ENERGY AUDIT
REPORT

Town of Needham
Department of Public Facilities
1471 Highland Avenue
Needham, Massachusetts 02492
Kate Fitzpatrick

ENERGY AUDIT REPORT

of
FIRE STATION-2
707 Highland Avenue
Needham, Massachusetts 02492

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1. CERTIFICATION

EMG has completed an Energy Audit of Fire Station-2 located at 707 Highland Avenue in Needham, Massachusetts. EMG visited the site on September 8, 2011.

The assessment was performed at the Client's request using methods and procedures consistent with ASHRAE Level II Energy Audit and using methods and procedures as outlined in EMG's Proposal.

This report is exclusively for the use and benefit of the Client identified on the first page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and EMG.

This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of EMG.

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Needham, Massachusetts. Since actual installed costs may vary widely for particular installation based on labor and material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

EMG certifies that EMG has no undisclosed interest in the subject property and that EMG's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies due to deferred maintenance and any noted component or system replacements.

Any questions regarding this report should be directed to Kalyana Vadala at 800.733.0660, ext. 6236.

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2. EXECUTIVE SUMMARY

The purpose of this Energy Audit is to provide Fire Station-2 with a baseline of energy usage, relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

The Fire Station-2 is a three-story building containing a total of 8,709 square feet. The construction of the property was completed in 1948. The property remained unoccupied for a few years in between until it was re-occupied by the fire department in 1991 after major renovation. During the 1991 renovation, a new section was added to the existing building that is being used as a dorm by the fire fighters. This section was built over the then existing second level. In addition to this the old windows were replaced with new double pane windows along with installing new ductwork on the third floor.

Significant upgrades were also made in later years like, replacing all the T12 lamps with energy efficient T8 lamps in 2006 and installation of two RTUs to condition the second floor. The latest modernization was done in terms of replacing the old boiler with a 299 MBH high efficiency condensing boiler in 2011.

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

Some of the important Energy Conservation Measures (ECM) are mentioned below:

- Install high efficiency fluorescent & exterior lighting
- Install automatic lighting controls
- Replace external windows on second floor
- Install low flow water fixtures

Other opportunities to consider as part of the overall energy improvement program, through not economically feasible for this building are:

- Install DDC controls and connect the building to town's central Energy Management System
- Install new garage doors with weather-stripping

Summary of Existing Energy Performance

Building's Annual Energy Consumption	940,781kBtu
Total Annual Energy Costs	$18,500

EMG has identified eight Energy Conservation Measures (ECMs) for this property. After evaluation, EMG recommends implementation of only six of the eight. The savings for each measure are calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix for reference. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, EMG has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Summary of Financial Information for Recommended Energy Conservation Measures

Item	Estimate
Total Projected Initial ECM Investment	$18,934 *(In Current Dollars)*
Estimated Annual Cost Savings Related to ECMs	$2,417 *(In Current Dollars)*
Net Effective ECM Payback	7.83 years
Estimated Annual Energy Savings	8%
Estimated Annual Cost Savings	13%

List of Recommended Energy Conservation Measures For Fire Station-2							
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Total Energy Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity			
		$	Therms	kWh	MMBtu	$	Years
No/Low Cost Recommendations							
1	Replace Incandescent Lamps With CFL's Details: Replace Incandescent Lamps With CFL's	$20	0	18	0	$3	6.03
2	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators Details: Replace All Faucet Aerators With 0.5 GPM Aerators	$43	26	0	3	$29	1.49
3	Install Energy Savers on Vending, Snack Machines Details: Install Energy Saver on The Vending Machine in The Soda Machines	$200	0	1,610	5	$263	0.76
4	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace External Wall Pack With New Photosensor	$306	0	1,002	3	$172	1.78
Totals for No/Low Cost Items		**$569**	**26**	**2,630**	**12**	**$467**	**1.22**
Capital Cost Recommendations							
1	Replace Lamps In Individual Rooms And Install Lighting Controls Details: Install Occupancy Sensors in All Spaces	$6,229	0	9,583	33	$1,568	3.97
2	Replace External Windows Details: Replace All External Windows On The Second Floor	$9,666	397	1,206	44	$650	14.86
Total For Capital Cost		**$15,895**	**397**	**10,789**	**76**	**$2,218**	**7.17**
	Interactive Savings Discount @ 10%		-42	-1,342	-9	-$269	
	Total Contingency Expenses @ 15%	$2,470					
Total for Improvements		**$18,934**	**380**	**12,077**	**79**	**$2,417**	**7.83**

Apart from the above recommended measures, EMG has analyzed the following measures for consideration and long term capital planning. These measures are not recommended at the current time due to high initial investment and long payback yielding negative life cycle savings, but are recommended either at the time of equipment replacement or renovation.

Detailed List of Measures Evaluated For Consideration For Fire Station-2							
ECM #	Description of ECM	Initial Investment	Annual Energy Savings		Total Energy Savings	Total Estimated Annual Cost Savings	Payback
		$	Therms	kWh	MMBtu	$	Years
1	Install Building Energy Management System and ReplaceTerminal Units Details: Install Central Energy Management System	$22,554	546	728	57	$786	28.70
2	Replace External Windows Details: Replace All External Ground and First Floor, Replace Garage Doors With New Insulated Doors With Sweeps	$30,414	1,169	0	117	$1,380	22.04
Total for Improvements		**$52,968**	**1,715**	**728**	**174**	**$2,166**	**24.46**

3. BENCHMARKING/ENERGY PERFORMANCE SUMMARY

3.1. ENERGY STAR PORTFOLIO MANAGER FACILITY SUMMARY

EMG uses the Portfolio Manager tool developed by the Federal Environmental Protection Agency to track relative energy uses of buildings by property type. This tool allows the input of a facility's historic utility data to be compared with normalized data of a large database of its peer facilities.

The facility is currently not eligible for rating as 50% or more of the property is designated as a fire station.

3.2. EPA ENERGY STAR RATING

The national energy performance rating is a type of external benchmark that helps energy managers to assess how efficiently their buildings use energy, relative to similar buildings nationwide. The rating system's 1-100 scale allows everyone to understand quickly how a building is performing. For example, a rating of 50 indicates an average energy performance, while a rating of 75 or better indicates top performance. The higher the rating, the better the building is performing. Organizations can evaluate energy performance among the buildings in their portfolio, while also comparing their performance with other similar buildings nationwide. Additionally, building owners and managers can use the performance ratings to help identify buildings that offer the best opportunity for energy improvement and recognition.

To receive the energy performance rating, facility-related data entered into the Portfolio Manager, must adhere to a series of operating and energy use conditions. If one or more of these conditions are not met, the facility will receive "N/A" (Not Available) as a rating. "NA" means that the Portfolio Manager is unable to calculate a rating for that particular period ending date, given the operating and energy use conditions provided.

A building must obtain a rating of 75 or better to be eligible to apply for the Energy Star Certification. However, a rating of 75 does not necessarily mean that a building will qualify.

3.3. SOURCE ENERGY AND SITE ENERGY

Buildings use a variety of forms of energy, including electricity, natural gas, fuel oil, and district steam. In order to provide an un-biased rating, the methodology must add together all of the energy used in a building. To combine energy in an equitable way, the ratings use source energy. Source energy is the energy that is consumed at the site, in addition to the energy used in generation and transmission.

The purpose of the conversion from site energy to source energy is to provide an equitable assessment of building-level energy efficiency. Because billed site energy use includes a combination of primary and secondary forms of energy, a comparison using site energy does not provide an equivalent thermodynamic assessment for buildings with different fuel mixes. In contrast, source energy incorporates all transmission, delivery, and production losses, which accounts for all primary fuel consumption and enables a complete assessment of energy efficiency in a building. When source energy is used to evaluate energy performance, an individual building's performance does not receive either a credit or a penalty for using any particular fuel type. The building's Statement of Energy Performance follows. Associated energy performance documents may be found in Appendix I.

General Information

Needham: Fire Station #2	
Gross Floor Area Excluding Parking: (ft²)	9,814
Year Built	1948
For 12-month Evaluation Period Ending Date:	June 30, 2011

Facility Space Use Summary

Fire Station	
Space Type	Other - Fire Station/Police Station
Gross Floor Area(ft²)	9,814
Number of PCs[a]	N/A
Weekly operating hours[a]	N/A
Workers on Main Shift[a]	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 06/30/2011)	**Baseline** (Ending Date 06/30/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft²)	96	96	0	N/A	82
Source (kBtu/ft²)	151	151	0	N/A	146
Energy Cost					
$/year	$ 18,500.00	$ 18,500.00	N/A	N/A	$ 15,825.16
$/ft²/year	$ 1.89	$ 1.89	N/A	N/A	$ 1.62
Greenhouse Gas Emissions					
$MtCO_2e$/year	62	62	0	N/A	53
$kgCO_2e/ft^2$/year	6	6	0	N/A	5

4. INTRODUCTION

The purpose of this Energy Audit is to provide Fire Station-2 with a baseline of energy usage, the relative energy efficiency of the facility, and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, as well as support performance contracting, justify a municipal bond-funded improvement program, or as a basis for replacement of equipment or systems.

The energy audit consisted of an onsite visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, Make-Up Air Units, DHW equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

ENERGY AND WATER USING EQUIPMENT

- EMG has surveyed the common areas, office areas, classrooms, maintenance facilities and mechanical rooms to document utility-related equipment, including heating systems, cooling systems, air handling systems and lighting systems.

BUILDING ENVELOPE

- EMG has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This review also includes an inspection of the condition of walls, windows, doors, roof areas, insulation and special use areas. Where we anticipated significant losses, we utilized infrared thermographs to analyze heat loss across the envelope.

RECOMMENDATIONS FOR ENERGY SAVINGS OPPORTUNITIES

- Based on the information gathered during the on site assessment, the utility rates, as well as recent consumption data and engineering analysis, EMG has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

ANALYSIS OF ENERGY CONSUMPTION

- Based on the information gathered during the on site assessment and a minimum of one year of utility billing history, EMG has conducted an analysis of the energy usage of all equipment, and identified which equipment is using the most energy and what equipment upgrades may be necessary. As a result, equipment upgrades or replacements are identified that may provide a reasonable return on the investment and improve maintenance reliability.

ENERGY AUDIT PROCESS

- Interviewing staff and review plans and past upgrades
- Performing an energy audit for each use type
- Performing a preliminary evaluation of the utility system
- Analyzing findings, utilizing ECM cost-benefit worksheets
- Making preliminary recommendations for system energy improvements and measures
- Estimating initial cost and changes in operating and maintenance costs based on implementation of energy efficiency measures
- Ranking recommended cost measures, based on the criticality of the project and the largest payback

REPORTING

The EMG Energy Audit Report includes:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priorities, based on initial cost and payback
- A narrative discussion of building systems/components considered and a discussion of energy improvement options;
- A summary of ECMs including initial costs and simple paybacks based on current utility rates and expected annual savings.

5. FACILITY OVERVIEW AND EXISTING CONDITIONS

5.1. BUILDING OCCUPANCY

The facility under review is a fire station and hence is occupied round the clock. The minimum occupancy at any given time is six.

Summary of Facility Operating Hours

	Hours Open to the Public	Hours Open to Employees
Monday-Friday	0 hrs	24 hrs
Saturday	0 hrs	24 hrs
Sunday	0 hrs	24 hrs

5.2. BUILDING ENVELOPE

The building envelope consists of the exterior shell, made up of the walls, windows, roof, and floor. The envelope provides building integrity and separates the exterior from the interior conditioned space.

The fire station consists of three levels. The Ground floor consists of the Maintenance floor, mechanical room, fire alarm room, store room and the fire men gm. The first floor is mainly the fire truck bay area, while the second floor consists of the firemen dorm, bathrooms, kitchen and lounge.

Foundation:

According to the structural drawings, the foundations consist of cast-in-place concrete perimeter wall footings with concrete foundation walls. The foundation systems include reinforced concrete column pads.

Walls:

The fire station was originally built in 1938 with the addition of the dorm space in 1991. The exterior walls consists of 8″ CMU block with vapor barrier followed by 2″ rigid insulation with 2 ¼″ brick veneer on outside. The internal walls consist of Gypsum boards.

Roof:

The primary roof on the fire station can be classified as pitched roof. In addition to the pitched roof, the property also has flat roof over the fire alarm workshop that houses the RTU and slit AC unit. The sloped roof consists of Asphalt Shingles over ¾″ plywood sheathing. The attic is well insulated with over 10″ thick fiberglass batt insulation. The fiberglass batt provides approximately R-28 insulation. Nevertheless EMG did observe that there are several void spaces around the pipe work that enters the attic and it is strongly recommended that these spaces be filled up so as to ensure no heat escapes into the attic during the heating season.

Windows:

The windows at the fire station were replaced in during the 1989-91 renovation. The existing windows are vinyl frame double pane windows. The existing windows are observed to be very loose and most of them have separated partially from the window frame. This has resulted in a very high outside air draft entering the building from different locations.

On further investigation EMG observed that some of the window frames were anchored to the dry wall rather than in the CMU block. This would be considered as a defective installation process. The existing windows are approximately 20 years old. The life of vinyl frame windows is approximately 25 years and thus the existing windows are near the end of their useful life. Further EMG feels it would not be cost effective in investing on repairing the windows but would rather recommend replacing them with new aluminum-framed thermally broken argon gas filled windows.

Doors:

The main garage doors leading to the maintenance bay and the fire truck bay were found to be un-insulated with visible air gaps between the door and the ground. EMG believes that this is a major source for hat loss through the large garage spaces. Further it was observed that the rubber air seals below the doors leading in and out of the maintenance and the fire truck bay were missing. This results in outside cold and hot air infiltrating the building.

Item	Construction Type
Foundation	8" thick reinforced concrete slab on grade
Structure	Metal Framed
Exterior Walls	CMU block with brick veneer
Roof	Sloped roof with R-28 attic insulation

The following table describes the observed or reported insulation levels at the property:

Building Element	Observed R-values
Roof and Attic	R – 28
Exterior Walls Above Grade	R – 15
Basement Walls and Slab Perimeter	NA

5.3. BUILDING HEATING, VENTILATION, AND AIR-CONDITIONING (HVAC)

The Fire Station-2 is conditioned year-round. The space heating is provided by hydronic unit heaters along with two roof top package units. The hot water to the unit heaters is provided by a single high efficiency Weil-McLain condensing boiler rated at 299 MBH. The new boiler was installed in 2011 and replaces an old cast Iron Weil-McLain hot water boiler that was rated at 325,000 Btuh input capacity and 253,500 Btuh output capacity. The Fire Station is currently equipped with four different types of unit heaters rated at 142 MBH (HUH-1), 37MBH (HUH-2), 23 MBH (HUH-3), and 8.3 MBH (HUH-4). Along with the unit heaters the property is also equipped with three cabinet type unit heaters located in the Fire alarm office along with one in both the stairs. All the unit heaters were observed to have individual analog thermostats. It is not clear if these thermostats are accurate.

The second floor is conditioned by two Trane package roof top units. The units were installed in 2004 and 2005 respectively. The air distribution to supply air registers by ducts concealed above the ceilings. Return air grilles are located in each space. Both the HVAC units are controlled by individual local analog thermostats. Each RTU has at nominal capacity of 4-tons.

The space ventilation is provided by a series of mechanical exhaust fans located in the Truck bay, maintenance bay and the fire alarm bay. EMG is particularly concerned about the exhausts fans in the Fire Alarm Room and the Maintenance bay, as in both these locations the fans and the vane controls are broken which has converted it into a large "Hole in the wall" allowing outside air to flow into the conditioned space in the winter. Further these fans are no longer required as the spaces applications have been modified since the building was built. The third exhaust fan serves the second floor dorm room. In addition to this there exists an inline exhaust fan that serves the second floor restrooms.

Currently Fire Station-2 does not have any central HVAC control system and it is strongly recommend that a central energy management system be installed.

Item	Measured Values
Major Heating system type/capacity	299 MBH Boiler Along With Two 80MBH rated RTU's
Major Cooling System type/capacity	Two 4-ton nominal RTUs
Heating hot water supply temperature	140°F
Outside Air temperature and Relative Humidity (%) at time of audit	55°F, 32% RH
Interior space temperatures and Relative Humidity (RH%)	75.2F and 57.3% RH in the Dorm room
Supply Air Temperature (SAT)	55°F Supply for cooling and 120°F for heating
Avg. Supply Air rate (CFM/Sq.ft)	250-300CFM/Register
Avg. Interior space thermostat set-point	74°F
Avg. Outside Air rate (% & CFM/Sq.ft or CFM/person)	NA

The Mechanical Equipment Schedule in Appendix contains a summary of the HVAC Equipment at the property.

5.4. BUILDING LIGHTING

The lighting in the Fire Station -2 was replaced with modern T-8 lamps in 2006. The general fixture type varies between two lamps per fixture and one lamp per fixture based on the area. During the site visit it was observed that none of the spaces were equipped with automatic lighting control except a set of fixtures in the fire truck bay area.

Keeping in mind that this is an emergency response unit it is not expected that the fire fighters turn off the lights each time they leave the facility. Hence EMG strongly advises install occupancy sensors in all spaces so as to turn off the lights when the space is unoccupied.

The rear of the building is lit by a single 250W HPS wall-mounted fixture. During the site visit it was observed that the photos sensor had blown off and the external light was ON round the clock.

Space type	Measured Light Levels (Lux/foot candles)	ASHRAE/IESNA Recommended Levels (foot candles)
Main Gym	450 Lux/42 FC	30
Main Lobby 2nd Flr	560 Lux/52 FC	20
Avg. Building Lighting Density, W/Sq.Ft	0.803W/Sq.Ft	1.2 W/Sq.Ft

Note: 1 foot candle = 10.764 Lux

The Lighting Systems Schedules in Appendix contain a summary of the Existing Lighting Systems at the property, along with proposed Lighting Energy Conservation Measures.

5.5. BUILDING ELEVATORS AND CONVEYING SYSTEMS

Not applicable. There are no elevators or conveying systems.

5.6. BUILDING DOMESTIC HOT WATER

The water meter for the property is located in the fire protection/sprinkler room on the ground floor. The hot water requirement for the building is satisfied by a central gas-fired domestic hot water heater located in the mechanical room. The Rheem manufactured hot water heater is rated at 70,000 Btuh and has a capacity of 75 gallons.

There was no visible dial to display the hot water supply temperature but based on the hot water temperature measurement at the faucet it was observed that the water is supplied at 120°F.The common area restrooms have commercial-grade fixtures and accessories, including water closets and lavatories. The toilets consist of water closets with flush valves. The typical flush volume was 1.6 GPF. The lavatories are equipped with aerators rated at 2.2 GPM. The lavatories are operated by manual controls. The shower heads have a rated flow rate of 2.5 GPM.

DHW type	Gas-fired Storage Water Heater
Storage Tank Capacity	75 Gal
Heating/tank set-point	125°F
DHW temperature at faucet	120°F
Building faucets, GPM	2.2 GPM
Water closets/toilets, GPF	1.6 GPF

5.7. BUILDING NATURAL GAS AND ELECTRICITY

Natural Gas

The building is connected to the natural gas utility (Nstar). The gas main on the adjacent public street supplies the natural gas service. The gas meter and regulators is located exterior to the building. The gas distribution piping within the building is malleable steel (black iron). The facility is master-metered for natural gas.

Electricity

The electrical supply lines run underground pad-mounted transformer to an interior-mounted electrical meter. The main electrical service size is 208/120-volt three-phase four-wire alternating current (AC). The electrical wiring is copper, installed in metallic conduit. Circuit breaker panels are located throughout the building. The facility is master-metered for electricity.

The facility has a single natural gas-engine-driven electric backup generator manufactured by Kohler Power Systems.

Electric Meter type (Master/Sub/Direct)	Direct	Natural Gas Meter type (Master/Sub/Direct)	Direct
Meter Location	Electrical Room	Meter Location	Exterior
Main meter number	50886	Main meter number	NA

6. UTILITY ANALYSIS

Establishing the energy baseline begins with an analysis of the utility cost and consumption of the building. Utilizing the historical energy data and local weather information, we evaluate the existing utility consumption and assign it to the various end-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

This data is analyzed, using standard engineering assumptions and practices. The analysis serves the following functions:

- Allows our engineers to benchmark the energy and water consumption of the facilities against consumption of efficient buildings of similar construction, use and occupancy.
- Generates the historical and current unit costs for energy and water
- Provides an indication of how well changes in energy consumption correlate to changes in weather.
- Reveals potential opportunities for energy consumption and/or cost reduction. For example, the analysis may indicate that there is excessive, simultaneous heating and cooling, which may mean that there is an opportunity to improve the control of the heating and cooling systems.

By performing this analysis and leveraging our experience, our engineers prioritize buildings and pinpoint systems for additional investigation during the site visit, thereby maximizing the benefit of their time spent on site and minimizing time and effort by the customer's personnel.

Based upon the utility information provided about the Fire Station-2, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

Electricity (Blended Rate)	Natural Gas
$0.15/kWh	$1.17/therm

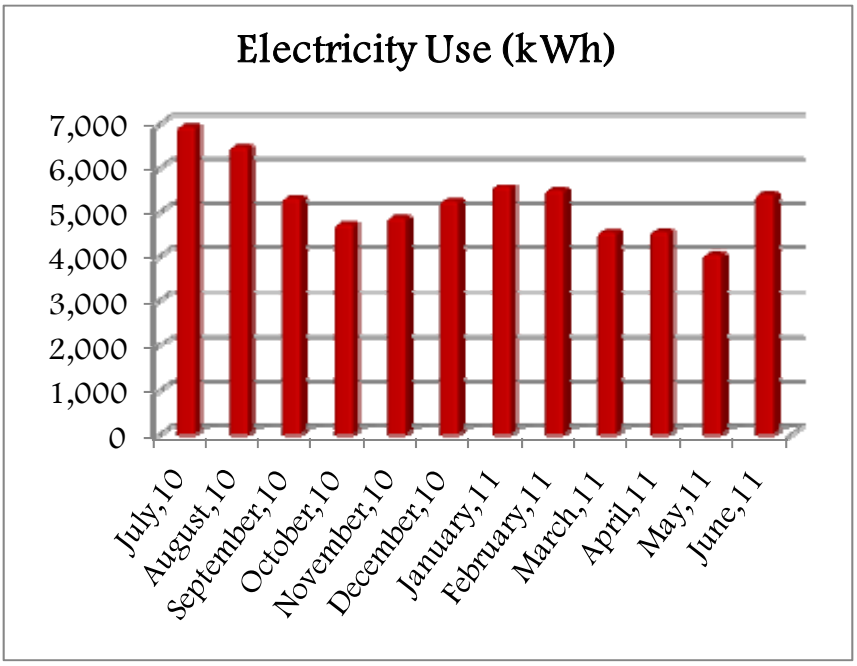
The data analyzed provides the following information: 1) breakdown of utilities by consumption, 2) cost and annual profile, 3) baseline consumption in terms of energy/utility at the facility, 4) the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data is combined to illustrate annual consumption for each utility type.

6.1. ELECTRICITY

NStar satisfies the electricity requirements of the facility. The rise in the electricity usage during the summer months is due to the use of electric driven air-conditioning equipment. The lighting is a large component of the electrical base-load because of both the number and inefficiency of fixtures and bulbs.

Based on the 2010-11 electric usage and costs, the average price paid during the year was $0.16 per kWh. The total annual electricity consumption for the 12-month period analyzed is 63,154 kWh for a total cost of $10,331.

Billing Month	Electricity Consumption (kWh)	Unit Cost/kWh	Total Cost
July,10	6,942	$0.19	$1,287
August,10	6,454	$0.18	$1,184
September,10	5,301	$0.20	$1,086
October,10	4,739	$0.17	$783
November,10	4,881	$0.16	$762
December,10	5,244	$0.15	$805
January,11	5,557	$0.14	$784
February,11	5,479	$0.14	$778
March,11	4,568	$0.15	$671
April,11	4,574	$0.14	$645
May,11	4,032	$0.15	$598
June,11	5,383	$0.18	$948
Total	**63,154**	**$0.16**	**$10,331**


Electricity Use (kWh)
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6,000
5,000
4,000
3,000
2,000
1,000
0
July,10
August,10
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October,10
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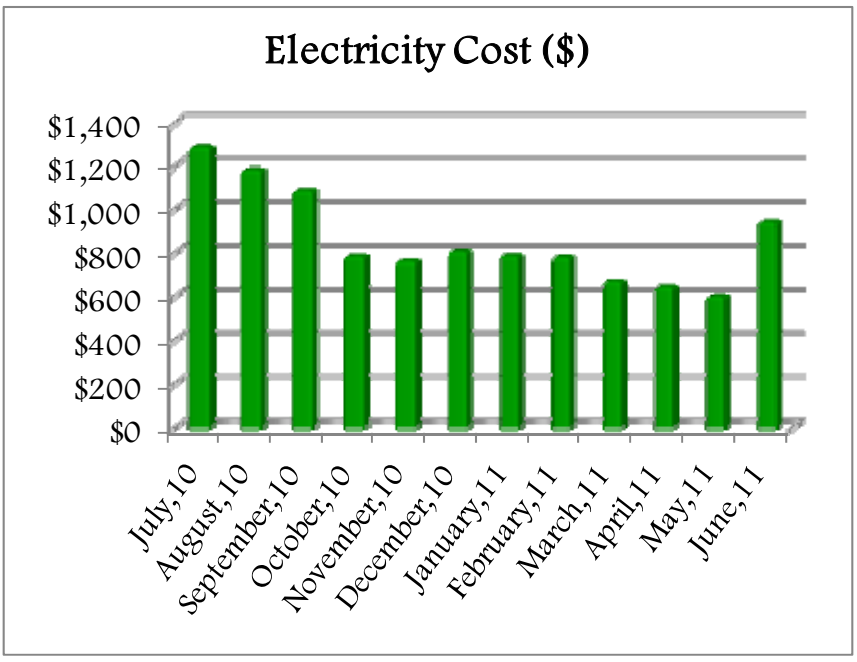
May,11
June,11

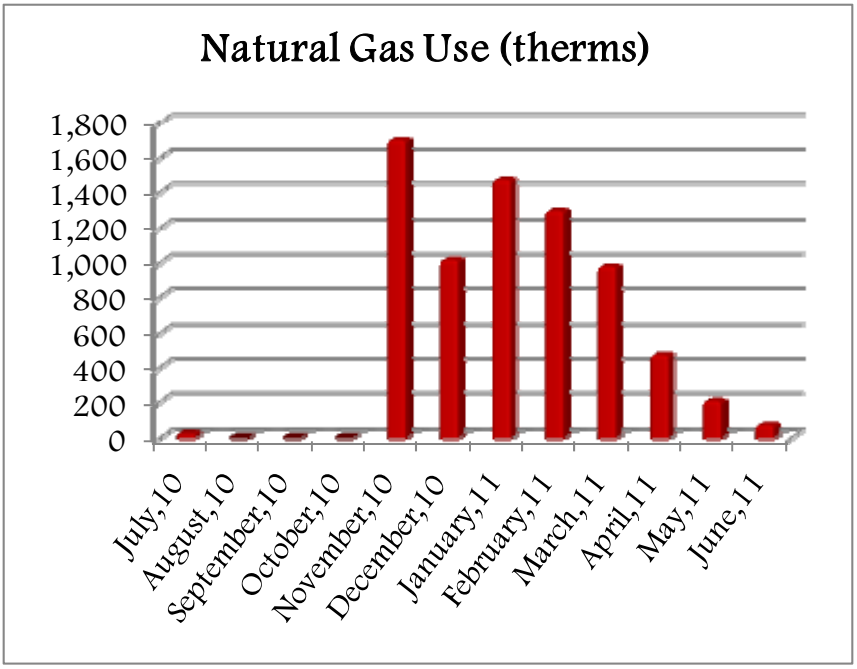

Electricity Cost ($)
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

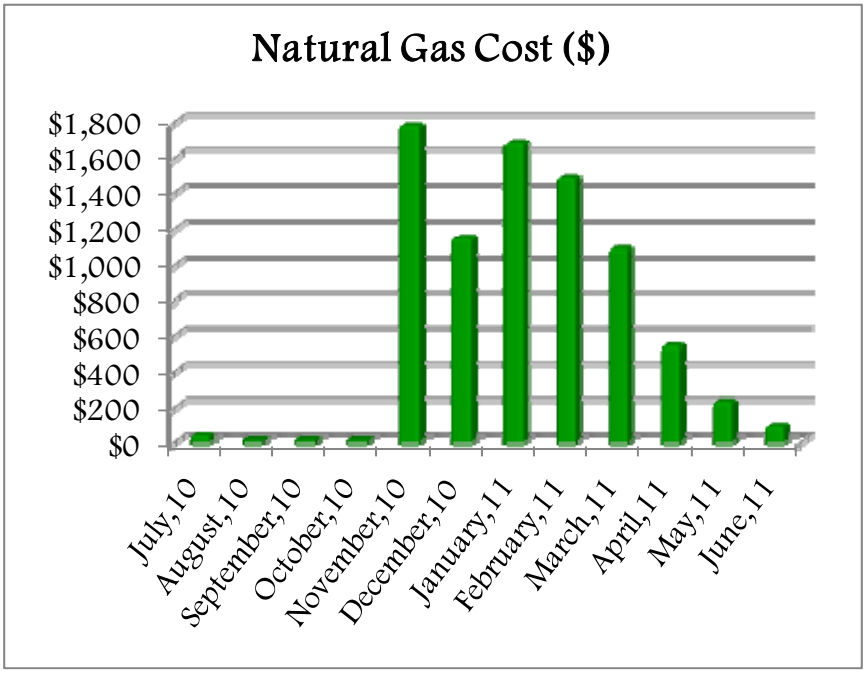
6.2. NATURAL GAS

The natural gas requirements of the facility are satisfied by NStar. The rise in the natural gas usage during the winter months is due to the use of natural gas driven heating equipment. The base-load for the building consists of the domestic hot potable water boiler along with some of a single kitchen stove.

Based on the 2010-11 natural gas usage and costs, the average price paid during the year was $1.13 per therm. The total annual natural gas consumption for the 12-month period analyzed is 7,253 for a total cost of $8,169.

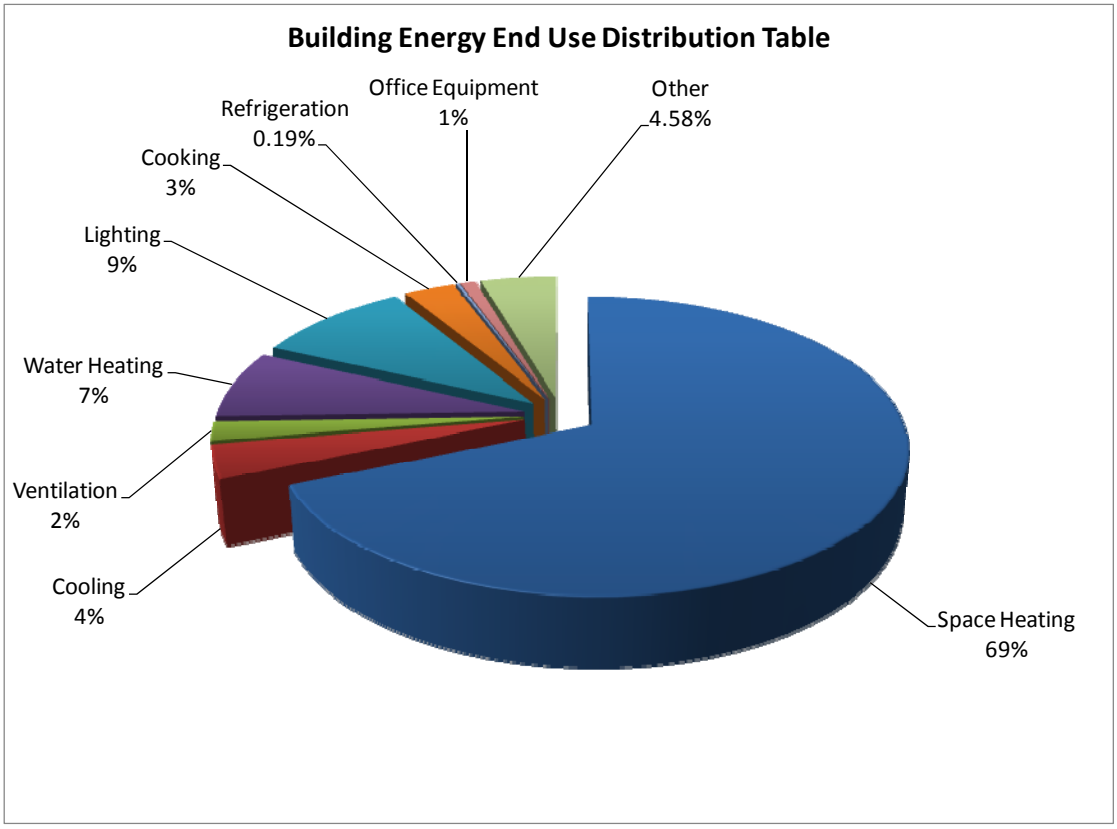
Billing Month	Natural gas Consumption (Therms)	Unit Cost/therm	Total Cost
July,10	27	$1.61	$44
August,10	0	$0.00	$15
September,10	0	$0.00	$15
October,10	0	$0.00	$15
November,10	1,701	$1.05	$1,784
December,10	1,018	$1.13	$1,149
January,11	1,470	$1.14	$1,683
February,11	1,299	$1.15	$1,492
March,11	982	$1.11	$1,092
April,11	472	$1.16	$547
May,11	208	$1.14	$237
June,11	76	$1.27	$96
Total	**7,253**	**$1.13**	**$8,169**


Natural Gas Use (therms)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11


Natural Gas Cost ($)
$1,800
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

7. END USE ENERGY DISTRIBUTION

Components of Annual Energy Use												
	Electricity (1 kWh = 3.412 kBtu)				Natural Gas				Total Energy		Total Cost	
	%	kWh	kBtu	Cost	%	therms	kBtu	Cost	MBtu	% Total	Total- $	% Total
Space Heating	***4.0%***	2,526	8,619	$413.23	***88.0%***	*6,383*	638,009	7,186	646.6	***68.8%***	$7,599	***41.1%***
Cooling	***16.0%***	10,105	34,477	$1,652.91			0	0	34.5	***3.7%***	$1,653	***8.9%***
Ventilation	***9.0%***	5,684	19,393	$929.76			0	0	19.4	***2.1%***	$930	***5.0%***
Water Heating	***0.3%***	158	539	$25.83	***9.5%***	*689*	68,876	776	69.4	***7.4%***	$802	***4.3%***
Lighting	***41.0%***	25,893	88,347	$4,235.58			0	0	88.3	***9.4%***	$4,236	***22.9%***
Cooking	***4.9%***	3,095	10,559	$506.20	***2.5%***	*181*	18,125	204	28.7	***3.0%***	$710	***3.8%***
Refrigeration	***0.8%***	530	1,810	$86.78			0	0	1.8	***0.2%***	$87	***0.5%***
Office Equipment	***4.0%***	2,526	8,619	$413.23			0	0	8.6	***0.9%***	$413	***2.2%***
Other	***20.0%***	12,631	43,096	$2,066.14			0	0	43.1	***4.6%***	$2,066	***11.2%***
Total	100.0%	**63,148**	215,460	$10,329.6	*100.0%*	***7,253***	725,010	8,166	**940.5**	100.0%	**$18,496**	100.0%



8. ENERGY CONSERVATION MEASURES (ECM)

EMG has identified a total of six Energy Conservation Measures (ECMs) for this property. All the ECMs are broken into two major categories:

1. **No/Low Cost Recommendations**: No/Low cost is defined as any project with initial investment of less than $1,000.
2. **Capital Cost Recommendations**: Capital cost defined as any project with initial investment equal to or greater than $1,000.

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

$$Simple\ Payback = \frac{Initial\ Cost}{Annual\ Savings}$$

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value over the estimated useful life (EUL) of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

$$SIR = \frac{Present\ Value\ (Annual\ Savings, i\%, EUL)}{Initial\ Cost}$$

Key Metrics to Benchmark the Subject Property's Energy Usage Profile

- Building Site Energy Use Intensity - The sum of the total site energy use in thousand of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.
- Building Source Energy Use Intensity – The sum of the total source energy use in thousand of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.
- Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.
- Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

Site Energy Use Intensity (EUI)	Rating
Current Site Energy Use Intensity (EUI)	108 kBtu/ft^2
Post ECM Site Energy Use Intensity (EUI)	99Btu/ft^2
Source Energy Use Intensity (EUI)	**Rating**
Current Source Energy Use Intensity (EUI)	170 kBtu/ft^2
Post ECM Source Energy Use Intensity (EUI)	149 kBtu/ft^2
Building Cost Intensity (BCI)	**Rating**
Current Building Cost Intensity	$2.12/ft^2
Post ECM Building Cost Intensity	$1.85/ft^2

Summary of the Greenhouse Gas Reductions from Recommended Energy Conservation Measures

The following table provides a summary of the projected Greenhouse Gas Emissions reductions as a result of the recommended Energy Conservation Measures:

Greenhouse Gas Emissions Reduction	Rating	
Estimated kWh Reduction	12,077	kWh
Estimated Annual Thermal Energy Reduction	380	Therms
Total CO_2 Emissions Reduced	3.97	$MtCO_2/yr$
Total Cars Off The Road (Equivalent)*	1	
Total Acres of Pine Trees Planted (Equivalent)*	1	

*Equivalent reductions per DOE emissions calculation algorithms.

The following table describes each recommended ECM in terms of initial investment, electricity and natural gas savings, water savings, annual energy cost and maintenance savings, payback and SIR.

List of Recommended Energy Conservation Measures For Fire Station-2

ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy Savings	Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity									
		$	Therms	kWh	kgal	MMBtu	$	$	$	Years		$	Years
No/Low Cost Recommendations													
1	Replace Incandescent Lamps With CFL's Details: Replace Incandescent Lamps With CFL's	$20	0	18	0	0	$3	$0	$3	6.03	1.23	$5	10
2	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators Details: Replace All Faucet Aerators With 0.5 GPM Aerators	$43	26	0	3	3	$29	$0	$29	1.49	3.07	$89	5
3	Install Energy Savers on Vending, Snack Machines Details: Install Energy Saver on The Vending Machine in The Soda Machines	$200	0	1,610	0	5	$263	$0	$263	0.76	11.23	$2,047	10
4	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace External Wall Pack With New Photosensor	$306	0	1,002	0	3	$164	$8	$172	1.78	4.57	$1,092	10
Totals for No/Low Cost Items		**$569**	**26**	**2,630**	**3**	**12**	**$459**	**$8**	**$467**	**1.22**			
Capital Cost Recommendations													
1	Replace Lamps In Individual Rooms And Install Lighting Controls Details: Install Occupancy Sensors in All Spaces	$6,229	0	9,583	0	33	$1,568	$0	$1,568	3.97	3.00	$12,484	15
2	Replace External Windows Details: Replace All External Windows On The Second Floor	$9,666	397	1,206	0	44	$644	$6	$650	14.86	1.31	$2,956	30
Total For Capital Cost		**$15,895**	**397**	**10,789**	**0**	**76**	**$2,212**	**$6**	**$2,218**	**7.17**			
	Interactive Savings Discount @ 10%		-42	-1,342		-9	-$267	-$1	-$269				
	Total Contingency Expenses @ 15%	$2,470											
Total for Improvements		**$18,934**	**380**	**12,077**	**3**	**79**	**$2,403**	**$13**	**$2,417**	**7.83**			

If all of the above mentioned ECM's are implemented, Fire Station-2 could potentially save approximately $2,417 per year with an investment of $18,934 yielding a net effective payback of 7.83 years.

8.1. ECM CALCULATION ASSUMPTIONS

EMG has made the following assumptions in calculation of the Energy Conservation Measures.

- Building operating hours, as detailed in section 5.1 are assumed to be 168 hours per week.
- The facility occupancy is assumed to be 6 people.
- Annual Heating Equipment Operating Hours are derived from actual consumption and equipment input rates to be 2,397 hours/year
- Annual Cooling Equipment Operating Hours are derived from actual consumption and equipment input rates to be 729 hours/year

8.2. NO/LOW COST ECM DESCRIPTIONS

EMG has identified four No/Low Cost Energy Conservation Measures (ECMs) for this property. This includes all measures which can be implemented below the cost threshold of $1000. The following paragraphs describe each of these ECMs.

8.2.1. Replace All Incandescent Lamps With CFL's

Fluorescent lighting is recommended for areas where color sensitivity is an important criterion (e.g., offices or small parts assembly rooms). Screw-in fluorescent lamps are available to replace incandescent lamps. Power savings are typically 60%. Screw-in self-contained lamps, with a 10,000-hour life, can replace flood lights that have a 7,000-hour life. Screw-in circle light fixtures are also available.

Screw-in fluorescent lamps are generally not compatible with dimmers. New energy-efficient fluorescent lamps are continually being introduced. It is important to stay abreast of this technology so that the most efficient products may be used.

The fire station has approximately four incandescent lamps. Though these lamps have very low hours of operations, EMG strongly recommends replacing them with CFL's. The proposed replacement is not expected to yield large savings but would be beneficial in a long run.

8.2.2. Replace Existing Water Faucets with Low Flow Faucet Aerators

By reducing the flow of water coming from the restroom faucets, aerators can generate energy savings at low cost and with easy installation. The savings generated would be in the form of reduced water and sewer costs and at the same time aerators would save energy by reducing the demand for hot water. The average faucet has a flow rate of about 2 to 2.5 GPM. Adding a screw-in faucet aerator reduces the flow to 0.5 to 1.0 GPM in the bathroom and 2.2 GPM in the kitchen. In addition to saving energy and water, the "foamier" water that comes from faucet aerators wets objects better than water from a faucet with no aerator, which tends to bounce off the object rather than thoroughly wetting it.

The fire station has two restrooms and one bathroom with a total of four faucet aerators. All the four faucets were found to be equipped with 2.5 GPM aerators. EMG recommends replacing all the aerators with new low flow aerators rated at 0.5GPM. The proposed retrofit is expected to reduce the water consumption by 3.49 kGal annually.

For this facility the hot water to the faucets is provided by a gas-fired water heater, supplying hot water at 120 F. The use of water efficient faucets results in additional savings in the form of reduction in water heating bills. In the present scenario a cost saving of $30 can be achieved from water heaters by installing low flow aerators.

8.2.3. Install Energy Controller On Vending Machine

Vending machines are usually designed to operate all day round irrespective of the occupancy level in the office. This means that the vending machines operate for more than 12 hours a day when not required in case of commercial establishments.

The Fire Station-2 has a single soda vending machine located in the maintenance bay on its ground floor. EMG recommends installing vend misers on this vending machines, which will automatically reduce the running time of the machines during weekends and unoccupied hours. There are two types of vend misers; one has a timer in it, which is programmed to turn off or tune down the vending machines after the office hours and bring it back up an hour before the office opens. The other is a motion sensor based system that tunes down the machines upon detecting no-occupancy for a pre-programmed duration of time. In the case of vending machines storing chilled products, the vend miser does not turn off the machine entirely, but reduces the operating time of the compressor, such that the machine maintains the products at a minimum tolerable temperature.

8.2.4. Replace High Intensity Discharge (HID) Lamp with Induction Lighting

An induction light is similar to a fluorescent light in that mercury in a gas fill inside the bulb is excited; emitting UV radiation that in turn is converted into visible white light by the phosphor coating on the bulb.

The generator produces a radio frequency magnetic field to excite gas fill. With no electrodes, the lamp lasts longer. Induction lamps, in fact, last up to 100,000 hours, with the lamp producing 70% of its light output at 60,000 hours. In other words, their rated life is 5-13 times longer than metal halide (7,500 to 20,000 hours at 10 hours/start).

Induction lamps are ideally suited for high-ceiling applications where the lamps are difficult, costly or hazardous to access. They are also ideally suited for such applications where the advantages of fluorescent lighting are sought but a light source is needed that can start and operate efficiently in extremely cold temperatures. As a result, induction lighting is a suitable for a wide range of applications, including not only warehouses, industrial buildings, cafeterias, gymnasiums, etc., but also signage, tunnels, bridges, roadways, outdoor area and security fixtures, parking garages, public spaces, and freezer and cold storage lighting.

The increased costs occurs in the induction systems themselves – which could be 5 to 6 times more than metal halide systems, and also in new fixtures, which can inflate payback periods and reduce return on investment. But you also generally get a 30% reduction in capital and operating costs immediately from the reduced number of fixtures made possible by the higher light output. You also get 15% more efficiency just because the induction system (lamp and electronic ballast) is more efficient. Apply that over ten years plus reduced replacement and maintenance costs compared to metal halide and other HID lamps and suddenly it makes a lot of sense to go into induction lighting systems.

- Long Service Life: up to 100,000hrs (5 times the lamp life of Metal Halides)
- Energy Saving: save up to 40% compared to metal halides, 13 times more efficient than incandescent light bulbs, and up to twice as efficient as compact fluorescent lights
- Instant On/Off: no waiting time between re-strike
- High Efficiency: lighting efficiency >80lm/w
- High Lumens Maintenance: >70% after 60,000 hrs
- Wide Selection of Color Temperature:2720K- 6500K

- High Power Factor Ballast: $\lambda > 0.95$
- Flicker-free : high frequency (250KHz) creates a better and more comfortable light for users and prevents eye injury when viewed directly
- Optional Dimmable Ballast for Integrated Control: linearly dimmable to 30%

The Fire Station-2 has a single 250W HPS wall pack light fixture to illuminate the maintenance bay entrance on the rear end of the building. EMG recommends replacing the HPS lamp with a new 120W induction lamp fixture capable of providing the same amount of light levels as provided by the existing high pressure sodium fixture.

8.3. CAPITAL COST ECM DESCRIPTIONS

EMG has identified two Capital Cost Energy Conservation Measures (ECMs) for this property. This list includes recommended measures which have an estimated implementation cost of greater than $1,000. The following paragraphs describe each of these ECMs.

8.3.1. Install Lighting Controls In All Open Spaces

One of the best ways to save energy is to turn off lights that are not needed. This saves energy, as well as extends the replacement time on lamps. (While frequent switching may in some cases shorten lamp life, the savings in electrical power will more than compensate).

The operating time of lighting systems can be reduced either automatically or manually. Automated controls are more reliable for ensuring that energy savings are achieved. Local switches can be labeled to encourage occupants to turn off lights when leaving an area. Individual switches in perimeter offices permit occupants to reduce lighting levels on sunny days. Sophisticated lighting control systems are available, but they are costly to retrofit. They should be considered when the lighting system is being replaced. With the exception of security lights, storeroom lighting can be placed on timed switches that shut off after the selected interval. All exterior lighting, as well as interior lighting in glass-enclosed vestibules, should be placed on photocell and/or timer control.

The Fire Station-2 has already undergone a lighting retrofit in 2006 where all the old T12 lamps equipped with magnetic ballasts were replaced with new energy efficient T8 lamps along with electronic ballasts. Nevertheless the property only had a single occupancy sensor located in the walkway along the wall in the truck bay. EMG strongly recommends use of similar occupancy sensors across all individual spaces. Further as mentioned before Fire Fighters have to respond to emergency calls that are time critical, hence it is not expected that they turn off the lights in individual spaces on the way out. This task can very well be fulfilled by the automatic occupancy sensors that can turn off the lights once they detect no motion or infrared heat from individuals for a specific programmed duration of time.

EMG recommends installing occupancy sensors in the following locations:

- Dorm room on the 2nd floor
- Bathroom on the 2nd floor
- Kitchen on the 2nd floor
- TV room/ break room on the 2nd floor
- Laundry room on the 2nd floor
- Radio control room on the 2nd floor
- Captain's Office on the 1st floor
- Fire Truck Bay on the 1st floor (2X sensors)
- Firemen's gym on the ground floor

- Fire alarm office on the ground floor
- Maintenance bay on the ground floor (1X sensor for the first row)

In case of the maintenance bay, EMG strongly recommends that the space be cleaned up and all the equipments are stored in their designated areas. This will allow the ceiling-mounted sensors to get a clear sense of the movement in its surroundings. Further it is recommend that only the first row that is closest to the stairwell be equipped with the OS while the other two be left on individual light switches. This is recommended based on the behavioral study.

It must be noted that when installing occupancy fixtures all the electronic instant start ballast of the impacted fixtures be replaced with rapid start/program start ballasts. This shall ensure that the life of the lamps is not affected by constant ON/OFF function.

8.3.2. Replace Windows on The Second Floor

In the winter, the heat in the building is lost when cold outside air conducts the colder temperatures through the glass and infiltrates around the edges of windows. The cold drafts and the cold window pane surfaces may make the interior occupants uncomfortable. This effect is measured by the window assembly's U-value (insulating property). The U-value is a measure of the rate of non-solar heat flow through a window assembly by conduction. The commonly used term R-value is a measure of the resistance to heat flow and is the inverse of the U-factor. U-factors provide a means to compare the heat transfer properties of different window assemblies. U-factor values generally range from 0.25 to 1.35 and are measured in Btu/h·ft²·°F. The lower the U-factor, the better the assembly insulates. Factors affecting the insulating property of a window assembly are: 1) the type of glazing material (e.g., glass, plastic, treated glass), 2) the number of layers of glass, 3) the size and gas content of the space between the layers of glass, and 4) the thermal resistance or conductance of the frame and spacer materials. The "tightness" of the installation, including the fit and air sealing at the perimeters does not affect the U-value of the assembly but has a substantial effect on the air infiltration in the building.

A single pane glass window with an aluminum frame without thermal spacers will have a U=factor of approximately 1.3. Two sheets of glass with an air or gas-filled space between them have better insulating properties than a single pane of glass. Gases resist changes in temperature, giving them a better insulating value than air. Window frames made of vinyl; fiberglass or wood composites reduce heat transfer and improve insulation.

Energy efficient windows avoid frames made of aluminum or other metals that easily transmit heat and cold. Also, spacers inserted between multi-pane windows reduce heat transfer and the formation of condensation thus increasing the insulating property of the window assembly. A U-value of 0.44 or less is recommended. Additional savings are achieved by properly installing and sealing the windows, thereby reducing the air infiltration rate into the building.

The Fire Station-2 had all its windows replaced during the 1989-1991 addition/renovation. The existing windows are vinyl framed double pane windows. Most of the existing "windows" were found to be in a good shape with no visible condensation visible between the two panes. Nevertheless it was observed that the windows had become loose and had a considerable amount of play thus allowing a significant amount of outside air draft to enter the conditioned space. This results in the two HVAC package units working for extra hours in order to keep the second floor space warm.

The general average expected useful life of vinyl framed window is around 25 years and since the existing windows are 21 years old, EMG would not recommended investing on fixing the damaged and broken windows. Whereas it is strongly recommended that the existing windows on the second floor be replaced with new aluminum framed, thermally broken argon filled double pane glazed windows.

It is estimated that the proposed window replacement would result in an annual energy savings of 1206 kWh from cooling and 397 therms from heating.

Savings will be enhanced through proper installation and caulking. It is recommended that this work be completed in conjunction with any additional repairs or replacements relating to the building envelope, such that comprehensive air sealing can be implemented upon completion.

8.4. ECMs EVALUATED FOR CONSIDERATION

EMG has identified two Energy Conservation Measures (ECMs) which were evaluated for this property but not recommended based on the financial criteria detailed at the beginning of Section 8. The following paragraphs describe each of the ECMs.

8.4.1. Install Building Energy Automation System

Fire Station-2 does not have any central energy management system. All the individual HVAC systems including the unit heaters are controlled by individual manual thermostats. The facility has not undergone commissioning since the last addition/renovation and hence the accuracy of the thermostats is questionable. EMG strongly recommends installing a building wide central building management system that would control all the HVAC systems along with facility lighting and ventilation. It is recommended that the system be integrated with the existing building management system that controls the HVAC across all other town owned major school buildings and libraries.

8.4.2. Replace Windows And Garage Doors on The Ground and First Floor

The windows on the first and the ground floor that house the fire truck bay, maintenance bay and the fire alarm repair shop were also replaced in 1991 addition. These windows were in the same state of disrepair as the windows on the second floor with visible air gaps between the window and the frames. Both the floors re only heated and not cooled. The heating of the space is done by a series of hot water unit heaters each controlled by individual manual thermostats. Based on the interaction with the fire man the thermostats are set to maintain space temperature around 55F. The hot water to the unit heaters is provided by a single hot water boiler which was recently replaced with a new gas-fired condensing boiler with a rated output capacity of 299MBH.

EMG recommends replacing all windows in the two levels with new aluminum framed thermally broken double pane argon filled windows. In addition to this it was also noted that four of the five garage doors lacked insulation from inside and had visible air gaps when shut. All the four doors were found to be a major source of energy loss via conduction and infiltration of outside air through the gaps. EMG would recommend replacing all the four doors with new insulated garage doors equipped with adequate weather stripping to prevent outside air draft. EMG estimates a total of $18,600 for installing the new garage doors.

In addition to the leaky doors and windows, EMG also identified two large exhaust fans through the exterior doors ventilating the maintenance bay and the fire alarm service bay. Both the exhaust fans have louvers that were not functioning properly. Based on the interaction none of the fans were being used currently and had turned out to be two large 2'x2' holes in the wall. EMG recommends demolishing the exhaust fans and plugging the gaps in the walls so as to stop the air infiltration.

As general practice it is strongly recommended that all the doors leading in and out of different spaces should be equipped with door sweeps to prevent infiltration of air.

9. IMPLEMENTION OF AN OPERATIONS AND MAINTENANCE PLAN

The quality of the maintenance and the operation of the facility's energy systems have a direct effect on its overall energy efficiency. Energy-efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property. These actions, which have been divided into specific and general recommendations, will insure that the energy conservation measures identified in this report will remain effective. The following general recommendations should be continued or implemented.

Building Envelope

1. Caulking and weather stripping of all windows and garage doors
2. Walls observed weekly and holes patched in the building envelope as required
3. Windows inspected monthly for damaged panes and failed thermal seals
4. Automatic door closing mechanisms repaired and adjusted as needed
5. Ensure that the exhaust fans louvers are operating and no air leaks through it when completely shut

Heating and Cooling

1. The burners cleaned and fuel/air ratios optimized during routine maintenance checks
2. Temperature settings reduced in unoccupied areas and set points seasonally adjusted.
3. Control Equipment inspected for worn or damaged parts as part of a monthly maintenance check
4. Ductwork visually inspected and checked for leaks or damaged insulation as part of a monthly maintenance check
5. Hot air registers and return air ductwork clean and unobstructed
6. Air dampers operating correctly
7. Test and balance completed annually to ensure heating uniform throughout the spaces
8. Air filters inspected monthly and replaced prior to excessive visual buildup (May increase filter costs, but will reduce fan energy costs)
9. Ensure that the hot water coils in the unit heaters are clean so as to achieve maximum heat transfer between the coils and the space.

Domestic Hot Water

1. Domestic hot water heater temperature set to the minimum temperature required (120F)
2. Hot water piping checked routinely for damaged insulated and leaks
3. Tank-type water heaters flushed monthly

Lighting

1. Only energy-efficient replacement lamps used and in-stock for replacement (28W T8 lamps)
2. Lighting fixture reflective surfaces and translucent covers clean (Second floor)
3. Walls clean and bright to maximize lighting effectiveness
4. Timers and/or photocells operating correctly on exterior lighting

Existing Equipment and Replacements

1. Refrigerator and freezer doors closed and sealed correctly
2. Kitchen exhaust fans only used when needed or timers installed to limit operation
3. All other recommended equipment specific preventive maintenance actions conducted

In addition, equipment replacement performed assuring that:

1. All equipment replacements not over/undersized for the particular application
2. All equipment replacements with energy conserving and/or high efficiency devices

10. APPENDICES

APPENDIX A: Photographic Record
APPENDIX B: Thermal Photographic Record
APPENDIX C: Site Plan
APPENDIX D: Records of Communication
APPENDIX E: Glossary of Terms
APPENDIX F: Mechanical Equipment Inventory
APPENDIX G: Lighting Systems Schedules
APPENDIX H: ECM Calculations
APPENDIX I: Supporting Documents

APPENDIX A:
PHOTOGRAPHIC RECORD

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #1:	Front elevation

Photo #2:	Side elevation

Photo #3:	Side elevation

Photo #4:	Back elevation

Photo #5:	Back and side elevation

Photo #6:	Un-insulated leaky garage doors

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #7:	Visible air gaps between the un-insulated garage door and the ground

Photo #8:	Attic space

Photo #9:	Attic hatch

Photo #10:	Natural gas meter

Photo #11:	Ventilation fan for fire alarm division. It's a hole in the wall for as it brings in cold air

Photo #12:	Ventilation fan for maintenance bay. Another hole in the wall as it brings in cold air

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #13:	Leaky broken window in the laundry room

Photo #14:	Loose window in the stairwell

Photo #15:	New 299 MBH condensing boiler

Photo #16:	Hot water distribution piping

Photo #17:	Telephone and building control panel

Photo #18:	Main 75-gal domestic water heater

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #19:	Air compressor for the trucks

Photo #20:	Sprinkler riser room

Photo #21:	Main domestic water meter

Photo #22:	Lavatory faucets

Photo #23:	Urinal

Photo #24:	Water closet

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #25:	Gas-fired generator transfer switch

Photo #26:	Main generator

Photo #27:	Electric meter

Photo #28:	Refrigerator

Photo #29:	Vending machine

Photo #30:	Hydronic unit heater - 174,000Btuh

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #31:	52,399 Btuh rated unit heater

Photo #32:	RTU TRANE package unit and split air condition system

Photo #33:	RTU-II

Photo #34:	Thermostats to control the RTU

APPENDIX B:
THERMAL PHOTOGRAPHIC RECORD

EMG THERMAL PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

Photo #1:	Front elevation-IR

Photo #2:	Leaky un-insulated garage-bay doors

Photo #3:	Side elevations

Photo #4:	Rear elevation

Photo #5:	Rear windows

Photo #6:	Side elevation

EMG THERMAL PHOTOGRAPHIC RECORD

Project No.: 98515.11R-009.268 **Project Name: Fire Station-2**

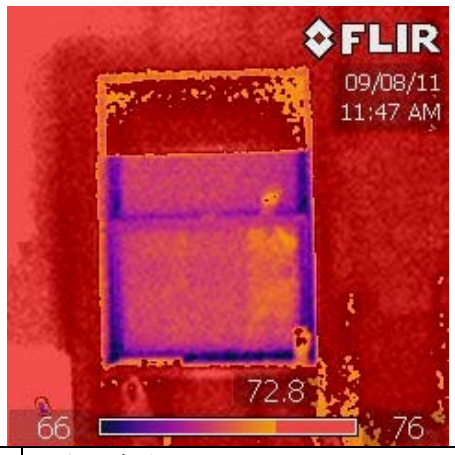


Photo #7:	Leaky windows

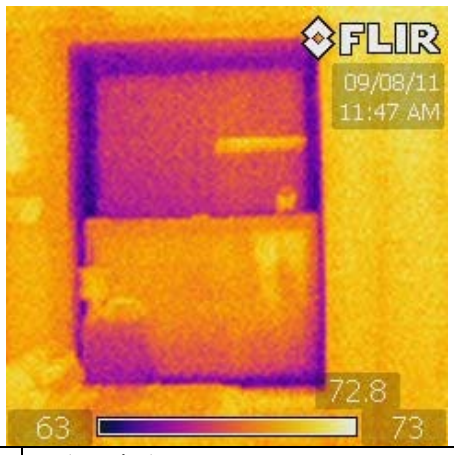


Photo #8:	Leaky windows

APPENDIX C:
SITE PLAN

Site Plan

EMG	**Source:** **WWW.Bing.com**	**Project Number:** **98515.11R-009.268**
		Project Name: **Fire Station-2**
N	**The north arrow indicator is an approximation of 0° North.**	**On-Site Date:** **September 8th, 2011**

APPENDIX D:
RECORDS OF COMMUNICATION

RECORD OF COMMUNICATION

Date:	**September 8th 2011**	**Time:**	**9:00 AM**
Project Number:	**98515.11R-009.268**	**Recorded by:**	**Kaustubh Anil Chabukswar**
Project Name:	**Fire Station-2**		

Communication with: John Krawiecki
of: Needham Fire Station-2
Phone: NA

Communication via:

- X Telephone Conversation
- X Discussions During Site Assessment
- X Office Visitation/Meeting at:
- Other:

RE:

Summary of Communication:

APPENDIX E:
GLOSSARY OF TERMS

Glossary of Terms and Acronyms

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates typically are based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR - The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy-efficiency recommendations be based on a calculated SIR, with larger SIRs receiving a higher priority. A project typically is recommended only if the SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost - The sum of the present values of (a) **I**nvestment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity - The sum of the total site energy use in thousand of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousand of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

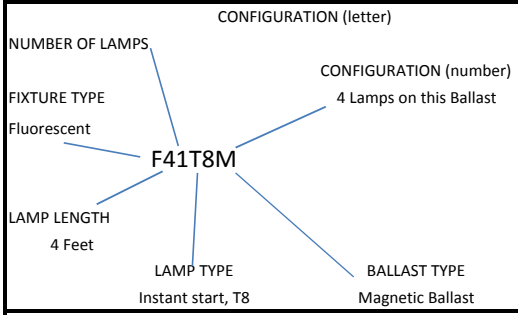
APPENDIX F:
MECHANICAL EQUIPMENT INVENTORY

Mechanical Equipment Inventory- Fire Station # 2								
Equipment	Manufacturer	Age	Location	Model/ Type	Capacity	Serves	Operating Hours/Year	Remarks
Boiler	Weil Mclain	New	Mech Rm.	383-500-705	299 MBH	Entire Bldg.	2500	New
Circulation Pumps (2X)	Taco Pumps	New	Mech Rm.	S 55CXJ FM-4927	1/2Hp	Entire Bldg.	2500	New
Unit Heaters (2X)	NA	NA	Varies	NA	37,000 Btuh	Truck & Maintenance Bay	2500	Works Well
Unit Heaters (5X)	NA	NA	Varies	NA	142,000 Btuh	Truck & Maintenance Bay	2500	Works Well
Unit Heaters (1X)	NA	NA	Varies	NA	23,000Btuh	Truck & Maintenance Bay	2500	Works Well
Unit Heaters (3X)	NA	NA	Varies	NA	8300Btuh	Truck & Maintenance Bay	2500	Works Well
Domestic Hot Water Heater	Rheem	NA	Mech.Rm	G75-75N-1	75Gal	Entire Bldg.	400	Works Well
Air Compressor	Wayne	NA	Air Compressor Rm.	NA	NA	Fire Trucks	1825	Works Well
RTU	TRANE	Sep-05	Roof Top	YSC048A1EMA	80,000Btuh	Kitchen, Laundry Rm and Break Rm	6500	Works Well
RTU	TRANE	June, 2004	Roof Top	YSC048A1RLA	60,000Btuh	Dorm	6500	Works Well

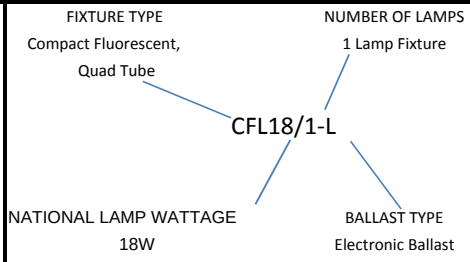
APPENDIX G:
LIGHTING SYSTEMS SCHEDULES

Fixture Code Legend and Notes

Sample Linear Fluorescent Fixture Code



Sample of Other Fixture Code:



Code Explanations

Fixture Type

CF	Compact Fluorescent
CFD	Compact Fluorescent, double-D shape
CFS	Compact Fluorescent, Spiral
CFT	Compact Fluorescent, Twin tube (including "Biaxial" fixtures)
CFQ	Compact Fluorescent, Quad tube
ECF	Exit sign, Compact Fluorescent
EI	Exit sign, Incandescent
ELED	Exit sign, LED
F	Fluorescent, linear
FC	Fluorescent, Circline
FU	Fluorescent, U-tube
H	Halogen
HLV	Halogen, Low Voltage
HPS	High Pressure Sodium
I	Incandescent
LED	Light Emitting Diode (LED) traffic signal
MH	Metal Halide
MHPS	Metal Halide, Pulse Start
MV	Mercury Vapor
QL	Induction

Lamp Type

for fluorescent fixtures

A	"F25T12" - 25 watt, 4ft, T12 lamp
IL or T8	T8, Instant start
SIL	T8, Instant start, Super 30 watt
SSIL or T8N	T8, rapid start, Super 28 watt
L	T8, rapid start
T5	T5, standard
T5HO	T5, standard, High output lamp
T12	T12, Energy efficient
EH	T12, Energy efficient, High output lamp
EI	T12, Energy efficient, Instant start
EV	T12, Energy efficient, Very high output
T12M	T12, Standard magnetic
SIL	T12, Standard, Instant start
HO	T12, Standard, High output lamp
SV	T12, Standard, Very high output lamp
T	T10, Standard

Ballast Type

for fluorescent fixtures

E	Electronic
M	Standard magnetic

Configuration (letter)

T	Tandem wired fixture
DL	Delamped fixture, i.e. some lamps permanently removed but ballasts remain

Configuration (number)

for delamped fixtures

Number signifies the total number of ballasts in the fixture: e.g. An "F42EEID2" is an "F44EE" with two lamps removed so that there is one extaneous ballast

for tandem wired ballasts

Number signifies the total number of lamps being run by the ballast: e.g. An "F42LLIT4" would indicate that a four-lamp ballast is wired to run two-lamp fixtures.

with no preceding letter

Number indicates the number of ballasts in an ambiguous multiple ballast fixture: e.g. An "F43ILU2" indicates a three-lamp fixture with two ballasts (as is often the case if there is A/B switching).

Notes:

1) The column labeled Watts/Fixtures in the data table includes ballast loads.

2) The fixture wattage values represent an average value, rounded to the nearest whole watt.

Existing Facilities Program Lighting Form:

Performance Based

Project Number:	98515.11R-009.268		
Facility Name:	Fire Station-2		
Project Manager	Kaustubh Anil Chabuksar		
Date:	9/8/2011	Square Footage (ft2)	6000

Existing Control Legend	
LS	Light Switch
PS	Photosensor
TM	Timer
MS	Motion/Occupancy Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend		
CF	Compact Fluorescent	I
F	Fluorescent, linear	LED
H	Halogen	MH
HPS	High Pressure Sodium	MV
I	Incandescent	QL

PRE-INSTALLATION

Line Item	ECM	Type of ECM Code (Refer to ECM Code Worksheet)	Additional ECM Code (if applicable)	Floor	Area Description	Light Reading (Record if ECM)	Usage	Usage	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM' for lighting retrofit)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ Week	Wks/Yr	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
2				Lower Flr	Mechanical Room	NA	5	52	LS	1	F41T8	31	0.03	260	8
3				Lower Flr	Air Compressor Rm.	NA	5	52	LS	1	F41T8	31	0.03	260	8
4				Lower Flr	Sprinkler Rm.	NA	2	52	LS	1	F41T8	31	0.03	104	3
5	ECM	MS		Lower Flr	Main Gym	450	120	52	LS	4	F42T8	59	0.24	6,240	1,473
6	ECM	MS		Lower Flr	Maintenance Bay	350	140	52	LS	18	F42T8	59	1.06	7,280	7,731
7				Lower Flr	Fire Alarm Division	350	14	52	LS	4	F42T8	59	0.24	728	172
8	ECM	MS		Lower Flr	Fire Alarm Division-Office	450	56	52	LS	2	F42T8	59	0.12	2,912	344
9				Lower Flr	Store Room	300	5	52	LS	1	F42T8	59	0.06	260	15
10				Lower Flr	Stairwell-2	350	84	52	LS	5	F42T8	59	0.30	4,368	1,289
11	ECM	OS		2nd	Main Dorm	550	100	52	LS	4	F42T8	59	0.24	5,200	1,227
12	ECM	OS		2nd	Restrooms	450	55	52	LS	2	F42T8	59	0.12	2,860	337
13	ECM	OS		2nd	Main Lobby	560	160	52	LS	5	F42T8	59	0.30	8,320	2,454
14	ECM	OS		2nd	Radio Control Rm.	600	100	52	LS	1	F42T8	59	0.06	5,200	307
15				2nd	Stairwell-1	350	126	52	LS	3	F42T8	59	0.18	6,552	1,160
16	ECM	OS		2nd	Captains's Office	400	70	52	LS	1	F42T8	59	0.06	3,640	215
17	ECM	OS		2nd	Engine Bay	250	80	52	LS	19	F42T8	59	1.12	4,160	4,663
18	ECM	OS		Exterior	Exterior	NA	95	52	LS	1	MH250	295	0.30	4,940	1,457
19	ECM	RB		Exterior	Exterior	NA	2	52	LS	4	I60	60	0.24	104	25
20															
									Total Pre Fixt.	**77**		**Total Pre kW**	**5**	**kWh Consumed**	**22,889**

Light Intensity	0.783	**Usage Intensity**	3.81
	Watt/ ft2		KWh / ft2

Existing Facilities Program Lighting Form:

Performance Based

Project Number:	98515.11R-009.268
Facility Name:	Fire Station-2

Date: 9/8/2011 Project Manager Kaustubh Anil Chabuksar

Existing Control Legend	
LS	Light Switch
PS	Photosensor
T	Timer
MS	Motion Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend			
CF	Compact Fluorescent	I	Incandescent
F	Fluorescent, linear	LED	Light Emitting Diode
H	Halogen	MH	Metal Halide
HPS	High Pressure Sodium	MV	Mercury Vapor
I	Incandescent	QL	Induction

					PRE-INSTALLATION							POST-INSTALLATION								
Line Item	**ECM**	**Type of ECM Code** (Refer to ECM Code Worksheet)	**Additional ECM Code (if applicable)**	**Floor**	**Area Description**	**Light Reading** (Record if ECM)	**Usage**	**Baseline Annual Hours**	**Existing Control**	**Pre Fixt. No.**	**Pre Fixt Code**	**Post Fixt No.**	**Post Fixt Code** (Refer to Wattable Table Worksheet)	**Post Watts/ Fixt**	**Post kW / Space**	**Proposed Weekly Hours**	**Proposed Annual Weeks**	**Proposed Control**	**kW Saved**	**Annual kWh Saved**
Integer line number	(Type 'ECM" if applied)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux (link to light standards)	hrs/ week	Existing annual hours for the usage group	Pre-installation control device	# of existing fixtures	TypWattage Table Link	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Post Watts/Fixt) * (Post Fixt No.)	Hrs / Wk	Wks/Yr	Post-installation control device	Pre kW/Space - Post kW/Space	(PreFixt #*PreWatts/Fixt * Baseline Hrs) - (PostFixt#*PostWatts/Fixt * Proposed Hours)
Ex.		*RB*		*10*	*Men's Room*		*5*	*3,000*	*Light Switch*	*3*	*F44T12*	*3*	*F42T8*	*59*	*0.18*			*Motion Sensor*	*0.26*	*765*
5	ECM	MS - Install Motion Sensors		Lower Flr	Main Gym	450	120	6,240	LS	4	F42T8	4	F42t8	59	0.236	45.00	52.00	OS	0.00	920
6	ECM	MS - Install Motion Sensors		Lower Flr	Maintenance Bay	350	140	7,280	LS	18	F42T8	18	F42T8	59	1.062	35.00	52.00	OS	0.00	5,799
8	ECM	MS - Install Motion Sensors		Lower Flr	Fire Alarm Division-Office	450	56	2,912	LS	2	F42T8	2	F42T8	59	0.118	39.20	52.00	OS	0.00	103
11	ECM	OS - Install Occupancy Sensors		2nd	Main Dorm	550	100	5,200	LS	4	F42T8	4	F42T8	59	0.236	70.00	52.00	OS	0.00	368
12	ECM	OS - Install Occupancy Sensors		2nd	Restrooms	450	55	2,860	LS	2	F42T8	2	F42T8	59	0.118	38.50	52.00	OS	0.00	101
13	ECM	OS - Install Occupancy Sensors		2nd	Main Lobby	560	160	8,320	LS	5	F42T8	5	F42T8	59	0.295	112.00	52.00	OS	0.00	736
14	ECM	OS - Install Occupancy Sensors		2nd	Radio Control Rm.	600	100	5,200	LS	1	F42T8	1	F42T8	59	0.059	70.00	52.00	OS	0.00	92
16	ECM	OS - Install Occupancy Sensors		2nd	Captains's Office	400	70	3,640	LS	1	F42T8	1	F42T8	59	0.059	49.00	52.00	OS	0.00	64
17	ECM	OS - Install Occupancy Sensors		2nd	Engine Bay	250	80	4,160	LS	19	F42T8	19	F42T8	59	1.121	56.00	52.00	OS	0.00	1,399
18	ECM	OS - Install Occupancy Sensors		Exterior	Exterior	NA	95	4,940	LS	1	MH250	1	QL120	125	0.125	70.00	52.00	PS	0.17	1,002
19	ECM	RB - Replace Bulb		Exterior	Exterior	NA	2	104	LS	4	I60	4	CFL13	17	0.068	2.00	52.00	LS	0.17	18
									Total Pre Fixt.	**61**		**61**	**Total Post kW**	**690.00**	**3.57**			**Total kW Saved**	**0.34**	**10,603.39**

APPENDIX H:
ECM CALCULATIONS

UIC	Replace Incandescent Lamps With CFL's			
EAL 1A	Details: Replace Incandescent Lamps With CFL's			
Step:1	Number of Lamps to Be Replaced		4	
Step:2	Current Wattage of Lamp		60.00	watt
Step:3	Proposed Replacement		13.00	watt
Step:4	Total labor Cost For Replacing lamps *Estimated Rate of $35/hr To Replace 20 Lamps/Hr*		$7.00	
Step:5	Estimated Cost Per Lamp	*(Select)*	$3.00	$$
Step:6	**Total Cost For Retrofit**		$20.41	
Step:7	Estimated Annual Energy Savings		18.00	kwh
Step:8	Current Electric Tarriff Per kWh		**$0.16**	$$
Step:9	Existing Annual Usage *(For O&M Savings)*		108	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*		108	hrs
	Estimated Annual O&M Savings		$0.44	$$
Step:10	Estimated Annual Cost Savings		$3.39	
Step:11	Simple Pay back Period		6.03	Yrs
Type of Recommendation	No/Low Cost ECM Recommendation			

UIC	Replace High Flow Faucet Aerators To Low Flow Faucet Aerators
EAP2	Details: Replace All Faucet Aerators With 0.5 GPM Aerators

No. of Residents	6		Number of Occupied Days/Week (Max 7)	7	

KITCHEN FAUCETS			BATHROOM FAUCETS		
Do You Want To Replace Kitchen Faucets	No	*(Select)*	Do You Want To Replace Bathroom Faucets	Yes	*(Select)*
Total Number of Faucet Aerators To Be Replaced	0		Total Number of Faucet Aerators To Be Replaced	4	
GPM of Existing Faucet Aerators	3.2	GPM	GPM of Existing Faucet Aerators	2.5	GPM
GPM of Proposed Faucet Aerator	2.2	GPM	GPM of Proposed Faucet Aerator	0.5	GPM
Estimated Number of Uses Per Day	0		Estimated Number of Uses Per Day	5	
Estimated No. of Operational Weeks	0		Estimated No. of Operational Weeks	52	
Estimated Time Per Faucet Use	0.50	Mins	Estimated Time Per Faucet Use	0.16	Mins
Annual Water Savings From Kitchen Faucets	0.00	kGal	Annual Water Savings From Bathroom Faucets	3.49	kGal

WATER & ENERGY SAVING CALCULATION			COST SAVING CALCULATION		
Select Type of Water Heater Fuel:	Natural Gas	(Select)	Heating Fuel Tariff	$1.126	$$
DHW plant efficiency:	82%		Water Tariff ($/1000 Gal)	**0**	$$
Equivalent Heating Energy savings:	2555.88	kBtu	Annual Cost Savings In Form of Water	$0	$$
Equivalent Heating Fuel Savings:	25.56	Therms	Annual Energy Savings From Water Heater	$29	$$
Annual Water Savings *(Assuming 3 uses/day/person for 365 days a year)*	3.49	kGal			

COST BENEFIT ANALYSIS				
Estimated Total Annual Cost Savings	$29	$$	Estimated Total Installation Cost	$43	$$
Simple Payback Period	1.49	Years	*Type of Recommendation*	No/Low Cost ECM Recommendation	

UIC	Install Energy Savers on Vending, Snack Machines
EAC8	Details: Install Energy Saver on The Vending Machine in The Soda Machines

No. of Vending Machines: 1.00 Qty

No. of Beverage Cooling Machines: 0.00 Qty

No. of Snack Machines 0.00 Qty

Vending Machines (Cold Beverage Vending Machines)

Estimated Annual kWh Consumption of Vending Machine:	3500.00	kWh
Estimated Annual kWh of Vending Machine With VendMiser:	1890.00	kWh
Total annual kWh savings:	1610.00	kWh
Total Annual kWh Savings for All Vending Machines:	1610.00	kWh

Beverage Cooling Machines

Estimated Annual kWh Consumption of Beverage Cooling Machine:	2300.00	kWh
Estimated Annual kWh of Cooling Machine With CoolerMiser:	1610.00	kWh
Total Annual kWh savings:	690.00	kWh
Total Annual kWh Savings For All Cooling Machines:	0.00	kWh

Snack Vending Machines

Estimated Annual kWh Consumption of Individual Snack Machine:	873.60	kWh
Estimated Annual kWh of Individual Snack Machines With VendMiser:	366.91	kWh
Total Annual kWh savings:	506.69	kWh
Total Annual kWh Savings For All Water Fountain Coolers:	0.00	kWh

Cost Analysis

Total estimated annual kWh savings withEnergy Misers:	**1610.00**	kWh
Cost/kWh:	**$0.16**	
Estimated Cost of Vendmiser/ Vending Machine:	$200	
Estimated Cost of Coolermiser/ Water cooler:	$190	
Estimated Cost of Vendmiser/ Snack Machine:	$70	
Estimated total installed cost of all VendMisers:	**$200**	
Estimated Total Annual Electricity Savings Using VendingMisers and CoolerMisers:	**$263**	
Simple Payback:	0.76	years

Type of Recommendation No/Low Cost ECM Recommendation

UIC	Replace High Intensity Discharge Lamp (HID) with Induction Lighting
EAL9	Details: Replace External Wall Pack With New Photosensor

Step:1	Number of 60-100W HID Lamps Replaced by 40W Induction	0	
	Number of 100-150W HID Lamps Replaced by 70W Induction	0	
	Number of 150-200W HID Lamps Replaced by 85W Induction	**0**	
	Number of 200-250W HID Lamps Replaced by 120W Induction	**1**	
	Number of 250-300W HID Lamps Replaced by 165W Induction	**0**	
	Number of 300-400W HID Lamps Replaced by 250W Induction	**0**	
	Number of 1000W HID Lamps Replaced by (2)300W Induction Lamps	**0**	
	Installation Cost Analysis		
Step:2	Subtotal Cost of 40 Watt Induction Self Ballast Retrofit	$0	
Step:3	Subtotal Cost of 70 Watt Induction Retrofit	$0	
Step:4	Subtotal Cost of 85 Watt Induction Retrofit	$0	
Step:5	Subtotal Cost of 120 Watt Induction Retrofit	$285	
Step:6	Subtotal Cost of 165 Watt Induction Retrofit	$0	
Step:7	Subtotal Cost of 250 Watt Induction Retrofit	$0	
Step:8	Subtotal Cost of 300 Watt Induction Retrofit	$0	
Step:9	**Total Cost For Retrofit**	$306	
	Energy & Cost Saving Analysis		
Step:10	Estimated Annual Energy Savings	1002.00	kwh
Step:11	Current Electric Price Per kWh	$0.16	$
Step:12	Estimated Annual Cost Savings	$164	
Step:13	Existing Annual Usage *(For O&M Savings)*	70	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	70	hrs
	Estimated Annual O&M Savings	$8	$$
Step:14	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$172	$$
Step:15	Simple Pay back Period	1.78	Yrs

Type of Recommendation — No/Low Cost ECM Recommendation

NOTE: Induction Lamps contain 3 to 4 times the life of HID lamps where significant Operation and Maintanence Savings are attained through minimizing frequency of bulb and ballast replacements

UIC	Replace Lamps In Individual Rooms And Install Lighting Controls
EAL4	Details: Install Occupancy Sensors in All Spaces

Total Number of Rooms		
Total Number of T12 lamps to Be replaced by T8's in All Rooms	0	
Total Number of Incandacent Lamps to be replaced with CFL's	0	
Total Number of Fixtures To Be Retrofitted with Rapid Start Ballast	40	
Are the Ballast being replaced? (Y/N)	Yes	
Total Number of Lighting Control Sensors To be Installed	12	
Price Per Lamp $6.00/CFL Lamp & $3.00 /T8 Lamp		
Cost / Rapid Start Electronic Ballast	$35.00	
Type of Proposed Lighting Control Sensors	Ceiling Mounted Occupancy Sensor	
Total Cost Of Ceiling Mounted Occupancy Sensor ($135X)	$135.00	
Total Material Cost	$3,020.00	

LABOR COSTS

Total Labor Cost For Installing Lighting Control Sensors ($ 65X)	$780.00	
Total Labor Cost For Replacing Ballasts ($50X)	$2,000.00	
Labor Cost For Replacing CFL Lamps ($65/20 Lamps)	$0.00	
Total Labor Cost For Replacing Individual Linear Fluroscent Lamps ($65/12 Lamps)	$0.00	
Total Labor Costs	$2,780.00	
TOTAL INSTALLATION COSTS	$6,229	
Total Energy Savings From Retrofits in Rooms:	9,583.00	kWh
Insert Current Tariff Rate For Electricity	**$0.16**	$
Total Cost Savings	$1,568	
Simple Pay Back Period	**3.97**	Yrs
Type of Recommendation	Capital Cost ECM Recommendation	

UIC	Replace External Windows
EAE2	Details: Replace All External Windows On The Second Floor

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	144	sq.ft
Approximate number of windows:	18	
Total existing window area:	144	Sq.Ft
Select The Existing Window Type	Vinyl Frame & Double Glazing	*(Select)*
Existing U-value of window: (1/R)	0.46	Btu/ ft²·°F·h
Select Property Location Zone	Zone-6	*(Select)*
New U-value with Double pane Low E window: (1/R)	0.42	Btu/ ft²·°F·h

AHRAE 90.1 Recommended Value

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1):	1.20	
(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)		
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.45	
Estimated Space Volume Under Consideration	22,050	Cu. Ft
Is the Property Cooled ?	Yes	*(Select)*

WINTER

Select Type of Heating Fuel	Natural Gas	*(Select)*
Net heating plant & distribution system efficiency:	82.00	%
Annual Heating Hours::	2,397	
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	0.17	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controling Air Leakage Through Windows	396.40	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	396.57	Therms

SUMMER

Select Type of Cooling Fuel	Electric	*(Default)*
Cooling Plant Efficiency (EER):	10.00	EER
Annual Cooling Hours:	729	
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	0.42	Kwh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controling Air Leakage Through Windows	1205.58	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	1206.00	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel: (Cost/Unit)	$1.13	$	Annual Heating Cost Savings:	$447	$$
Insert Cost of Cooling Fuel: (Cost/Unit)	$0.16	$	Annual Cooling Cost Savings:	$197	$$
Total Annual Cost Savings	$650		Total Annual Cost Savings From Heating & Cooling:	$644	$$
Cost of window upgrade:	$9,666		Estimated Annual O&M Savings	$6.44	$
Simple payback:	14.86	**years**	*Type of Recommendation*	Capital Cost ECM Recommendation	

UIC	Replace External Windows
EAE2B	Details: Replace All External Ground and First Floor, Replace Garage Doors With New Insulated Doors With Sweeps

ENTER EXISTING CONDITIONS

Existing and Proposed Window Properties

Total Sq.Ft window area:	176	sq.ft
Approximate number of windows:	22	
Total existing window area:	176	Sq.Ft
Select The Existing Window Type	Vinyl Frame & Double Glazing	*(Select)*
Existing U-value of window: (1/R)	0.46	Btu/ ft²·°F·h
Select Property Location Zone	Zone-6	*(Select)*
New U-value with Double pane Low E window: (1/R)	0.42	Btu/ ft²·°F·h

AHRAE 90.1 Recommended Value

Existing & Proposed Air Leakage Through Windows

Insert Existing Estimated Air Change Rate/Hr (ACH 1):	1.90	
(Existing Air Changes Per Hour, 3 is very leaky and 0.35 ideal)		
Insert Proposed Estimated Air Change Rate/Hr (ACH 2):	0.60	
Estimated Space Volume Under Consideration	37,500	Cu. Ft
Is the Property Cooled ?	No	*(Select)*

WINTER

Select Type of Heating Fuel	Natural Gas	*(Select)*
Net heating plant & distribution system efficiency:	91.00	%
Annual Heating Hours::	2,397	
Estimated Total Annual Input Heating Energy Savings By Replacing Windows	0.19	Therms
Estimated Total Annual Input Heating Energy Savings Achieved By Controling Air Leakage Through Windows	1168.54	Therms
Estimated Total Input Heating Fuel Savings From Replacing Windows	1168.72	Therms

SUMMER

Select Type of Cooling Fuel	Electric	*(Default)*
Cooling Plant Efficiency (EER):	10.00	EER
Annual Cooling Hours:	729	
Annual Total Input Cooling Fuel Savings During Summer Season By Replacing Windows	0.51	Kwh
Estimated Total Annual Input Cooling Energy Savings Achieved By Controling Air Leakage Through Windows	0.00	kWh
Estimated Total Input Cooling Fuel Savings From Replacing Windows	0.00	kWh

ENERGY & COST ANALYSIS

Insert Cost of Heating Fuel: (Cost/Unit)	$1.13	$	Annual Heating Cost Savings:	$1,316	$$
Insert Cost of Cooling Fuel: (Cost/Unit)	$0.16	$	Annual Cooling Cost Savings:	$0	$$
Total Annual Cost Savings	$1,330		Total Annual Cost Savings From Heating & Cooling:	$1,316	$$
Cost of window upgrade:	$30,414		Estimated Annual O&M Savings	$13.16	$
Simple payback:	22.88	**years**	*Type of Recommendation*	Capital Cost ECM Recommendation	

UIC	Install Building Energy Management System and ReplaceTerminal Units
EAC9	Details: Install Central Energy Management System

Facility HVAC Details:

Building Square Footage	6,000	SF	Select Heating Fuel:	Natural Gas	*(Select)*
Annual Cooling Consumption	7,284	kWh	Annual Heating Consumption	5,458	Therms
Estimated Electric Rate:	$0.16	$/kWh	Estimated Heating Fuel Rate:	$1.13	$/Therm
Existing Annual Cooling Cost:	$1,191.51		Existing Annual Heating Cost:	$6,147.41	

BUILDING ENERGY MANAGEMENT SYSTEM

Install New Controls (BMS)?				Yes	
DOE Estimated Savings for New Building Energy Management Controls & Terminals:				10%	
Estimated Cooling Energy Saving:	728	kWh	Estimated Heating Fuel Savings:	546	Therms

Upgrade Fan Coil Units- *This Would Be Capital Improvement*

No. of Fan Coil Units To Be Replaced:	0	Qty

ENERGY & COST ANALYSIS

Estimated Installed Cost of New BMS ($3.50 per SF):	$21,000	$$
Estimated Installed Cost of New Fan Coil Units ($1,450 per unit):	$0	$$
Estimated Total Initial Investment Cost:	$22,554	$$
Estimated Total Annual Cost Savings from New Building Energy Management System:	$733.89	$$
Estimated Annual O&M Savings:	$37	$$
Projected Annual Energy and O&M Cost Savings:	$771	$$
Simple Payback:	29.27	years

Type of Recommendation — Capital Cost ECM Recommendation

APPENDIX I:
SUPPORTING DOCUMENTS

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Needham: Fire Station #2

Building ID: 2884540
For 12-month Period Ending: June 30, 2011[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: October 11, 2011

Facility
Needham: Fire Station #2
707 Highland Avenue
Needham, MA 02492

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1950
Gross Floor Area (ft²): 6,000

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

Site Energy Use Summary[3]

Electricity - Grid Purchase(kBtu)	207,753
Natural Gas (kBtu)[4]	682,500
Total Energy (kBtu)	890,253

Energy Intensity[5]

Site (kBtu/ft²/yr)	148
Source (kBtu/ft²/yr)	235

Emissions (based on site energy use)

Greenhouse Gas Emissions ($MtCO_2e$/year)	59

Electric Distribution Utility
NSTAR Electric Co

National Average Comparison

National Average Site EUI	78
National Average Source EUI	157
% Difference from National Average Source EUI	50%
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.

Certifying Professional
N/A

Meets Industry Standards[6] **for Indoor Environmental Conditions:**

Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**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.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) or a Registered Architect (RA) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE or RA in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Needham: Fire Station #2	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Fire Station/Police Station	Is this an accurate description of the space in question?		☐
Location	707 Highland Avenue, Needham, MA 02492	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of acute care or children's hospitals) nor can they be submitted as representing only a portion of a building		☐
Fire Station (Other)				
CRITERION	**VALUE AS ENTERED IN PORTFOLIO MANAGER**	**VERIFICATION QUESTIONS**	**NOTES**	☑
Gross Floor Area	6,000 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Number of PCs	N/A(Optional)	Is this the number of personal computers in the space?		☐
Weekly operating hours	N/A(Optional)	Is this the total number of hours per week that the space is 75% occupied? This number should exclude hours when the facility is occupied only by maintenance, security, or other support personnel. For facilities with a schedule that varies during the year, "operating hours/week" refers to the total weekly hours for the schedule most often followed.		☐
Workers on Main Shift	N/A(Optional)	Is this the number of employees present during the main shift? Note this is not the total number of employees or visitors who are in a building during an entire 24 hour period. For example, if there are two daily 8 hour shifts of 100 workers each, the Workers on Main Shift value is 100.		☐

ENERGY STAR® Data Checklist for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: NSTAR Electric Co

Fuel Type: Electricity

Meter: Electricity (kWh (thousand Watt-hours))
Space(s): Entire Facility
Generation Method: Grid Purchase

Start Date	End Date	Energy Use (kWh (thousand Watt-hours))
06/01/2011	06/30/2011	5,739.00
05/01/2011	05/31/2011	4,817.00
04/01/2011	04/30/2011	4,413.00
03/01/2011	03/31/2011	4,463.00
02/01/2011	02/28/2011	5,389.00
01/01/2011	01/31/2011	5,573.00
12/01/2010	12/31/2010	5,037.00
11/01/2010	11/30/2010	4,696.00
10/01/2010	10/31/2010	4,264.00
09/01/2010	09/30/2010	4,481.00
08/01/2010	08/31/2010	6,961.00
07/01/2010	07/31/2010	5,056.00
Electricity Consumption (kWh (thousand Watt-hours))		**60,889.00**
Electricity Consumption (kBtu (thousand Btu))		**207,753.27**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**207,753.27**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Natural Gas

Meter: Natural Gas (therms)
Space(s): Entire Facility

Start Date	End Date	Energy Use (therms)
06/01/2011	06/30/2011	136.00
05/01/2011	05/31/2011	236.00
04/01/2011	04/30/2011	489.00
03/01/2011	03/31/2011	841.00
02/01/2011	02/28/2011	1,261.00
01/01/2011	01/31/2011	1,133.00
12/01/2010	12/31/2010	1,406.00
11/01/2010	11/30/2010	652.00
10/01/2010	10/31/2010	500.00
09/01/2010	09/30/2010	76.00

08/01/2010	08/31/2010	42.00
07/01/2010	07/31/2010	53.00
Natural Gas Consumption (therms)		**6,825.00**
Natural Gas Consumption (kBtu (thousand Btu))		**682,500.00**
Total Natural Gas Consumption (kBtu (thousand Btu))		**682,500.00**
Is this the total Natural Gas consumption at this building including all Natural Gas meters?		☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	☐

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same PE or RA that signed and stamped the SEP.)

Name: _____ Date: _____

Signature: _____

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
Needham: Fire Station #2
707 Highland Avenue
Needham, MA 02492

Facility Owner
N/A

Primary Contact for this Facility
N/A

General Information

Needham: Fire Station #2	
Gross Floor Area Excluding Parking: (ft^2)	6,000
Year Built	1950
For 12-month Evaluation Period Ending Date:	June 30, 2011

Facility Space Use Summary

Fire Station	
Space Type	Other - Fire Station/Police Station
Gross Floor Area(ft^2)	6,000
Number of PCs[o]	N/A
Weekly operating hours[o]	N/A
Workers on Main Shift[o]	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 06/30/2011)	**Baseline** (Ending Date 06/30/2011)	**Rating of 75**	**Target**	**National Average**
Energy Performance Rating	N/A	N/A	75	N/A	N/A
Energy Intensity					
Site (kBtu/ft^2)	148	148	0	N/A	78
Source (kBtu/ft^2)	235	235	0	N/A	157
Energy Cost					
$/year	$ 17,181.00	$ 17,181.00	N/A	N/A	$ 9,031.66
$/$ft^2$/year	$ 2.86	$ 2.86	N/A	N/A	$ 1.50
Greenhouse Gas Emissions					
$MtCO_2e$/year	59	59	0	N/A	31
$kgCO_2e/ft^2$/year	10	10	0	N/A	5

More than 50% of your building is defined as Fire Station/Police Station. This building is currently ineligible for a rating. Please note the National Average column represents the CBECS national average data for Fire Station/Police Station. This building uses X% less energy per square foot than the CBECS national average for Fire Station/Police Station.

Notes:
o - This attribute is optional.
d - A default value has been supplied by Portfolio Manager.