lamp fixtures 2-lamp fixtures 3-lamp fixtures 4-lamp fixtures	 **$65** per fixture **$70** per fixture **$75** per fixture **$80** per fixture
	Interior metal-halide fixtures <350 watts ≥350 watts	 **$110** per fixture **$125** per fixture
	Relamp and Reballasting	**50%** of full replacement incentive
	Common area CFLs <32 watts ≥32 watts pin-based CFLs, hardwired	 **$3** per fixture **$4** per fixture **$60** per fixture
	LED exit signs (Must replace existing incandescent or CFL exit sign)	 **$50** per fixture
	Occupancy and photocell sensors Bi-level stairwell and hallway fixtures	**$50** per sensor **$150** per fixture

In-Unit

Measure:	Incentive Detail:	Incentive $:
CFLs	Up to 6 per unit, installed	**FREE**
Smart Strips	2 per unit for electronics, installed	**FREE**
Showerheads	1.5 GPM, installed	**FREE**
Faucet aerators	1.0-1.5 GPM, installed	**FREE**

Con Edison reserves the right to change incentives at any time.

3/13

NYSERDA Multifamily Performance Program

NYSERDA - Energy. Innovation. Solutions.

Make Your Multifamily Building More Energy Efficient

Take advantage of incentives, low-interest loans, and technological expertise for bottom-line savings

As the owner of an existing building of 5+ units and 4+ floors, you can save substantially on monthly energy costs by participating in NYSERDA's Multifamily Performance Program for Existing Buildings — a marquee part of our Multifamily Energy Performance Portfolio.

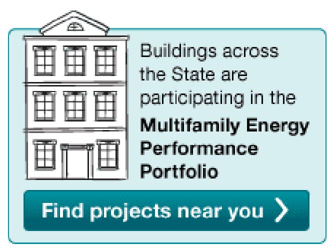
Locate a Partner near you

Through a partner network of engineers, energy consultants, and other industry professionals, the program applies the latest in building science technology to your existing building's design and daily operation, showing you how to save substantially on energy costs.

To participate, you'll work with your selected Performance Partner to conduct a whole-building assessment that looks for energy-saving potential. The resulting Energy Reduction Plan will set a performance target for your building, and detail specific recommendations to achieve them. As you implement your Energy Reduction Plan and achieve its energy goals for your building, you will be eligible for NYSERDA incentives.

The fastest way to get started is to find a Multifamily Performance Partner.

How your building will benefit



- Save on annual energy costs—potentially hundreds of thousands of dollars
- Protect yourself against future volatility of energy costs
- Provide tenants with a comfortable and affordable living environment

Determining if your building is eligible

- Buildings must contain five or more units with at least four floors.
- At least 50 percent of the building's gross heated footage must be residential space; the remaining space can be nonresidential-related commercial space.
- You must receive your electricity through one of the following utilities: Central Hudson Gas & Electric., Consolidated Edison Company of NY (ConEd), New York State Electric and Gas (NYSEG), National Grid, Orange and Rockland Utilities and Rochester Gas and Electric.
- NYSERDA incentives cannot be combined with incentives or rebates from utility company programs.
- Buildings that have received incentives or rebates from other programs are not eligible for NYSERDA support for 12

months after receipt of payment.

Financial Incentives

Existing Buildings - Maximum Incentives

Project Type	Firm Gas (per unit)	Non-Firm Gas (per unit)
Affordable	$1,000	$800
Market Rate	$700	$500

A project's incentive may be reduced based on the cost and/or cost-effectiveness of the recommended upgrades.

Additional Performance Payment

Existing buildings that project at least 20% energy reduction in the Energy Reduction Plan may also be eligible for an additional Performance Payment in accordance with the table below.

Tier	Performance Payment (per unit)
Tier #1 - 20%-22%	$150
Tier #2 - 23%-25%	$200
Tier #3 - 26%-28%	$250
Tier #4 - 29%+	$300

Existing Buildings - Incentive Payment Schedule

The following incentive payment schedule detail the specific payment of a project's base incentive.

Stage 1 - Upon approval of the project's Energy Reduction Plan

Project Size	Affordable Firm Gas (per unit)	Affordable Non-Firm Gas (per unit)	Market Rate Firm Gas (per unit)	Market Rate Non-Firm Gas (per unit)
Fast Track 5-49 units	N/A	N/A	N/A	N/A
Standard Path 5-49 units	$100	$80	$70	$50
Standard Path 50 units & up	N/A	N/A	N/A	N/A

Stage 2 - Upon inspection of at least 50% of the installed upgrades

Project Size	Affordable Firm Gas (per unit)	Affordable Non-Firm Gas (per unit)	Market Rate Firm Gas (per unit)	Market Rate Non-Firm Gas (per unit)
Fast Track 5-49 units	N/A	N/A	N/A	N/A
Standard Path 5-49 units	$400	$320	$280	$200
Standard Path 50 units & up	$500	$400	$350	$250

Stage 3 - Upon inspection of 100% of the installed upgrades

Project Size	Affordable Firm Gas (per unit)	Affordable Non-Firm Gas (per unit)	Market Rate Firm Gas (per unit)	Market Rate Non-Firm Gas (per unit)
Fast Track 5-49 units	$1000	$800	$700	$500
Standard Path 5-49 units	$500	$400	$350	$250
Standard Path 50 units & up	$500	$400	$350	$250

Financing at about half the market rate

Financing for multifamily energy upgrades is more affordable through Green Jobs – Green NY, which advances 50 percent of the principal borrowed directly to your lender at an interest rate of 0%, effectively reducing the cost of your loan (up to $1 million) to about half the market rate. Green Jobs – Green NY can contribute up to $5,000 per unit or up to $500,000 per project. Read more about Green Jobs – Green NY for multifamily buildings.

What's the best deal: deciding between NYSERDA programs and utility company programs

Some utility companies offer programs specifically for multifamily buildings; some do not. We recommend that you carefully compare the benefits of working with a utility company program and the NYSERDA Multifamily Performance Program. You must choose one or the other. NYSERDA takes a whole-building approach and creates incentives based on energy savings; utility companies tend to offer rebates on specific improvements or upgrades. Utility companies are generally restricted to working with building of 75 units or less; there is no upper size limit for working with NYSERDA.

Contact your utility company directly or check out following web sites to help you decide:

- Con Edison of NY
- National Grid
- NYSEG
- Orange and Rockland Utilities
- Rochester Gas & Electric

Case Study

- **Via Verde** – The Multifamily Performance Program was an integral part of a larger initiative to develop this cutting-edge green building in The Bronx. Developers earned more than $600,000 in NYSERDA incentives to design energy-

www.greenlightec.com 216 River Ave · Lakewood, NJ 08701 · Phone:732.312.5550 · Fax: 732.200.3737

efficient features into Via Verde, which also has several green roofs and a large solar array. View the Via Verde video Case Study.

- **Trump Tower at City Center** – Just a few years after this White Plains high-rise was built, residents saw energy bills that were dramatically higher than expected. After completing a comprehensive energy upgrade project that improved lighting and added a combined heat and power unit, the building slashed energy use by 21 percent.
  - Download the Trump Tower at City Center case study [PDF].
  - View the video version of the Trump Tower at City Center case study.

Learn More

Your Performance Partner will help you get started in the program. You can preview the application documents below:

- Multifamily Existing Buildings Terms and Conditions [PDF]

Ready to get started?

Learn how to participate.

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GreenLight LLC
an energy conservation company

NYCEEC Energy Efficiency Financing Program Case Study

NYCEEC Opens Field For Successful Retrofit Financings at 125 MAIDEN LANE

THE CHALLENGE

125 Maiden Lane had dated building systems, but limited capital resources to implement upgrades.

Most of 125 Maiden Lane's core systems were original from its 1958 construction, making this building an ideal target for energy efficiency retrofits. The systems were typical of most office buildings of this era, built with pneumatic controls, constant volume pumps for water and constant volume motors for air.

However, the building owners had limited funds, and wanted to explore alternative funding strategies to avoid drawing on building reserves.

THE BACKGROUND

- 320,000 square foot Class B office condominium building
- Built in 1958
- Aging physical plant
- Dated HVAC systems requiring frequent repairs
- Building owners had limited appetite and funds to cover upfront costs

THE SOLUTION

Transcend Equity provided a turn-key retrofit and financing solution, using a managed energy service agreement (MESA). NYCEEC participated in the MESA by providing credit enhancement, thus, permitting the financing to close and construction to start.

Highlights include:

- Projected to achieve 23.6% energy savings or 5,743 MBTUs per year
- Building owners paid no upfront cost
- No debt on the building
- No increase in operating expenses. Building owners continue to pay historical energy bill
- Retrofit repaid through energy savings
- 10 year contract with building owners

THE MARKET IMPACT

The successful energy efficiency financing at 125 Maiden Lane proves the commercial viability of energy service agreements for private building owners.

Under the MESA, a Class B commercial building with limited funds was able to implement energy efficiency retrofits, thereby, improving tenant comfort and increasing occupancy levels.The project also benefitted from incentives from the New York State Energy Research and Development Authority (NYSERDA).

TOMBSTONE

Building Owners:
Time Equities Inc. + 13 other condominium owners

Developer:
Transcend Equity Development Corporation (acquired by SCIenergy in 2012)

Lender: BB&T Bank

Incentives Provider: NYSERDA

Credit Enhancement Provider:
New York City Energy Efficiency Corporation

RETROFIT MEASURES

- State-of-the-art direct digital controls
- Automated building management system
- High efficiency, variable speed motors
- Controls for new floor isolation dampers
- Controls for induction riser control dampers
- Control valves

PROJECT BUDGET

$1.4 Million

NYCEEC
New York City Energy Efficiency Corporation

NYCEEC GRANTORS

- U.S. Department of Energy
- Rockefeller Foundation
- Kresge Foundation
- Deutsche Bank Americas Foundation
- Living Cities
- Natural Resources Defense Council

NYCEEC SUPPORTERS

- New York City Mayor's Office of Long-Term Planning and Sustainability
- New York City Department of Citywide Administrative Services
- New York City Department of Environmental Protection
- NYSERDA

CONTACT NYCEEC

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ABOUT NYCEEC

The New York City Energy Efficiency Corporation (NYCEEC) is an independent, non-profit financial corporation established by the City of New York to assist with the implementation of the City's Greener, Greater Buildings Plan and advance the goals of PlaNYC. NYCEEC's mission is to support New York City's energy and climate action goals by catalyzing an energy efficiency retrofit financing market for private building owners.

To achieve its mission, NYCEEC is partnering with banks, community development financial institutions and energy services companies to provide financing products for energy efficiency and clean heat improvements in buildings throughout the five boroughs of New York City.

NYCEEC is financially supported by the Energy Efficiency and Conservation Block Grant Program under the American Recovery and Reinvestment Act of 2009, and by private philanthropic foundations.

TESTIMONIALS

"We evaluated a variety of retrofit funding options before selecting MESA. It shifts the performance risk and funding responsibility away from the office condominium unit owners. MESA is an important tool in Time Equities' overall strategy for achieving sustainability in the buildings it manages."

Rick Recny, Director of Asset Management, Time Equities

"NYCEEC played a critical role in this transaction and really showed the capacity to help bring the energy efficiency market to scale. As word gets out that this is a viable option to retrofit existing buildings in the City, we expect many others will follow."

Steve Gossett Jr., Vice President, Transcend Equity

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