



## RESIDENTIAL ENERGY ANALYSIS REPORT

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Client: Sample

Date of Inspection: 12/3/08

### Scope of Analysis and Report:

1. Visual inspection to identify existing energy related problem areas.
2. Blower door test to identify overall air leakage / infiltration.
3. Infrared scan to identify and illustrate air leakage and potential insulation problems.
4. Provide suggestions on energy efficient upgrades to improve home's overall energy efficiency and performance.
5. Provide a written report outlining findings and remediation strategies.

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Structure Type: Single family home / Two story

Heating Fuel: Natural Gas

Fuel Cost: \$1.53 / Therm

Annual Usage: 1998 Therms / Baseline (not used for heating) 20 Therms per month

Electrical Cost: \$.15 / KWH

Floor Area: 3300 Square Feet (includes partial finished basement)

Volume: 26400 Cubic Feet

**HOME HEATING INDEX (HHI)****HHI**

HHI is a measurement of a building's energy efficiency that quickly evaluates a building's energy saving potential.

It is the number of BTUs of energy used by a building divided by its area (SQFT) and then the number of heating degree days (HDD) for the climate region over a specific time period.

$$\text{HHI} = \text{BTU/Sq.Ft./HDD}$$

A HHI can vary from 2 in very efficient homes to 20 or more in inefficient homes. Homes with a HHI of 6 or more can benefit from energy efficient improvements. Those with the highest HHIs benefit the most.

Natural gas = 100,000 Btu per therm / Fuel oil = 138,690 Btu per gallon /

Propane = 91690 per gallon

Electricity = 3412 Btu per KWH / HDD FOR Boston = 5634

**Analysis:**

Based on the utility bills you have provided and adjusting for baseline consumption,

**your HHI including finished basement is 9.45.**

Your HHI without finished basement is 11.6.

Your home would benefit from energy efficient upgrades.

## AIR INFILTRATION and BLOWER DOOR TESTING

### AIR INFILTRATION

Air infiltration is one of the largest contributors to a home's energy inefficiency and can represent up to 40% of its space conditioning costs. Although sometimes difficult to control, air sealing can be the most cost effective energy conservation improvement to make. Conditioned air, air that has cost money to heat or cool, leaking to the outside of a home will be replaced naturally, by unconditioned air from the outside. The rate of replacing that air is measured by the number of times the entire volume of air within a home is replaced (ACHnat). Minimizing and controlling ACHnat is fundamental to a home's energy performance, increased comfort, air quality, insulation's thermal integrity, moisture control, mildew control and building durability.

The old adage regarding home ventilation, "a house needs to breathe" would be better represented by "build tight and ventilate right". Rather than counting on unpredictable air leakage, ASHRAE Ventilation Guidelines can be met utilizing more controlled and reliable mechanical ventilation system.

### BLOWER DOORS

Blower doors are pressure-testing tools used to determine the air tightness of a home. They measure and can help locate air leaks in the air barrier of a home. Natural air leaks can be difficult to measure and blower door tests, at increased air pressures of 50 pascals, provide constant, measurable and repeatable results. Those results, measured at CFM50, are converted to ACHnat using volume and an "n" factor (related to a homes climate region, height and exposure).

## Analysis:

Description		
Area (including finished basement)	3300	Square Feet
Conditioned volume	27780	Cubic Feet
Fuel Cost per Therm	\$ 1.53	Per Therm
n Factor	14.8	
Blower door test @ 50 Pascals	6300	CFM50

Air changes per hour at 50 Pascals	13.6	ACH50
Natural Air Leakage	426	CFM <sub>Nat</sub>
Natural Air changes per hour	0.9	ACH <sub>Nat</sub>
Approximate Leakage Area	630	Square Inches
Annual air leakage heating cost	\$ 715.52	ALH

Your home is leaking at approximately three times the Code compliant building standard. An aggressive plan to reduce air infiltration should be implemented before any other energy savings measures are taken.

Blower door testing and Infrared scanning revealed a number of leaks in the building's envelope. They are listed below with suggestions for remediation:

- Attic floor:  
The attic floor had the most significant air leaks. Due to the framing technique used in constructing the house, there are numerous pathways (thermal bypasses) connecting the interior of the house and basement with the outside through the attic. Exterior and interior walls without plates allow air to migrate to the attic. My suggestion, especially considering your vocation, would be to remove the attic floor to gain proper access to the second floor wall extensions and any other thermal bypasses. While there is access, exterior walls should be checked for and filled with appropriate insulation from the top before sealing. Infrared testing indicated what appeared to be voids and settling insulation in some of the wall cavities. Cellulose or foam would be good choices to fill those voids due to their inherent filling and air sealing properties. Once insulated, each wall cavity should be capped / blocked off and properly air sealed. This can be achieved by caulking each cap individually when installed or later with a two part closed cell foam spray. Zero Draft makes a kit for this purpose and it is available from EFI in Westboro, Ma. ([www.efi.org](http://www.efi.org)) Interior walls are also connected to the attic and should be similarly blocked and sealed, thus reducing inside wall airflow as evidenced by the pocket door leakage in the main hallway.

Since there are no band joists in balloon framing, air can migrate from the inside via the second floor cavity. Access to those areas is more difficult but could be achieved from the outside by removing siding or from inside by removing baseboards and filling and sealing the voids with spray foam.

- **Chimney:**  
With the attic floor removed, there is access to the gap between chimney and the second floor ceiling framing. Similarly, seal the gaps between the chimney and main floor in the basement. Gaps should be blocked with metal and sealed with a fireproof caulk and/or foam. Check with your building inspector for Code compliance.
- **Rim Joist:**  
The rim joist and any open wall cavities accessible from the basement should be blocked with rigid insulation and sealed with caulking or foam or with two-part spray foam, as recommended for the attic. Additionally, the areas above the walls separating the conditioned from unconditioned basement should be filled in, air sealed and insulated.
- **Band Joists:**  
There are two frame floors, one over the front entrance and one over the old office that should be sealed with two-part spray foam before increasing insulation levels by completely filling the cavities. If a decision is made not to fill the cavities, note that heat transfer differs between the two areas. Over the front entrance install insulation to be in contact with the bedroom floor above. Over the office install the insulation to be in contact with the office ceiling. Access to the floors will require some demolition but their limited areas will mitigate upgrade costs.
- **Second Floor Bathroom**  
The ledge over the second floor bathroom shower has a good size connection to the outside. Use expandable foam for air sealing.
- **Fireplaces:** The fireplaces leak through the flues. Inflatable bladders are available for the flues to block air from exiting the house. Check with local building inspectors for Code compliance. Obviously, care should be taken to mark their presence and to remove these items when using the fireplaces.
- **Doors:**  
All exterior doors and attic access door exhibited air leakage. Complete weather stripping is recommended.

## INSULATION

### INSULATION

Generally, heat transmission is considered to be a home's leading cause of heat loss. Insulation impedes heat transmission and therefore conserves energy, enhances comfort by lowering temperature variations and helps prevent wintertime condensation. Insulation's ability to impede heat transmission is measured by its R-value, or thermal resistance. Higher R-values translate to higher resistance to heat transfer. It is important to install insulating materials properly. Gaps, voids and inconsistent densities drastically reduce performance.

### Analysis:

Visual inspection and Infrared scanning revealed deficits in your home's insulation. They are listed below with suggestions for remediation.

- **Attic Floor:**  
The attic floor had the most significant problems. Further exacerbating inadequate insulation levels are numerous voids, gaps and areas of missing insulation. As with air sealing remediation, my suggestion would be to remove the attic floor, air seal and bring the insulation level to a minimum of R38. Foam would work well. It would provide air sealing as well as insulation but its high cost could be an issue. Cellulose would be a good second choice with its inherent ability to fill voids. Fiberglass, while being the least expensive, is difficult to install correctly. Gaps and voids drastically reduce its thermal performance. Properly installed attic insulation could save you \$210 to \$250 per year on your gas bill.
- **Exterior Walls:**  
The infrared scan appeared to reveal sagging insulation in the second floor walls and areas above windows. Some of the wall bays appeared to have no insulation at all. Most of the upper wall cavities in the second floor can be accessed and filled from the attic. Lower areas could be filled with cellulose or foam accessed from the outside by removing siding as necessary.

- **Basement Walls:**  
There is little or no insulation in the walls dividing the conditioned basement from the unconditioned basement. Insulate or increase the insulation in those walls to R13 with an air barrier on each side and extend and seal them to the first floor.
- **Basement Ceiling:**  
There is heat loss from the first floor of the home and into the unconditioned basement area. Mass Energy Code requires new homes to have floors between conditioned and unconditioned areas to be insulated to R19. I would suggest, at a minimum, this be done and recommend increasing that to R25 or 30.
- **Frame Floors:**  
Over front entrance and over office should be upgraded when air sealing is done. Note that heat transfer differs between the two areas. Over the front entrance install insulation to be in contact with the bedroom floor above. Over the office install the insulation to be in contact with the office ceiling. Savings similar to those of the attic could be realized.

## INFRARED SCAN

### INFRARED SCANNERS

Infrared Scanners are tools that can detect temperature differences and provide thermal images. These images can be used to pin point thermal flaws in the building shell that may be due to inadequate insulation and/or air leakage.

#### Analysis:

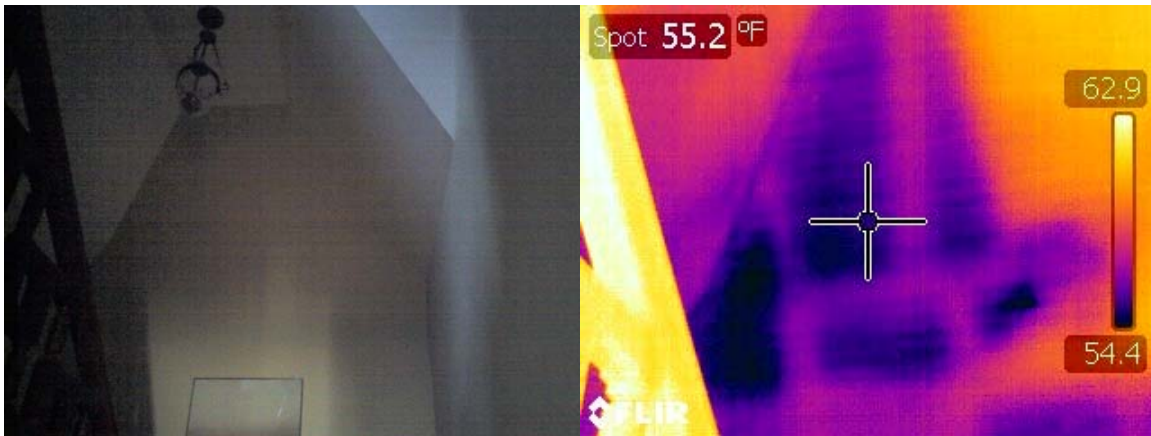


Stairway bay window header and ceiling.



Dining Room window header.





Attic Stairway



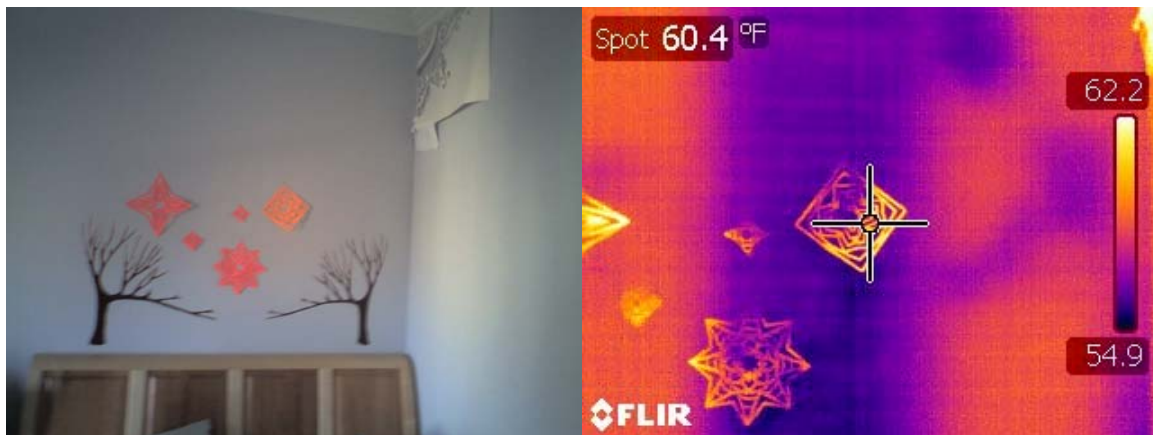
Bedroom



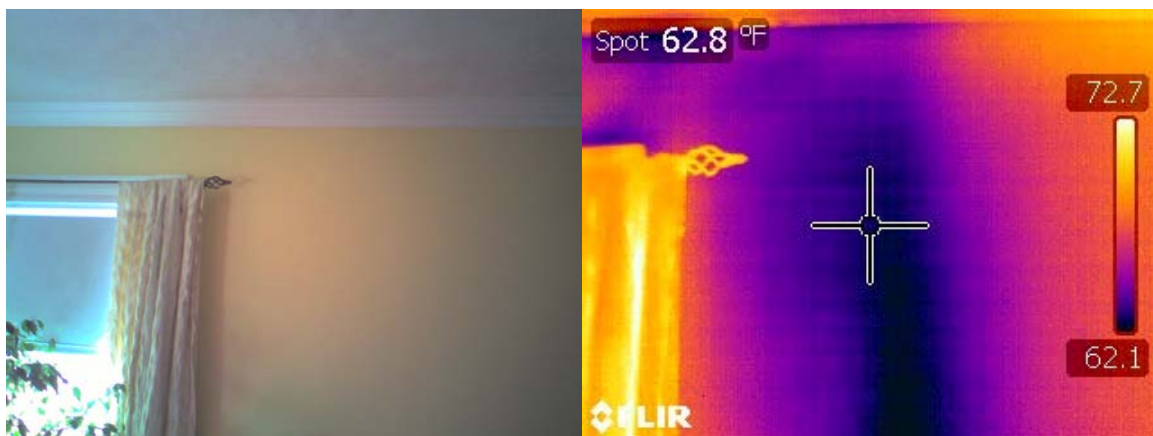
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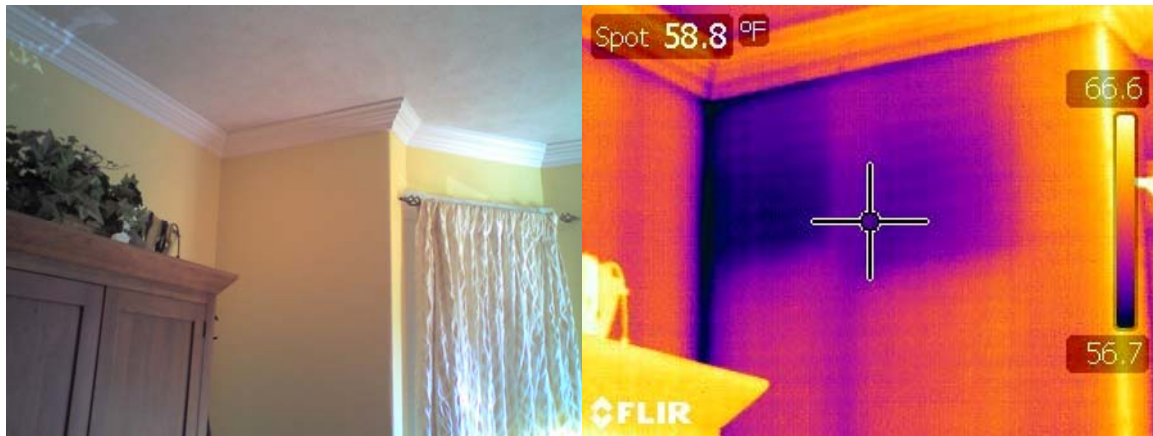
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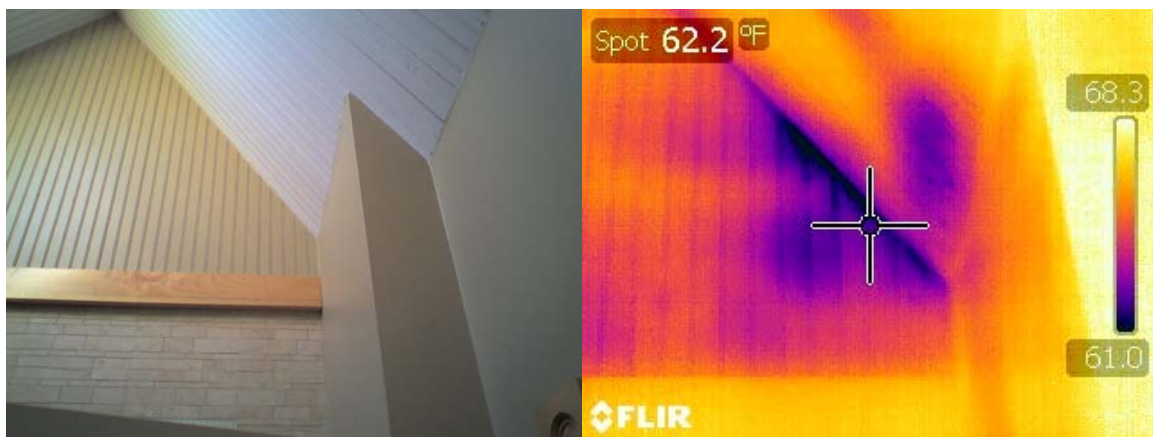
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Bedroom



Bedroom

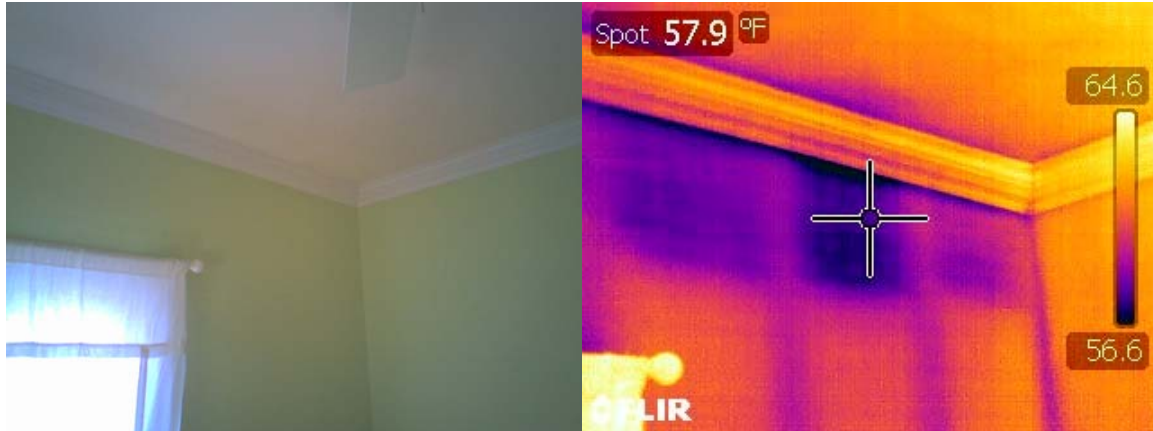


Bathroom



Bedroom





Bedroom

Cooler wall temperatures, indicated by darker colors, show connection to outside and appear to reveal sagging or missing insulation. Warmer wall temperatures, indicated by lighter colors, appear to reveal increased insulation levels.

### **Heating System – Boiler**

No data was available on the age of the boiler. It appears to be several years old indicating that the efficiency would, at best, be 82%. At 82%, 360 Therms costing \$550.00 per year are being wasted. Upgrading to a new boiler with a 92% efficiency rating could save \$306 per year.

Bear in mind that air sealing and increased insulation levels will reduce the amount of Btus necessary to heat the home and therefore savings on replacing your heating system will be effected.

### **Distribution Losses:**

Compounding the boiler's inefficiency are losses in the distribution of its heated water to the various zones in the house. Much of the heat that should be delivered to the heating zones is being lost before it even gets to those zones. Additionally, more heat is lost on the return to the boiler. This means the boiler is working harder to heat the intended conditioned area of the house. Sealed insulation around the distribution pipes as well as the DHW piping will reduce much of the loss and is a very cost effective measure. Extra insulation around the hot water tank would help (Cost approximately \$20).

Adding additional zones, controlled by programmable thermostats, would be another way to reduce heating costs by keeping unused areas of the house at lower temperatures.

### **Rebate Programs:**

Information on rebates or incentive programs on energy conservation measures is available at:

[www.masssave.com](http://www.masssave.com)

### **Ongoing Support:**

If you have any questions or comments regarding this report or proposed energy conservation upgrades, please feel free to call or email me: