



Custom Audit Report  
Prepared for

# Hoover Elementary School

**Client Number(s):**100156  
**National Grid Gas Account Number(s):**44534/22000

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Melrose, MA



**Date:** February 5, 2010  
**Conducted by:** Jean-Paul Vandeputte

**I. Purpose:**

Interest is expressed in energy efficiency upgrades regarding the steam heating distribution system. Currently the custom incentive for gas efficiency measures in Massachusetts is valued at 50% of the incremental cost to go from standard efficiency to high efficiency. Please note that project incentives are capped at \$100,000.00 for the facility per program year. All projects must pass National Grid's societal benefit cost ratio test.

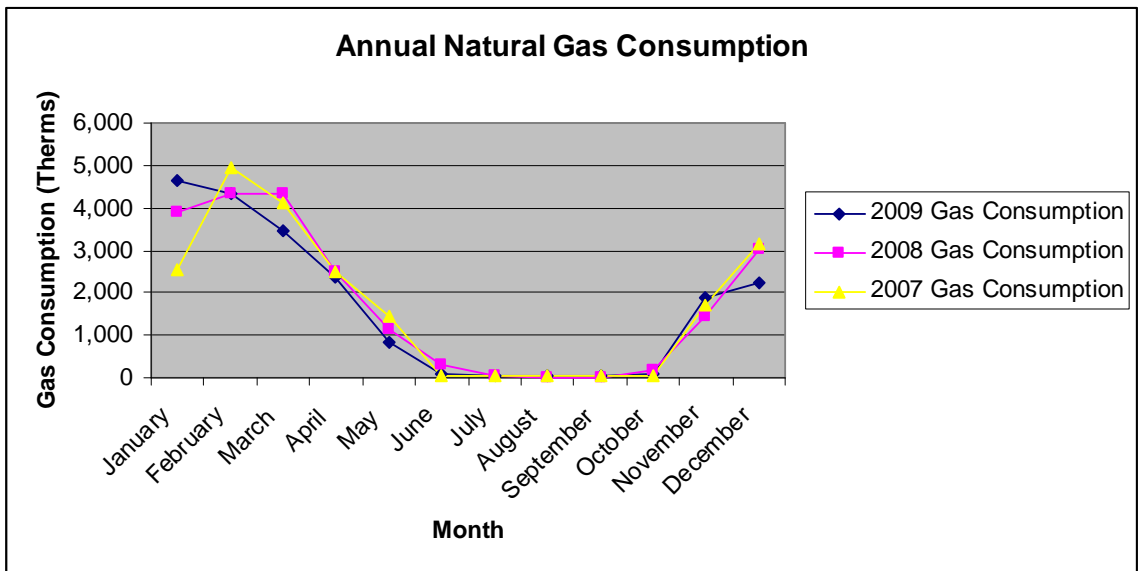
**II. Facility Overview:****A. Type of Institution**

1. Building Use: Built in 1967, the building is used classrooms for Kindergarten through fifth grade.
2. Original Architects / Engineers: Floor plans were provided and were created by Universal Engineering. They are dated
3. Previous Studies: Previous lighting audits have been performed on the building. The last retrofit took place nearly 10 years ago.

**B. Utility Introduction**

The following is a table and graph representing the current natural gas consumption over the past year.

Annual Natural Gas Consumption (Therms)			
Month	2009	2008	2007
January	4,634	3,877	2,544
February	4,349	4,327	4,934
March	3,462	4,350	4,100
April	2,382	2,516	2,506
May	839	1,123	1,447
June	69	312	57
July	54	25	52
August	27	0	44
September	27	0	0
October	96	156	0
November	1,896	1,460	1,692
December	2,222	3,039	3,173
Total	20,057	21,185	20,549



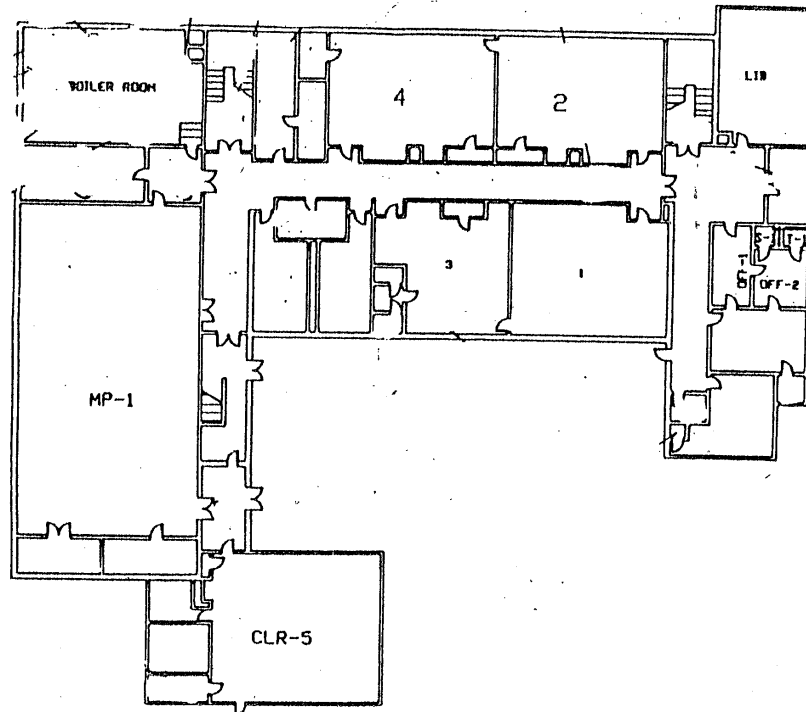
### C. General Facility Information

1. Operations Schedule: The building is open from 7AM to 6PM to accommodate students for regular and after school programs. Heating set points are kept around 70 degrees in the classrooms and between 65 and 67 degrees in the hallways.
2. Equipment Usage: Natural Gas fuels two steam boilers used for heating and one domestic water heater. Heat is delivered via steam radiators in the halls, unit vents in the 13 classrooms and an air handler in the all purpose room.

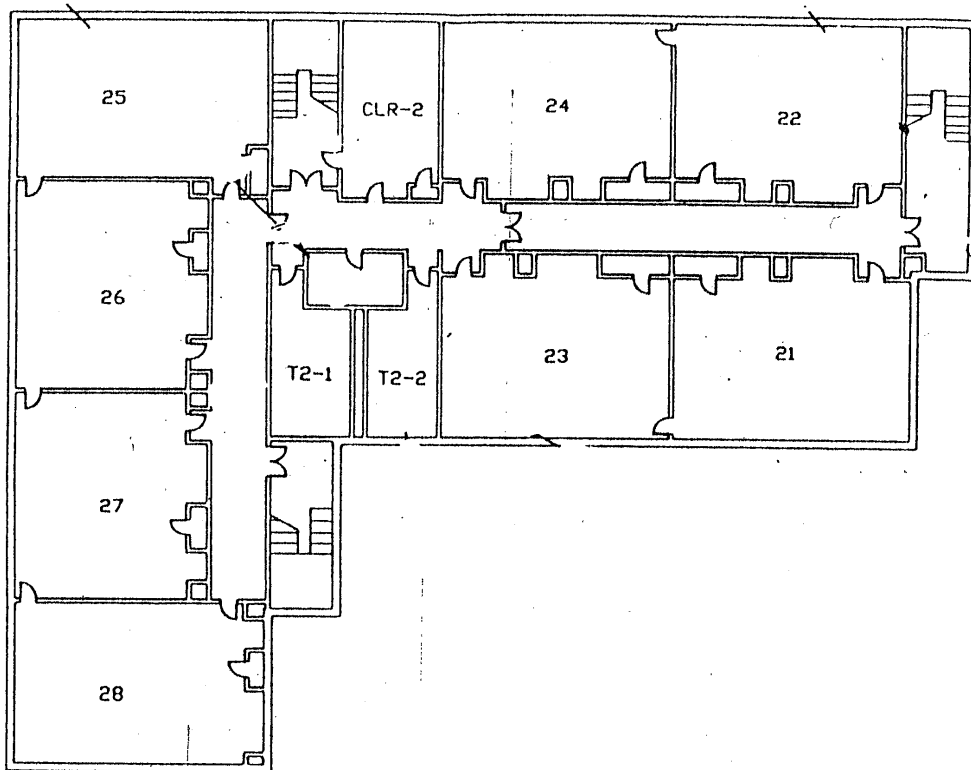


3. Occupancy Schedule: 270 to 300 students occupy the facility Monday through Friday in addition to 30 facility members

4. Site layout:



First Floor



Second Floor

## D. Facility Details

1. Gross Floor Area: (2) stories with similar floor plans totaling 34,500 square ft
2. The entire floor area is heated. No cooling takes place on site.
3. With the exception of several doors, fenestration is original to the construction of the building.
4. Insulation levels in the walls are original to construction. The entire building is a brick façade. Several portions of the roof have additional rigid board insulation added in the past 20 years. Some portions of the roof may have become saturated.
5. One gas meter is located outside the boiler room in the South East corner. This meter supplies all of the natural gas to the site.
6. The building is 43 years old and would benefit substantially from efficiency upgrades as all of the building construction is original.



## III. Analysis of Current Energy Usage

### A. Review of data and analysis of trends

1. Space heating: Consumption attributed to space heating in 2009 is estimated at 19,553 therms when normalized for local degree day data. Although the facilities department is constantly monitoring and adjusting the boilers to save gas, a recently added after school program has negated such savings due to the necessity of added heating hours<sup>1</sup>.
2. Domestic Hot Water: Used for janitorial purposes and hand washing in lavatories. There is a small sink in the kitchen but it is used minimally. Based off of analysis of gas consumption it is predicted that the school consumed 851 therms for domestic hot water in 2009.
3. Cooking: All cooking is done off site.
4. Processes: There are no processes that occur on site.

<sup>1</sup> The after school program is open for three hours after normal educational hours are complete.

## IV. Proposed / Installed Energy Improvements

### A. Boiler Replacement

Prior to the site visit the customer expressed interest in converting the current 2-pipe steam system over to hot water. This item was considered but is not economically feasible. It would require removal of the cast iron piping and most likely asbestos abatement.

Heat is provided via (2) HB Smith boilers over 40 years old. These boilers were converted from oil to natural gas around 10 years ago and received new industrial combustion burners. These Low-High-Off burners have the following specifications:



Capacities & Specification	Burner Size
Gas Input (Mbtu/hr)	3,000
Oil Input (U.S. GPH)	21.4
Boiler HP @ 80% EFF.	72
Gas Manifold HP ("w.c.)	3.5
Blower Motor HP	3/4
Approx. Shipping Weight (lbs.)	500

The boilers are primarily controlled automatically unless facilities know that the boiler may benefit from being shut off. Operating pressure is set to 3 ~ 5 psi. A 20 minute cycle allows the boilers to run for a total of 5 minutes.

Tables with your boilers' current combustion reports are below:

Boiler #1	
Date:	6/19/2009
Flue Temperature	409.1 F
O2	12.00%
CO	10 ppm
Comb. Eff.	77.70%
CO2	5.00%
Excess Air	116.30%
Ambient Temp.	68.2 F

Boiler #2	
Date:	6/19/2009
Flue Temperature	385.6
O2	5.30%
CO	25 ppm
Comb. Eff.	83.50%
CO2	8.70%
Excess Air	30.00%
Ambient Temp.	68.2 F

Boilers are serviced every summer and are maintained in good condition considering their age. It is recommended that new high efficiency steam boilers be installed instead of converting to a hydronic system. Newer boilers are capable of producing steam at an efficiency of 85% while also following the building's load closer. It is estimated that installation could save 3,450 therms annually.

## B. Steam Trap Assessment

Steam traps were checked 10 years ago. It is unknown exactly how many there are but I was told that there are a significant amount of them. Traps are replaced on an as needed basis.

It is recommended that the facility receive a steam trap assessment. The purpose of this assessment is to test the operational status of the traps. Identifying which traps need to be replaced and are not properly functioning allows you to maintain your facility's heating system at a high operational efficiency. New steam traps will improve the heating system's energy efficiency, but also provide better temperature control and comfort for the occupants. Compared to poorly operating steam traps, new steam traps will typically reduce fuel usage by approximately 10 to 20 percent of the heating system's related energy usage and cost. National Grid will pay for 25% of the survey cost. Executing at least half of the measures noted in the survey permits another 25% of the survey to be paid. Please note that funding is capped at \$10,000 for a steam trap assessment.

National Grid offers prescriptive incentives for the replacement of steam traps. Currently in MA replaced steam traps are eligible to receive \$25.00 per installed unit (limit 100).

## C. Domestic Water Heater

Domestic hot water is provided via (1) State Select High-Output Residential Gas Water Heater. This atmospheric water heater has a storage capacity of 74 gallons and an input of 75,100 btu per hr. This boiler was installed May 16, 2006. There are no problems supplying enough hot water to the 10 bathrooms, janitorial purposes, or the kitchen. It would not be cost effective to upgrade the current system at this time as the units are still new.

When the time comes to replace the module you may want to consider a standalone condensing water heater. These heaters are upwards of 96% efficient and are eligible for a prescriptive incentive. Condensing Standalone water heaters with thermal efficiency of 95% or greater and greater than 75,000 btu may receive \$500.



#### D. Destratification Fans

The multipurpose room, used as a gymnasium, cafeteria, and auditorium, is conditioned by 1 large air handling unit. Although the ceiling height is only 14 feet, facilities made it evident that a 20 degree temperature differential between the floor and the ceiling can exist.



Destratification fans may be a good application. When air is heated, it rises. Air layered by temperature, or thermal stratification, develops in areas with high ceilings. These high ceilings permit creation of temperature differentials which are more easily defined and have a much greater impact on heat loss. Air at the ceiling is much higher in temperature than it is at the floor level. Destratification fans help to alleviate this differential and provide even temperature distribution. The fans are suspended from the ceilings and may offer significant gas savings for the affected area. Cages and impact resistant fans do exist and would help to prevent damage that may be afflicted during sports activities. This measure is evaluated through the custom program.

## E. Windows

While visiting the facility it was noticed that windows may need to be replaced. The current windows are original to the building and have a high U-value. Air infiltration is an issue with older windows as air is able to escape between the



window and the framing. It is recommended you choose at least a double paned window with a low U-value (0.55 or lower). A thermally broken window, filled with argon, and having a Low-e coating will all improve the energy efficiency of the window system. In MA all window replacement measures are looked at through our custom program. Windows would be analyzed by comparing the baseline performance of the current fenestration system to the upgraded fenestration system taking into account both transmission and infiltration.

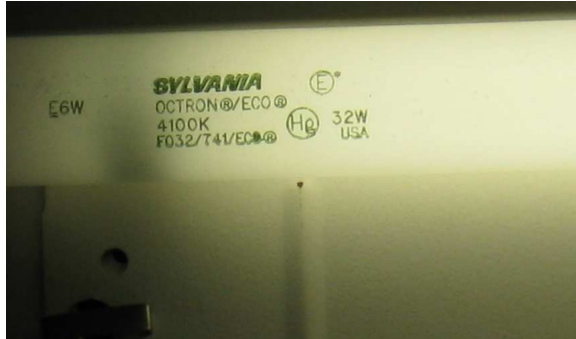


Currently glass blocks above the operable windows offer low visibility and have a minimum insulating value as many are broken from the outside. If visibility is not an issue, it is recommended to install a translucent window replacement. Kalwall manufactures a window replacement system. This system is not only translucent to allow light to enter but has a high thermal efficiency with R-values ranging from 13 to 20. This project should be evaluated closer as the upfront cost may be high. The system may be eligible for an incentive under the current program if the project is able to pass a benefit cost ratio test.

## F. Electric Opportunities

A little retrofit / upgrade was performed on the school 10 years ago. All interior hallway and classroom lights have electronic ballasts with 32w T8 lamps (FO32 741 Eco bulbs). A re-lamp and re-ballast could be performed by installing a 28w lamp with a low ballast factor ballast. You should contact your electric service provider (National Grid) to determine eligibility to receive an incentive.

As this facility is a school it has relatively low hours of operation. The new after school program may help to better the project economics.



## V. Executive Summary

### A. Energy Action Plan

1. In culmination the Hoover School has much potential to save energy. National Grid incentives are designed to offset 50% of the incremental cost in going from standard efficiency to high efficiency equipment. If there are particular aspects to this report that you would like to explore further please contact your energy engineer to guide you through the process.

2. I recommend that upgrades be performed in the following order:

1. Steam Trap Assessment – Identify underlying problems and perform recommendations to improve the distribution system efficiency
2. Steam Boiler Replacement – Replace the current steam boilers with high efficiency units
3. Envelope Improvements – Tighten up the envelop via window and door retrofit projects

*\*Recommendations made in this report are based on engineering estimates. Costs and saving are not guaranteed. It is recommended that the customer obtain a proposal and firm price from a qualified contractor for recommended measures before making final decisions about a course of action. Utility provided incentives indicated in this report are valid for the equipment and/or measures recommended. Any change in the measure, equipment size or efficiency may change or eliminate the amount of the incentive. It is recommended that you contact the energy auditor who prepared your report to answer any of your questions.*

**VI. References**

Normalization Affected by Weatherization										
Month	Days	Read Date	Therm Equivalent	Degree Days	30 yr avg. DD	Therms affected by DD	"HW" Gas Consumption	Load Change Factor	Revised "Affected" Load	Normalized Consumption
January	33	1/13/2009	4,634	1,240	1,104	4,552	83	89.03%	4,052	4,135
February	29	2/11/2009	4,349	899	951	4,267	83	105.78%	4,513	4,596
March	29	3/12/2009	3,462	846	815	3,380	83	96.34%	3,256	3,338
April	29	4/10/2009	2,382	447	503	2,300	83	112.53%	2,588	2,670
May	32	5/12/2009	839	193	233	757	83	120.73%	913	996
June	30	6/11/2009	69	79	48	0	69	60.76%	0	69
July	34	7/15/2009	54	14	4	0	54	28.57%	0	54
August	29	8/13/2009	27	6	8	0	27	133.33%	0	27
September	32	9/14/2009	27	89	84	0	27	94.38%	0	27
October	29	10/13/2009	96	399	344	0	96	86.22%	0	96
November	29	11/11/2009	1,896	496	604	1,814	83	121.77%	2,208	2,291
December	29	12/10/2009	2,222	986	932	2,140	83	94.52%	2,022	2,105
Annual	364	Annual	20,057	5,894	5,630	19,207	851	Annual	19,553	20,403