Steven Winter Associates, Inc.
Improving the Built Environment Since 1972

May 3rd, 2013

FLEXTECH STUDY

Town of Bedford – Police Department

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Bedford Hills, NY 10507

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We hope the findings of this report will assist you in making decisions about energy efficiency improvements in your facility. Thank you for your participation in this program.

State of New York

Andrew Cuomo, Governor

New York State Energy Research and Development Authority

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EXECUTIVE SUMMARY

Project Overview

During multiple site visits Steven Winter Associates conducted walk-through energy surveys at the Town of Bedford Police Department in Bedford Hills, New York. The surveys were performed under the guidelines for an ASHRAE Level II Energy Audit as part of NYSERDA's FlexTech Program. The objective of the study was to determine if energy use at the building could be decreased, thereby increasing efficiency. This report will provide the Town of Bedford and the Police Department with a technical and economic strategy by which to modify their energy systems and operating practices while improving occupant comfort and reducing energy consumption.

The Town of Bedford Police Department is a single-story, 8,000 square foot police station located at 307 Bedford Road in Bedford Hills. Renovated in 1979, the building was formerly operated as a milk and cheese processing facility and then a restaurant. The building consists of various spaces including offices for lieutenants, detectives and the Chief of Police as well as locker rooms, police dispatch, a classroom, a processing and holding area and a small kitchen.

Utility billing for the Town of Bedford Police Department was collected and entered into the U.S. Environmental Protection Agency's (EPA) Energy Star® Portfolio Manager Energy Benchmarking System. During the 12-month period from December 2011 to November 2012, the building consumed 159,000 kWh of electricity and 3,156 gallons of No.2 fuel oil for a total annual consumption of 980 MMBtu of energy. The total energy cost for the period was $24,854, or $3.11 per square foot.

The Police Department was categorized in Portfolio Manager as an "Other – Fire Station/Police Station" space type. As a result the building has not received an Energy Star Rating®. However, for the period from December 2011 to November 2012 the Site and Source Energy Use Intensities (EUI) were calculated to be 126 kBtu/ft^2/yr and 282 kBtu/ft^2/yr, respectively. This compares to National Median Site and Source EUIs of 82 kBtu/ft^2/yr and 146 kBtu/ft^2/yr, respectively, indicating that the building performs more poorly than other fire stations/police stations with similar characteristics.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The table below shows measures identified for potential energy reduction:

Measure Description	Measure Status (See Notes)	Fuel Type Saved (See Notes)	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
ECM #1: Exterior Lighting Controls	R	Elec	3,030	-	-	$307	$0	0.0
ECM #2: Insulate Hot Water Piping	R	Oil2	-	-	43	$1,068	$300	0.3
ECM #3: Hot Water Temperature Reset	R	Oil2	-	-	59	$1,452	$1,000	0.7
ECM #4: Install Natural Gas Boiler	R	Oil2	-	-	24	$5,665	$8,200	1.4
ECM #5: Install Occupancy Sensors	R	Elec	6,063	-	-	$546	$2,550	4.7
ECM #6: Façade Upgrades	R	Elec, Oil2	2,492	-	92	$2,490	$24,799	10.0
		Total	11,585	0	219	$11,527	$36,849	3.2
NR: RTU Replacement	NR	Elec	24,944	-	-	$2,200	$58,660	26.7
NR: Install Solar PV System on the Roof	NR	Elec	31,632	-	-	$2,847	$123,849	43.5

Notes:

1. Measure Status: Implemented (I); Recommended (R); Further Study Recommended (RS); Not Recommended (NR)
2. Fuel Type Saved: Elec, NGas, Oil2, Oil4, Oil6, Coal, LPG. MMBtu = 1,000,000 Btu

BUILDING DESCRIPTION

Renovated in 1979 to become the Town of Bedford Police Department the building is a single-story structure of approximately 8,000 square feet that operates 24 hours per day 7 days per week. Prior to 1979 the building was used as a restaurant and prior to the restaurant served as a milk and cheese processing facility. The building consists of various spaces including offices, locker rooms, police dispatch, a classroom, a processing and holding area and a small kitchen. The Police Department neighbors several other town buildings and as such the surrounding parking lots serve as parking for both various official police vehicles, town equipment vehicles and visitor parking.

The Police Department has approximately 53 occupants with most office staff occupying the building under a normal work schedule of 9AM to 5PM, Monday through Friday. Detectives occupy the building for an extended period from approximately 7AM to 11PM, Monday through Friday. Areas such as police dispatch have 24 hour occupancy 7 days per week.

NYSEG both supplies and delivers electricity to the Police Department while No.2 fuel oil is supplied and delivered by Goodrow Fuel Oil.

SWA engineers completed the energy surveys and subsequent report for the Town of Bedford with full cooperation from the police department and the Town of Bedford staff. There is no maintenance staff for the building but a facility conditions interview was conducted with Chief of Police William Hayes, Lieutenant Collins and the Town of Bedford Director of Energy Resources Mark Thielking to acquire critical information including weekly hours of operation, occupancy, space temperature set points and other building operational details. The interview was followed by a comprehensive facility walkthrough and inspection of all major HVAC equipment, controls, lighting systems, and building envelope. Lieutenant Collins and Mr. Thielking accompanied SWA throughout the walk-through so as to best address any questions and concerns. SWA noted equipment conditions, operational deficiencies and concerns expressed by building staff.

Building Systems Narrative

Heating System

The Town of Bedford Police Department is heated by a single Weil-McLain No.2 fuel oil hot water boiler. The boiler has a nominal output of 212,000 Btu/Hr with an efficiency of 85% and is maintained by Goodrow Fuel Oil. The HW is distributed by two 1/12 HP constant volume pumps to perimeter baseboard radiators that are fitted with hand valves. The control valves are not modulated by the building staff and it was indicated that the space is often overheated. It was also indicated that the heating system and the RTUs responsible for cooling the space may be operated at the same time and building occupants have witnessed this occur. Additionally, during the initial site survey of the Police Department many of the windows were open to regulate the overheating of the space.

The heating hot water system is activated when outside air temperature is below an adjustable set point temperature which was set to 50°F during the site surveys. Hot water supply temperature is constant and not based on an outdoor air temperature reset schedule. Supply temperature was approximately 148°F during a site survey when outside air temperatures were approximately 35°F. The HW system is operated 24/7 during the winter months to maintain space temperatures even during times of low occupancy. Fuel oil is stored in a buried tank outside of the Police Department.

It was also observed during the site survey that several sections of the HW piping were inadequately insulated and because the HW piping travels through the plenum space above the drop ceiling the heat loss from the piping is increased.

Cooling System

Cooling at the Town of Bedford Police Department is provided by five Carrier roof-top units and a single Sanyo split package unit. All of the units use R-22 refrigerant and total 20 Tons of cooling. The units are run 24/7 during the summer months to maintain space conditions which are regulated by occupant controlled thermostats placed throughout the Police Department. It was indicated that space temperatures were often inconsistent when moving between various areas and was a notable issue. Another indicated issue for the Police Department was air quality. According to building staff complaints have been received previously and the system was given a basic cleaning however the supply grills for the RTUs were noticeably dusty/dirty. Additionally, it was noted that the RTUs appeared to be nearing the end of their useful life, one of the compressors requires repair and the units have not received regular maintenance which includes filter replacement. As a general note, the production of R-22 will be phased out by 2020 in accordance with The Montreal Protocol[1]. Any new equipment to be installed should utilize refrigerant 410A or other similarly environmentally conscious refrigerant with no phase-out date.

The original design detailed that the five RTUs are zoned such that HVAC-1 delivers air solely to the classroom and the thermostat for this unit is also located in the classroom. HVAC-2 delivers air to the record room, a lieutenant's office and the reporting room. The thermostat for the zone is located in the record room. HVAC-3 delivers air to the zone which contains the chief's office, the secretary's office, vestibule, lobby, two conference rooms, hallway, juvenile officer room and corridor. The thermostat for the zone is located in the chief's office. HVAC-4 serves the detective office, corridor, two interrogation rooms, processing room, locker room and call room. The thermostat for the zone is located in the detectives' office. HVAC-5 serves the desk area, work area, smaller locker room, dark room, lab, corridor and the detective sergeant's office. The zone control thermostat is located in the desk area. However, after the site survey it was noted that several of the rooms have changed function as there are now three lieutenants whereas in the original design there was only a

[1] http://www.epa.gov/ozone/intpol/

single lieutenant office. One of the new lieutenant offices is served by the Sanyo split unit. For the purposes of estimating the load within each of the zones it is assumed that the ductwork has not undergone major changes and the zones are still served by the unit installed in same location as the original unit. As such the cooling capacities of each unit are listed below.

HVAC-1: 3 Ton Carrier RTU

HVAC-2: 3 Ton Carrier RTU

HVAC-3: 5 Ton Carrier RTU

HVAC-4: 4 Ton Carrier RTU

HVAC-5: 4 Ton Carrier RTU

1 Ton Sanyo Split Unit

Ventilation System

A total of 13 exhaust fans work in unison to provide ventilation throughout the building. Five (5) exhaust fans are installed horizontally through the back wall of the Police Department, two (2) exhaust fans are installed vertically through the roof and six (6) smaller exhaust fans are installed in the plenum space. The exhaust fans are controlled by switches and serve areas including the classroom, kitchen, locker room, bathrooms, and holding area. Specifically two (2) horizontally mounted fans are responsible for the classroom, one (1) is responsible for the call room, one (1) for the detectives and the last is for locker rooms and adjacent toilets. One (1) of the roof mounted exhaust fans is responsible for what was originally designated as two conference rooms but have since changed purpose. The other roof mounted exhaust fan serves the holding area. Finally, the smaller exhaust fans are allocated such that a single fan serves the original teletype room and communications room, one (1) fan serves the dark room, one (1) for existing men’s bathroom, one (1) for the existing women’s bathroom and two (2) for the additional two (2) lavatories. All of the smaller exhaust fans are ducted to vents in the plenum side wall and are equipped with electronic dampers.

During the survey it was noted that the ductwork for the exhaust fan which serves the classroom is not connected to the exhaust grill. As a result the exhaust fan works to pull plenum air out of the building. This disconnection also allows plenum air to enter the classroom which can lead to increase energy consumption and decreased air quality.

Domestic Hot Water

The Town of Bedford Police Department is provided DHW by a single electric hot water heater. Although the hot water heater is not equipped with any means of determining water temperature the water is delivered to the bathrooms and showers before returning back to the boiler to be reheated. It was noted that the DHW temperature appeared to be adequate when called for the bathrooms throughout the Police Department.

Lighting

Interior lighting throughout the Town of Bedford Police Department has been recently upgraded with efficient lamps and ballasts. The new fixtures are equipped with electronic ballasts and four (4) 32W lamps. Exterior lighting in the front of the building is provided by eight (8) recessed 150W incandescent lamps while lighting in the rear of the building is provided by five (5) recessed 175W mercury vapor lamps. A single halogen spot light provides lighting for the flag pole in front of the building. SWA also noted that all exit signs were equipped with LEDs.

Interior lighting is manually operated by wall switches. During the site surveys SWA noticed lights on in several unoccupied areas throughout the building. Exterior lighting is operated by a time-clock which was noted to activate the lights at 6PM and deactivate at Noon the following day. Lastly, the flag pole light is operated by a daylight sensor.

Controls System

The building does not currently use a centralized control system to monitor and control equipment. Instead the heating system is controlled by a local controller which activates when the measured temperature is below the adjustable set point which was set at 50°F. At which point the boiler is fired to deliver hot water to the perimeter baseboard radiators. Hand valves isolate flow into the radiators and are seldom used. Due to the 24/7 occupancy of the building the heating system must maintain comfort conditions 24/7 during the heating season. Cooling is available year round and the cooling system is operated 24/7 during the cooling season to maintain comfort conditions throughout the building even during low occupancy. The individual RTUs are controlled by a corresponding thermostat that is placed within the controlled zone. The thermostats are adjusted by building occupants to satisfy comfort requirements. The exhaust fans are run as needed and are controlled by switches placed within the exhausted space. SWA recommends the installation of a sophisticated programmable thermostat to control both the RTUs and the boiler. This will prevent any simultaneous heating and cooling by locking out the RTUs during the heat season and also track space temperatures to limit overheating.

Electrical Systems

Electric service to the building is provided by NYSEG and configured as a 208 volt, three-phase, four-wire wye system. The service passes through a single 400A switch and is connected to three distribution panels designated LM, PM, and MDP. Also connected to the electrical system is a single 45kW diesel generator. The generator if needed supplies power to the panels designated LM and PM which include lighting, receptacles and various other electrical loads. However, the five RTUs and Sanyo split unit are not connected and would not be available in the case of power failure. The Police Department is currently considering replacing the generator as it is nearing the end of its useful life.

Building Envelope

The Town of Bedford Police Department was formerly operated as both a milk and cheese processing facility and a restaurant but received several updates and renovations when it officially became the Police Department in 1979. The building's exterior walls are comprised primarily of a brick masonry façade backed by concrete masonry units (CMU) and rigid insulation. It was noted that the finished interior walls were constructed such that a narrow air gap exists between the CMU exterior wall and the gypsum board interior wall. During a site survey air movement was documented in the small gap. The exterior wall is penetrated by sliding double-pane aluminum frame windows that are equipped with locks but some were not fully closed and locked during the site surveys. As a result air infiltration was documented and results in increased energy consumption. Additionally, unlocked windows can pose as a security risk for a building which normally has restricted access.

During the interview with building occupants SWA was informed that a portion of the roofing material peeled back sometime in 2009. It was estimated that approximately 25% of the roof was affected and subsequently reattached. SWA noted that the roof was generally in poor condition with much of the roofing material bubbling up and large collections of water. However, after the repair building staff has not experienced any leakage issues. It is recommended that the roof be replaced to prevent any further damage or prevent the possibility of leakage in the future. To determine the energy savings resulting from the roof replacement a Level III energy audit with energy model would need to be completed but the estimated cost to remove the current roof and install a new roof is approximately $63,000.

The Police Department main entrance includes a vestibule area with the exterior and interior doors being constructed of glass and aluminum frames. Access to the Police Department is restricted by electronically locking the interior set of doors which were noted to have proper weather-stripping. The exterior doors however permit access to the vestibule and were noted to require weather-stripping replacement. Within the vestibule is a single hot water radiator and two (2) vending machines. The lack of proper weather-stripping and door sweeps on these doors allows conditioned air to escape the building and results in wasted energy.

Finally, the Police Department has a small plenum area above the drop ceiling which is consistent throughout the building. It was noted during the inspection of the roof that this plenum area is vented to the outside and allows conditioned air to exit as well as unconditioned air to enter the plenum space. This can not only affect occupant comfort by decreasing air quality but also significantly increase energy consumption. The drop ceiling was intended to act as a thermal barrier but has sporadic insulation coverage. A more permanent thermal barrier should be created at the roof line to maintain a comfortable temperature in the conditioned space.

ENERGY USE ANALYSIS WITH EPA PORTFOLIO MANAGER RESULTS

Overall Energy Performance

Energy consumption at the Town of Bedford Police Department is comprised of electricity and No.2 fuel oil. Billing analysis and Energy Star® benchmarking was conducted for the 12-month time period between December 2011 and November 2012. Total energy consumption for the analysis period was 980 MMBtu, resulting in a utility cost of $24,854.

Town of Bedford - Police Department - Annual Energy Consumption and Costs									
	Energy		*Site Energy in MMBtu*	*Source Energy in MMBtu*	*Cost*	*% Total Site Energy*	*% Total Source Energy*	*% Total Cost*	*Cost / Site MMBtu*
Electricity	159,000	kWh	543	1,812	$14,021	55%	80%	56%	$26
No. 2 Fuel Oil	3,156	Gallons	438	442	$10,832	45%	20%	44%	$25
Totals			**980**	**2,254**	**$24,854**	**100%**	**100%**	**100%**	**$25**

SWA entered information about the Town of Bedford Police Department into the U.S. Environmental Protection Agency's (EPA) Energy Star® Portfolio Manager Energy Benchmarking System. The facility was categorized as an "Other – Fire Station/Police Station" space type. Currently, the system does not determine Energy Star Rating® values for "Other" space types. However, should Energy Star start providing Fire Stations/Police Stations with rating in the future a score of 69 is required for LEED for Existing Buildings certification and a score of 75 is required for Energy Star® certification. While an Energy Star Rating was unavailable, the system did generate Site and Source Energy Use Intensities (EUI). The Site EUI for the building is 126 kBtu/ft^2/yr and the Source EUI is 282 kBtu/ft^2/yr. This compares to National Median Site and Source EUIs of 82 kBtu/ft^2/yr and 146 kBtu/ft^2/yr, respectively, indicating that the building performs more poorly than other fire stations/police stations with similar characteristics

The EPA considers source energy (energy used at point of generation) a more equitable assessment of building-level energy efficiency than site energy (energy used in the building). Source energy incorporates system losses from transmission, delivery and generation, where as the site energy is a measure of the energy used by the building itself.

Energy Analysis

The annual energy consumption and costs are broken down in Figures 1 and 2 below:

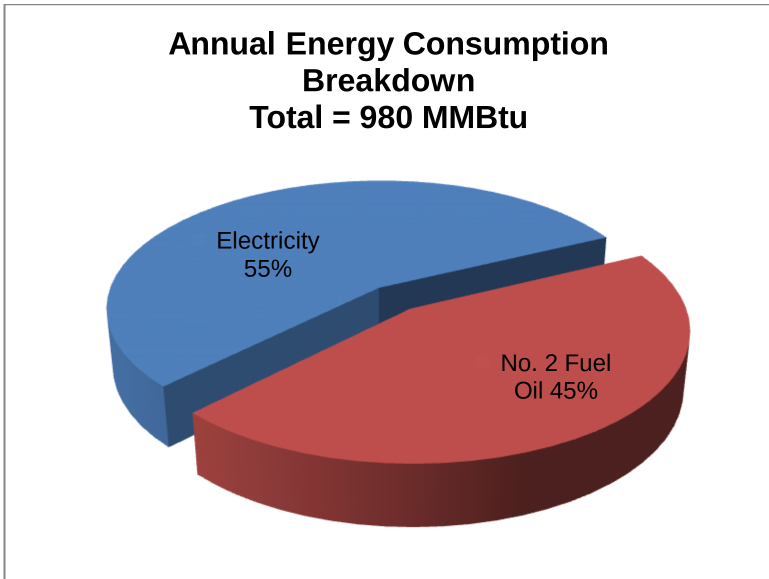


Figure 1

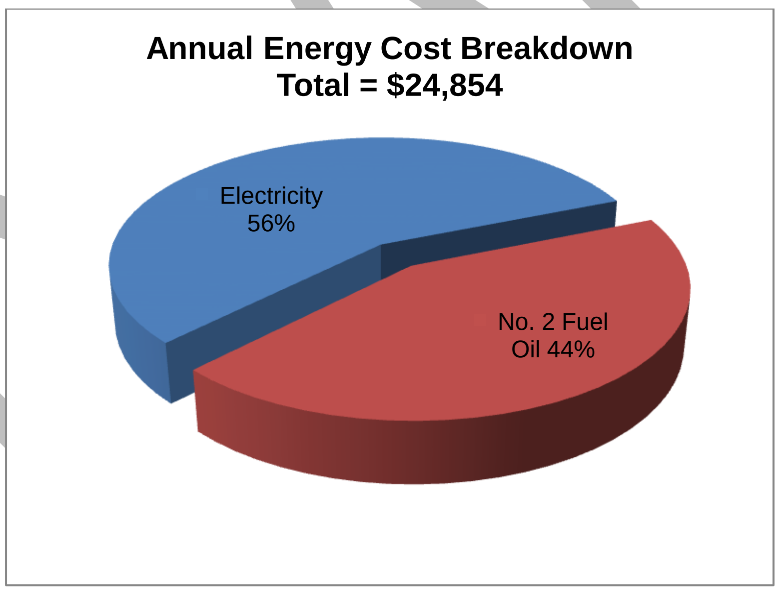


Figure 2

Electricity accounts for approximately 55% of total energy consumption and 56% of the cost. While No.2 fuel oil consumption accounts for only 45% of total energy consumption and 44% of the cost. As such the cost per MMBtu is nearly the same. This is due to the low cost of electric energy which is discussed below.

The Town of Bedford does not currently employ the services of an Energy Services Company (ESCO). An ESCO is a business that, among other things, assesses a client's utility requirements and arranges for the client to procure energy commodities at the most competitive rates. SWA recommends that the Town of Bedford investigate ESCO options in order to ensure they receive the most attractive utility pricing.

Utility consumption at the Town of Bedford Police Department has been further broken down by major building end uses and because consumption is not sub-metered by separate end uses; the figures calculated in the breakdowns are estimates based on building and equipment information and facility-provided hours of operation.

Figure 3.1 below shows a breakdown of annual energy costs by end use while figures 3.2 and 3.3 show site and source energy use broken down by end use.

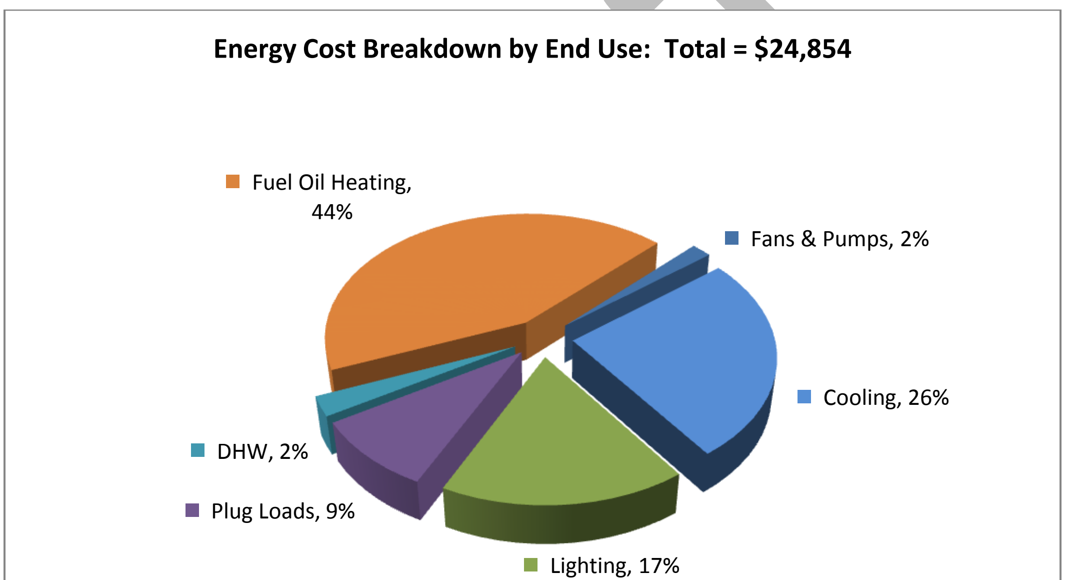


Figure 3.1

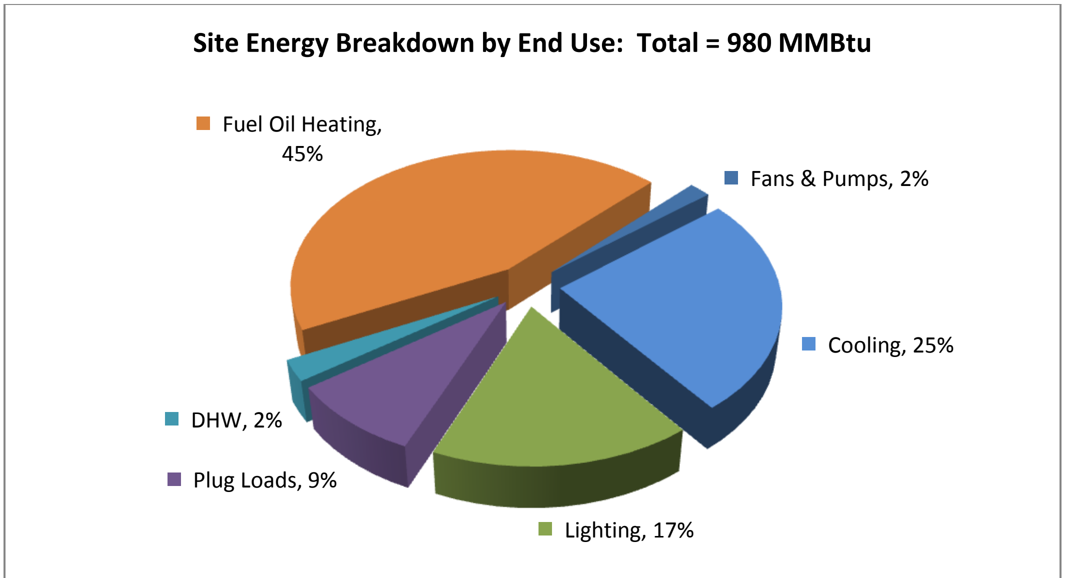


Figure 3.2

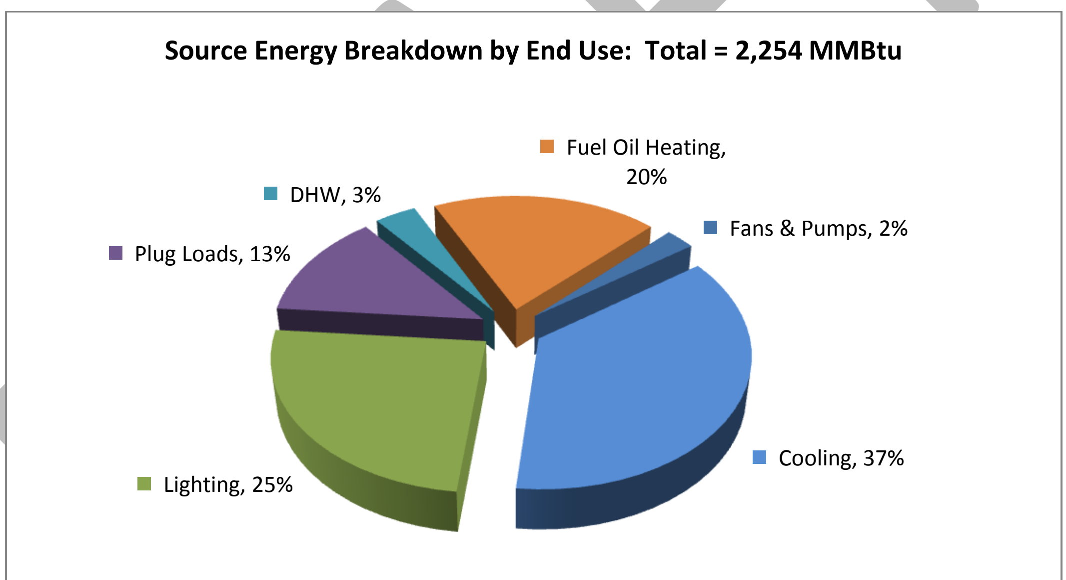


Figure 3.3

Because buildings are the major users of energy, they also contribute significantly to greenhouse gas emissions. Carbon dioxide is by far the most common greenhouse gas released during energy generation; however, others like methane and nitrous oxide also contribute. When analyzing a commercial building, Carbon Dioxide Equivalent (CO_2e) can be calculated based on the total energy consumed by the building. This calculation takes all greenhouse gases and energy generation methods into account and results in a single quantity for simple comparison. Annual energy use at the Town of Bedford Police Department generates approximately 182,934 pounds of CO_2e. Figure 4 below shows a breakdown of the building's greenhouse gas emissions by end use:

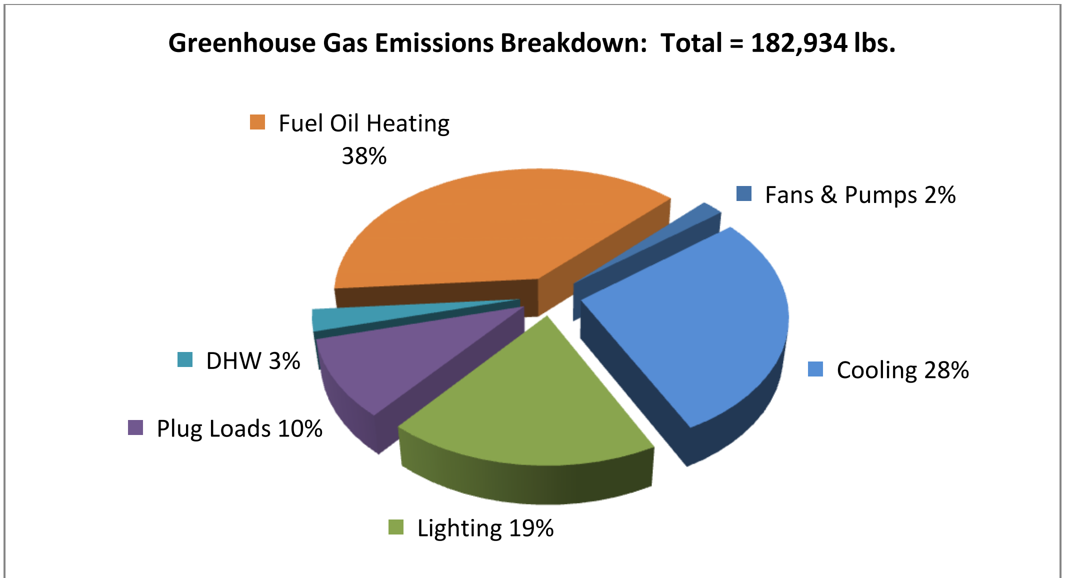


Figure 4

Electricity

Electricity is purchased and delivered to the building by Con Edison. A single electric service supplies the entire building. Annual electric consumption between December 2011 and November 2012 was 159,000 kWh, resulting in a total cost of $14,021 and an average aggregated rate of $0.09 per kWh. Consumption for this period was greatest during the month of January, when the building used approximately 17,940 kWh of electricity. For the limited available demand data a peak demand of 50 kW occurred in March. Figure 5.1 below provides a breakdown of total electrical consumption based on end use.

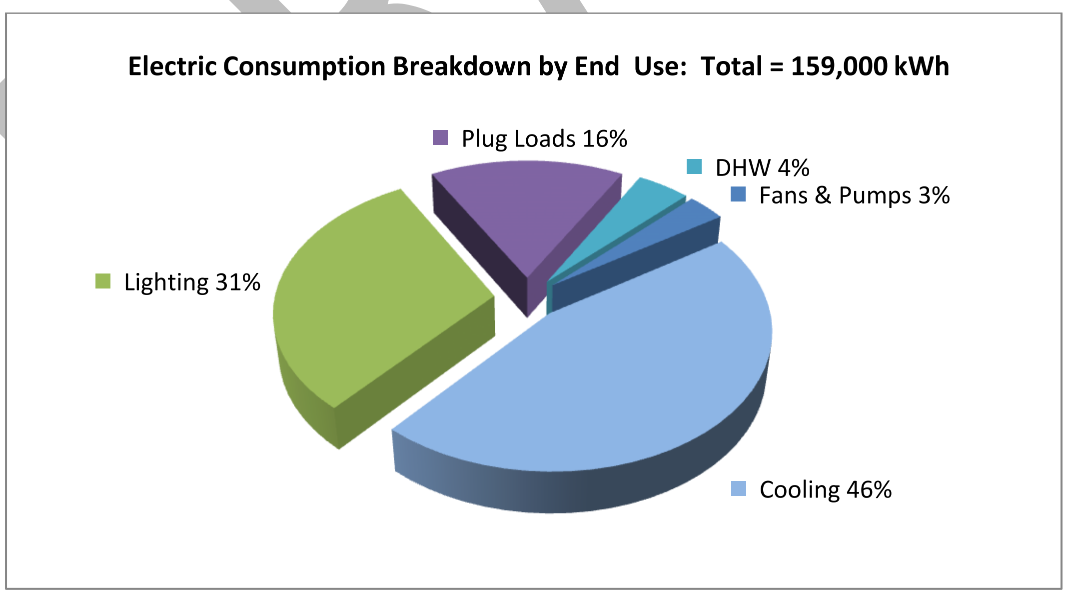


Figure 5.1

Figure 5.2 graphs a comparison of the building's monthly electrical usage for the previous two years. Overall, electrical use decreased by 18% when comparing the 2010-2011 period to the 2011-2012 period and is particularly apparent in peak winter and peak summer months indicated by the annual kWh line. The cause for the change in consumption for the winter months could be a reduction in simultaneous heating and cooling while the reduction for the summer months could be the result of the lighting upgrade completed in the spring. It was also noted that one RTU was inoperable during the previous summer and could also have impacted the energy consumption. In general it is noted that the shape of the consumption profiles is not consistent from year to year. This suggests that the controls, set points, equipment or occupancy may also be inconsistent and further suggests the need for a centralized controls system. The graph also shows that the Police Department's electric consumption profile does not follow a typical pattern for buildings of similar type; electric consumption should be at a minimum during the winter months when the cooling system is not in use and the fuel oil fired boiler is active.

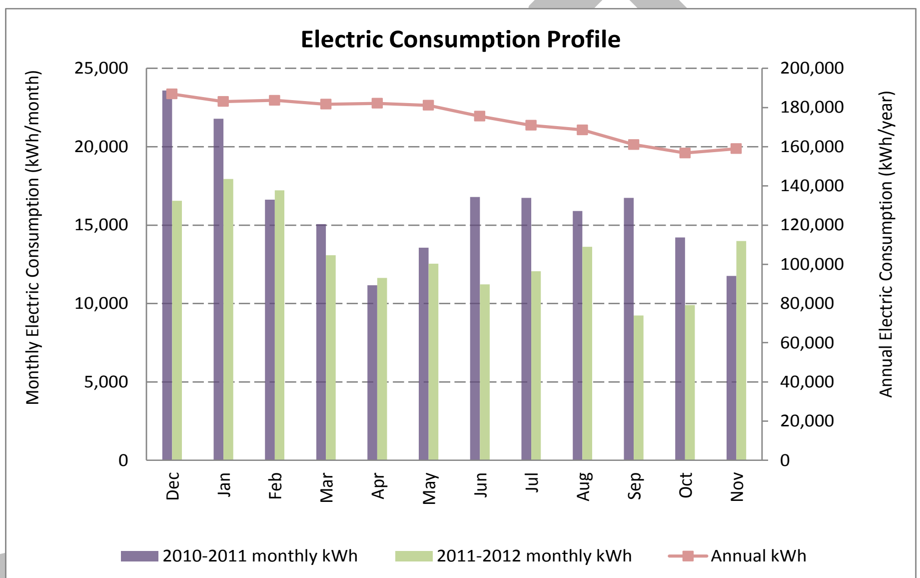


Figure 5.2

Figure 5.3 shows the building's monthly electric demand profile for the period between February 2012 and November 2012. Electric demand is the highest average kilowatts used in a thirty minute interval during the month. The graph shows the peak demand during each monthly billing period. Because only a short period of demand data was available for analysis a comparison between two years of data was not completed and the peak demand may have occurred in January which is not available for analysis. However, the graph does show a demand spike in March 2012 which is not typical for a building with electrical cooling systems. Additionally, a minimum demand of 25 kW in both June 2012 and July 2012 is inconsistent with an electrically cooled building. This further suggests variations in the controls and set points and also further suggests the need for a centralized controls system.

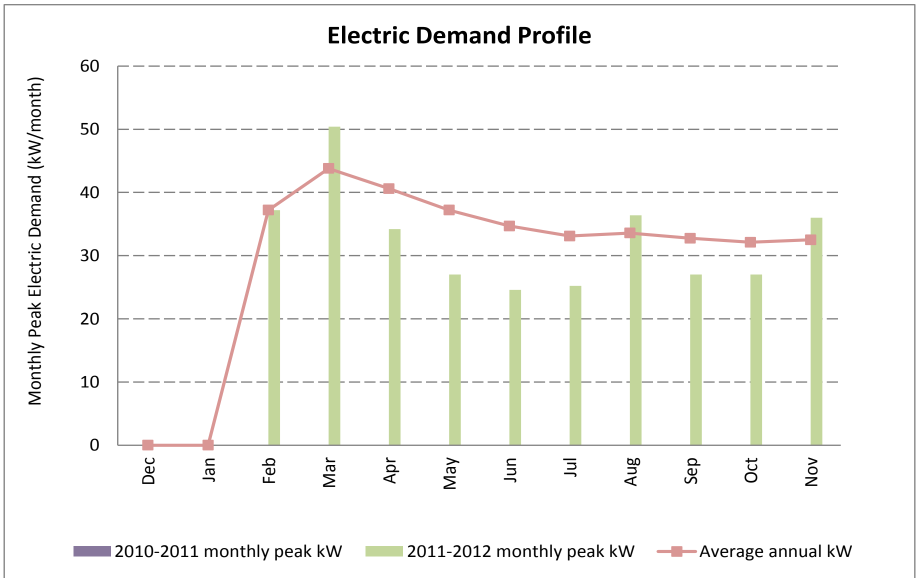


Figure 5.3

Figure 5.4 below relates the monthly electrical consumption and the number of Cooling Degree Days in that month. Cooling degree days (CDD) are the number of degrees that a day's average temperature is above a specified baseline temperature of 50°F. On days when the average temperature is more than 50°F, it is assumed that the building requires cooling. On days when the average temperature is below 50°F, cooling is not required and CDD equals zero. It is apparent from the graph that electrical consumption does not correlate with the curve of CDD. This is particularly apparent during November 2012 when CDD are at and a minimum and consumption has increased from October when the number of CDD was higher. This suggests the need for a centralized controls system which can prevent fluctuation in energy consumption and prevent simultaneous heating and cooling which may have occurred in November.

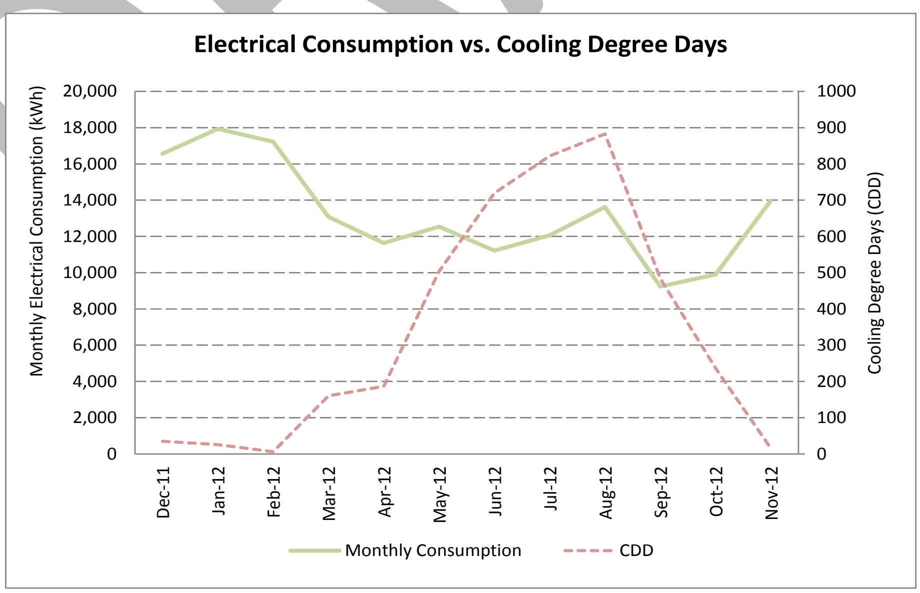


Figure 5.4

No. 2 Fuel Oil

Fuel Oil is purchased and delivered to the Town of Bedford Police Department by Goodrow Fuel Oil. Oil is used solely by the hot water boiler that provides heat for all spaces in the Police Department. Annual fuel oil consumption between December 2011 and November 2012 was 3,156 gallons, resulting in a total cost of $10,832 and an average aggregated rate of $3.43 per gallon. Figure 6 shows the bill date, gallons purchased and cost per purchase for the No.6 fuel oil that the Police Department procures from Goodrow Fuel Oil.

Bill Date	Amount (Gallons)	Cost ($)
12/21/2010	300	$797
2/5/2011	800	$2,398
8/26/2011	75	$284
9/1/2011	97	$369
10/31/2011	1,006	$3,773
12/12/2011	**1,174**	**$3,766**
2/17/2012	**701**	**$2,422**
10/12/2012	**1,100**	**$3,893**
10/26/2012	**66**	**$275**
10/31/2012	**52**	**$217**
11/2/2012	**63**	**$260**
Totals	**3,156**	**$10,832**

Figure 6

A figure providing the breakdown of total fuel oil consumption based on end use is not included as the only system to contribute to the consumption is the heating system. As such the entire consumption is attributed to space heating.

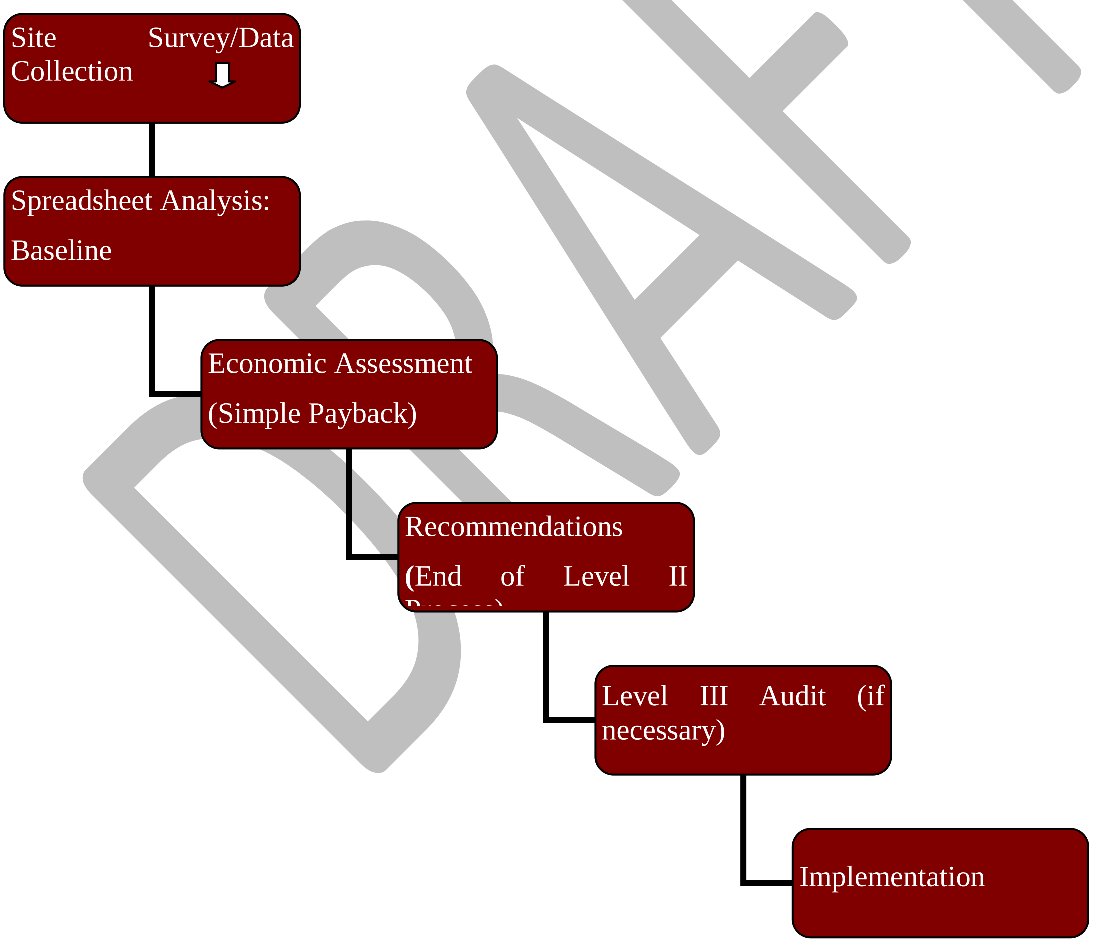
PROJECT RESULTS AND RECOMMENDATIONS

Overview

The Project Summary Sheet that follows the Executive Summary lists estimated costs and savings for each recommended ECM. Each ECM is discussed in detail in the following section with a brief recommendation on how to measure and verify the savings after implementation. These Measurement and Verification (M&V) methods are recommended in accordance with the International Performance for Measurement and Verification Protocol (IPMVP) guidelines. The recommended options (A, B, C or D) were determined based on a combination of cost, magnitude of savings, and reasonableness of methods. This process is described in more detail at the Efficiency Valuation Organization's website: www.evo-world.com.

Methodology

Potential energy conservation measures (ECMs) were evaluated after the site survey, operator interviews and collection of data necessary to perform the technical and economic analyses. This evaluation was completed to ASHRAE Level II standards through spreadsheet analysis. It is recommended that complex measures be further evaluated to Level III standards prior to implementation.



Methodology Flow Chart

To assess energy savings associated with each measure, the baseline for consumption was compared individually to consumption totals calculated for each measure. The baseline for equipment was obtained from monthly utility bills and steam and electric data and analyzed against daily weather data. Results were then calibrated as necessary.

Energy consumption associated with each measure was then assessed individually based on the technical performance of new equipment and then compared to the corresponding baseline in order to determine energy savings. Cost savings were determined using the projected energy savings and incremental energy rates from energy bills.

All potential ECMs were analyzed. They are listed in this section of the report as *Recommended* or *Considered but Not Recommended* based on technical and/or economic feasibility. Prior to implementation, confirmation of projected savings and cost may be required for capital intensive measures.

The following assumptions were used in calculating the savings:

1. Building energy usage patterns remain relatively unchanged in the near future (no significant occupancy change and/or space conversion).
2. Energy costs remain relatively stable (although we believe electricity costs will escalate).
3. Building systems operation remains relatively unchanged (unless change is related to a recommended ECM).

An economic analysis was performed for each measure using historical cost estimates from similar projects and pricing solicited from vendors. The cost savings were divided by implementation costs in order to determine simple payback for each measure.

Proposed Energy Conservation Measures (ECMs)

Each ECM is discussed in this section. Please see the Project Summary Sheet at the end of the Executive Summary for estimated costs and savings.

ECM #1: Exterior Lighting Controls

Existing Conditions

Exterior lighting for the building is limited but is controlled by a timer. Upon inspection it was noted that the timer may be incorrectly setup such that it provides lighting from 6PM to Noon the following day. SWA recommends reevaluating the operating hours of the exterior lighting as it may not be necessary to operate the exterior lights until Noon.

Measure Description

It is recommended that the timer be set such that exterior lighting is provided from 6PM to 8AM the following day. This will reduce the operating time of the lighting and reduce the associated electrical consumption.

Repairs Required

No repairs are expected as a result of this measure.

Operations and Maintenance Impacts

A limited impact in operations and maintenance can be expected as the reduction in operating hours will increase the life of each lamp.

Equipment Life

Only a limited increase in lamp life can be expected as a result of this measure.

Savings

Savings is the result of reduced operating hours and reduced electrical consumption.

Measurement and Verification

Option A, Retrofit Isolation with Key Parameter Measurement, would be appropriate for this measure. Actual power draw from each fixture, before and after retrofit, can be measured initially with a Watt meter, and assumed to be constant during operation. Operating hours then must be determined and energy savings can be calculated.

ECM #2: Insulate Hot Water Piping

Existing Conditions

While surveying the HW piping throughout the Police Department, it was noted that the hot water piping was well insulated within the boiler room but was lacking insulation for portions of the piping above the drop ceiling. Missing insulation allows for hot water pipes to radiate heat into the plenum space which does not require heating. This unwanted heat transfer allows for system heat loss, which greatly reduces the amount of heat delivered to the baseboard radiators. These system losses are energy wasted, which also results in added fuel oil costs.

Measure Description

SWA recommends that all non-insulated hot water piping be insulated to mitigate heat loss and reduce fuel oil consumption. The existing insulation appeared to be in good condition however any section found to be damaged should also be replaced. Included below is a table from ASHRAE 90.1 2007 documenting the recommended pipe insulation thickness based on pipe size and operating temperatures. This should serve as the guideline for any new insulation installed as well as means of evaluation for the existing insulation. Savings for this measure will result from reduced fuel oil consumption in producing hot water for use throughout the PD.

TABLE 6.8.3 Minimum Pipe Insulation Thickness[a]

Fluid Design Operating Temp. Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity Btu·in./(h·ft²·°F)	Mean Rating Temp. °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Heating Systems (Steam, Steam Condensate, and Hot Water)[b,c]							
>350	0.32 – 0.34	250	2.5	3.0	3.0	4.0	4.0
251 – 350	0.29 – 0.32	200	1.5	2.5	3.0	3.0	3.0
201 – 250	0.27 – 0.30	150	1.5	1.5	2.0	2.0	2.0
141 – 200	0.25 – 0.29	125	1.0	1.0	1.0	1.5	1.5
105 – 140	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Domestic and Service Hot-Water Systems							
105+	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
Cooling Systems (Chilled Water, Brine, and Refrigerant)[d]							
40 – 60	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
<40	0.22 – 0.28	100	0.5	1.0	1.0	1.0	1.5

[a] For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:
$T = r\{(1 + t/r)^{K/k} - 1\}$
where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/[h·ft²·°F]); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
[b] These thicknesses are based on energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.
[c] Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in. or less.
[d] These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

Repairs Required

Any damaged insulation found should be replaced following the table above. Piping throughout the PD appeared to be in good condition however any damaged or leaking piping will need to be replaced prior to the installation of the insulation.

Operations and Maintenance Impacts

Operations and maintenance will be slightly increased such that periodic inspection of the insulation should be completed to ensure that it is good condition and complete.

Equipment Life

The new piping insulation can be expected to last 20 years with minimal disturbance.

Savings

Savings is the result of reduced heat loss and reduced fuel oil consumption during the entire heating season.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to track the results of this ECM. Fuel oil delivery data is available through Goodrow. Delivery amount and frequency should be compared before and after measure implementation and normalized with weather data.

ECM #3: Hot Water Temperature Reset

Existing Conditions

The heating hot water system is activated when outside air temperature is below an adjustable set point temperature which was set to 50°F during the site surveys. Hot water supply temperature is constant and not based on an outdoor air temperature reset schedule.

Measure Description

SWA recommends that the Town of Bedford Police Department consider implementing a heating hot water temperature reset schedule based on outdoor air temperature. As the outdoor air temperature increases, the boilers can generate lower heating hot water supply temperatures. A reduction in heating hot water supply temperature will reduce the load on the boilers and reduce fuel oil consumption. This will require a controller to be installed to determine the appropriate heating hot water based on the measured OA temperature. This will also reduce the occurrence of overheating.

Repairs Required

Any broken or improperly functioning heating hot water equipment will need to be repaired/replaced prior to the implementation of the reset schedule.

Operations and Maintenance Impacts

The implementation of the reset schedule should have very little impact on the operations and maintenance of the heating system. However, the OA temperature sensor will need to be checked periodically to verify calibration.

Equipment Life

The controls equipment require to implement the reset schedule can be expected to last approximately 15 years.

Savings

Energy savings are the result of lower HW temperatures being delivered from the boiler. By basing the temperature on OA it reduces the load on the boiler and allows the amount of heat being delivered to the space to vary based on building load.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to track the results of this ECM. Fuel oil delivery data is available through Goodrow. Delivery amount and frequency should be compared before and after measure implementation and normalized with weather data.

ECM #4: Install Natural Gas Boiler

Existing Conditions

The heating hot water system is currently supplied by a Weil-McLain No.2 fuel oil hot water boiler which has a nominal output of 212,000 Btu/Hr and an efficiency of 85%. The boiler is maintained by Goodrow Fuel Oil but is not as efficient as newer boilers. In addition, the cost of fuel per MMBtu is approximately $25. In comparison, other Town of Bedford properties which utilize natural gas for heating purposes pay approximately $12.50 per MMBtu for natural gas.

Measure Description

SWA recommends that the Town of Bedford Police Department consider replacing the Weil-Mclain fuel oil hot water boiler with a more efficient natural gas boiler. This will not only reduce the energy required to provide comfort heating but also significantly reduce fuel costs. However, as natural gas is currently not in use within the Police Department a new natural gas line will need to be installed. Based on information provided by the Town of Bedford the cost associated with the new gas line is minimal and as such has not been included in this analysis.

Repairs Required

Any broken or improperly functioning heating hot water equipment will need to be repaired/replaced prior to the installation of the new boiler.

Operations and Maintenance Impacts

The new boiler will require regular maintenance similar to the existing boiler.

Equipment Life

The new boiler can be expected to last approximately 15 years.

Savings

Energy and cost savings are the result of more efficient boiler combustion with added cost savings from the fuel source switch.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to track the results of this ECM. Fuel oil delivery data is available through Goodrow and natural gas billing will be available through Con Edison. Fuel oil delivery amount and frequency before the installation should be compared with natural gas billing after measure implementation and normalized with weather data.

<u>ECM #5: Install Occupancy Sensors</u>

Existing Conditions

While the Town of Bedford Police Department has already implemented T8 lamping throughout all of the spaces interior lighting is, for the most part, operated manually; control by occupancy sensor is not currently utilized at the building. During the survey, SWA noted many spaces with continuous lighting and zero occupancy. This results in significantly increased electrical consumption and costs.

Measure Description

SWA recommends replacing the existing wall switches with occupancy sensors in all areas except the dispatch room. By installing occupancy sensors, light fixtures are capable of shutting off automatically when a room becomes unoccupied. The dispatch room is occupied 24/7 and would not benefit from a occupancy sensor installation. The Police Department can expect to pay up to $150 per occupancy sensor, which includes material and labor, with both infrared and ultrasonic technology.

Repairs Required

No repairs are expected as a result of this measure.

Operations and Maintenance Impacts

Operations and maintenance will likely be reduced as the reduction in lighting hours will increased the lamp life.

Equipment Life

The occupancy sensors can be expected to last 15 years while lamp life will be extended.

Savings

Savings is the result of reduced hours of lighting operation and reduced electrical consumption.

Measurement and Verification

Option A, Retrofit Isolation with Key Parameter Measurement, would be appropriate for this measure. Actual power draw from each fixture can be measured with a Watt meter, and assumed to be constant during operation. Operating hours then must be estimated and energy savings can be calculated.

<u>*ECM #6: Façade Upgrades*</u>

Existing Conditions

Upon completion of the multiple site visits at the Town of Bedford Police Department it was determined that the building had a number of penetrations through the façade which contribute to the high energy consumption and poor air quality. The high level of leakage was confirmed with a blower door test which concluded that the building experienced 8.79 air changes per hour (ACH) under an average 30 Pascal differential pressure which equates to 0.657 ACH when under natural pressure conditions. As a general note a differential pressure of 50 Pascal is usually maintained while conducting a blower door test but due to the excessive leakage was not achievable.

Measure Description

In an effort to reduce the amount of air infiltration, reduce the air change rate, improve air quality and reduce energy consumption SWA recommends the implementation of several façade improvements. The major improvements are described below and a complete listing of issues with accompanying images has been included as Appendix D.

- Install Weather-stripping and Door Sweeps on Exterior Doors
    - In surveying the building envelope, SWA observed gaps between the doors and frames on the exterior set of entrance doors at the front of the building and the side door of the building. These gaps allow for unwanted air infiltration and heat transfer between conditioned and unconditioned spaces, resulting in increased fuel oil usage to heat and electric energy to cool the vestibule, front lobby and youth bureau. Unfiltered air infiltration also contains dust and particulates that impact cleanliness and indoor environmental quality. SWA recommends installing high-quality weather-stripping and door sweeps on all doors to the exterior. Additionally, the roof hatch weather-stripping in the server room should receive similar treatment when necessary but was noted to be in good condition during the surveys.
- Install Weather-stripping on Windows
    - During the surveys, SWA observed gaps between the sliding window frames when the windows were fully closed. These gaps further contribute to the air leakage of conditioned air and infiltration of unconditioned air. Weather-stripping should be installed to ensure that an air seal is created between the sliding windows frames when the windows are closed.
- Seal Façade Penetrations
    - While surveying the building envelope, SWA noted approximately 31 vents penetrate the façade and serve to ventilate the plenum space above the drop ceiling. However, due to the lack of the thermal barrier at the drop ceiling level conditioned air is allowed to escape into the plenum and unconditioned air is allowed to enter into the building. It is likely that these vents contribute a majority of the leakage air and sealing the openings would significantly reduce energy consumption and improve air quality. SWA recommends removing the vents and bricking up the openings.

  - Included in the façade penetrations are any gaps created by mechanical equipment penetrating the building façade. It was noted when inspecting several of the exhaust fans installed in the rear of the building that air seals were not created around the openings through which the duct work runs. These gaps should be sealed to prevent leakage and infiltration.
  - Another possible source for excessive outside air infiltration and conditioned air loss are the exhaust fan dampers. As the condition of each damper was difficult to determine during the site surveys it is recommended that each damper be thoroughly inspected to verify tight closure when the fan is not in operation. This will ensure ductwork isolation and limit the amount of infiltrating air being delivered through exhaust ductwork.

- Exhaust Fan Ductwork Connections
  - SWA noted during the site surveys that the exhaust fan ductwork was incomplete in some areas and specifically it was noted that the ductwork for the classroom exhaust fan did not make a proper connection to the grill. This allows for unconditioned air which has entered into the plenum space to further infiltrate the building and enter in the occupied space. This also limits the effectiveness of the exhaust fan as it will begin to exhaust the plenum area and not the classroom. Completing the ductwork connection will not decrease the required exhaust fan energy but will more effectively exhaust the space and improve air quality.
- Boiler Room Windows
  - It was observed that the windows within the boiler room do not provide daylight to any normally occupied area but serve as another location for infiltrating air. SWA recommends that these windows be insulated and air sealed over to provide an adequate barrier to prevent infiltration.
- Direct Boiler Combustion Air
  - The Town of Bedford Police Department is heated by a single Weil-McLain No.2 fuel oil hot water boiler. The boiler currently receives its combustion air from an outside air intake which is ducted into the boiler room. A damper was not found to be installed and results in an open duct for air infiltration. By directly ducting the combustion air intake to the boiler and fitting the ductwork with a damper the amount of infiltrating air can be reduced. The damper will need to be tied to the boiler ignition such that when the boiler fires the damper automatically opens and automatically closes when the boiler is not in operation.

Repairs Required

Repairs required vary from the installation of new weather-stripping and door sweeps to the repair of the building façade.

Operations and Maintenance Impacts

As part of a regular maintenance schedule the weather-stripping and seals on both the exterior doors and windows should be inspected to ensure a tight seal is maintained. Any seal found leaking should be replaced.

Equipment Life

Weather-stripping can be expected to last a year with regular use but should be inspected periodically for early failure.

Savings

Energy savings from this measure are due to a reduction in conditioned air leakage and unconditioned air infiltration.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to look at the results of this ECM. Fuel oil delivery data is available through Goodrow and electric usage data is available through NYSEG. Monthly usage should be compared before and after measure implementation and normalized with weather data.

Not Recommended Energy Conservation Measures

NR - Rooftop Unit Replacement

Existing Conditions

During the site surveys, it was documented that the existing five (5) RTUs currently serving the Town of Bedford Police Department have reached the end of their useful life. Most of the units are still operable although one of the RTUs failed during the previous summer. Additionally, the units also have an average EER of 9.5 which can be assumed to have degraded 15% to 7.95 for the purposes of this calculation and all of the units utilize R-22 refrigerant for which production will be phased out by 2020.

Measure Description

Replace the existing RTUs with new and more efficient RTUs. This will reduce the peak summer electrical consumption and will increase occupant comfort. The new units will also utilize R410a refrigerant. A more detailed description of the installation process can be found in Appendix E.

Repairs Required

As the units will be completely replaced there are no repairs necessary for the units. However, the supply and return ductwork should be evaluated for leaks and proper insulation. This will ensure that the units operate at optimum efficiency. Any roof repair or replacement should be completed after the installation of the new units.

Operations and Maintenance Impacts

Operations and maintenance will likely increase as the current units received limited maintenance and the new units will require regular maintenance to maintain the manufacturer's warranty. This will include cleaning of the coils and replacement of the internal filters. However, these maintenance procedures will ensure that the units have a prolonged life and operate at peak efficiency while offsetting the cost to repair the existing units.

Equipment Life

The new equipment can be expected to have a useful life of 15 years with proper maintenance.

Savings

Energy and cost savings are the result of increased efficiency of the new units. Additionally, savings will likely be generated if the ductwork which is found to be leaky or poorly insulated is repaired and properly insulated. However, these savings are not included in the payback analysis and the analysis shows that the units will not generate an adequate payback. As such the RTU replacement is not recommended as an energy conservation measure but instead should be implemented as a capital improvement measure because the units have reached the end of their useful life and will prevent the potential loss of cooling during the next cooling season.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to track the results of this ECM. Electric usage data is available through NYSEG. Monthly usage should be compared before and after measure implementation and normalized with weather data.

<u>NR - Install Solar Photovoltaic System on the Roof</u>

Existing Conditions

The Town of Bedford Police Department does not currently use any renewable energy systems however interest was expressed in a photovoltaic system. Photovoltaic (PV) panels can be mounted on the building's roof facing south which can offset a portion of the purchased electricity for the building. Power stations generally have two separate electrical charges: usage and demand. Usage is the amount of electricity in kilowatt-hours that a building uses from month to month. Demand is the amount of electrical power that a building uses at any given instance in a month period. During the summer periods, electric demand at a power station is high, due to the amount of air conditioners, lights, and other equipment being used within the region. Demand charges increase to offset the utility's infrastructure cost to provide enough electricity at that given time. Photovoltaic systems offset the amount of electricity used by a building and help to reduce the building's electric demand, resulting in a higher cost savings. Installing a PV system will offset electric demand and reduce annual electric consumption.

Measure Description

The size of the PV system was determined considering the available roof surface area, without compromising service space for roof equipment and safety, as well as the facilities' annual base load and mode of operation. It was estimated that approximately 2,450 ft^2 would be available to install the PV panels and would be the limiting factor when determining the ultimate size of the PV system. Due to the size restriction the system output was determined to be 27 kW. Additionally, PV system installations should be accompanied by an evaluation of the roof's structural stability and current roof condition. In the case of the Police Department the roof is nearing the end of its lifespan and should be replaced in conjunction with the installation of the PV system.

Repairs Required

The installation of the PV system would require that the roof be replaced.

Operations and Maintenance Impacts

Operations and maintenance would be greatly increased by the installation of a PV system. This is due to the added equipment necessary to operate a PV system including the panels which will need to maintained and cleaned periodically to ensure optimum output.

Equipment Life

A PV system can be expected to last approximately 20 years.

Savings

Presented savings is determined by the Solar Pathfinder system and is the result of the electrical output of the PV system. However, due to the large implementation cost determined by the National Renewable Energy Laboratories' System Advisor Model and the substantial cost associated with the roof replacement this measure would have a lengthy payback. Without including the roof replacement the payback is estimated at 40 years. Both the cost estimate and savings estimate report are included as Appendix F and Appendix G respectively.

Measurement and Verification

Option C, *Utility Data Analysis*, would be the most accurate assessment tool to look at the results of this ECM. Electric usage data is available through NYSEG. Monthly usage should be compared before and after measure implementation and normalized with weather data.

APPENDICES

- APPENDIX A: EPA Portfolio Manager Statement Of Energy Performance
- APPENDIX B: ECM Calculations
- APPENDIX C: BIN Data Calculation Spreadsheet Printouts
- APPENDIX D: Façade Upgrade Findings
- APPENDIX E: Rooftop Unit Proposal
- APPENDIX F: PV System Cost – NREL SAM Report
- APPENDIX G: PV System Savings – Solar Pathfinder Report
- APPENDIX H: Glossary and Method of Calculations
- APPENDIX I: Method of Analysis

APPENDIX A: EPA Portfolio Manager Statement of Energy Performance

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Town of Bedford - Police Department

Building ID: 3415681
For 12-month Period Ending: November 30, 2012[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: March 13, 2013

Facility
Town of Bedford - Police Department
307 Bedford Road
Bedford Hills, NY 10507

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1979
Gross Floor Area (ft²): 8,000

Energy Performance Rating[2] (1-100) N/A

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	533,728
Fuel Oil (No. 2) (kBtu)	470,996
Natural Gas - (kBtu)[4]	0
Total Energy (kBtu)	1,004,724
Energy Intensity[4]	
Site (kBtu/ft²/yr)	126
Source (kBtu/ft²/yr)	282
Emissions (based on site energy use)	
Greenhouse Gas Emissions (MtCO$_2$e/year)	83
Electric Distribution Utility	
New York State Electric & Gas Corp [Iberdrola SA]	
National Median Comparison	
National Median Site EUI	82
National Median Source EUI	146
% Difference from National Median Source EUI	93%
Building Type	Fire Station/Police Station

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Meets Industry Standards[5] **for Indoor Environmental Conditions:**	
Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Certifying Professional
N/A

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Values represent energy intensity, annualized to a 12-month period.
5. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, Licensed Professional facility inspection, and notarizing the SEP) and welcomes suggestions for reducing this level of effort. Send comments (referencing OMB control number) to the Director, Collection Strategies Division, U.S., EPA (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

EPA Form 5900-16

APPENDIX B: Energy Conservation Measure Calculations

ECM #1: Exterior Lighting Controls

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Exterior Lighting Controls	3,030	-	-	$307	$0	0.0

Inputs	
# of Front of Bldg Fixtures	8
# of Rear Bldg Fixture	5
Front of Bldg Fixture Wattage	150
Rear of Bldg Fixture Wattage	175
Baseline Operating Hours (6PM - 12PM)	6570
Proposed Operating Hours (6PM - 8AM)	5110
Electric Utility Rate	$0.09

Equations

kWh Savings =	[(Fixture Wattage) x (Operating Hours)] / 1000
Annual Savings =	[Electric Savings] x [Electric Rate]
Total Energy Savings =	[kWh Savings] x 3.412
Simple Payback =	[Annual Savings] / [Est. Costs for Implementation]

Area	Fixture Wattage	Baseline		Proposed		Savings	
		Op Hours (6P -12P)	kWh	Op Hours (6P-8A)	kWh		
Front Exterior Lights	1,200	6,570	7,884	5110	6,132	1,752	$249.66
Rear Exterior Lights	875	6,570	5,749	5110	4,471	1,278	$57.49
Totals			**13,633**	**10,220**	**10,603**	**3,030**	**$307.15**

ECM #2: Insulate Hot Water Piping

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Insulated Hot Water Piping	-	-	43.5	$1,068	$300	0.3

Inputs		
Length of Piping Run	30	Feet
Pipe Size	1.25	Inches
Operating Temperature	150	°F
Heat Loss w/o Insulation*	7000	Btu/HR
Heat Loss w/ 1" Insulation*	421	Btu/HR
No. 2 Fuel Oil Conversion	139,690	Btu/Gal
Operating Hours per Year	5,615	Hours
Insulation Type	Fiberglass	N/A
Ambient Temperature	70	°F
Cost per Foot to Insulate	$10.00	$
Cost of No. 2 Fuel Oil	$3.43	$/Gallon
Boiler Efficiency	85%	%

Equations

Fuel Savings = [((Heat Loss per Hour x Operating Hours) / Boiler Efficiency) / Fuel Oil Conversion]
Annual Savings = [Fuel Savings] x [Fuel Rate]
Total Energy Savings = [Fuel Savings] x 138.6905
Simple Payback = [Annual Savings] / [Est. Costs for Implementation]
* Based on Whole Building Design Guide's Energy Calculator for Horizontal Piping

Case	Heat Loss (Btu/HR)	Operating Hours	Total Heat Loss (Btu)	Equivalent Fuel (Gal)	Fuel Savings (Gal)	Cost Savings ($)
Baseline (w/o Insulation)	7,000	5,615	39,305,000	331	-	-
Proposed (w/ 1" Insulation)	421	5,615	2,363,915	20	311	$1,068

ECM #3: Hot Water Temperature Reset

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Hot Water Temperature Reset	-	-	59.1	$1,452	$1,000	0.7

Inputs		
Heating Activation Temp	50	°F
Current HW Temperature Stpt	150	°F
Current HW Delta	20	°F
Proposed Highest HW Temp	150	°F
High Limit HW Delta	20	°F
OAT at Highest HW Temp	30	°F
Proposed Lowest HW Temp	120	°F
Low Limit HW Delta	12.5	°F
OAT at Lowest HW Temp	50	°F
HW Pump Capacity	30	GPM
# of HW Pumps	2	Pumps
Total HW Flow	60	GPM
No. 2 Fuel Oil Conversion	139,690	Btu/Gal
Cost of No. 2 Fuel Oil	$3.43	$/Gallon
Boiler Efficiency	85%	%
Boiler Fire Rate	14%	%

Equations

Hourly HW Gallons =	(Total HW Flow) x 60
Hourly HW Pounds =	(Hourly HW Gallons) x 8.33
Annual HW Pounds =	(Hourly HW Pounds) x (Operating Hours)
Energy Consumption =	((Delta T) x (Annual HW Pounds) x (Boiler Fire Rate)) / 1,000,000
Fuel Oil Consumption =	((Energy Consumption) x 1,000) / (Fuel Oil Conversion)

Bin Data			Baseline						Proposed						Savings	
Temp Boundaries		Hrs Dry Bulb														
Low Temp (°F)	High Temp (°F)		Boiler Activated	Fire Rate	HW Temperature	Delta	Energy Cons. (MMBtu)	Fuel Oil (Gallons)	Boiler Activated	Fire Rate	HW Temperature	Delta	Energy Cons. (Btu)	Fuel Oil (Gallons)	Fuel Oil (Gallons)	Cost Savings ($)
94.0	96.0	7	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
92.0	94.0	12	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
90.0	92.0	11	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
88.0	90.0	29	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
86.0	88.0	22	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
84.0	86.0	77	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
82.0	84.0	65	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
80.0	82.0	93	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
78.0	80.0	112	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
76.0	78.0	93	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
74.0	76.0	175	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
72.0	74.0	241	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
70.0	72.0	289	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
68.0	70.0	345	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
66.0	68.0	465	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
64.0	66.0	360	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
62.0	64.0	363	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
60.0	62.0	379	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
58.0	60.0	253	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
56.0	58.0	336	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
54.0	56.0	278	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
52.0	54.0	260	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50.0	52.0	268	N	N/A	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
48.0	50.0	553	Y	14%	150.0	20.0	54.6	393.9	Y	14%	122	12.9	35.2	253.6	140.3	482
46.0	48.0	292	Y	14%	150.0	20.0	28.8	208.0	Y	14%	125	13.6	19.7	141.7	66.3	228
44.0	46.0	279	Y	14%	150.0	20.0	27.6	198.7	Y	14%	128	14.4	19.8	142.8	55.9	192
42.0	44.0	277	Y	14%	150.0	20.0	27.4	197.3	Y	14%	131	15.1	20.7	149.2	48.1	165
40.0	42.0	212	Y	14%	150.0	20.0	20.9	151.0	Y	14%	134	15.9	16.6	119.9	31.1	107
38.0	40.0	248	Y	14%	150.0	20.0	24.5	176.6	Y	14%	137	16.6	20.4	146.8	29.8	102
36.0	38.0	236	Y	14%	150.0	20.0	23.3	168.1	Y	14%	140	17.4	20.3	146.0	22.1	76
34.0	36.0	230	Y	14%	150.0	20.0	22.7	163.8	Y	14%	143	18.1	20.6	148.5	15.4	53
32.0	34.0	220	Y	14%	150.0	20.0	21.7	156.7	Y	14%	146	18.9	20.5	147.9	8.8	30
30.0	32.0	398	Y	14%	150.0	20.0	39.3	283.5	Y	14%	149	19.6	38.6	278.2	5.3	18
28.0	30.0	198	Y	14%	150.0	20.0	19.6	141.0	Y	14%	150	20.0	19.6	141.0	0.0	0
26.0	28.0	235	Y	14%	150.0	20.0	23.2	167.4	Y	14%	150	20.0	23.2	167.4	0.0	0
24.0	26.0	238	Y	14%	150.0	20.0	23.5	169.5	Y	14%	150	20.0	23.5	169.5	0.0	0
22.0	24.0	110	Y	14%	150.0	20.0	10.9	78.3	Y	14%	150	20.0	10.9	78.3	0.0	0
20.0	22.0	131	Y	14%	150.0	20.0	12.9	93.3	Y	14%	150	20.0	12.9	93.3	0.0	0
18.0	20.0	100	Y	14%	150.0	20.0	9.9	71.2	Y	14%	150	20.0	9.9	71.2	0.0	0
16.0	18.0	73	Y	14%	150.0	20.0	7.2	52.0	Y	14%	150	20.0	7.2	52.0	0.0	0
14.0	16.0	40	Y	14%	150.0	20.0	4.0	28.5	Y	14%	150	20.0	4.0	28.5	0.0	0
12.0	14.0	64	Y	14%	150.0	20.0	6.3	45.6	Y	14%	150	20.0	6.3	45.6	0.0	0
10.0	12.0	86	Y	14%	150.0	20.0	8.5	61.3	Y	14%	150	20.0	8.5	61.3	0.0	0
Totals		**8753**					**417**	**3006**					**358**	**2583**	**423**	**$1,452**

ECM #4: Install Natural Gas Boiler

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Install Natural Gas Boiler	-	-	24.3	$5,665	$8,200	1.4

Inputs		
Boiler Capacity	212,000	Btu/HR
Baseline Boiler Efficiency	85%	%
Proposed Boiler Efficiency	90%	%
Total Fuel Consumption	3,156	Gallons
Fuel Oil Rate	$3.43	$/Gallons
Natural Gas Rate	$1.25	$/Therm
Implementation Cost	$8,200	$

Equations

Total Output Energy = [(Total Quantity of Fuel Oil) x (Fuel Oil Conversion) x (Boiler Efficiency)]

Total Quantity of Fuel (NGas) = [(Required Output Energy) / (Boiler Efficiency)] / (Natural Gas Conversion)

Total Cost of Fuel = [(Cost per Unit of Fuel) x (Total Quantity of Fuel)]

Total Energy Savings = [(Total Quantity of Fuel Oil) x (Fuel Oil Conversion)] - [(Total Quantity of Natural Gas) x (Natural Gas Conversion)]

Total Cost Savings = [(Total Cost of Fuel Oil) - (Total Cost of Natural Gas)]

Simple Payback = [Total Cost Savings] / [Est. Costs for Implementation]

Baseline		
Fuel Type	Fuel Oil (#2)	
Fuel Type Energy Conversion	138,690	Btu/Gallon
Total Quantity of Fuel	3,156	Gallons
Total Cost of Fuel	$10,832	$
Cost/Unit of Fuel	$3.43	$/Gallon
Boiler Efficiency	85%	%
Total Output Energy	372	MMBtu

Proposed		
Fuel Type	Natural Gas	
Fuel Type Energy Conversion	100,000	Btu/Therm
Required Output Energy	372	MMBtu
Boiler Efficiency	90%	%
Total Quantity of Fuel	4,134	Therm
Cost/Unit of Fuel	$1.25	$/Therm
Total Cost of Fuel	$5,167	$

Savings		
Total Energy Savings	24.3	MMBtu
Total Cost Savings	$5,665	$

ECM #5: Install Occupancy Sensors

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Install Occupancy Sensors	6,063	-	-	$546	$2,550	4.7

Inputs	
Electric Utility Rate	$0.09
# of Wall Occ Sensors	17
Cost / Wall Occ Sensor	$150

Equations

kWh Savings =	[(Fixture Wattage) x (Operating Hours-(Operating Hours *(1- % Reduction))] /1000
Annual Savings =	[Electric Savings] x [Electric Rate]
Total Energy Savings =	[kWh Savings] x 3.412
Simple Payback =	[Annual Savings] / [Est. Costs for Implementation]

Room	Existing Wattage	Op Hours	kWh	20% Reduction	Savings
Processing Room	1,024	3,640	3,727	2982	$67.09
Hallway 1	256	8,760	2,243	1794	$40.37
Dectective Bureau	768	3,640	2,796	2236	$50.32
Laboratory	128	1,850	237	237	$0.00
Dark Room	32	104	3	3	$0.00
Detective Sergeant	128	3,640	466	373	$8.39
Chief's Office	256	3,640	932	745	$16.77
Administrative Office	256	3,640	932	745	$16.77
Youth Bureau	256	3,640	932	745	$16.77
Lieutenant Collins	128	3,640	466	373	$8.39
Lieutenant Dickan	*256*	3,640	932	745	$16.77
Hallway 2	640	8,760	5,606	4485	$100.92
Outside Sergeant	256	3,640	932	745	$16.77
Sergeant	128	3,640	466	373	$8.39
Lieutenant	256	3,640	932	745	$16.77
Report Room	128	8,760	1,121	897	$20.18
Record Room	768	3,640	2,796	2236	$50.32
Pantry	256	8,760	2,243	1794	$40.37
Training Room/Classroom	768	3,640	2,796	2236	$50.32
Dispatch Room	512	8760	4,485	4485	$0.00
Totals			**35,041**	**28,978**	**$546**

ECM #6: Façade Upgrades

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Façade Upgrades	2,492	-	91.7	$2,490	$24,799	10.0

Inputs		
Building Area	8,000	SqFT
Low Roof Height	11.5	FT
Low Roof Area	4,112	SqFT
High Roof Height	15	FT
High Roof Area	3,888	SqFT
Building Volume	105,609	FT^3
Measured Air Flow	15,473	CFM
Measure Differential	-30.5	Pascals
Calibrated Baseline Leakage (Nat. Press)	0.657	ACH
Calibrated Baseline Air Flow (Nat. Press)	1,156	CFM
Precent Reduction in Leakage	38%	%
Proposed Leakage	0.407	ACH
Proposed Air Flow	717	CFM
Heating Activation	55	°F
Heating Setpoint	72	°F
Cooling Activation	25.3	h (Btu/lb)
Cooling Setpoint	70	°F
	25.3	h (Btu/lb)
Boiler Efficiency	85%	%
Avg Cooling Efficiency	7.95	EER
Electric Rate	$0.09	$/kWh
Fuel Oil Rate	$3.43	$/Gallon
No. 2 Fuel Oil Conversion	139,690	Btu/Gal
Electric Conversion	3,412	Btu/kWh

Equations

Cooling Energy = [4.5 x (Air Flow CFM) x [(OA Enthalpy) - (Cond. Air Enthalpy)] x (Hours)] / 1,000,000

Electric Energy to Cool = [((Cooling Energy) x 1,000,000) / 12,000] x [12 / Avg Cooling Efficiency]

Heating Energy = [1.08 x (Air Flow CFM) x [(Cond Air Temp) - (OA Temp)] x (Hours)] / 1,000,000

Fuel Oil to Heat = [((Heating Energy) x 1,000,000) / (Boiler Efficiency)] / (Fuel Oil Conversion)

Simple Payback = [Annual Savings] / [Est. Costs for Implementation]

Bin Data				Baseline						Proposed						Savings		
Temp Boundaries		Enthalpy	Hrs Dry Bulb	Cooling			Heating			Cooling			Heating			Cooling	Heating	Cost
Low Temp (°F)	High Temp (°F)	h (BTU/lb)		Cooling Energy (MMBtu)	Elec to Cool (kWh)	Elec Cost ($)	Heating Energy (MMBtu)	Fuel Oil to Heat (Gallons)	Fuel Oil Cost ($)	Cooling Energy (MMBtu)	Elec to Cool (kWh)	Elec Cost ($)	Heating Energy (MMBtu)	Fuel Oil to Heat (Gallons)	Fuel Oil Cost ($)	Electric (kWh)	Fuel Oil (Gallons)	Cost ($)
94.0	96.0	38.1	7	0.5	58.5	$5	-	-	-	0.3	36.3	$3	-	-	-	22.2	-	$2
92.0	94.0	37.4	12	0.8	95.2	$8	-	-	-	0.5	59.0	$5	-	-	-	36.2	-	$3
90.0	92.0	37.7	11	0.7	89.0	$8	-	-	-	0.4	55.2	$5	-	-	-	33.8	-	$3
88.0	90.0	37.0	29	1.8	222.5	$20	-	-	-	1.1	137.9	$12	-	-	-	84.5	-	$7
86.0	88.0	36.6	22	1.3	163.3	$14	-	-	-	0.8	101.2	$9	-	-	-	62.0	-	$5
84.0	86.0	33.1	77	3.1	393.6	$35	-	-	-	1.9	244.0	$22	-	-	-	149.6	-	$13
82.0	84.0	33.5	65	2.8	347.2	$31	-	-	-	1.7	215.3	$19	-	-	-	131.9	-	$12
80.0	82.0	32.3	93	3.4	423.3	$37	-	-	-	2.1	262.5	$23	-	-	-	160.9	-	$14
78.0	80.0	33.4	112	4.7	596.9	$53	-	-	-	2.9	370.1	$33	-	-	-	226.8	-	$20
76.0	78.0	31.4	93	2.9	369.3	$33	-	-	-	1.8	229.0	$20	-	-	-	140.3	-	$12
74.0	76.0	30.7	175	4.9	618.2	$55	-	-	-	3.0	383.3	$34	-	-	-	234.9	-	$21
72.0	74.0	30.7	241	6.7	846.6	$75	-	-	-	4.2	524.9	$46	-	-	-	321.7	-	$28
70.0	72.0	29.3	289	6.0	753.6	$66	-	-	-	3.7	467.2	$41	-	-	-	286.4	-	$25
68.0	70.0	28.6	345	6.0	753.1	$66	-	-	-	3.7	466.9	$41	-	-	-	286.2	-	$25
66.0	68.0	27.3	465	4.8	599.9	$53	-	-	-	3.0	371.9	$33	-	-	-	228.0	-	$20
64.0	66.0	26.3	360	1.8	229.0	$20	-	-	-	1.1	142.0	$13	-	-	-	87.0	-	$8
62.0	64.0	24.9	363	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60.0	62.0	24.0	379	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58.0	60.0	22.0	253	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56.0	58.0	21.4	336	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54.0	56.0	20.4	278	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52.0	54.0	18.5	260	-	-	-	6.2	51.9	$178	-	-	-	3.8	32.2	$111	-	19.7	$68
50.0	52.0	17.9	268	-	-	-	7.0	59.2	$203	-	-	-	4.4	36.7	$126	-	22.5	$77
48.0	50.0	17.1	553	-	-	-	15.9	133.8	$459	-	-	-	9.8	82.9	$285	-	50.8	$174
46.0	48.0	16.2	292	-	-	-	9.1	76.8	$263	-	-	-	5.7	47.6	$163	-	29.2	$100
44.0	46.0	15.1	279	-	-	-	9.4	79.2	$272	-	-	-	5.8	49.1	$169	-	30.1	$103
42.0	44.0	14.4	277	-	-	-	10.0	84.5	$290	-	-	-	6.2	52.4	$180	-	32.1	$110
40.0	42.0	13.6	212	-	-	-	8.2	69.1	$237	-	-	-	5.1	42.8	$147	-	26.3	$90
38.0	40.0	12.7	248	-	-	-	10.2	86.1	$295	-	-	-	6.3	53.4	$183	-	32.7	$112
36.0	38.0	12.2	236	-	-	-	10.3	86.9	$298	-	-	-	6.4	53.9	$185	-	33.0	$113
34.0	36.0	11.5	230	-	-	-	10.6	89.5	$307	-	-	-	6.6	55.5	$190	-	34.0	$117
32.0	34.0	10.4	220	-	-	-	10.7	90.2	$310	-	-	-	6.6	55.9	$192	-	34.3	$118
30.0	32.0	9.7	398	-	-	-	20.4	171.6	$589	-	-	-	12.6	106.4	$365	-	65.2	$224
28.0	30.0	8.9	198	-	-	-	10.6	89.5	$307	-	-	-	6.6	55.5	$191	-	34.0	$117
26.0	28.0	8.3	235	-	-	-	13.2	111.2	$382	-	-	-	8.2	68.9	$237	-	42.3	$145
24.0	26.0	7.5	238	-	-	-	14.0	117.6	$404	-	-	-	8.7	72.9	$250	-	44.7	$153
22.0	24.0	7.0	110	-	-	-	6.7	56.7	$195	-	-	-	4.2	35.1	$121	-	21.5	$74
20.0	22.0	6.4	131	-	-	-	8.3	70.3	$241	-	-	-	5.2	43.6	$149	-	26.7	$92
18.0	20.0	5.7	100	-	-	-	6.6	55.7	$191	-	-	-	4.1	34.6	$119	-	21.2	$73
16.0	18.0	5.1	73	-	-	-	5.0	42.2	$145	-	-	-	3.1	26.2	$90	-	16.0	$55
14.0	16.0	4.5	40	-	-	-	2.8	24.0	$82	-	-	-	1.8	14.9	$51	-	9.1	$31
12.0	14.0	4.0	64	-	-	-	4.7	39.7	$136	-	-	-	2.9	24.6	$84	-	15.1	$52
10.0	12.0	3.3	86	-	-	-	6.6	55.2	$189	-	-	-	4.1	34.2	$117	-	21.0	$72
Totals			8753	52	6559	$578	207	1741	$5,974	32	4067	$359	128	1079	$3,704	2492	661	$2,490

NR - Rooftop Unit Replacement

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
RTU Replacement	24,944	-	-	$2,200	$58,660	26.7

Inputs		
Cooling Activation Temp	50	°F
Peak Capacity Temperature	85	°F
Peak Cooling Capacity	100%	%
Minimum Capacity Temperature	50	°F
Minimum Cooling Capacity	15%	%
Assumed Efficiency Degradation	85%	% of Original Eff.
Maximum Economizer Temperature	60	°F
Minimum Economizer Temperature	50	°F
Electric Conversion	3,412	Btu/kWh
Cost of Electric	$0.09	$/kWh

Baseline Inputs				Proposed Inputs			
Unit	Capacity (Tons)	Design Efficiency (EER)	Current Efficiency (EER)	Unit	Capacity (Tons)	Efficiency (EER)	Fan Energy (kW)
RTU-1	3	8.7	7.395	Unit 1	3	11	0.45
RTU-2	3	11.2	9.52	Unit 2	3	11	0.45
RTU-3	5	7.3	6.188	Unit 3	3	11	0.45
RTU-4	4	8.6	7.31	Unit 4	5	10.8	0.87
RTU-5	4	11.0	9.35	Unit 5	5	10.8	0.87
Total	**19**			**Total**	**19**		**3.1**

Equations

Current Equipment Efficiency =	(Design EER) x (Assumed Degradation)
Energy Consumption (Normal Op) =	[(12 / EER) x (Cooling Capacity %) x (RTU Capacity) x (Hours) x (Electric Converison)] / 1,000,000
Energy Consumption (Econo Op) =	[(Fan Energy) x (Hours) x (Conversion)] / 1,000,000
Elec Consumption (Normal Op) =	(12 / EER) x (Cooling Capacity %) x (RTU Capacity) x (Hours)
Elec Consumption (Econo Op) =	(Fan Energy) x (Hours)
Annual Savings =	[Electric Savings] x [Electric Rate]
Simple Payback =	[Annual Savings] / [Est. Costs for Implementation]

Bin Data			Baseline					Proposed					Savings	
Temp Boundaries		Hrs Dry Bulb												
Low Temp (°F)	High Temp (°F)		Cooling Activated	Cooling Capacity (%)	Cooling Capacity (Tons)	Energy Cons. (MMBtu)	Electric (kWh)	Cooling Activated	Cooling Capacity (%)	Cooling Capacity (Tons)	Energy Cons. (MMBtu)	Electric (kWh)	Electric Savings (kWh)	Cost Savings ($)
94.0	96.0	7	Y	100%	19.0	0.7	210.3	Y	100%	19.0	0.5	146.5	63.8	5.63
92.0	94.0	12	Y	100%	19.0	1.2	360.6	Y	100%	19.0	0.9	251.2	109.4	9.65
90.0	92.0	11	Y	100%	19.0	1.1	330.5	Y	100%	19.0	0.8	230.2	100.3	8.84
88.0	90.0	29	Y	100%	19.0	3.0	871.3	Y	100%	19.0	2.1	606.9	264.4	23.31
86.0	88.0	22	Y	100%	19.0	2.3	661.0	Y	100%	19.0	1.6	460.4	200.6	17.69
84.0	86.0	77	Y	100%	19.0	7.9	2313.5	Y	100%	19.0	5.5	1611.6	702.0	61.90
82.0	84.0	65	Y	95%	18.1	6.3	1858.1	Y	95%	18.1	4.4	1294.3	563.8	49.72
80.0	82.0	93	Y	90%	17.2	8.6	2522.8	Y	90%	17.2	6.0	1757.3	765.5	67.50
78.0	80.0	112	Y	85%	16.2	9.8	2874.8	Y	85%	16.2	6.8	2002.5	872.3	76.92
76.0	78.0	93	Y	81%	15.3	7.7	2251.4	Y	81%	15.3	5.4	1568.3	683.1	60.24
74.0	76.0	175	Y	76%	14.4	13.6	3981.1	Y	76%	14.4	9.5	2773.1	1207.9	106.52
72.0	74.0	241	Y	71%	13.5	17.5	5130.8	Y	71%	13.5	12.2	3574.0	1556.8	137.28
70.0	72.0	289	Y	66%	12.5	19.6	5731.0	Y	66%	12.5	13.6	3992.1	1738.9	153.34
68.0	70.0	345	Y	61%	11.6	21.6	6338.0	Y	61%	11.6	15.1	4414.9	1923.1	169.58
66.0	68.0	465	Y	56%	10.7	26.8	7863.9	Y	56%	10.7	18.7	5477.8	2386.1	210.41
64.0	66.0	360	Y	51%	9.8	19.0	5562.8	Y	51%	9.8	13.2	3874.9	1687.9	148.84
62.0	64.0	363	Y	47%	8.8	17.3	5079.4	Y	47%	8.8	12.1	3538.2	1541.2	135.91
60.0	62.0	379	Y	42%	7.9	16.2	4750.2	Y	42%	7.9	11.3	3308.9	1441.3	127.10
58.0	60.0	253	Y	37%	7.0	9.6	2801.7	ECONO	ECONO	ECONO	2.7	781.4	2020.4	178.16
56.0	58.0	336	Y	32%	6.1	11.0	3230.5	ECONO	ECONO	ECONO	3.5	1037.7	2192.8	193.37
54.0	56.0	278	Y	27%	5.2	7.7	2267.2	ECONO	ECONO	ECONO	2.9	858.6	1408.6	124.21
52.0	54.0	260	Y	22%	4.2	5.9	1740.9	ECONO	ECONO	ECONO	2.7	803.0	938.0	82.71
50.0	52.0	268	Y	17%	3.3	4.8	1403.4	ECONO	ECONO	ECONO	2.8	827.7	575.7	50.77
48.0	50.0	553	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
46.0	48.0	292	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
44.0	46.0	279	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
42.0	44.0	277	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
40.0	42.0	212	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
38.0	40.0	248	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
36.0	38.0	236	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
34.0	36.0	230	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
32.0	34.0	220	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
30.0	32.0	398	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
28.0	30.0	198	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
26.0	28.0	235	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
24.0	26.0	238	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
22.0	24.0	110	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
20.0	22.0	131	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
18.0	20.0	100	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
16.0	18.0	73	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
14.0	16.0	40	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
12.0	14.0	64	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
10.0	12.0	86	N	N/A	N/A	N/A	N/A	N	N/A	N/A	N/A	N/A	N/A	N/A
Totals		**8753**				**239**	**70135**				**154**	**45191**	**24944**	**$2,200**

NR - Install Solar Photovoltaic System on the Roof

ECM Description	Energy Saved in kWh	Energy Saved in kW	Energy Saved in MMBtu	Annual Dollars Saved	Estimated Costs for Implementation	Simple Payback in Years
Install Solar PV System on the Roof	31,632	-	-	$2,847	$123,849	43.5

Inputs		
NREL SAM Cost Estimate	$123,849	$ Cost
Pathfinder Energy Savings Est.	31,632	kWh Savings
Electric Rate	$0.09	$/kWh
Cost Savings	$2,847	$ Savings

Equations

Annual Savings = [Electric Savings] x [Electric Rate]

Simple Payback = [Annual Savings] / [Est. Costs for Implementation]

APPENDIX C: BIN Data Calculation Spreadsheet Printouts

Hour	Yes/No	Weekday	Yes/No	Month	Yes/No
1	Yes	1	Yes	1	Yes
2	Yes	2	Yes	2	Yes
3	Yes	3	Yes	3	Yes
4	Yes	4	Yes	4	Yes
5	Yes	5	Yes	5	Yes
6	Yes	6	Yes	6	Yes
7	Yes	7	Yes	7	Yes
8	Yes			8	Yes
9	Yes			9	Yes
10	Yes			10	Yes
11	Yes			11	Yes
12	Yes			12	Yes
13	Yes				
14	Yes				
15	Yes				
16	Yes				
17	Yes				
18	Yes				
19	Yes				
20	Yes				
21	Yes				
22	Yes				
23	Yes				
0	Yes				

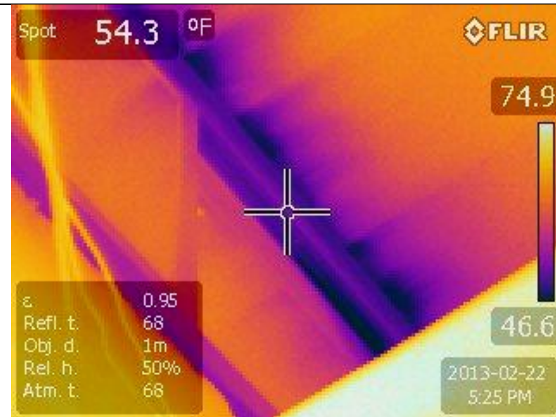
Temp Boundaries								
Low	High							
F	F	DB (F)	Mid-pts	DP (F)	WB (F)	h (BTU/lb)	HR(gr/lb)	Hrs Dry Bulb
94.0	96.0	94 to 96	95	66.3	74.7	38.1	96.9	7
92.0	94.0	92 to 94	93	66.0	74.0	37.4	95.9	12
90.0	92.0	90 to 92	91	67.4	74.3	37.7	100.6	11
88.0	90.0	88 to 90	89	67.1	73.6	37.0	99.7	29
86.0	88.0	86 to 88	87	67.3	73.1	36.6	100.3	22
84.0	86.0	84 to 86	85	61.3	69.1	33.1	81.0	77
82.0	84.0	82 to 84	83	63.1	69.5	33.5	86.4	65
80.0	82.0	80 to 82	81	61.6	68.0	32.3	81.8	93
78.0	80.0	78 to 80	79	65.0	69.4	33.4	92.5	112
76.0	78.0	76 to 78	77	61.8	66.9	31.4	82.4	93
74.0	76.0	74 to 76	75	61.4	66.0	30.7	81.2	175
72.0	74.0	72 to 74	73	62.4	65.9	30.7	84.2	241
70.0	72.0	70 to 72	71	60.4	64.1	29.3	78.5	289
68.0	70.0	68 to 70	69	60.1	63.2	28.6	77.4	345
66.0	68.0	66 to 68	67	58.0	61.3	27.3	71.8	465
64.0	66.0	64 to 66	65	56.7	59.8	26.3	68.5	360
62.0	64.0	62 to 64	63	54.3	57.7	24.9	62.7	363
60.0	62.0	60 to 62	61	53.1	56.3	24.0	60.0	379
58.0	60.0	58 to 60	59	48.3	53.0	22.0	50.2	253
56.0	58.0	56 to 58	57	48.2	52.1	21.4	50.0	336
54.0	56.0	54 to 56	55	46.4	50.3	20.4	46.6	278
52.0	54.0	52 to 54	53	40.8	46.8	18.5	37.5	260
50.0	52.0	50 to 52	51	40.3	45.6	17.9	36.8	268
48.0	50.0	48 to 50	49	38.6	44.0	17.1	34.5	553
46.0	48.0	46 to 48	47	36.6	42.1	16.2	31.8	292
44.0	46.0	44 to 46	45	33.4	39.8	15.1	28.0	279
42.0	44.0	42 to 44	43	31.8	38.2	14.4	26.2	277
40.0	42.0	40 to 42	41	30.5	36.5	13.6	24.7	212
38.0	40.0	38 to 40	39	27.9	34.4	12.7	21.9	248
36.0	38.0	36 to 38	37	27.6	33.1	12.2	21.5	236
34.0	36.0	34 to 36	35	26.3	31.5	11.5	20.2	230
32.0	34.0	32 to 34	33	21.7	28.8	10.4	16.3	220
30.0	32.0	30 to 32	31	20.0	27.1	9.7	15.0	398
28.0	30.0	28 to 30	29	16.6	25.0	8.9	12.7	198
26.0	28.0	26 to 28	27	14.7	23.2	8.3	11.6	235
24.0	26.0	24 to 26	25	11.9	21.2	7.5	10.1	238
22.0	24.0	22 to 24	23	10.6	19.6	7.0	9.4	110
20.0	22.0	20 to 22	21	8.7	17.8	6.4	8.6	131
18.0	20.0	18 to 20	19	6.1	15.9	5.7	7.5	100
16.0	18.0	16 to 18	17	3.6	14.0	5.1	6.6	73
14.0	16.0	14 to 16	15	2.1	12.3	4.5	6.1	40
12.0	14.0	12 to 14	13	-0.1	10.5	4.0	5.5	64
10.0	12.0	10 to 12	11	-5.0	8.3	3.3	4.2	86
								8753

APPENDIX D: Façade Upgrade Findings

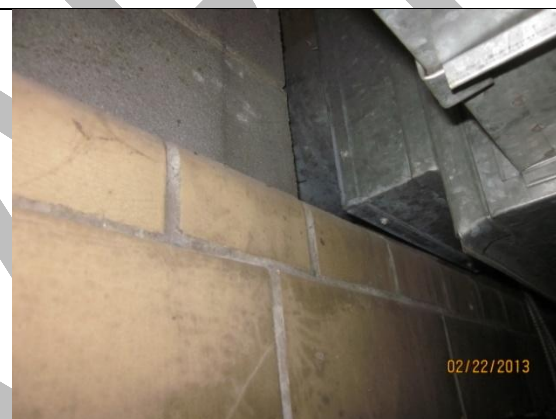
Town of Bedford New York – Police Department

Façade Upgrade Findings

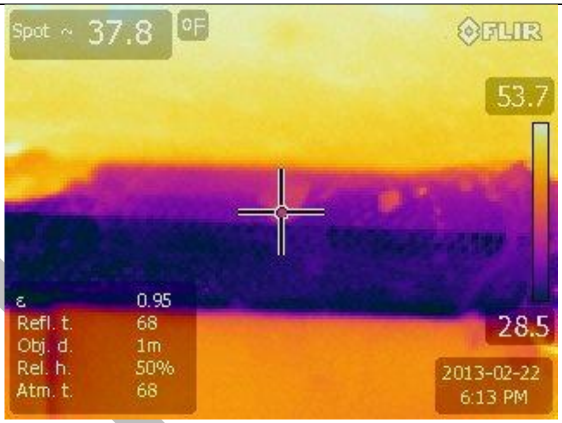
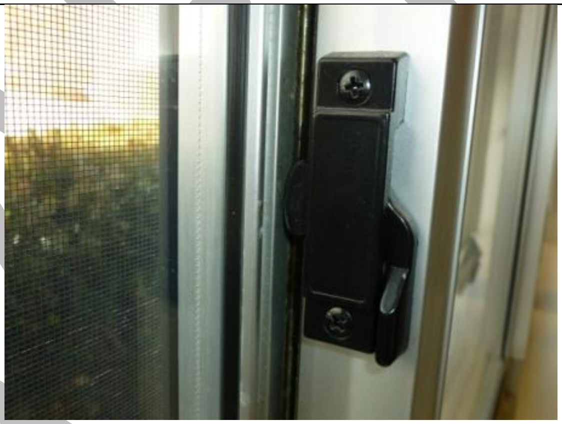
Area	Issue/Recommendation	Photos
Classroom	Exhaust vent in rear corner, dampers or louver is not operating which is providing a direct connection to outside. Adjust louvers, add a damper.	
Classroom	Exhaust vent duct does not make a connection with grill. Air can be pulled from plenum space.	 

Boiler Room	Clearstory windows provide daylight not appreciated in this space. Insulate and air seal over windows.	 
Boiler Room	Lots of air movement in this space. Air seal various penetrations.	

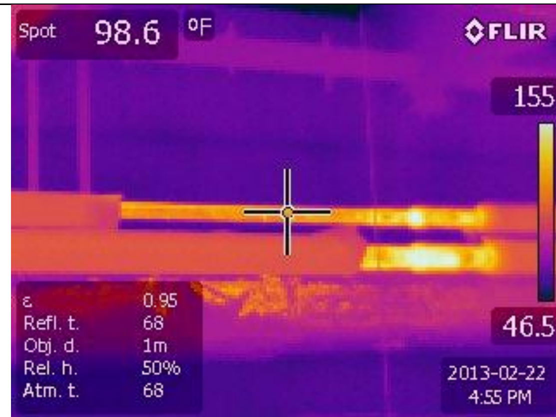
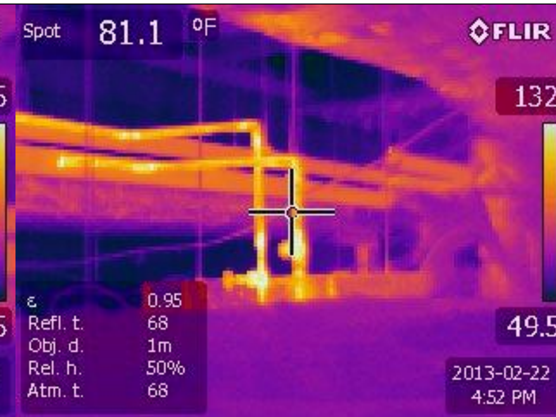
Sheetrock at Ext. Wall	Sheetrock is offset from the wall approx.. 1", air movement in space. Air seal.	 
Original Ceiling Line	Original finish ceiling is offset from tile/block exterior wall. Wood molding is present with an air space. Air movement observed between tile and wood molding.	

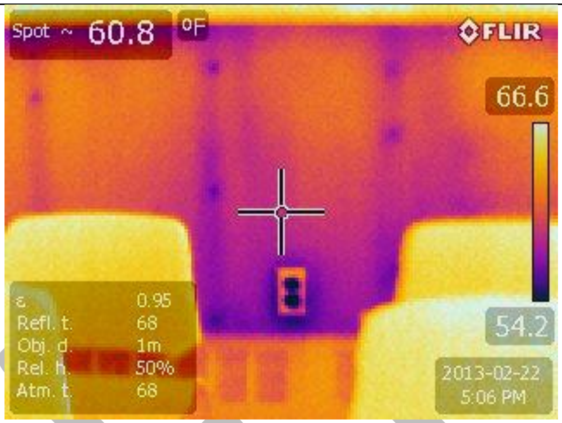
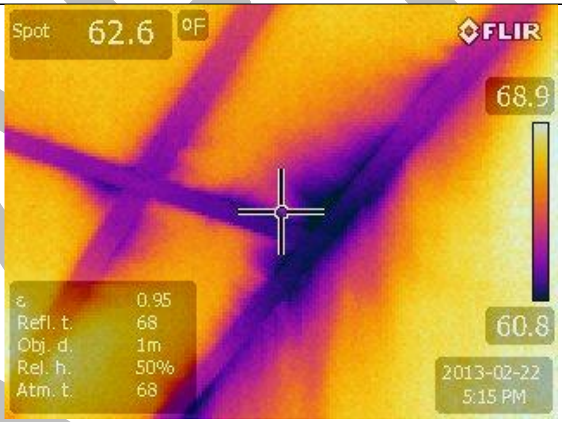
Above Drop Ceiling	There is not a consistent thermal barrier. There are 3 ½ fiberglass batts, however, coverage is not complete. A thermal barrier should be created along with an air barrier. These should be continuous.	
Duct Work Penetrations	Air seal around metal duct penetration.	

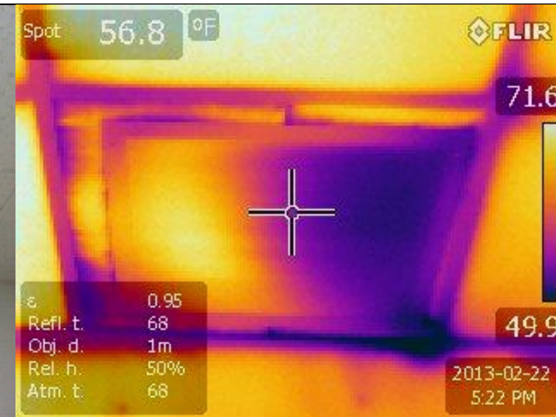
Existing Conditions	Clean ducts and replace filters regularly.	
Plenum Vents at Ext. Wall	Seal vents.	 

Plenum Vents at Ext. Wall	Seal vents.	 
Windows	Window cannot be locked and is leaking air.	

Ext. Doors	Needs to be weather-stripped.	 
Existing Conditions	Previous ceiling level and lighting.	

Hot Water Piping	Improperly insulated piping. Add/replace insulation.	 
		

Classroom	Thermal bridging and air movement within the walls. Air seal.	
Drop Ceiling	Lack of air barrier at ceiling line/thermal line Cold air from the attic washing down the wall and through the drop ceiling.	

Investigate Louver	Grill is partially cold and partially warm. Ductwork may only connect with half of the grill. May be pulling cold air down from attic.	 

APPENDIX E: Rooftop Unit Proposal

PROPOSAL

Michael F. Flatley CEM, LEED AP, CPMP
Senior Building Systems Consultant
Steven Winter Associates Inc
307 Seventh Avenue, Suite 1701
New York, NY 10001

March 15, 2013

Project: Turnkey Pricing for Town of Bedford Police Department

Dear Michael:

On behalf of Johnson Controls, I am pleased to present this turnkey proposal to provide new rooftop units for the Town of Bedford Police Department in Bedford, NY as follows:

Scope of Work – JCI

1. Furnish three (3) new York J03ZFE10P2BAA2 Packaged Roof Top Units with Electric Heat, SEER 13.0, EER 11.0. Please see attached specifications for more detailed information.
2. Furnish three (2) new York J05ZFE10P2BAA2 Packaged Roof Top Units with Electric Heat, SEER 13.0, EER 10.8 EER. Please see attached specifications for more detailed information.
3. Recover refrigerant from existing Roof Top Units
4. Remove and dispose of existing roof top units
5. Crane and rig new equipment curbs and roof top units in place
6. Tie in existing power feeds to new units
7. Supply and install new thermostats for each unit
8. Supply and install new condensate traps and drain lines for each unit
9. Startup and test systems to ensure proper operation
10. Provide 12 month warranty on equipment, material and labor.

Scope of Work – Town of Bedford

1. Provide unobstructed access to work site.
2. Provide safety, security, traffic and pedestrian coordination as may be needed during rigging activities.

Exclusions

1. Premium time is excluded from this proposal.
2. Balancing of equipment is excluded from this proposal
3. All parts, labor, material, additional work or additional repairs not specifically noted herein.
4. Permits are excluded from this proposal.

Notes:

1. All work to be performed on weekdays, 8:00 AM to 5:00 PM, excluding holidays.
2. Price is valid for 60 days from date of proposal and excludes sales tax, if any.
3. Payment Terms are Net 30 Days. See attached General Terms & Conditions.

Price: **$58,660.00** with Economizer option
$55,431.00 without Economizer option

Thank you for the opportunity to present our proposal. Please feel free to contact me at 914-523-9587 if you have any questions. Thank you for considering Johnson Controls.

Sincerely,

Dean J. Angeledes
HVAC Services
Johnson Controls, Inc.
8 Skyline Drive
Hawthorne, NY 10532
Tel. (914) 325-2789
Fax. (914) 593-5262
dean.j.angeledes@jci.com

____
Customer Signature

____
Customer Name (printed)

____
Purchase Order #

____
Date

TERMS AND CONDITIONS

By accepting this proposal, Purchaser agrees to be bound by the following Terms and Conditions:

1. SCOPE OF WORK: Plastering, patching, and painting are excluded. Purchaser agrees to provide Johnson with required field utilities (electricity, toilers, drinking water, project hoist, elevator service, etc.) without charge. Johnson agrees to keep the job site clean of debris arising out of its own operations. Purchaser shall not back charge Johnson for any costs or expenses without Johnson's written consent. Unless specifically noted in the statement of the scope of work or services undertaken by JCI under this agreement, JCI's obligations under this agreement expressly exclude any work of service of any nature associated or connected with the identification, abatement, clean up, control, removal, or disposal of environment Hazards or dangerous substances, to include but not be limited to asbestos of PCB's, discovered in or on the premises. Any language or provision of the agreement elsewhere contained which may authorize or empower the Purchaser to change, modify, or alter the scope of work or services to be performed by JCI shall not operate to compel JCI to perform any work relating to Hazards without JCI's express written consent. This proposal expires 60 days after proposal date.

2. PAYMENT TERMs: Upon acceptance of this proposal, an invoice for payment in the amount of 10% of the contract price will be issued for engineering and mobilization. When engineering is complete and the material is shipped, an invoice for payment in the amount of 50% of the contract price will be issued. When the installation is substantially complete you will receive an invoice for payment in the amount of 30% of the contract price. Upon completion of punch-list you will receive an invoice for payment in the amount of 10%. Waivers of lien will be furnished upon request, as work progresses; to the extent payments are received. Payment Terms are Net 30 Days. If Johnson's invoice is not paid within 30 days of its issuance, it is delinquent.

3. MATERIALS: If the materials or equipment included in this proposal become temporally or permanently unavailable for reasons beyond the control and without the fault of Johnson, then in the case of such temporary unavailability, the time for performance of the work shall be extended to the extent thereof, and in the case of permanent unavailability, Johnson shall (a) be excused from furnishing said materials or equipment, and (b) be reimbursed for the difference between the cost of the materials of equipment permanently unavailable and the cost of a reasonably available substitute therefore.

4. WARRANTY: Johnson warrants that the equipment manufactured by it shall be free from defects in material and workmanship arising from normal usage for a period of one (1) year from delivery of said equipment, or if installed by Johnson, for a period of one (1) year from installation. Johnson warrants that for equipment furnished and/or installed but not manufactured by Johnson, Johnson will extend the same warranty terms and conditions which Johnson receives from the manufacturer of said equipment. For equipment installed by Johnson, if Purchaser provides written notice to Johnson of any such defect within thirty (30) days after the appearance of discovery of such defect, Johnson shall, at its option, repair or replace the defective equipment. For equipment not installed by Johnson, if purchaser returns the defective equipment to Johnson within thirty (30) days after appearance of discovery of such defect, Johnson shall, at its option, repair or replace the defective equipment and return said equipment to Purchaser. All transportation charges incurred in connection with the warranty for equipment not installed by Johnson shall be borne by Purchaser. These warranties do not extend to any equipment which has been repaired by others, abused, altered or misused, or which has not been properly and reasonably maintained. THESE WARRANTIES ARE IN LIEU of ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THOSE OF MERCHANTABILITY AND FITNESS FOR A SPECIFIC PURPOSE.

5. LIABILITY: Johnson shall not be liable for any special, indirect or consequential damages arising in any manner from the equipment or material furnished or the work performed pursuant to this agreement.

6. TAXES: The price of this proposal does not include duties, sales, use, excise, or other similar taxes, unless required by federal, state or local law. Purchaser shall pay, in addition to the stated price; all taxes not legally required to be paid by Johnson or, alternatively, shall provide Johnson with acceptable tax exemption certificates. Johnson shall provide Purchaser with any tax payment certificate upon request and after completion and acceptance of the work.

7. DELAYS: Johnson shall not be liable for any delay in the performance of the work resulting from or attributed to acts or circumstances beyond Johnson's control, including, but not limited to, acts of God, fire, riots, labor disputes, conditions of the premises, acts or omissions of the Purchaser, Owner, or other Contractors or delays caused by suppliers or subcontractors of Johnson, etc.

8. COMPLIANCE WITH LAWS: Johnson shall comply with all applicable federal, state and local laws and regulations. Customer shall procure and pay for all licenses and permits required for the prosecution of the work, including professional engineering fees, unless otherwise noted herein.

9. DISPUTES: All disputes involving more than $15,000 shall be resolved by arbitration in accordance with the rules of the American Arbitration Association. The prevailing party shall recover all legal costs and attorney's fees incurred as a result. Nothing here shall limit any rights under construction lien laws.

10. INSURANCE: Insurance coverage in excess of Johnson's standard limits will be furnished when requested and required. No credit will be given or premium paid by Johnson for insurance afforded by others.

Johnson Controls, Inc. *Page 3 of 3*

Series 5 (3-6 Ton)

Johnson Controls

Single Package R-410A Air Conditioner

Page: 1

Project Name: **Town of Bedford** Unit Model #: **J03ZFE10P2BAA2**

Quantity: **3** System: **J03ZFE10P2BAA2**

Cooling Performance		
Total capacity	37.5	MBH
Sensible capacity	27.1	MBH
Refrigerant type	R-410A	
Seasonal Efficiency (at ARI)	13.00	SEER
Efficiency (at ARI)	11.00	EER
Ambient DB temp.	95.0	°F
Entering DB temp.	80.0	°F
Entering WB temp.	67.0	°F
Leaving DB temp.	59.1	°F
Leaving WB temp.	57.1	°F
Power input (w/o blower)	2.79	kW
Sound power	81	dB(A)

Heating Performance		
Entering DB temp.	60	°F
Heating output capacity (Max)	36.1	MBH
Nominal electric heat	10	kW
Applied electric heat	10.6	kW
Installed	Factory	
Supply air	1200	
Leaving DB temp.	87.9	°F
Air temp. rise	27.9	°F
Stages	1	

Supply Air Blower Performance		
Supply air	1200	CFM
Ext. static pressure	0.6	IWG
Unit static resistance	0.03	IWG
Blower speed	895	RPM
Max BHP of Motor (including service factor)	1.73	HP
Duct location	Bottom	
Motor rating	1.50	HP
Actual required BHP	0.60	HP
Power input	0.56	kW
Elevation	0	ft.
Drive type	BELT	

Electrical Data		
Power supply	230-3-60	
Unit min circuit ampacity	38.40	Amps
Unit max over-current protection	40	Amps

Dimensions & Weight					
Hgt	33 in.	Len	83 in.	Wth	45 in.
Weight with factory installed options					551 lbs.

Clearances					
Right	24 in.	Front	24 in.	Back	36 in.
Top	72 in.	Bottom	0 in.	Left	36 in.

Note: Please refer to the tech guide for listed maximum static pressures

3 Ton

- Johnson Controls Units are Manufactured at an ISO 9001 Registered Facility and Each Rooftop is Completely Computer-Run Tested Prior to Shipment.

Unit Features

- Unit Cabinet Constructed of Powder Painted Steel, Certified At 1000 Hours Salt Spray Test (ASTM B-117 Standards)
- Through-the-Curb and Through-The-Base Utility Connections
- Either Supply and/or Return can be Field Converted from Vertical to Horizontal Configuration without Cutting Panels.
- Full Perimeter Base Rails with Built in Rigging Capabilities
- Galvanized Steel Drain Pan
- Reciprocating Compressor
- Single Stage Cooling
- Solid Core Liquid Line Filter Driers
- Microchannel Condenser Coil
- 10 kW Single Stage Factory Installed Electric Heat
- 1.5 HP Standard Static Belt Drive Blower
- Unit Ships with 1" Throwaway Filters with a Standard Filter Rack That Will Accept up to 2" Filters
- Single Point Power Connection
- HACR Circuit Breaker/Disconnect (Sized for 208 Volts)
- Single Enthalpy Economizer and Hood (No Barometric Relief Damper)
- Short Circuit Current: 5kA RMS Symmetrical

Standard Unit Controller: Simplicity® Control Board

- An Integrated Low-Ambient Control, Anti-Short Cycle Protection, Lead-Lag, Fan On and Fan off Delays, Low Voltage Protection, On-Board Diagnostic and Fault Code Display.
- Safety Monitoring - Monitors the High and Low-Pressure Switches, the Freezestats, the Gas Valve, if Applicable, and the Temperature Limit Switch on Gas and Electric Heat Units. The Unit Control Board will Alarm on Ignition Failures, Safety Lockouts and Repeated Limit Switch Trips.

Warranty

- One (1) Year Limited Warranty on the Complete Unit
- Five (5) Year Warranty - Compressors and Electric Heater Elements

Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

Johnson Controls

Series 5 (3-6 Ton)

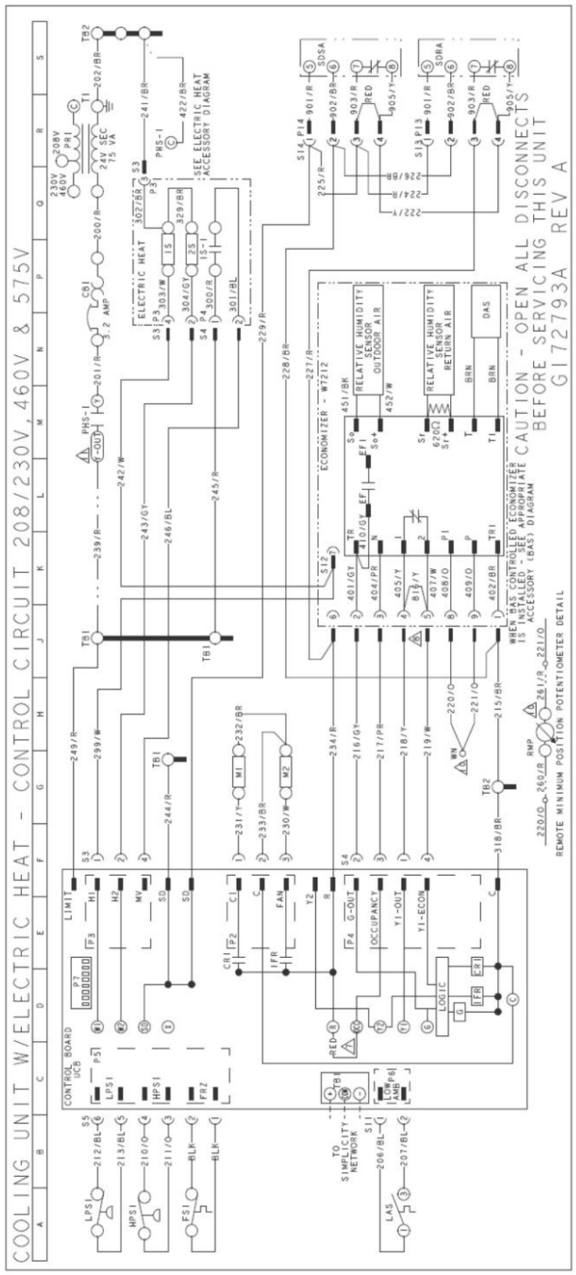
Single Package R-410A Air Conditioner

Page: 2

Project Name: **Town of Bedford**	Unit Model #: **J03ZFE10P2BAA2**
Quantity: **3**	System: **J03ZFE10P2BAA2**

Wiring Diagram 172793

Typical ZF Belt Drive With Electric Heat Control Circuit 208/230V, 460V and 575V Diagram



Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

Johnson Controls

Series 5 (3-6 Ton)

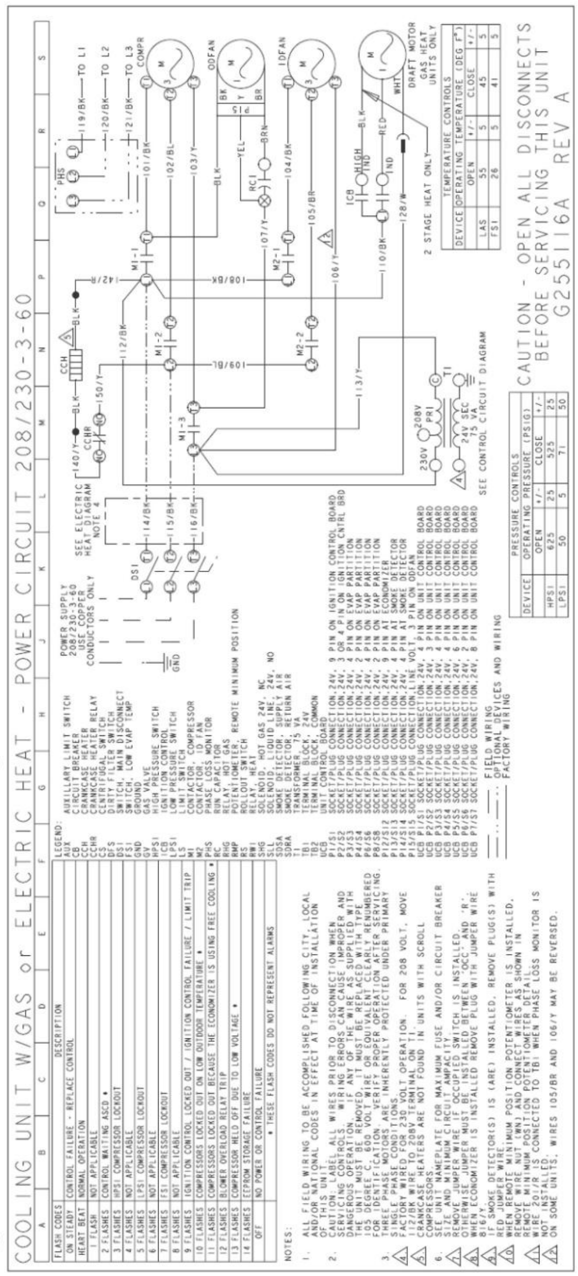
Single Package R-410A Air Conditioner

Page: 3

Project Name: **Town of Bedford**	Unit Model #: **J03ZFE10P2BAA2**
Quantity: **3**	System: **J03ZFE10P2BAA2**

Wiring Diagram 255116

Typical ZF/ZR Belt Drive Power Circuit 208/230-3-60 Diagram



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Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 4

Project Name: **Town of Bedford** Unit Model #: **J03ZFE10P2BAA2**

Quantity: **3** System: **J03ZFE10P2BAA2**

J03ZF Consolidated Drawing

NOTES:
1. FOR OUTDOOR USE ONLY.
2. WEIGHTS SHOWN ARE FOR COOLING ONLY UNITS.
3. MIN. CLEARANCES TO BE:
   - RIGHT SIDE: 24 [609,6]
   - LEFT SIDE: 24 [609,6] (LESS ECONOMIZER); 36 [914,4] (WITH ECONOMIZER)
   - FRONT: 24 [609,6] (COOLING/ELECTRIC HEAT); 32 [812,8] (GAS HEAT)
   - REAR: 12 [304,8] (LESS ECONOMIZER); 36 [914,4] (WITH ECONOMIZER OR FIXED AIR/MOTORIZED DAMPER)
   - TOP: 72 [1828,8]
   - BOTTOM: 0 [0]
4. FOR SMALLER SERVICE AND OPERATIONAL CLEARANCES CONTACT YOUR APPLICATION ENGINEERING DEPARTMENT.
5. DOWNFLOW DUCTS DESIGNED TO BE ATTACHED TO ACCESSORY ROOF CURB ONLY. IF UNIT IS MOUNTED SIDE SUPPLY, IT IS RECOMMENDED THAT THE DUCTS ARE SUPPORTED BY CROSS BRACES, AS DONE ON ACCESSORY ROOF CURBS.
6. SIDE DUCT FLANGES ARE 0.875" [22,2] HIGH. BOTTOM DUCTS DO NOT HAVE FLANGES.
7. MINIMUM CONDENSATION TRAP HEIGHT SHALL BE 1.5 TIMES THE LOWEST NEGATIVE STATIC.
8. DIMENSIONS IN [ ] ARE IN MILLIMETERS OR KILOGRAMS.
9. OPTIONAL COIL GUARD, GAS HEAT, ECONOMIZER HOOD, DISCONNECT SWITCH, CONVENIENCE OUTLET, AND OUTLET/INLET HOOD SHOWN.

⚠10 EXCEPT XP (HEAT PUMP) UNITS.

TONNAGE	UNIT	OPERATING WEIGHT (LBS) (BASE UNIT)	CENTER OF GRAVITY LOCATION (BASE UNIT)		4 POINT CORNER LOADS (LBS) (BASE UNIT)			
			X	Y	A	B	C	D
3	ZF	468 [212]	33 [838,2]	18.25 [463,6]	114 [52]	76 [35]	111 [50]	167 [76]
4	ZF	541 [245]	31.50 [800,1]	18.50 [469,9]	138 [63]	85 [39]	122 [55]	196 [89]
5	ZF	569 [258]	37 [939,8]	15 [381]	105 [48]	86 [39]	170 [77]	208 [94]
6	ZF	640 [290]	37 [939,8]	15 [381]	118 [54]	96 [44]	192 [87]	234 [106]
3	ZR	575 [261]	40 [1016]	20 [508]	132 [60]	125 [57]	155 [70]	164 [74]
4	ZR	585 [265]	40 [1016]	20 [508]	134 [61]	127 [58]	158 [72]	167 [76]
5	ZR	590 [268]	40 [1016]	20 [508]	135 [61]	128 [58]	159 [72]	168 [76]
3	XP	575 [261]	39 [990,6]	20 [508]	135 [61]	121 [55]	151 [69]	168 [76]
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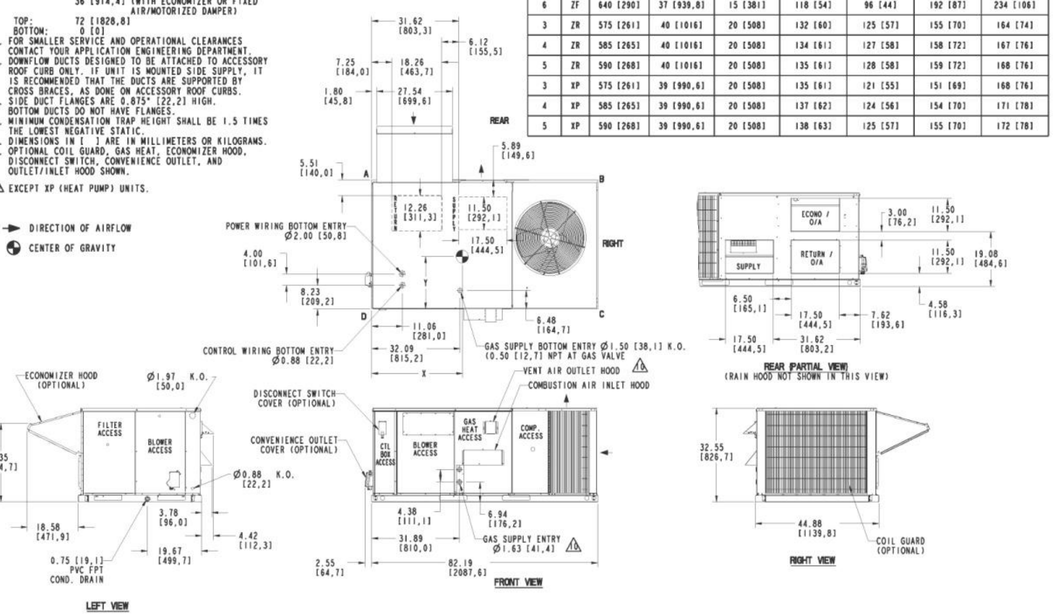


Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

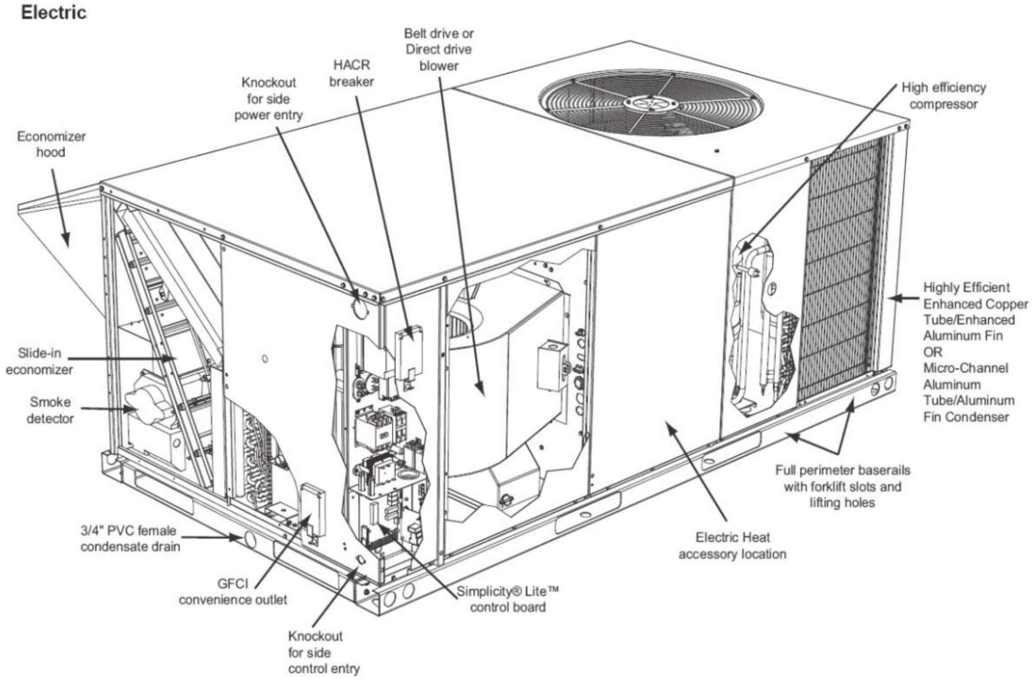
Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 5

Project Name:	Town of Bedford	Unit Model #:	J03ZFE10P2BAA2
Quantity:	3	System:	J03ZFE10P2BAA2

Electric and Heat Pump Typical Component Location



Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

Johnson Controls

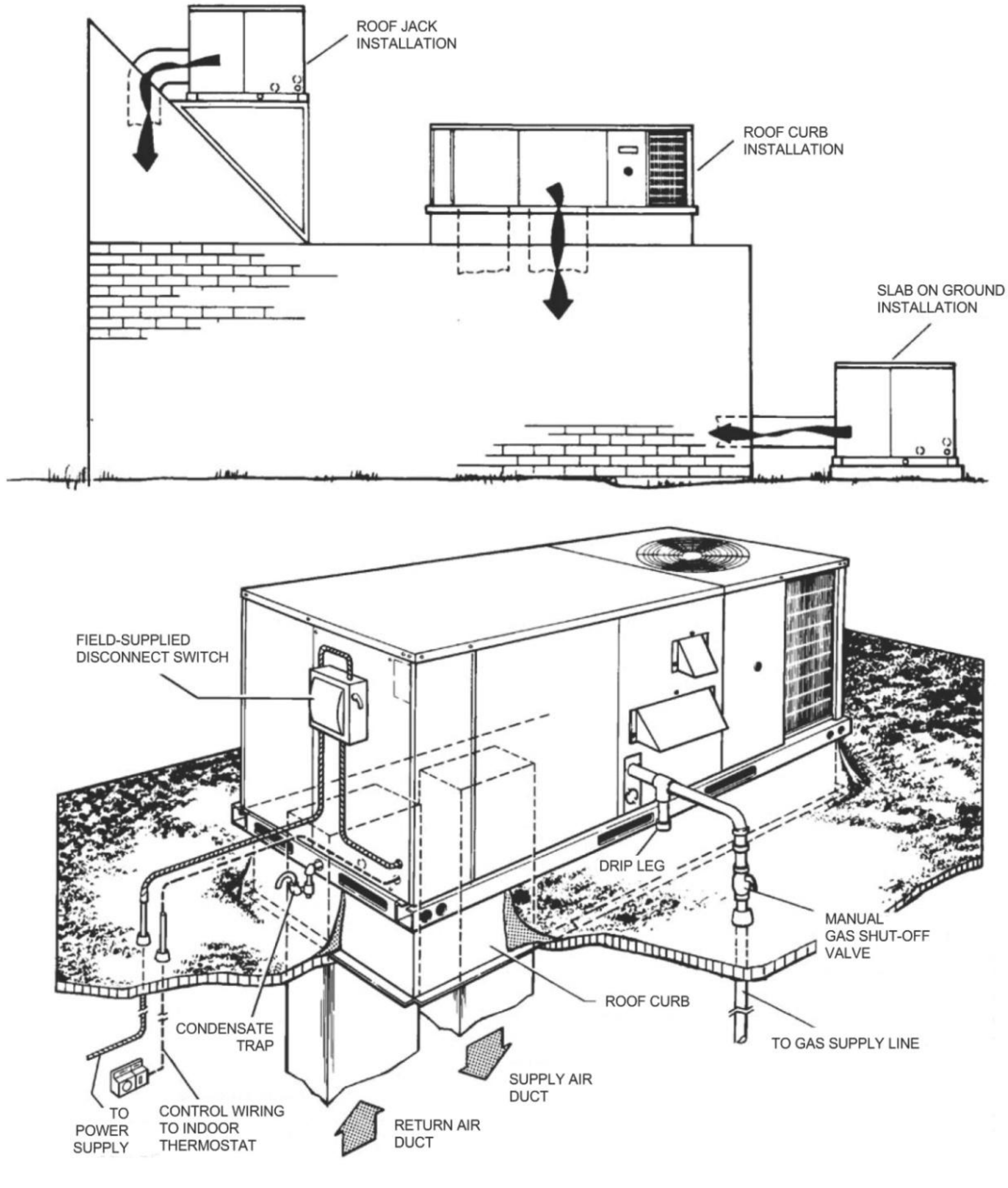
Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 6

Project Name: **Town of Bedford**		Unit Model #:	**J03ZFE10P2BAA2**
Quantity: **3**		System:	**J03ZFE10P2BAA2**

Typical Applications



Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

Johnson Controls

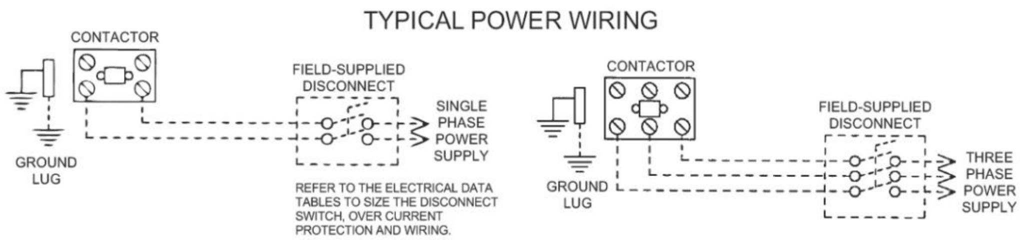
Series 5 (3-6 Ton)

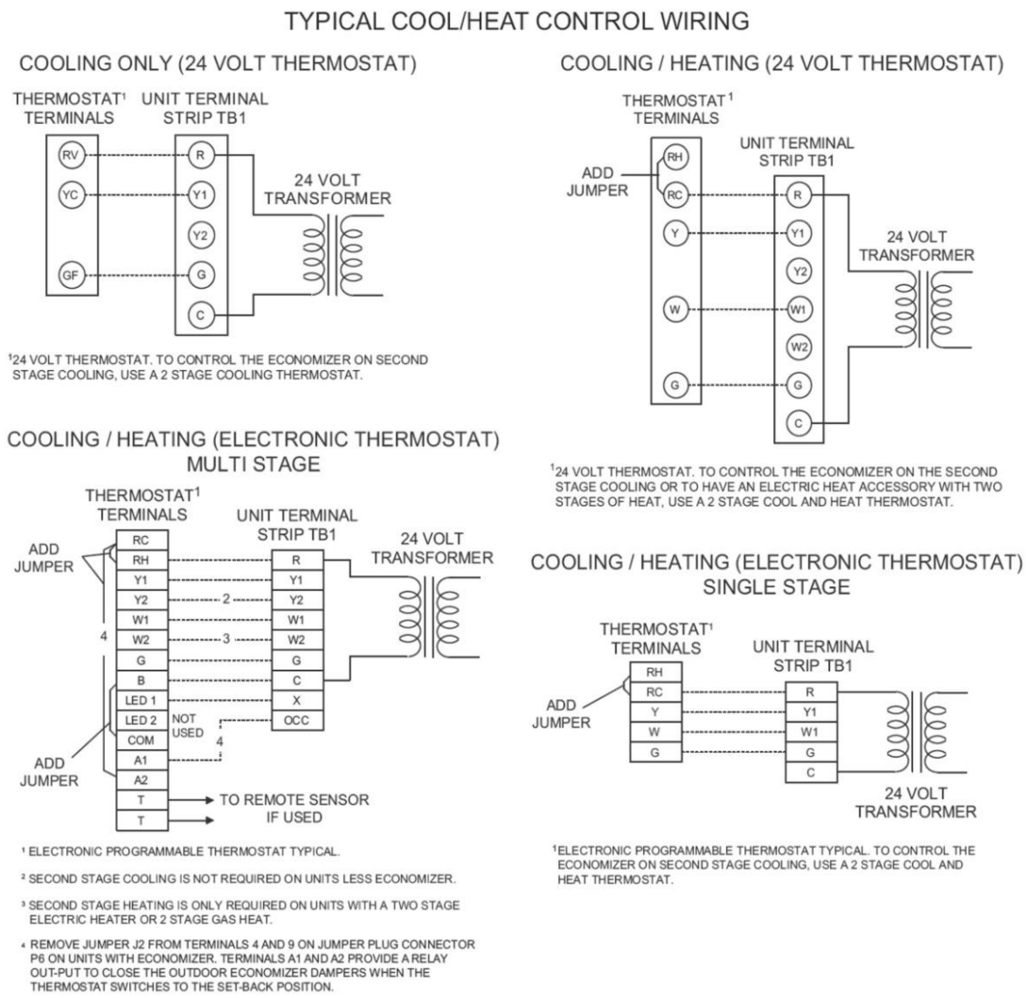
Single Package R-410A Air Conditioner

Page: 7

Project Name: **Town of Bedford**	Unit Model #: **J03ZFE10P2BAA2**
Quantity: **3**	System: **J03ZFE10P2BAA2**

Typical Field Power and Control Wiring





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Johnson Controls

Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 8

Project Name: **Town of Bedford** Unit Model #: **J05ZFE10P2BAA2**

Quantity: **2** System: **J05ZFE10P2BAA2**

Cooling Performance

Total capacity	59.8	MBH
Sensible capacity	45.3	MBH
Refrigerant type	R-410A	
Seasonal Efficiency (at ARI)	13.00	SEER
Efficiency (at ARI)	10.80	EER
Ambient DB temp.	95.0	°F
Entering DB temp.	80.0	°F
Entering WB temp.	67.0	°F
Leaving DB temp.	59.0	°F
Leaving WB temp.	57.6	°F
Power input (w/o blower)	4.54	kW
Sound power	82	dB(A)

Heating Performance

Entering DB temp.	60	°F
Heating output capacity (Max)	36.1	MBH
Nominal electric heat	10	kW
Applied electric heat	10.6	kW
Installed	Factory	
Supply air	2000	
Leaving DB temp.	76.7	°F
Air temp. rise	16.7	°F
Stages	1	

Supply Air Blower Performance

Supply air	2000	CFM
Ext. static pressure	0.6	IWG
Unit static resistance	0.07	IWG
Blower speed	1117	RPM
Max BHP of Motor (including service factor)	1.73	HP
Duct location	Bottom	
Motor rating	1.50	HP
Actual required BHP	1.17	HP
Power input	1.09	kW
Elevation	0	ft.
Drive type	BELT	

Electrical Data

Power supply	230-3-60	
Unit min circuit ampacity	38.40	Amps
Unit max over-current protection	40	Amps

Dimensions & Weight

Hgt	33 in.	Len	83 in.	Wth	45 in.
Weight with factory installed options					652 lbs.

Clearances

Right	24 in.	Front	24 in.	Back	36 in.
Top	72 in.	Bottom	0 in.	Left	36 in.

Note: Please refer to the tech guide for listed maximum static pressures

5 Ton

- Johnson Controls Units are Manufactured at an ISO 9001 Registered Facility and Each Rooftop is Completely Computer-Run Tested Prior to Shipment.

Unit Features

- Unit Cabinet Constructed of Powder Painted Steel, Certified At 1000 Hours Salt Spray Test (ASTM B-117 Standards)
- Through-the-Curb and Through-The-Base Utility Connections
- Either Supply and/or Return can be Field Converted from Vertical to Horizontal Configuration without Cutting Panels.
- Full Perimeter Base Rails with Built in Rigging Capabilities
- Galvanized Steel Drain Pan
- Reciprocating Compressor
- Single Stage Cooling
- Solid Core Liquid Line Filter Driers
- Microchannel Condenser Coil
- 10 kW Single Stage Factory Installed Electric Heat
- 1.5 HP Standard Static Belt Drive Blower
- Unit Ships with 1" Throwaway Filters with a Standard Filter Rack That Will Accept up to 2" Filters
- Single Point Power Connection
- HACR Circuit Breaker/Disconnect (Sized for 208 Volts)
- Single Enthalpy Economizer and Hood (No Barometric Relief Damper)
- Short Circuit Current: 5kA RMS Symmetrical

Standard Unit Controller: Simplicity® Control Board

- An Integrated Low-Ambient Control, Anti-Short Cycle Protection, Lead-Lag, Fan On and Fan off Delays, Low Voltage Protection, On-Board Diagnostic and Fault Code Display.
- Safety Monitoring - Monitors the High and Low-Pressure Switches, the Freezestats, the Gas Valve, if Applicable, and the Temperature Limit Switch on Gas and Electric Heat Units. The Unit Control Board will Alarm on Ignition Failures, Safety Lockouts and Repeated Limit Switch Trips.

Warranty

- One (1) Year Limited Warranty on the Complete Unit
- Five (5) Year Warranty - Compressors and Electric Heater Elements

Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

Johnson Controls

Series 5 (3-6 Ton)

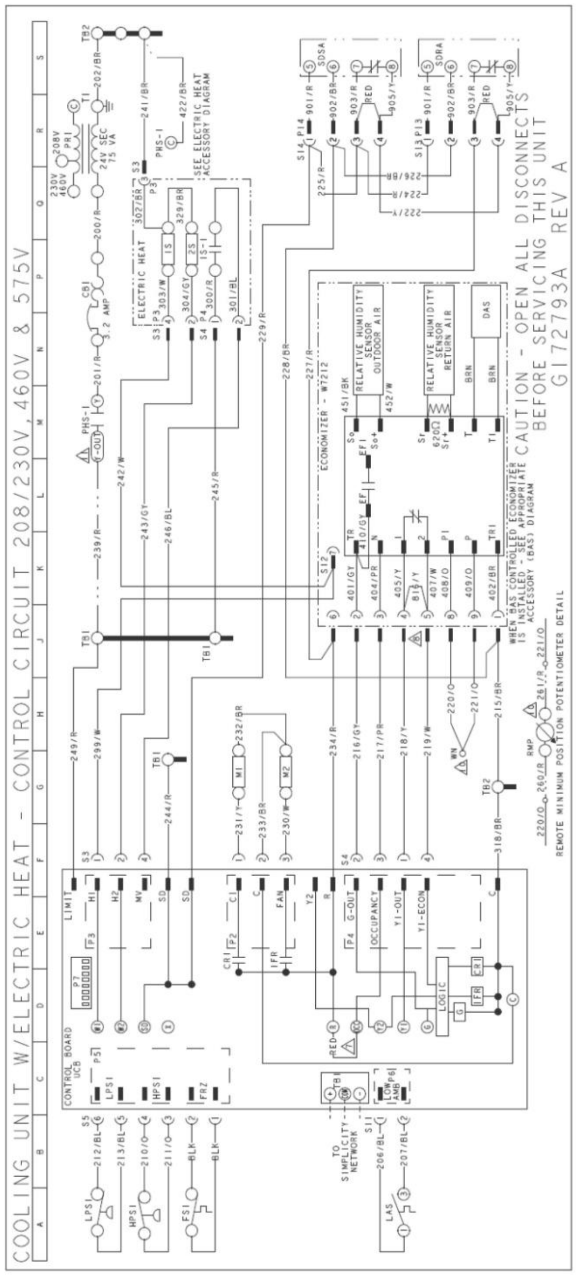
Single Package R-410A Air Conditioner

Page: 9

Project Name: **Town of Bedford**		Unit Model #:	**J05ZFE10P2BAA2**
Quantity: **2**		System:	**J05ZFE10P2BAA2**

Wiring Diagram 172793

Typical ZF Belt Drive With Electric Heat Control Circuit 208/230V, 460V and 575V Diagram



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Johnson Controls

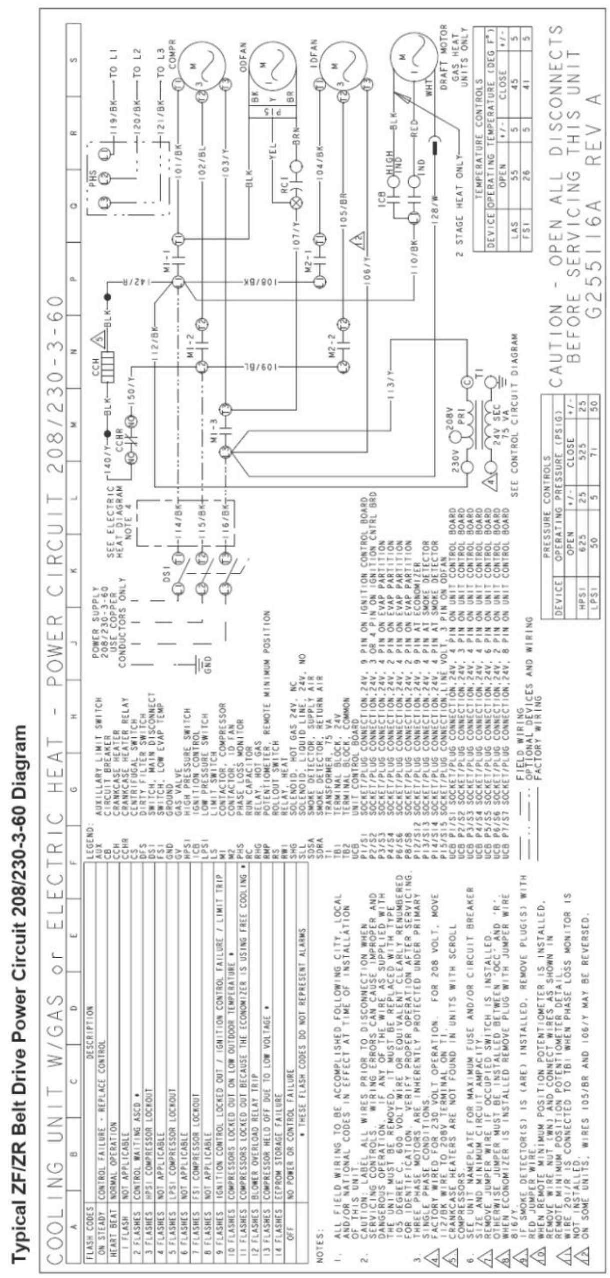
Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 10

Project Name: **Town of Bedford**		Unit Model #:	**J05ZFE10P2BAA2**
Quantity: **2**		System:	**J05ZFE10P2BAA2**

Wiring Diagram 255116



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Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 11

Project Name: **Town of Bedford** Unit Model #: **J05ZFE10P2BAA2**

Quantity: **2** System: **J05ZFE10P2BAA2**

J05ZF Consolidated Drawing

NOTES:
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   - LEFT SIDE: 24 [609,6] (LESS ECONOMIZER); 36 [914,4] (WITH ECONOMIZER)
   - FRONT: 24 [609,6] (COOLING/ELECTRIC HEAT); 32 [812,8] (GAS HEAT)
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⚠10 EXCEPT XP (HEAT PUMP) UNITS.

DIRECTION OF AIRFLOW

CENTER OF GRAVITY

TONNAGE	UNIT	OPERATING WEIGHT (LBS) (BASE UNIT)	CENTER OF GRAVITY LOCATION (BASE UNIT)		4 POINT CORNER LOADS (LBS) (BASE UNIT)			
			X	Y	A	B	C	D
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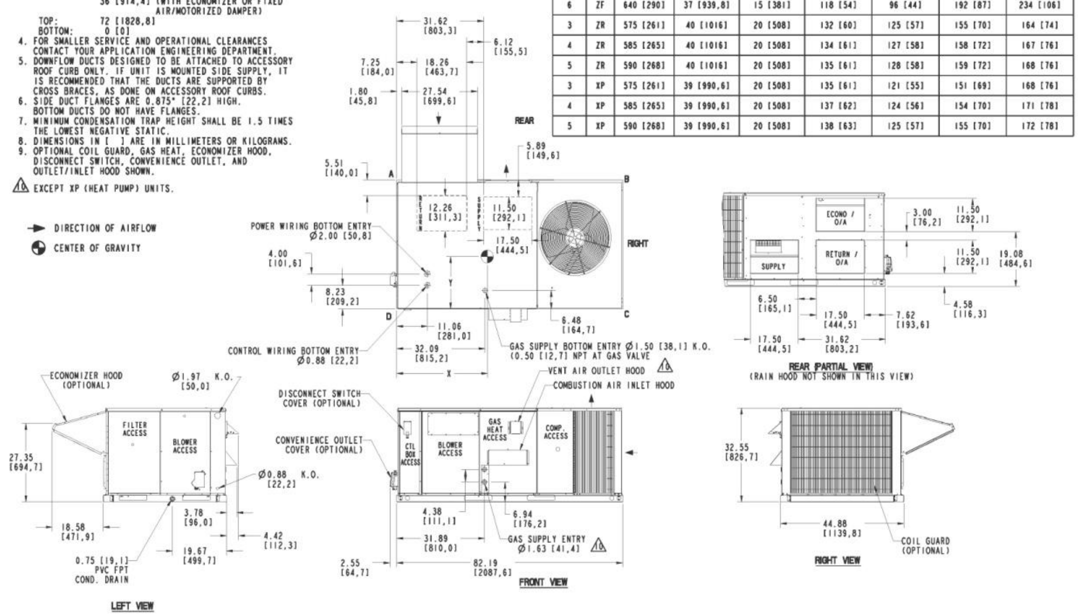

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Johnson Controls

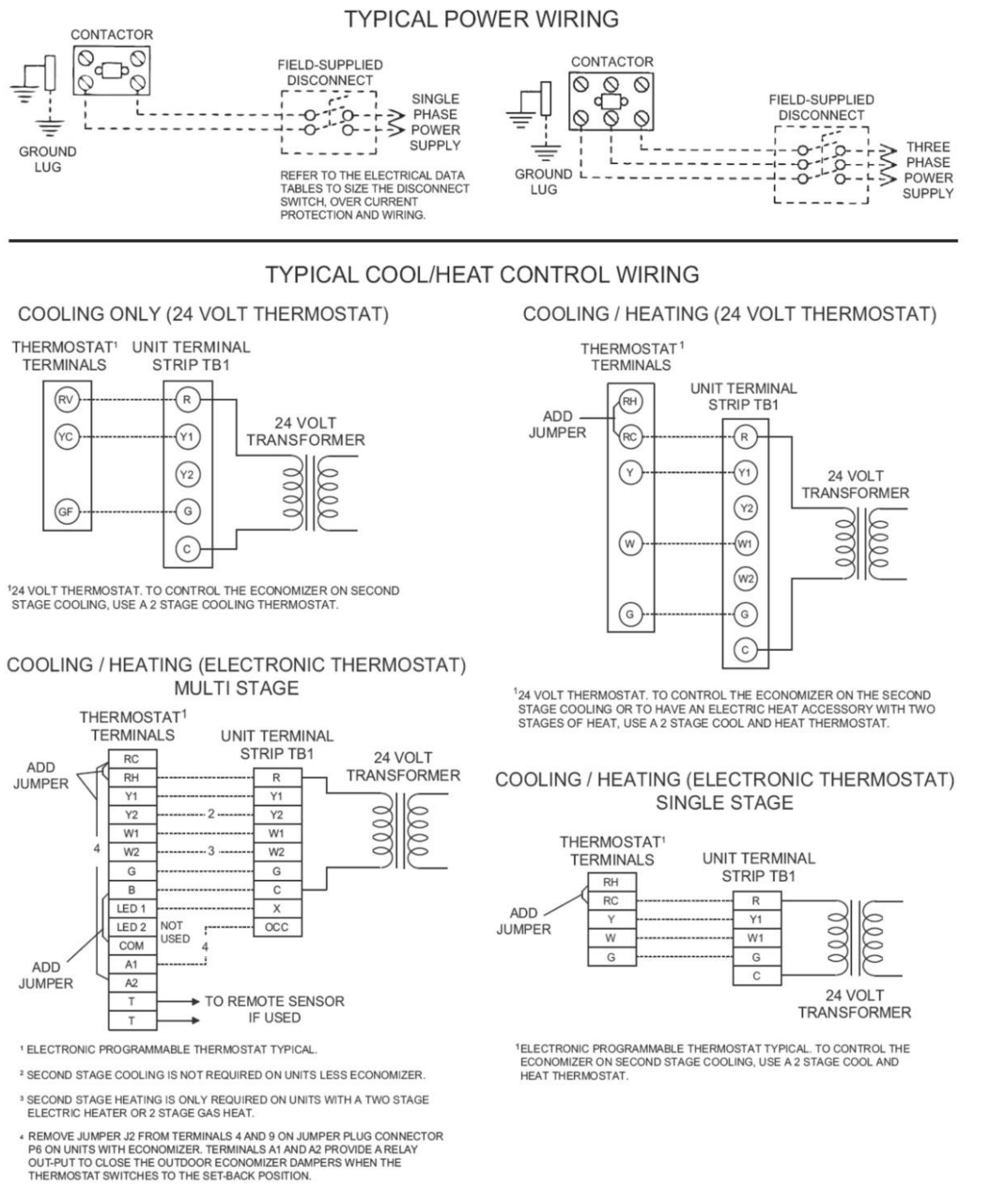
Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 12

Project Name:	**Town of Bedford**	Unit Model #:	**J05ZFE10P2BAA2**
Quantity:	**2**	System:	**J05ZFE10P2BAA2**

Typical Field Power and Control Wiring



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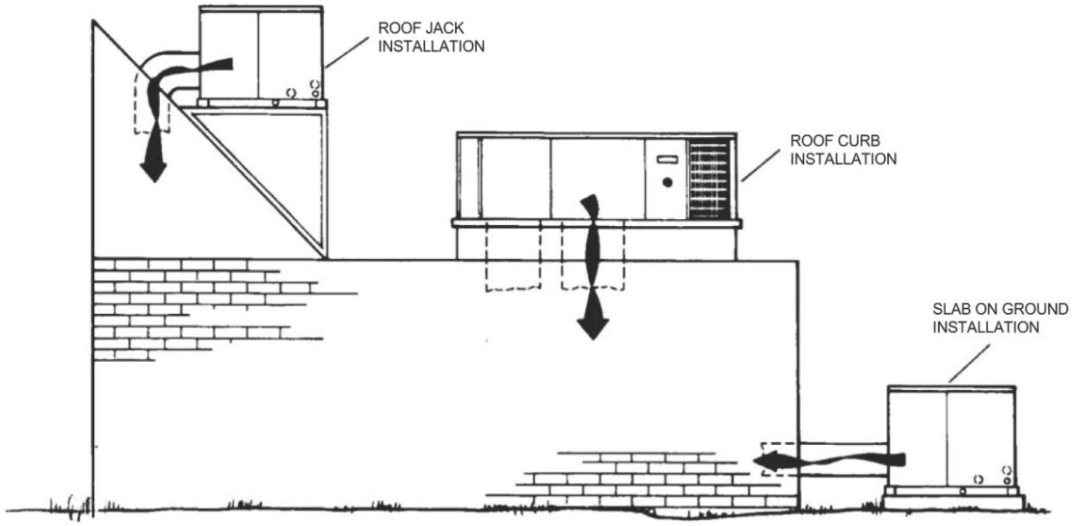
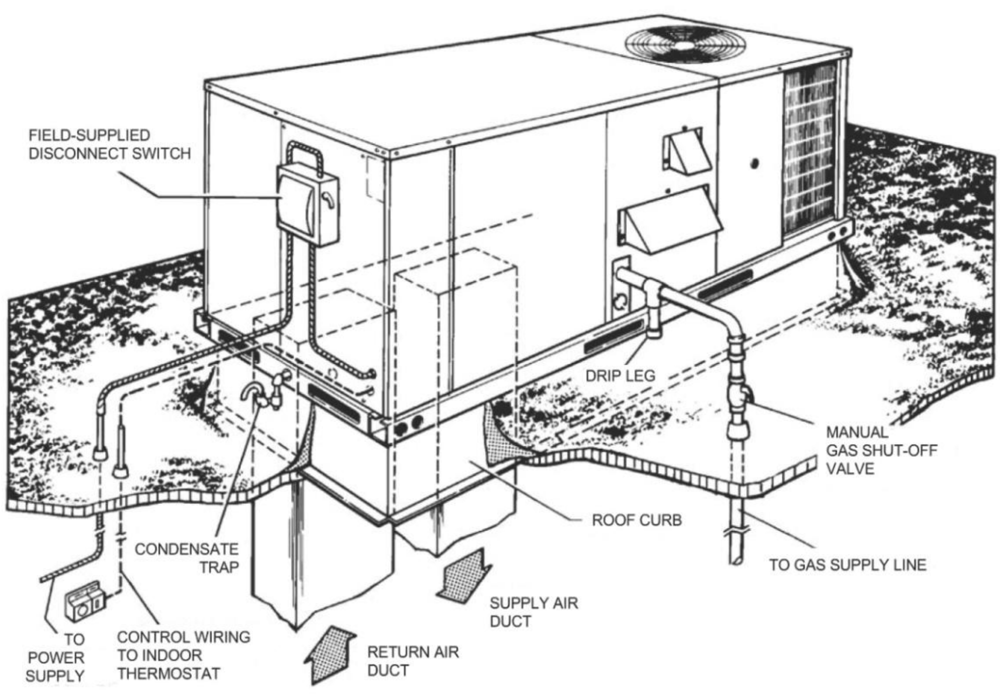
Johnson Controls	**Series 5 (3-6 Ton)** Single Package R-410A Air Conditioner	Page: 13
Project Name: **Town of Bedford**		Unit Model #: **J05ZFE10P2BAA2**
Quantity: **2**		System: **J05ZFE10P2BAA2**

Typical Applications





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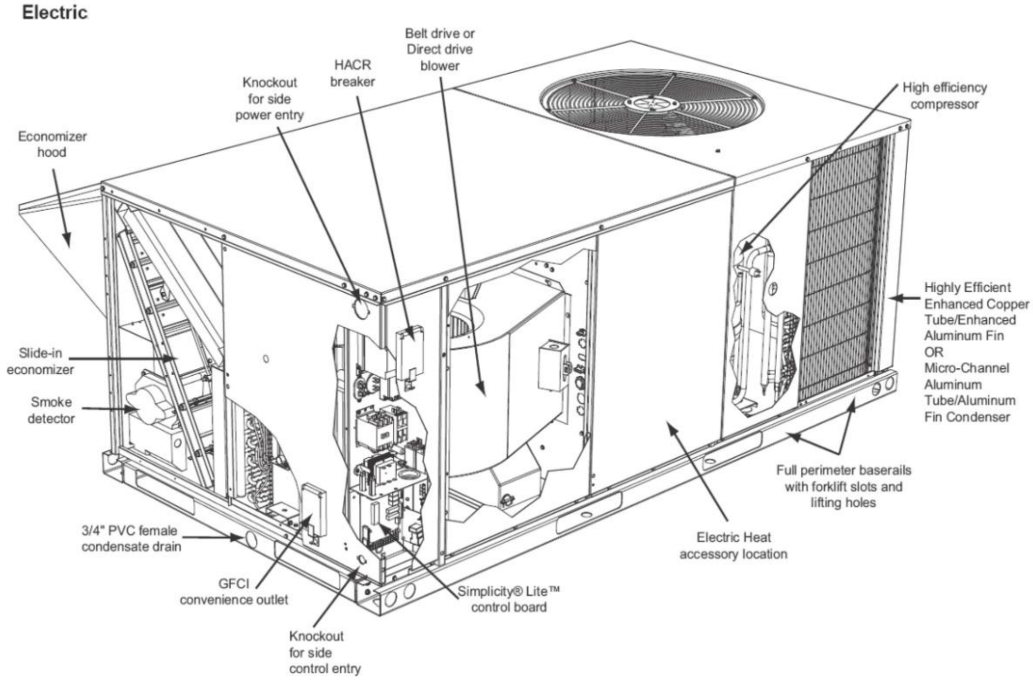
Series 5 (3-6 Ton)

Single Package R-410A Air Conditioner

Page: 14

Project Name: **Town of Bedford**		Unit Model #:	**J05ZFE10P2BAA2**
Quantity: **2**		System:	**J05ZFE10P2BAA2**

Electric and Heat Pump Typical Component Location



Unitary Sales Tool v1.5.6.0 Information is subject to change without notice. Check local codes. Printed 03/15/2013

APPENDIX F: PV System Cost – NREL SAM Report

System Advisor Model Report

Photovoltaic System	27 DC kW Nameplate	NEW_YORK_CITY, NY
Commercial	$4.59/W Installed Cost	40.78 N, -73.97 E GMT -5

Performance Model

PV System Specifications	
DC rating	27 kW
DC to AC derate factor	0.77
AC rating	20.8 kW
Array type	fixed
Array tilt	33 degrees
Array azimuth	180 degrees
Shading	no

Performance Adjustment	
Annual	none
Year-to-year decline	0.5%/yr
Hourly factors	no

Results	Solar Radiation	AC Energy
	(kWh/m2/day)	(kWh)
Jan	3	2,006
Feb	4.02	2,411
Mar	4.55	2,904
Apr	5.35	3,208
May	5.51	3,330
Jun	6.06	3,443
Jul	5.89	3,398
Aug	5.66	3,299
Sep	5.08	2,923
Oct	4.37	2,697
Nov	2.79	1,708
Dec	2.69	1,757
Year	4.58	33,090

Financial Model

Project Costs	
Total installed cost	$123,849
Salvage value	$0

Analysis Parameters	
Project life	25 years
Inflation rate	2.5%
Real discount rate	5.2%

Project Debt Parameters	
Debt fraction	100%
Amount	$123,849
Term	25 years
Rate	7.5%

Tax and Insurance Rates	(% of installed cost)
Federal income tax	28%/year
State income tax	7%/year
Sales tax	5%
Insurance	0.5%/year
Property tax (% of assess. val.)	2%/year

Incentives	
Federal ITC	30%
Federal Depreciation	None
State Depreciation	None

Electricity Demand and Rate Summary

System delivers power directly to grid (no building load)

Flat rate (buy = sell) $0.09/kWh

Results	
Nominal LCOE	25.6 cents/kWh
Net present value	$-62,300
Payback period	> 25 years

Commercial | PVWatts System Model

System Advisor Model Standard Report SAM 2013.1.15 Mon Mar 18 13:04:37 2013 Page 1 of 3

APPENDIX G: PV System Savings – Solar Pathfinder Report

Site Report

Report Name	Town of Bedford - Police Dept
Report Date	3/11/2013 4:40:49 PM
Declination	0d 00m
Location	BEDFORD HILLS, NY 10507
Lat/Long	41.229 / -73.698
Weather Station	White Plains-Westchester Count, NY, Elevation: 400 Feet, (41.067/-73.7
Site distance	11 Miles
Report Type	PV
Array Type	Fixed
Tilt Angle	41.23 deg
Ideal Tilt Angle	41.23 deg
Azimuth	180.00 deg
Ideal Azimuth	180.00 deg
Electric Cost	0.09 ($/KWH)
Panel Make	<not specified>
Panel Model	<not specified>
Panel Count	2
DC Rate (per panel)	13,475.0 W
Total System Size	26,950.0 W
Inverter Make	<not specified>
Inverter Model	<not specified>
Inverter Count	1
Derate Method	System Setting
Derate Factor	0.770
Layout Configuration	SinglePicture
Layout Point Count	1

Notes: [None]

Report generated by SolarPathfinder Assistant Version 4.1.27.0. http://www.solarpathfinder.com

Page: 1/4

System Picture Layout

Layout Type Single Picture
Layout Point Count 1

Report generated by SolarPathfinder Assistant Version 4.1.27.0. http://www.solarpathfinder.com
Page: 2/4

Solar Site Analysis Report

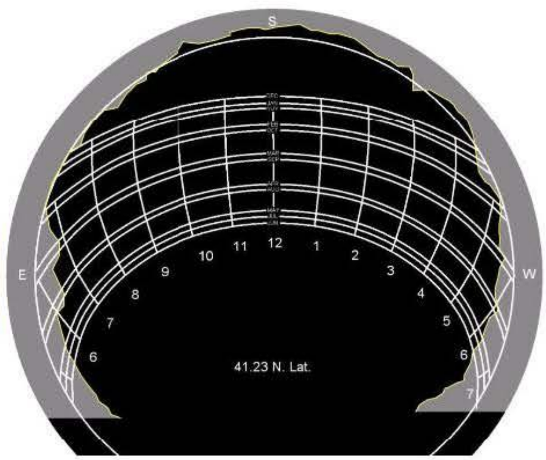
1

Image File IMG_6136.jpg

Solar Obstruction Data

Month	Unshaded % of Ideal Site Azimuth=180 Tilt=41.23	Actual Solar Rad w/ Shading Azimuth=180.0 Tilt=41.23 KWH/m^2/day	Actual AC Energy (KWH) w/ shading Azimuth=180.00 Tilt=41.23	Actual AC Energy (KWH) w/o shading Azimuth=180.0 Tilt=41.23	Ideal AC Energy (KWH) w/o shading Azimuth=180.0 Tilt=41.23	Solar Cost Savings 0.09 ($/KWH)	PVWatts Unshaded % Actual Site Azimuth=180.0 Tilt=41.23	Actual Site Efficiency % Azimuth=180.0 Tilt=41.23	Ideal Site Efficiency % Azimuth=180.0 Tilt=41.23
January	100.00%	3.66	2,460.00	2,460.00	2,460.00	$221.40	99.92 %	99.92 %	99.92 %
February	100.00%	5.55	3,350.00	3,350.00	3,350.00	$301.50	99.91 %	99.91 %	99.91 %
March	99.73%	5.17	3,250.60	3,252.00	3,252.00	$292.55	99.62 %	99.62 %	99.62 %
April	99.16%	4.27	2,504.50	2,509.00	2,509.00	$225.40	98.96 %	98.96 %	98.96 %
May	99.20%	4.83	2,907.00	2,907.00	2,907.00	$261.63	99.16 %	99.16 %	99.16 %
June	99.12%	4.40	2,454.28	2,456.00	2,456.00	$220.89	99.11 %	99.11 %	99.11 %
July	99.13%	4.42	2,504.00	2,504.00	2,504.00	$225.36	99.23 %	99.01 %	99.01 %
August	98.82%	4.52	2,629.08	2,633.00	2,633.00	$236.62	98.78 %	98.78 %	98.78 %
September	98.62%	4.07	2,289.64	2,300.00	2,300.00	$206.07	98.37 %	98.37 %	98.37 %
October	100.00%	4.53	2,786.00	2,787.00	2,787.00	$250.74	99.93 %	99.71 %	99.71 %
November	100.00%	3.55	2,184.00	2,184.00	2,184.00	$196.56	99.93 %	99.93 %	99.93 %
December	100.00%	3.46	2,313.00	2,313.00	2,313.00	$208.17	99.95 %	99.95 %	99.95 %
Totals	**99.48%**	**52.41**	**31,632.09**	**31,655.00**	**31,655.00**	**$2,846.89**	**99.41 %**	**99.37 %**	**99.37 %**
	Unweighted Yearly Avg	**Effect: 99.39% Sun Hrs: 4.37**					**Unweighted Yearly Avg**	**Unweighted Yearly Avg**	**Unweighted Yearly Avg**

Notes: [None]



Report generated by SolarPathfinder Assistant Version 4.1.27.0. http://www.solarpathfinder.com
Page: 3/4

Summary Report

Solar Obstruction Data

Month	Unshaded % of Ideal Site Azimuth=180 Tilt=41.23	Actual Solar Rad w/ Shading Azimuth=180.0 Tilt=41.23 KWH/m^2 /day	Actual AC Energy (KWH) w/ shading Azimuth=180.00 Tilt=41.23	Actual AC Energy (KWH) w/o shading Azimuth=180.0 Tilt=41.23	Ideal AC Energy (KWH) w/o shading Azimuth=180.0 Tilt=41.23	Solar Cost Savings 0.09 ($/KWH)	PVWatts Unshaded % Actual Site Azimuth=180.0 Tilt=41.23	Actual Site Efficiency % Azimuth=180.0 Tilt=41.23	Ideal Site Efficiency % Azimuth=180.0 Tilt=41.23
January	100.00%	3.66	2,460.00	2,460.00	2,460.00	$221.40	99.92 %	99.92 %	99.92 %
February	100.00%	5.55	3,350.00	3,350.00	3,350.00	$301.50	99.91 %	99.91 %	99.91 %
March	99.73%	5.17	3,250.60	3,252.00	3,252.00	$292.55	99.62 %	99.62 %	99.62 %
April	99.16%	4.27	2,504.50	2,509.00	2,509.00	$225.40	98.96 %	98.96 %	98.96 %
May	99.20%	4.83	2,907.00	2,907.00	2,907.00	$261.63	99.16 %	99.16 %	99.16 %
June	99.12%	4.40	2,454.28	2,456.00	2,456.00	$220.89	99.11 %	99.11 %	99.11 %
July	99.13%	4.42	2,504.00	2,504.00	2,504.00	$225.36	99.23 %	99.01 %	99.01 %
August	98.82%	4.52	2,629.08	2,633.00	2,633.00	$236.62	98.78 %	98.78 %	98.78 %
September	98.62%	4.07	2,289.64	2,300.00	2,300.00	$206.07	98.37 %	98.37 %	98.37 %
October	100.00%	4.53	2,786.00	2,787.00	2,787.00	$250.74	99.93 %	99.71 %	99.71 %
November	100.00%	3.55	2,184.00	2,184.00	2,184.00	$196.56	99.93 %	99.93 %	99.93 %
December	100.00%	3.46	2,313.00	2,313.00	2,313.00	$208.17	99.95 %	99.95 %	99.95 %
Totals	**99.48%**	**52.41**	**31,632.09**	**31,655.00**	**31,655.00**	**$2,846.89**	**99.41 %**	**99.37 %**	**99.37 %**
	Unweighted Yearly Avg	**Effect: 99.39% Sun Hrs: 4.37**					**Unweighted Yearly Avg**	**Unweighted Yearly Avg**	**Unweighted Yearly Avg**

Notes: [None]

Report generated by SolarPathfinder Assistant Version 4.1.27.0. http://www.solarpathfinder.com

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APPENDIX H: Glossary and Method of Calculations

Net ECM Cost: The net ECM cost is the cost experienced by the customer, which is typically the total cost (materials + labor) of installing the measure. The total cost is expressed in the summary for each ECM.

Simple Payback: This is a simple measure that displays how long the ECM will take to break-even based on the annual energy and maintenance savings of the measure.

ECM Lifetime: This is included with each ECM so that the owner can see how long the ECM will be in place and whether or not it will exceed the simple payback period. Additional guidance for calculating ECM lifetimes can be found below. This value can come from manufacturer's rated lifetime or warranty, the ASHRAE rated lifetime, or any other valid source.

Operating Cost Savings (OCS): This calculation is an annual operating savings for the ECM. It is the difference in the operating, maintenance, and / or equipment replacement costs of the existing case versus the ECM. In the case where an ECM lifetime will be longer than the existing measure (such as LED lighting versus fluorescent) the operating savings will factor in the cost of replacing the units to match the lifetime of the ECM. In this case or in one where one-time repairs are made, the total replacement / repair sum is averaged over the lifetime of the ECM.

Return on Investment (ROI): The ROI is expresses the percentage return of the investment based on the lifetime cost savings of the ECM. This value can be included as an annual or lifetime value, or both.

Fuel Oil Rate and Electric Rate ($/gallon and $/kWh): The fuel oil rate and electric rate used in the financial analysis is the total annual energy cost divided by the total annual energy usage for the 12 month billing period studied. The graphs of the electric rates reflect the total monthly energy costs divided by the monthly usage, and display how the average rate fluctuates throughout the year. The average annual rate is the only rate used in energy savings calculations.

APPENDIX I: Method of Analysis

Assumptions and Tools

Savings Estimates: Established/Standard Industry Spreadsheets
Solar Pathfinder

Cost Estimates: RS Means 2012 (Facilities Maintenance & Repair Cost Data)
RS Means 2012 (Building Construction Cost Data)
RS Means 2012 (Mechanical Cost Data)
National Renewable Energy Laboratory: System Advisor Model
Published and established specialized equipment material and labor costs
Cost estimates also based on utility bill analysis and prior experience with similar projects

<u>**DISCLAIMER**</u>

Steven Winter Associates, Inc. (SWA) prepared this engineering assessment and was using the most current and accurate fuel consumption data available for the site. The estimated savings that are projected are intended to help guide the owner toward the best energy choices. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs estimates, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

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PLEASE NOTE:

THE RECOMMENDATIONS PRESENTED IN THIS REPORT ARE BASED ON THE RESULTS OF ANALYSIS, INSPECTION, AND PERFORMANCE TESTING OF A SAMPLE OF COMPONENTS OF THE BUILDING SITE. ALTHOUGH CODE-RELATED ISSUES MAY BE NOTED, SWA STAFF HAVE NOT COMPLETED A COMPREHENSIVE EVALUATION FOR CODE-COMPLIANCE. THE OWNER(S) AND MANAGER(S) OF THE BUILDING(S) CONTAINED IN THIS REPORT ARE REMINDED THAT ANY IMPROVEMENTS SUGGESTED IN THIS SCOPE OF WORK MUST BE PERFORMED IN ACCORDANCE WITH ALL LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS THAT APPLY TO SAID WORK. PARTICULAR ATTENTION MUST BE PAID TO ANY WORK WHICH INVOLVES HEATING AND AIR MOVEMENT SYSTEMS AND ANY WORK WHICH WILL INVOLVE THE DISTURBANCE OF PRODUCTS CONTAINING MOLD, ASBESTOS, OR LEAD.

