
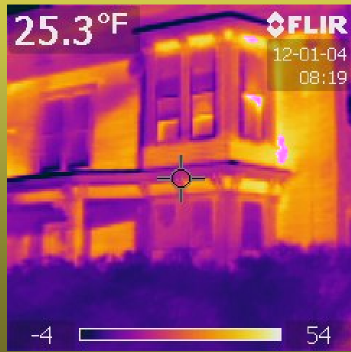

Facility Audit Report

SAU 41 Administration Building

FINAL

May 2012

Prepared for:
Town of Hollis
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Hollis Energy Committee

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A. EXECUTIVE SUMMARY

Program Introduction

The Town of Hollis requested investment grade audits for seven (7) municipal buildings and five (5) school buildings located within the Town. Funding was provided by the United States Department of Energy (DOE) through the New Hampshire Office of Energy and Planning (NHOEP) Energy Efficiency Conservation Block Grant (EECBG) program.

Figure 1: SAU 41 Administration Facility

Phase one of the evaluation process involves site assessment planning including evaluating utility bills, benchmarking, reviewing available building and mechanical plans and coordinating site reviews with facility managers. Phase two involves a comprehensive and holistic facility evaluation to gather relevant information and data. Analyzing the collected data and developing recommendations for energy efficiency measures is completed in Phase three. This information is presented to the Town and School District within this report.

The objective of the building evaluation completed at the School Administrative Unit No. 41 (SAU 41) (Figure 1) is to identify measures that reduce the net energy consumption thereby reducing operating costs and the consumption of non-renewable fossil fuel energies. In addition to energy conservation, the evaluations and recommendations presented herein consider occupant comfort and holistic building performance consistent with its intended use and function. The information obtained as part of this evaluation has been used to develop recommended Energy Efficiency Measures (EEMs). These EEMs provide the basis for future building improvements and modifying the manner in which the building systems are operated.

Procedure

Facility audits or evaluations identify all appropriate EEMs and a financial analysis that considers implementation costs, operating costs, and attainable savings. The objective is to identify the predicted energy savings, the amount the measure will cost, and the estimated payback period for each EEM. The evaluation also identifies any changes to operations and maintenance procedures that will reduce energy consumption. A comprehensive field survey of the facility is completed to evaluate the following:

- *Building Characteristics*
- *Building Use and Function*
- *Envelope Systems*
- *Heating and Cooling Systems*
- *Ventilation Systems*
- *Electrical and Lighting Systems*
- *Domestic Hot Water Systems*
- *Plug Loads*

Following completion of the field evaluation, the data and information are reviewed to develop proposed recommendations for the facility. All information, data, and recommendations are then compiled into a comprehensive report. The final report is then distributed to the municipality or school to assist with implementation and budgeting of the proposed EEMs. The information provided in the reports will assist the owner with determining the best value EEMs for their facilities. The reports also identify potential financial resources available to help fund the EEMs.

On January 4th and January 20th, 2012, AEC personnel completed site surveys at the SAU 41 to obtain the information necessary to complete an assessment of overall building performance. All building systems that impact energy consumption were evaluated including the building envelope, heating and cooling, ventilation, electrical, plumbing, and mechanical. Secondary observations are also reported herein and include building code compliance, life safety, structural systems, and roofing systems. This evaluation also considers whole building performance that measures how well the integrated building systems in the SAU function as a composite system.

AEC completed a desktop review of the data provided by the Town including historical energy consumption data. The field review included an evaluation of all building systems and data collection including an infra-red thermal imaging survey, indoor air quality measurements, lighting density measurements, and metering of lighting fixtures and HVAC equipment. The SAU building was modeled using a building energy modeling computer program (eQUEST®) and calibrated to historical energy data. A series of energy efficiency measures (EEMs) were then simulated in the 3-D building model to measure their effect on energy consumption. Capital investment costs for each EEM were developed, and based upon the predicted cost savings associated with the energy efficiency measure, the payback term is calculated. A savings to investment ratio (SIR) for each EEM is then calculated based on the cost of implementation, the predicted energy cost savings, and the predicted service life of the measure/equipment. Other noted recommendations relate to indoor air quality, occupant comfort, code compliance, accessibility, and life safety.

Summary of Findings

The following significant findings are presented for the SAU 41 Administration Building:

1. A major renovation is required if the facility is expected to continue functioning in its current capacity.

Notable Observations

The following notable observations were made during the desktop data review and/or the building evaluation. Notable observations may be related to data that is outside the normal or expected range, irregularities in building use or function, or problematic systems.

- The SAU 41 office building is a converted residential home with two significant additions. It was not entirely re-purposed for the current use as a commercial office space. Floor plans and layout are not consistent with the current use and function.
- The building requires significant capital investment to modernize the space and systems consistent with building code standards and the current use and function.
- In general, the building does not comply with current building and accessibility code standards for commercial office spaces.
- The building is poorly air sealed. Substantial heat is lost by passive air leakage. Windows throughout the building performed poorly under infra-red imaging.
- The building does not have any mechanical exchange air ventilation systems.
- Typical of older residential buildings, envelope insulation in the building is poor. This is contributes to thermal losses and heating of the attic. This is evidenced by a history of ice damming on the roof eaves.

- Although the building has a modern high-efficiency oil-fired hydronic boiler unit with several zones, the heating distribution systems are inadequate. Dated steam registers are difficult to control and result in inefficient distribution of heating. Windows are opened during winter months in over-heated spaces.
- There are no central cooling systems installed in the building and numerous inefficient window air conditioning units (10) are utilized to cool the space in summer months.
- Electrical code issues were noted in the basement including exposed abandoned wiring, unsupported wiring, and unprotected wiring.
- Some structural concerns were noted including deteriorated mortar and loose stones in the original building foundation and cut/removed sections of main carrying timber support beams for the first floor.
- Storm window units are installed in the building however most were observed to remain open in heating months.
- Lighting densities throughout the building exceed industry standards for the prescribed use.

Summary of Recommendations

Following is a summary table identifying the proposed recommendations, EEM investment costs, predicted annual energy cost savings, simple payback period and savings to investment ratio. Part G provides a more detailed explanation of these recommendations.

The energy cost savings and resulting payback are based upon each independent measure implemented for the building in its current condition and function. There are interdependencies among measures that will affect the net composite energy savings. Interdependent measures are parametrically related therefore the net energy savings from two dependent measures do not equal the resulting savings determined by the addition of the two measures considered independent of each other. Investment costs are provided for budgetary planning only. They are estimated based on current industry pricing. A detailed cost estimate should be developed prior to appropriating capital funds for the more costly measures. Budgetary cost estimates for the Tier III and more costly Tier II measures are presented in Appendix J.

Table 1: Energy Efficiency Measures Summary Table

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T1-1	Close all storm windows in the building during heating periods.	$0	$450	0	-
T1-2	Power down all electric equipment when not in use. Install power strips on large consuming items.	$70	$300	0.2	43
T1-3	Seal and insulate open basement window and addition openings in basement foundation wall.	$650	$400	1.6	19
T1-4	Replace clock-face manual thermostats with 7-day programmable units and optimize heating setpoints and schedule consistent with occupancy.	$300	$750	0.4	18
T1-5	Insulate all hot water piping in basement.	$200	$160	1.3	12
T1-6	Install rigid insulation and weather-stripping on the third floor attic door.	$150	$45	3.3	9.0
T1-7	Replace the dated refrigerator with an ENERGY STAR® rated model.	$500	$150	3.3	4.5
T1-8	Reduce lighting densities throughout the building with added task lighting and removal of overhead fixtures.	$350	$80	4.4	2.7
T1-9	Air-seal all doors and windows. Install new weather-stripping at jambs and thresholds. Caulk trim and moldings.	$1,200	$254	4.7	1.5
T2-1	Install a thermostatically controlled solar powered attic roof fan to reduce heating loads in summer months.	$850	$350	2.4	4.1
T2-2	Install 4-mil polyurethane sheeting barrier and 2" foil-faced polyisocyanurate insulation (R-14) on bottom of floor joists of wing addition and tape-seal joints. Apply spray-foam polyurethane insulation around sill interior.	$2,312	$280	8.3	2.4
T2-3	Install 2" rigid polyisocyanurate insulation (R-14) on interior basement walls and tape-seal joints.	$2,448	$220	11.1	1.8
T2-4	Install interior lighting controllers to reduce lighting density and runtime (photosensors, dimming controls, motion sensors, timers).	$1,600	$180	8.8	1.7
T2-5	Replace indirect hot water heater with an electric tankless demand hot water heater.	$2,519	$210	12.0	1.3
T3-1	Remove attic flooring in original building and install blown cellulose insulation in the floor joists, cover with 4-mil polyurethane sheeting air barrier, add 1" polyisocyanurate rigid insulation w/ tape-sealed joints, and cover with 5/8" plywood T&G floor decking.	$6,799	$1,550	4.4	4.6
T3-2	Insulate wall cavities with blown in cellulose. Add 4" of cellulose to the addition attic floor.	$28,911	$1,650	17.5	1.1
T3-3	Replace all older window units with high thermal efficiency fiberglass frame double-pane units (29). Fill cavities with spray-foam insulation and caulk all gaps and moldings.	$18,709	$750	24.9	1.0
T3-4	Replace window air-conditioning units with several split condenser wall mounted units w/ minimum SEER of 20.	$14,663	$850	17.3	1.0

The following table summarizes the renewable energy technologies that were considered for the Hollis Police Department. Scores are determined based upon the feasibility of the technology for the facility. A more focused feasibility study should be completed prior to considering any renewable energy system(s).

Table 2: Renewable Energy Technology Feasibility Scoring Results

Renewable Energy Technology	Grade
Biomass Heating	79%
Geothermal Heating/Cooling	79%
Ground Photovoltaic	78%
Solar DHW	75%
Wind Turbine Generator	68%
Roof Photovoltaic	68%
Solar Thermal	61%
Combined Heat & Power	59%

Insulation resistance values (R-values) were determined based on given information, time of construction and visual observations. The industry standard *International Energy Conservation Code (IECC), 2009* for Commercial Buildings in Climate Zone 5 required values are provided along with the installed values in Table 3. The IECC values are for new construction only, however provide a guide as to how this facilities insulation compares with new construction.

Table 3: Facility Insulation Summary

Insulation Values			
Space	Required (IECC, 2009)	Recommended	Installed
Basement Floor	NA	10	1.0
Non-Basement Floor	NA	10	2.7
Wall System	13.0 +3.8 ci	13.0 +3.8 ci	11.9
Roof	38	38	14.4

Master Planning Considerations

The School Administration Unit Building 41 is a two-story residential structure constructed in 1900 and re-configured to provide commercial office spaces for the Hollis-Brookline Cooperative School District (HBCSD) and an unconditioned storage space for the school. The building has undergone two major additions to provide added office space. The facility and land are currently owned by the Town of Hollis and rented to the school district at a low cost. Space in the current building is constrained. Renovating the unconditioned attic space to provide additional offices is being considered. Access to one of the offices on the first floor involves going through a meeting room which creates a circulation conflict.

Figure 2: SAU 41 Building

The envelope integrity of the building is poor allowing substantial thermal transfer and air leakage. This results in frequent operation of mechanical systems to maintain setpoint temperatures. Heating and cooling distribution is poor resulting in reduced occupant comfort. Windows are opened in the heating season to regulate temperatures. The boiler is an efficient unit installed two (2) years ago. Heat is distributed by dated steam registers and through uninsulated pipes which resulting in poor heat distribution and thermal losses. A window air-conditioning (A/C) unit in the server equipment closet operates frequently. A window A/C unit in a second floor office remains installed year-round allowing additional air leakage. Nine (9) additional window A/C units are installed in warmer months to cool the office spaces. This inefficient means of conditioning the building requires a substantial amount of energy usage.

Due to current inefficiencies in energy consumption and in overall building space, a substantial capital investment is necessary to improve the building consistent with modern standards and code requirements for a commercial office space. There are several energy efficiency measures (EEMs) that will provide a reasonable savings to investment ratio and improve occupant comfort. However, prior to appropriating funds for the more costly measures, a feasibility study is recommended to ensure that the measures are consistent with future plans for the facility.

B. PROCEDURES & METHODOLOGY

Standards and Protocol

The American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has developed the most widely accepted process for completing energy audits at commercial facilities. ASHRAE document RP-669, SP-56, *Procedures for Commercial Building Energy Audits* defines several levels of audits. The appropriate level of audit for a particular facility depends on the availability of existing data and information, owner objectives, and owner budget. Levels range from simple benchmarking to a comprehensive review of all building systems. The most comprehensive audit is a Level III audit which was performed at the facility. Level III audits are commonly referred to as "Investment Grade Audits".

Basic elements of a Level III Investment Grade Audit include the following:

- A review of existing facility data including energy usage.
- Benchmarking the facilities energy usage relative to similar use facilities.
- An on-site inspection and survey of all facility systems.
- On-site measurements and data collection.
- Informal interviews with owners, facility managers, and occupants.
- Energy use analysis and development of efficiency measures.
- Developing a simple payback cost estimate for each recommended measure.
- Development of a comprehensive report that clearly presents all findings and provides recommended energy conservation measures and the associated costs.

In addition to the ASHRAE standard for commercial audits, there are industry and code-based standards that must be considered when analyzing building systems and evaluating energy conservation measures. All recommendations must be consistent with the intent of these standards. For example, the US Environmental Protection Agency (EPA) has established a recommended carbon dioxide (CO_2) threshold concentration of 1,000 parts per million (ppm) to promote a healthy indoor air environment. ASHRAE defines recommended temperatures, relative humidity levels, minimum ventilation rates, and energy standards. The Illuminating Engineering Society of North America (IESNA) prescribes recommended lighting densities based on the designated space use. The International Code Council (ICC) is the adopted standard for all building and energy codes (2009) in the state of New Hampshire. New Hampshire has also adopted ASHRAE Standards 62.1 and 90.1.

Table 4: Relevant Industry Codes and Standards

Standard	Description
28 CFR Part 36	ADA Standards for Accessible Design
ANSI/ASHRAE Standard 55	Thermal Environmental Conditions for Occupancy
ANSI/ASHRAE Standard 62.1	Ventilation for Acceptable Indoor Air Quality
ANSI/ASHRAE/IESNA Standard 90.1	Energy Standards for Buildings Except Low-Rise Residential Buildings
ICC 2009	International Building Code (IBC)
ICC 2009	International Existing Building Code (IEBC)
ICC 2009	International Energy Conservation Code (IECC)
ICC 2009	International Mechanical Code (IMC)
ICC 2009	International Fuel Gas Code (IFGC)
IESNA Lighting Handbook	Reference and Application
NFPA 70	National Electrical Code (NEC)

While the primary objective of an energy audit is identify energy conservation measures, such measures cannot adversely affect occupant comfort and indoor air quality. For example, if a building ventilation system is inadequate then it would be recommended that additional ventilation capacity be added. The electrical power required to operate the added ventilation equipment would increase energy consumption. Typically, the net energy usage incorporating the sum of the recommended conservation measures would still be less than the current usage even with the added ventilation equipment.

It is noted that although there is a prescriptive approach to commercial building audits, that every building is unique in many ways. Buildings should be evaluated consistent with the characteristics that define its need and appropriate function. This includes the following:

- *Use*: Current building use and occupant needs.
- *Systems*: Building systems characteristics and integration.
- *Control*: The effectiveness in which the existing building systems controls are utilized.

Desktop Data Review

Ideally, the building owner provides all available information to the engineering firm prior to initiating the facility site review. Information such as utility bills, building plans, repair records, planned improvements, and occupant concerns will help the building engineer identify potential issues before initiating the site review. The Building Engineer can then focus the site review toward problematic and energy intensive building systems.

Facility Site Review

Following the desktop data review, the Engineer initiates the facility site review. This review includes all major building systems including the envelope, electrical, mechanical, heating, cooling, and ventilation. The Engineer not only determines the performance and operating characteristics of all building systems, they also evaluate how the users operate the systems and how they perceive building performance. Photographs of representative systems, major equipment, and any identified issues are obtained to help document existing conditions. Field notes are maintained by the Engineer to further document building and user characteristics.

Data Measurements

In addition to collecting equipment information, several data measurements are obtained as part of the facility site review. This data is necessary to identify potential building issues and to collect the information needed to develop an accurate energy analysis. Measurements include:

- Infra-red thermal imaging survey of the building envelope.
- Indoor air quality (IAQ) measurements (temperature, relative humidity, and CO_2).
- Lighting metering to determine energy use and operating schedules.
- Lighting output density.
- Metering of energy intensive electrical equipment (e.g., motors, compressors, heaters) to determine energy use and operating schedules.
- Metering of energy intensive plug-loads to determine energy use and operating schedules.

Data Gap Review

Once the facility site review and data measurements are substantially complete, the Engineer begins reviewing and processing all of the collected data. Any data gaps discovered during this process are addressed prior to completing the audit report.

Energy Modeling and Conservation Measures

To identify the best value EEMs and ensure that the calculated energy and cost savings are relatively accurate, a DOE approved energy modeling software program is utilized. A three-dimensional model of the building is created using the simulation program. This includes all characteristic envelope systems, HVAC systems, domestic hot water systems, and mechanical systems. The geographic position and orientation of the building is input and regional climatic data is imported from the program database.

After the building is accurately modeled, the program simulates building performance and provides the estimated energy use for electric and heating fuel(s). The Engineer then compares the energy data to actual building data. The cause for any significant differences is determined and the building is re-simulated until the model closely matches the actual data. AEC utilizes eQUEST© for all building simulations and energy modeling.

With the base model complete, the Engineer then implements various energy reducing measures and simulates the performance of the building with the new measure. The resulting energy consumption is then compared to the baseline model and predicted energy savings are analyzed.

Cost Estimating and Payback

The cost for implementing each evaluated EEM is then estimated by the Engineer. This provides a net estimated energy savings per dollar invested. Simple payback calculations determine the number of years required for the capital investment cost to equal the present day cost savings realized from energy reductions. The savings to investment ratio (SIR) is the accumulated annual cost savings (as determined by the expected service life of the material or equipment associated with the EEM) divided by the cost of investment. A SIR equal to 1.0 indicates that the EEM has a “break-even” or net-zero cost. The higher the SIR, the more favorable the return on investment is.

C. FACILITY INFORMATION / EXISTING CONDITIONS

Setting

The School Administration Unit 41 building (SAU 41) is located at 4 Lund Drive, in Hollis, NH (Figure 3). The building and facilities is set on a parcel of land owned by the Town of Hollis. The building is accessed off of the west side Silver Lake Road (State Route 122) and is a half mile north of the center of Town. Parking is available along the south side and north side of the facility. There is a large storage barn to attach to the rear of the building that is unconditioned. The gross area of the SAU building is 8,096 square feet.

Figure 3: SAU 41 Facility

History

The building was constructed in 1900 as a residential building and reconfigured to serve and as office building in the 1970s. Plans and building date information were not available. It was evident that an addition was constructed on the north and west sides of the original structure to increase office space. The building is currently owned by the Town of Hollis and leased to the Hollis-Brookline Cooperative School District (HBCSD).

Use, Function & Occupancy Schedule

The SAU and the land it occupies are owned by the Town of Hollis. The building is a two-story structure and serves as the school administrative offices for the Hollis Brookline School District with multiple offices and a meeting space. The building operates as a typical office building at 40 hours a week year round. Current space is constrained and there is limited capacity for additional space. The interior layout and circulation of the original residential facility is not consistent with a commercial office space.

Anecdotal Information

Anecdotal information includes all relevant information collected during the desktop review, as part of occupant interviews, or general observations noted during the site evaluation. Generally, anecdotal information corresponds to issues or concerns that may not be apparent during the building evaluation. It includes complaints about seasonal occupant comfort, maintenance issues, systems or equipment performance issues, recent improvements or changes in use, and previous reports prepared by others. Anecdotal information obtained during the SAU evaluation includes the following:

- Multiple (10) through window AC units are used for cooling in the summertime.
- The second floor is warm in the morning and gets cools as the day goes on. The downstairs is cold in the morning and is warm in the afternoon.
- Users are considering renovating the attic space to provide additional office space.
- Users are considering reconfiguring the meeting room on the first floor by combining it with the adjoining office.
- Persistent ice damming on the roof eaves indicates that there is significant heat being lost into the unconditioned attic space.

Utility Data

Utility data for the SAU 41 was provided by the District. Table 5 summarizes the total energy consumption for the year including electric and oil usage. Energy consumption and cost for electricity per pay period is shown in Table 6 and Figure 4. The regional electric utility supplier is Public Service Company of New Hampshire (PSNH) and No. 2 fuel oil is provided a local supplier.

Table 5 : Annual Energy Consumption (2011-2012)

Energy	Period	Consumption	Units	Cost
Electric	March 2011 – February 2012	21,630	Kilowatt hours	$3,682
No. 2 Fuel Oil	March 2011 – February 2012	1,620	Gallons	$4,864
Total Annual Energy Cost:				$8,546

Over the twelve (12) month period (2011-2012), August was the peak demand month, consuming 2,640 kWh of electricity. This is most likely attributed to the multiple through window AC units which consume a high amount of energy in the summertime to condition the building. November and December are the lowest consumption months due to the lack of energy intensive cooling equipment.

Table 6 : Monthly Electric Consumption (2011)

Month	Electric Consumption (kWh)	Electric Cost
Mar	1,750	$287
Apr	1,700	$263
May	1,560	$236
June	2,050	$328
July	2,320	$356
Aug	2,640	$407
Sep	1,970	$304
Oct	1,750	$325
Nov	1,460	$295
Dec	1,460	$296
Jan	1,490	$294
Feb	1,480	$289
Totals:	21,630	$3,682

Annual electric usage for the SAU 41 based on the most recent data provided by District (March 2011 through February 2012) is 21,630 kWh at a cost of $3,682. Based on the building size and function, this usage is within the expected range for a commercial office facility.

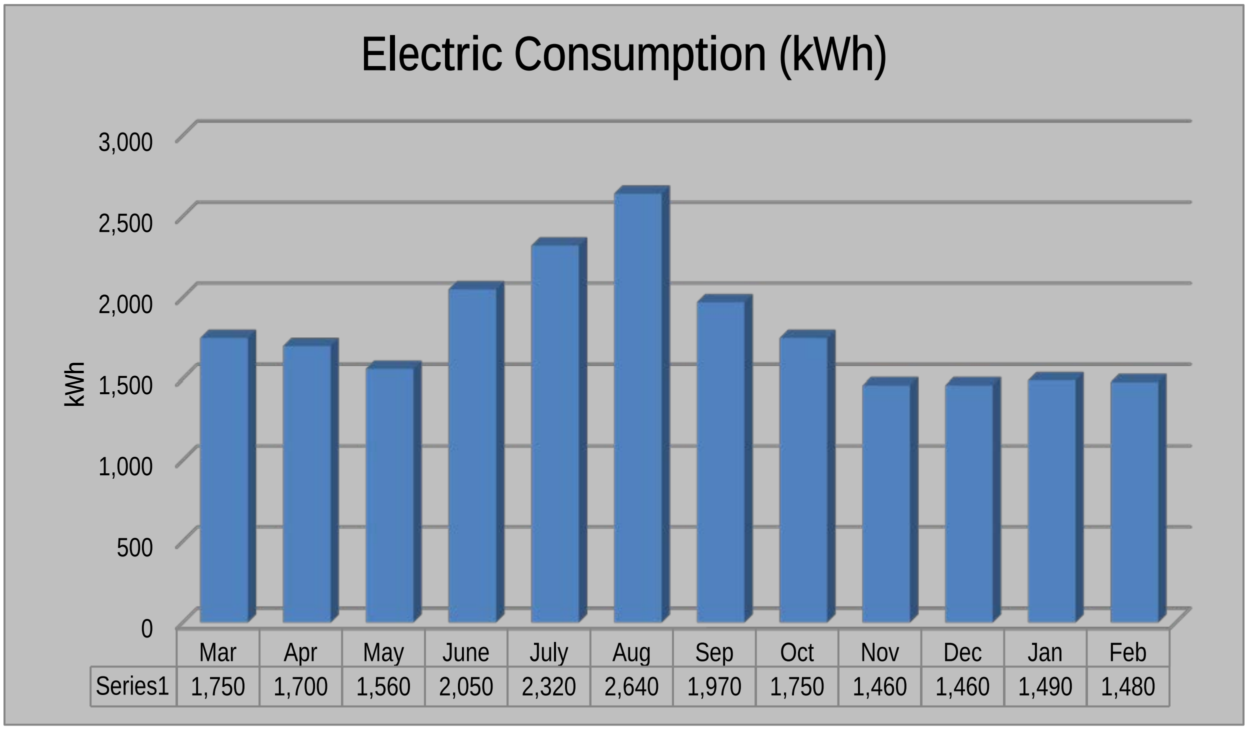


Figure 4 : Electric Consumption (2011-2012)

To provide the most accurate recommendations for energy conservation, the energy consumption based on end use was determined. Table 7 presents the estimated electrical usage for categories including lighting, plug loads, and mechanical equipment. Mechanical equipment includes all hard-wired, permanently installed equipment including ventilation, exhaust, heating, cooling, pumps, etc. These values were determined using observations from the field audit and typical energy consumption data for appliances observed throughout the building. A more detailed accounting of all electrical equipment by end-use is presented in Part C of this Report.

Table 7 : Categorized Electrical Consumption (2011)

Equipment Type	Annual Consumption (kWh/yr)	% of Total Consumption	Annual Cost
Plug Loads	14,452	68%	$2,023
Lighting Fixtures	5,268	25%	$737
Mechanical Equipment	1,580	7%	$221
Totals:	21,300	100%	$2,982

Electrical consumption is largely consumed by plug loads which are mostly due to the through window air conditioners (A/C). The unit in the server room is used year around and ten (10) other A/C units are used in the summer to condition the building. This usage is predicted to be 14,542 kWh/yr and 68% of total electrical consumption. Lighting fixtures consume a moderate amount of electricity at an estimated 5,268 kWh/yr and 25% of consumption. A Town-wide lighting upgrade project competed in 2011 included the SAU building. Mechanical equipment limited to the heating boiler blower consuming an estimated 1,580 kWh/yr.

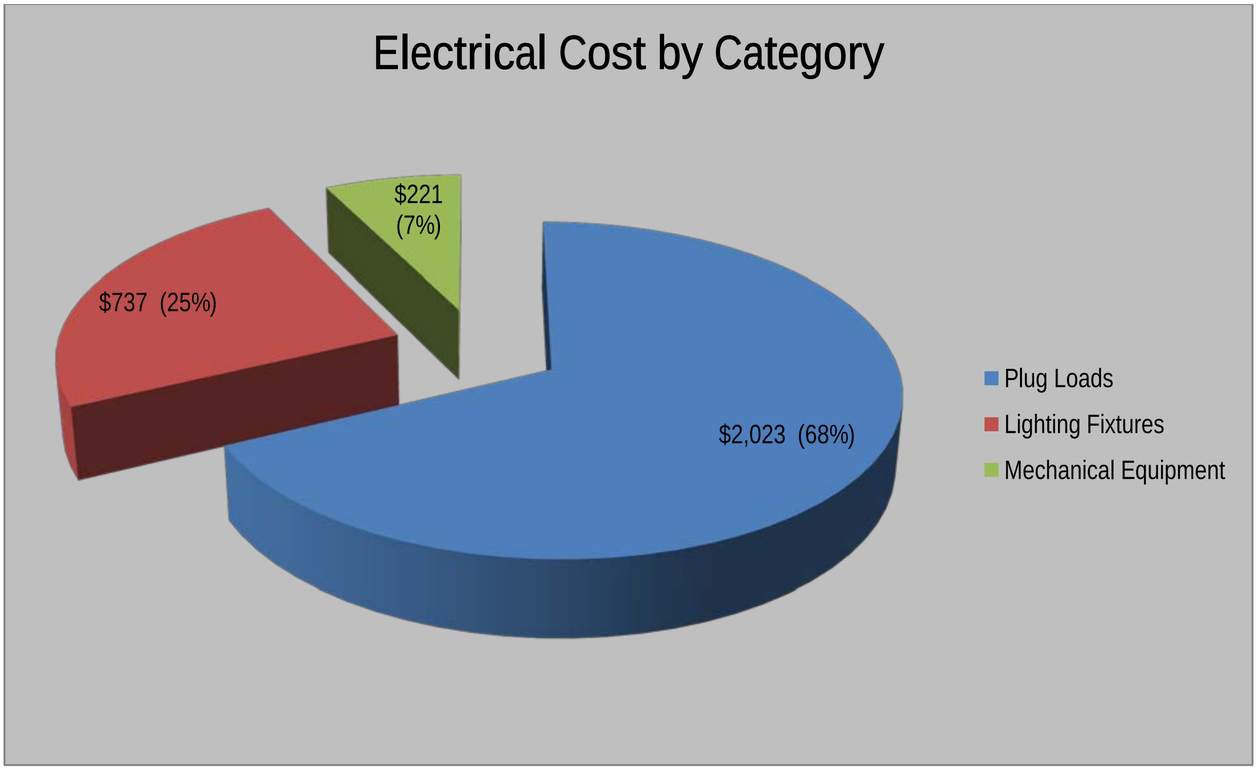


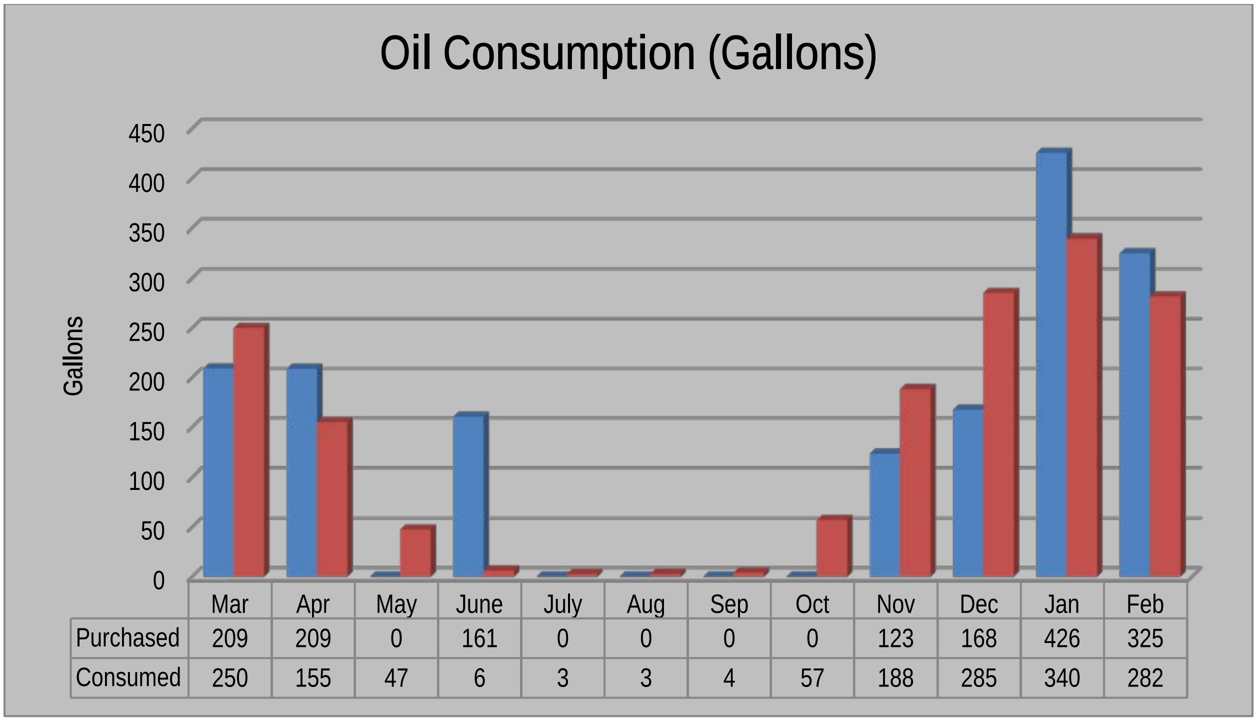
Figure 5 : Hollis SAU Electrical Cost by Category (2011)

Consumption for plug loads is higher than expected. A large amount of the load (5,226 kWh/yr, 36%) is due to the through window AC units. Lighting fixtures consume a moderate amount of electricity but are still within a reasonable electrical consumption at 25% and a cost of $737. Mechanical equipment accounts for an annual cost of $221.

Table 8 : Monthly Heating Fuel Consumption (2011)

Month	Oil Purchased (Gallons)	Cost of Purchase	Oil Consumption (Gallons)	Cost of Consumption
Mar	209	$504	250	$602
Apr	209	$503	155	$374
May	0	$0	47	$140
June	161	$512	6	$20
July	0	$0	3	$9
Aug	0	$0	3	$9
Sep	0	$0	4	$13
Oct	0	$0	57	$182
Nov	123	$396	188	$605
Dec	168	$538	285	$915
Jan	426	$1,366	340	$1,090
Feb	325	$1,044	282	$904
Totals:	1,620	$4,864	1,620	$4,864

Heating fuel for SAU is provided by a local supplier. (Table 8, Figure 6). The building consumes 1,620 gallons of oil annually (2011-2012).



	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Purchased	209	209	0	161	0	0	0	0	123	168	426	325
Consumed	250	155	47	6	3	3	4	57	188	285	340	282

Figure 6: Fuel Oil Consumption (2011-2012)

Considering the envelope integrity (insulation and air leakage), mechanical equipment, and use of the facility, the heating fuel usage is within the expected range. A new 87% efficient Buderus® oil-fired boiler was installed in May 2010. This unit is considered relatively efficient for a residential sized oil fired boiler. Poor insulation and heat distribution require a higher demand of the boiler which increases energy usage.

D. FACILITY SYSTEMS

Building Envelope

The following sections present the building envelope systems and insulation values for each assembly. Assembly values are compared to the *International Energy Conservation Code (IECC), 2009* for commercial buildings located in Climate Zone 5. The IECC code is used as a standard of comparison only and existing buildings are not required to comply with the code unless it undergoes a substantial renovation. New construction and major renovations are required to comply with current energy codes. No plans for the building were available during the audit.

Floor Systems

The original building is constructed on a slab on grade concrete floor in the full basement. The addition of the building to the west and north of the original building has a crawl space between the ground and first floor with 2x8 joists supporting the floor. The floor system has an installed assembly insulation resistance (R) value of 1.0 and 2.7 respectively. Although the IECC does not specify an insulation requirement for unheated slab on grade floors in Climate Zone 5, a minimum value of R-10 is generally recommended.

Table 9 : Floor Insulation Values

Floor Area (Basement)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	1.0
			2009 IECC Requirement:	NR
			Best Practice Recommendation	10.0
Floor Area (No Basement)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Plywood	¾	0.9	0.9	0.8
Carpet	NA	1.2	1.0	1.2
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	2.7
			2009 IECC Requirement:	NR
			Best Practice Recommendation	10.0

Wall Systems

The building is timber framed two-story structure with an attached single-story structure on the west side. Exterior walls are clad in vinyl siding installed over the original wood clapboard siding. The interior walls are finished in gypsum wallboard. Wall cavities are insulated with four (4) inches of fiberglass (FG) batt insulation. The interior walls are finished with plaster. The wall systems do not comply with current energy code standards (IECC 2009) as presented in Table 10. Infra-red imaging reveals thermal bridging and non-continuous insulation (Figure 7)

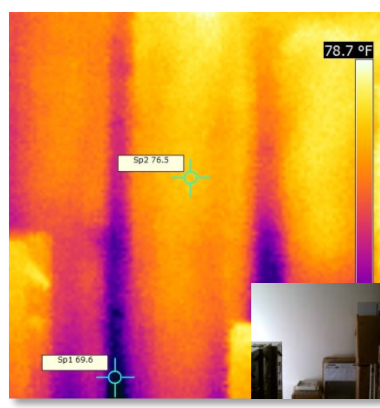


Figure 7: IR Image of Interior Wall

Table 10 : Wall Assembly Insulation Values

Wall Type 1				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Vinyl Siding	NA	0.2	0.9	0.1
Wood Bevel	NA	0.8	0.9	0.7
Wood Planking	1.0	0.8	0.9	0.7
Fiberglass Batt Insulation	4.0	13.0	0.7	9.1
Plaster	5/8	0.5	0.9	0.4
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	11.9
			2009 IECC Requirement:	13+3.8ci

Ceiling Systems

Ceilings throughout the building are finished with plaster. The ceiling of the attic to the roof is exposed bays with FG batt insulation between the bays above the northern addition. The attic of above the single-story addition contains FG batt insulation above the stairs and in the interior walls and blown cellulose fiber on the floor. Ceiling penetrations are not properly sealed allowing additional air leakage.

Roofing Systems

The roof of the building is framed with 2-inch by 8-inch timber rafters with plywood decking. The roof is clad with asphalt shingles. The original roof of the north of the building was built into the new addition with FG batt insulation in the attic floor. A crawl space exists above the attic space of the original building extending east to west with blown cellulose insulation in the floor. The loose insulation is poorly distributed. A portion of the roof extends into the attic space and abuts the exterior walls.

Figure 8: Partially Insulated Roof (ice-damming)

Table 11: Ceiling Insulation Values

Roof Insulation				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Plywood Sheathing	¾	0.9	1.0	0.9
Batt Insulation/Blown cellulous	8.0	21.0	0.6	12.6
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	14.4
			2009 IECC Requirement:	38.0

Fenestration Systems

Fenestration systems on the SAU building include operable double hung windows and partially glazed entry doors. A portion of the single pane windows were replaced with newer double pane units and the existing signal pane units are equipped with storm windows. Consistent with IECC requirements, fenestration performance is measured by the U-factor, the solar heat gain coefficient (SHGC), and air leakage as determined by the unit manufacturer. No manufacturer information was available for the windows or doors therefore compliance with IECC standards for commercial buildings located in Climate Zone 5 cannot be established.

Thermal transfer and air leakage commonly occurs at the seals of operable windows and the interface between the window and the wall opening which was observed using infrared imaging. Recommendations include exterior and interior inspection and re-caulking of window jambs, headers, and sills as needed. If the operable window units have adjustable jambs, they should be inspected and adjusted as necessary to maintain a complete air seal. Overall performance of all of the window units (original and addition windows) is poor (Figure 9).

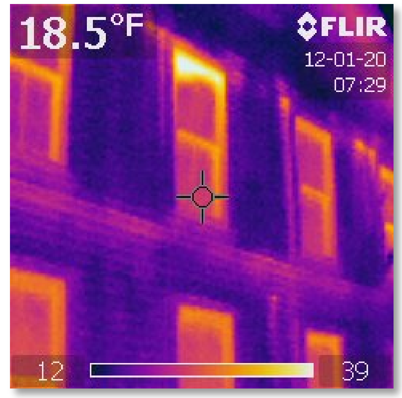


Figure 9: IR Image of Windows

Doors

The door units in SAU building include hollow metal doors with partial glazing. Based on visual observations and thermal imaging, the insulation values of door units are satisfactory however the seals on door jambs, partings, and thresholds are incomplete allowing substantial air leakage (Figure 10). Recommendations include exterior and interior inspection, weather stripping, and re-caulking of doors.

Air Sealing

Based on the thermal imaging survey and visual observations, air leakage occurs through windows and entry doors. Although this is typical even for a modern building, simple measures can significantly reduce air leakage. Recommended measures for windows include: 1) adjusting jamb seals on operating windows; 2) adding weather-stripping; 3) caulking interior frames and moldings; and, 4) locking/clasping windows to maintain a complete seal.

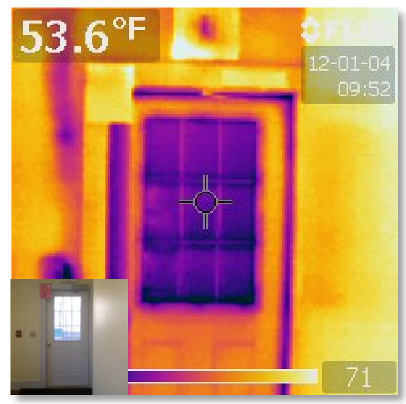


Figure 10: IR Image of Rear Entry Door

Air sealing of all door units can be improved with commercial weather-stripping. All door and window units should be regularly inspected (every 2 to 3 years) to ensure proper operation, identify faulty seals, and to identify any deteriorated caulking requiring replacement. Other air sealing recommendations include inspecting all exhaust and ventilation ducts to determine if they have a positive pressure actuated damper.

Based on the air leakage potential at the SAU 41 Administration Building, a blower door test was conducted to baseline the building before completing any air sealing measures. The test was conducted on the morning of March 7th, 2012. The building was placed under negative pressure to measure leakage in air changes per hour (ACH) through passive leaks in the envelope.

Table 12: Blower Door Results

ACH (-50 pascals)	Flow Rate (CFM)	Est. Annual ACH (normal conditions)
16.80	8,912	0.98

With the building depressurized to -50 pascals the total volume of interior air exchanged 16.80 times per hour or once every 3.5 minutes. A negative pressure of -50 pascals represents the pressure exerted by a 20 mile per hour wind acting simultaneously on all exterior surfaces of the building. ENERGY STAR® recommends that an office building will have less than three (3) ACH under -50 pascals. Therefore, the air is exchanged in the SAU 41 building nearly six (6) times more than the recommended exchange rate indicating there is significant air leakage. This means the envelopes' seal could be greatly improved which would minimize drafts and lost thermal energy while still providing the necessary ACH for fresh air.

Under normal conditions (with no pressure differential) the building has a predicted leakage of 1.8 ACH in winter months and 0.9 ACH in summer months with an average annual exchange of 0.98 ACH.

Thermal Imaging Survey

The thermal imaging survey was conducted on January 4th and January 20th, 2012, Outdoor ambient temperature was approximately 21°F during the first survey and 28°F during the second survey. The survey was conducted using a FLIR© B-CAM infra-red (IR) camera. The building exterior and interior envelope and major mechanical and electrical equipment were surveyed with the IR camera. IR camera surveys not only identify heat transfer through building envelopes, they also identify trapped moisture, electrical system overloading, heat loss through ducting and piping, high energy lighting fixtures, and energy intensive plug load equipment. Appendix B presents the survey report.

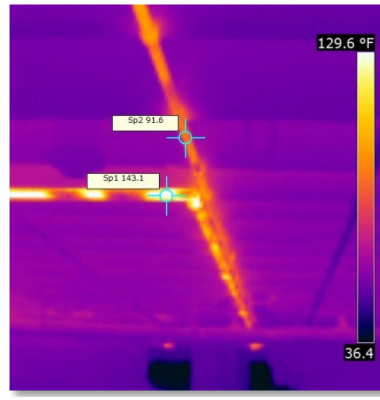


Figure 11: IR Image of Uninsulated Hot Water Pipes

The IR surveys revealed the following notable observations:

- The integrity of wall insulation is poor. Significant thermal loss occurs in all areas of the building.
- Poorly sealed windows and entry doors. The modern windows on the additions performed poorly.
- Uninsulated hot water pipes result in a thermal loss.
- Window A/C units allow substantial thermal transfer and air leakage.
- Cast iron radiators throughout the building operate at high temperatures.
- The server equipment which runs constantly generates a high amount of thermal energy which needs to be cooled by the window A/C unit.

Electrical Systems

Supply & Distribution

Grid electricity is supplied to SAU building by an overhead service with the meter at the southeast corner of the building. The main electrical panel is in the basement along the east wall. Single-phase grid power is supplied to the property by PSNH via overhead transmission lines (three-phase is available at the road).

Figure 12: Electrical Panel in Basement

Lighting Systems

As presented in Table 13, there are five (5) types of lighting fixtures and lamp types at the SAU facility. Lighting in the building was upgraded as part of the 2011 lighting upgrade project throughout the Town. Lighting fixtures in the building consist mostly of recessed mounted high performance T8 fluorescent fixtures. Compact florescent lamps (CFL) are the other most prevalent fixtures in the building with 19 but only total 349 watts. There are a few incandescent fixtures still installed but are seldom used which is most likely why they were not part of the upgrade project. There is one (1) wall pack exterior fixture and eight (8) LED exit signs.

Table 13: Lighting Fixture Schedule

Fixture Lamp Type	Location(s)	Control	No. Lamps	Watts	Qty.	Total Watts
T8	Throughout	Switch	2-4, 8	32	40	2,212
CFL	Throughout	Switch	1, 2, 6	17	19	349
Inc.	Attic	Switch	1	150	3	175
Wallpack	Exterior	Switch	1	94	1	150
LED	Exit Signs	Always On	1	5	8	24
				Totals:	71	2,910

Table 14 presents the energy consumption by lighting fixture type. Lighting fixtures account for an estimated 5,268 kWh of electricity per year. The high performance T8 fluorescent fixtures are the main source of lighting and account for 76% of all lighting energy consumption annually at an estimated 3,998 kWh/yr. The single exterior wallpack fixture consumes the second most electricity for lighting loads at an estimated 9% and 476 kWh/yr. CFL, LED and incandescent fixtures are the remaining 15% of lighting consumption.

Table 14: Lighting Fixture Energy Consumption

Fixture Lamp Type	Location(s)	Est. Usage (KWH/yr)	% of Total
T8	Throughout	3,998	76%
Wallpack	Exterior	476	9%
CFL	Throughout	391	7%
LED	Exit Signs	210	4%
Inc.	Attic	193	4%
	Totals:	5,268	100%

Lighting density measurements in School Administrative Unit 41 building were obtained to establish if building illumination is consistent with the *Illuminating Engineer Society of North America* (IESNA) standards for the prescribed use. These measurements were obtained during normal operating conditions on January 4th, 2012 between the hours of 0838 and 0933. Table 15 presents the lighting density measurements obtained in units of foot-candles (FCs).

IESNA Standards

Lighting densities were recorded at thirteen (13) representative locations. Twelve of the thirteen measurements exceed IESNA recommended standards. Natural sunlight attributed some to the high densities but spaces were still over lit. These fixtures were designed to be brighter than recommended and wear down over time to proper densities, therefore methods to reduce runtime or current densities should be employed. Methods to reduce lighting densities include reducing the quantity of fixtures, replacing them with lower-wattage fixtures, and installing lower wattage bulbs in the existing fixtures. Other methods to reduce lighting density include replacing overhead lighting with task lighting, adding multiple control zones, adding daylight controls and adding dimming controls. Newer technology fixtures provide higher lighting density per watt than the existing older fixtures and provide improved lighting quality. The lighting density data is included in Appendix C.

Table 15: Illumination Densities

Location	Lighting Density (FC)	Recommended Density (FC) (1)
Main Office 1st Floor	44	30
Conference room	32	30
Front Office 1st Floor	56	30
Superintendent Office	38	30
Lavatory	26	5
NW Office 2nd Floor	59	30
SE Office 2nd Floor	61	30
S Office 2nd Floor	68	30
Kitchen	39	30
Rear Stairwell	5	10
NE Addition Office 2nd Floor	61	30
NW Addition Office 2nd Floor	62	30
S Office 1st Floor	47	30

(1) Based upon IESNA standards and AEC recommendations.

Plug Loads

Plug loads for the SAU facility were determined based on equipment nameplate information. The operating time for each item is based on observations, occupant loading, schedule, and typical operating time for the equipment. Plug loads are categorized as either appliances or electronics and office equipment. Appendix F presents an inventory of all plug load equipment.

Figure 13: Installed Window A/C Unit

Based on this analysis, the total annual plug load is 14,452 kWh/yr. This accounts for the most consumption of the three categories between plug loads, lighting fixtures and mechanical equipment at 68% of total consumption. Appliances account for an estimated 58% of plug load consumption and office equipment such as, computers and electronics, are estimated to consume 42%. Appliances consist of the window AC unit in the server room which is plugged in and running for most the time year round while another ten (10) units are installed in the summertime. The refrigerator in the kitchen is also old and consumes a considerable amount of energy. Replacing the AC units and refrigerator with ENERGY STAR® certified equipment would produce an energy savings. The office equipment, computer and miscellaneous electronic loads are about as expected for the size of the building and number of occupants however can still be reduced. Many pieces of equipment are left powered on when the building is unoccupied and can consume a considerable amount of electricity even if they are in a low powered state. Placing equipment such as copiers and computers on time clocks to automatically cut power when the building is unoccupied would reduce energy consumption.

Table 16: Plug Load Energy Consumption

Category	Location(s)	Est. Usage (kWh/year)	% of Total
Appliances	Throughout	8,424	58%
Office Equipment, Computers, Electronics	Throughout	6,028	42%
	Subtotals	14,452	100%

Motors

There are no large electric motors in the SAU building.

Emergency Power Systems

There are no emergency power systems at the SAU facility.

Plumbing Systems

Domestic Water Supply

Domestic water supply for the SAU facility is provided by an on-site well at the southeast corner of the building with a Goulds® pump in the basement. Water demand includes lavatory and kitchen uses. Demand is expected to be limited.

Domestic Water Treatment Systems

Water is treated by a Pura® filtration system with an ultraviolet control module.

Domestic Hot Water Systems

Domestic hot water is provided by a 41-gallon Amtrol Boilermate® indirect oil-fired hot water tank. Capacity is expected to exceed demand. It is recommended that the system be replaced with a tankless demand unit. Replacing this unit with an electric tankless unit would allow the main boiler to be powered off during the non-heating seasons.

Hydronic Systems

Hot water is distributed by hot water pipes in the basement to the upper floors and distributed by cast iron radiators and floor baseboards. Hot water pipes were found uninsulated resulting in a loss of thermal energy in an unconditioned space. It is recommended that all hot water pipes be insulated to reduce heat losses.

Mechanical Systems

Figure 14: Buderus® Boiler

Heating Systems

Heat is provided to the building by an oil-fired Buderus® boiler which was installed in May 2010. The unit is an efficient unit with an annual fuel utilization efficiency (AFUE) of 87% which will decrease with age and use.

Heat is distributed by cast iron and baseboard radiators throughout the building. The dated cast iron radiators provide poor distribution of heat. Occupants indicated that the first floor is too cold in the morning and uncomfortably warm in the afternoon. The second floor is too warm in the morning and too cold in the afternoon indicating heat distribution throughout the building is poor. Poor envelope integrity contributes to the heating distribution issues and low occupant comfort including nuisance drafts.

Figure 15: Digital Thermostat

Cooling Systems

Cooling for the computer server room is provided by a dedicated window A/C unit. A window unit on the second floor remains installed year-round. Nine (9) additional window A/C units are installed during warmer months. The numerous window units are an inefficient means of cooling the building as evidenced by electrical usage peaks in summer months.

Pumps

There are no pumps at the SAU building.

Controls Systems

The heating system in the building is controlled by non-programmable digital and clock faced thermostats (Figure 15). It is recommended that all non-programmable thermostats be replaced with 7-day programmable units. The thermostats should be scheduled consistent with normal occupancy.

Refrigeration

There are no commercial refrigeration systems in the SAU building.

Mechanical Equipment Energy Consumption

The electrical energy consumption for mechanical equipment was determined according to nameplate information and building function and occupancy schedules. Table 17 presents a summary of the mechanical equipment and annual energy usage. Appendix E presents the detailed inventory and the associated energy consumption for each piece of mechanical equipment. Total mechanical consumption per year is estimated to be 1,580 kWh per year compared to 5,268 kWh for light fixture loads and 14,452 kWh for plug loads.

Table 17: Mechanical Equipment Energy Consumption

Equipment Type	Qty.	Consumption (kWh/yr)	% of Total
Boiler Blower	1	1,580	100%
	Total:	1,580	100%

The only mechanical equipment which is present at the SAU 41 building is the blower and small circulation pumps on the Buderus® boiler. This is estimated to consume 1,580 kWh/yr.

Ventilation Systems

Exhaust Ventilation Systems

Exhaust fan units provide several functions including humidity control, odor control, venting of VOC containing materials (e.g., cleaning solvents), chemical gas venting in laboratories, and venting of cooking fumes. Operation frequency and schedules for the fans units should be consistent with the use type and intensity of the vented space. For example, lavatories may be demand ventilated (interlocked with light switch) or they may operate continuously at a low rate during occupied periods. Spaces equipped with exhaust fans are commonly over-ventilated resulting in increased energy consumption. All exhaust controls and rates should be consistent with ASHRAE Standard 62.1.

Exhaust ventilation systems in the SAU building are limited to lavatory exhaust fan units.

Exchange Air Ventilation Systems

Exchange air ventilation systems exhaust interior air with high CO_2 concentrations and humidity and replace it with fresh outdoor air. Ventilation rates and system capacity should be designed consistent with the minimum prescribed code standards (ASHRAE 62.1). Systems should be demand (CO_2) controlled with energy recovery capacity (ASHRAE 90.1).

There are no exchange air ventilation systems in the SAU building. Ventilation is presumed to be provided by passive ventilation including operating doors and windows and envelope leakage. Current building code requires mechanical exchange air ventilation systems in commercial office spaces.

Energy Recovery Ventilation Systems

There are no energy recovery ventilation systems installed at the SAU building. Installation of exchange air ventilation systems should include energy recovery units.

Indoor Air Quality

Indoor air quality (IAQ) is established based upon temperature (°F), relative humidity (%), and carbon dioxide (CO_2); measured in parts per million (ppm). This data provides the best representation of building ventilation performance and occupant comfort. They are also indicative of conditions that are detrimental to building systems including moisture intrusion and the potential for fungi growth (mold and mildew) and related damage of building materials.

Recommended temperatures vary based on the season, occupant activity, and relative humidity levels. Generally, recommended setpoint heating temperatures in northern New England range between 67°F and 70°F and recommended cooling setpoint temperatures range between 73°F and 76°F. Relative humidity (RH) levels fluctuate consistent with seasonal atmospheric conditions. A range between 30% and 65% is recommended (ASHRAE). While there are no known adverse health effects related to elevated CO_2 concentrations, it can cause acute illness including headaches, drowsiness, lethargy, and nausea. For this reason, the U.S. Environmental Protection Agency (EPA) has established a recommended threshold concentration of 1,000 ppm.

The IAQ in the SAU was measured on January 4th, 2012 between the hours of 0838 and 0933. The building was normally occupied when the measurements were obtained. Thirteen (13) IAQ measurements were obtained at representative locations throughout the building. Appendix C presents all of the measurements. Results of the IAQ measurements are summarized as follows:

- Temperatures in the building ranged from 64.4°F in the back staircase to 77.5°F in the second floor kitchen. The average recorded temperature was 71.3°F.
- Relative humidity measurements ranged from 10.1% in back staircase to 17.7% in the second floor bathroom. The average relative humidity was 13.9%.
- CO_2 concentrations ranged from 227 ppm in the receptionist office to 1,069 ppm in a second floor office (NW) with an average of 592 ppm.

Table 18: Summary of IAQ Data

IAQ Metric	Low	High	Avg.	Range of Variance	Recommendation
Temperature (°F)	64.4	77.5	71.3	13.1	67 – 70
Relative Humidity (%)	10.1	17.7	13.9	7.6	30 – 65
Carbon Dioxide (ppm)	227	1,069	592	842	<1,000

Temperatures had an overall wide range of variance of 13.1°F. Consistent with occupant statements, the second floor was warmer than the first floor in the morning when measurements were obtained. Relative humidity had a moderate variance with a range of 7.6% between the lowest and highest recordings. CO_2 concentrations varied widely, with one of the measurements above the recommended threshold (1,000 ppm) set by the EPA. Figure 16 below graphically depicts the relationships between temperature, relative humidity and CO_2 concentrations.

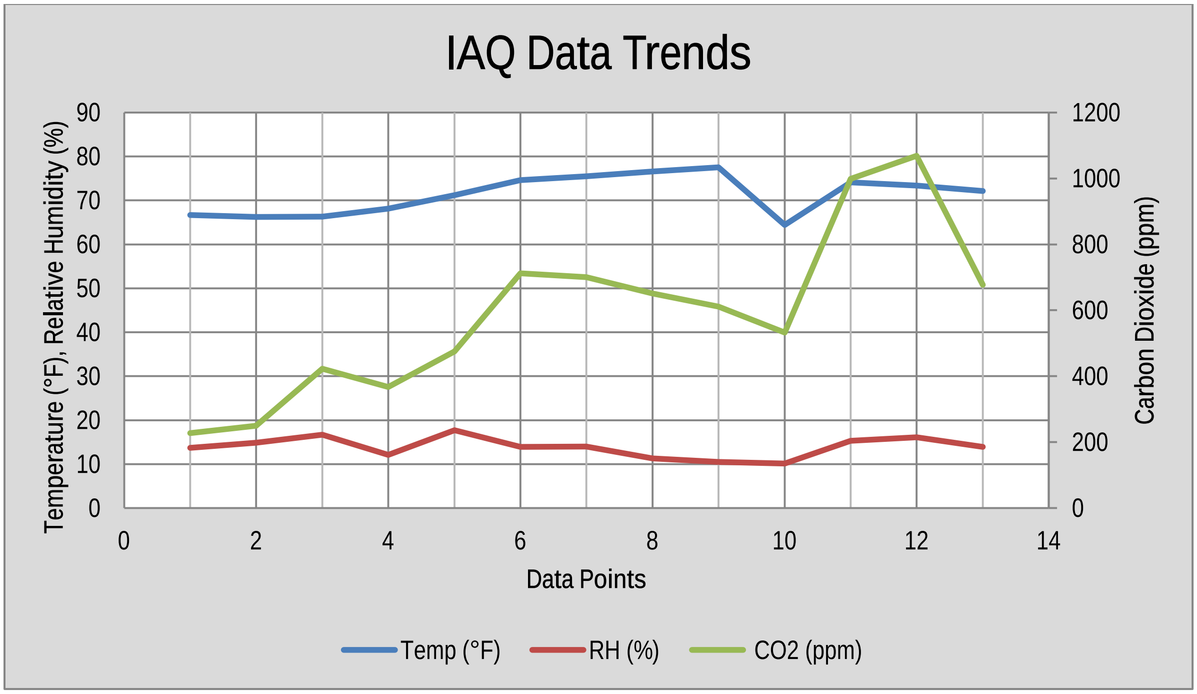


Figure 16: Indoor Air Quality Data Trends

Secondary Observations

Observations noted herein are not directly related to the objective of the energy audit. Investigation of these items is beyond the defined scope of services and these observations are not intended to be inclusive of all building issues and code infractions. They are provided as anecdotal information for the Town's consideration and may warrant further investigation.

Structural Systems

It is recommended than a licensed structural engineer study the building. A main supporting beam in the basement was observed to be poorly supported.

Roofing Systems

There appears to have been a leak in the attic of the building around the existing chimney. This was said to have been rectified during the recent roof replacement.

Building Code

It is recommend that the electrical system throughout the building be reviewed be a licensed electrician. Numerous minor infractions were observed during the audit.

Current building code requires mechanical exchange air ventilation of commercial office spaces. Air exchange in the SAU 41 Administration Building is limited to passive envelope leakage (minimal) and operating doors and windows. During high occupancy events when the building is in heating mode the ventilation will not be adequate pursuant to code requirements. Installation of an energy recovery ventilation (ERV) system for the main hall is recommended. The system should be designed and sized consistent with the occupancy loads. Demand CO_2 controllers should be used to optimize the ERV system and prevent over-ventilation of the building.

Life Safety Code

Considering the unique building configuration (residential structure used for commercial office) and occupancy, a life safety code review by a Licensed Fire Safety Professional Engineer is recommended.

ADA Accessibility

The building does not fully comply with ADA accessibility standards. This includes second floor access and spatial configuration of common spaces and lavatories. Planned renovations of the building should consider improving accessibility to comply with ADA standards.

Hazardous Building Materials

Based on the year of construction all painted surfaces are presumed to contain lead.

E. BUILDING ENERGY MODELING

Source Data

Required source data input for the eQUEST© model includes geographical location, building use type(s), occupancy schedules, building dimensions, envelope systems, fenestration systems, lighting systems, and all mechanical systems (heating, cooling, ventilation domestic hot water). The building characteristics and systems data was obtained during the building site review. Energy usage was provided by the Town for grid electricity and heating oil.

Model Calibration

The quality of the output data is a function of the accuracy of the input data. While eQUEST© is a sophisticated computer simulation program, like any program there are limitations resulting from unusual building characteristics and operating variables that cannot be discretely defined in the program. To ensure that the model simulates the building operation with high accuracy, an iterative model calibration process is completed where actual building energy usage data is checked against the model output values. This process is repeated until the deviation between the energy usage derived from the baseline building simulation and the actual energy consumption is within an acceptable range.

Summary of Model Results

The SAU 41 building was modeled using eQUEST© computer simulation program. Developing an accurate baseline model of the building presented certain challenges including accounting for the high electrical usage and the high heating fuel usage.

Tables 19 and 20 present a summary of the model predicted annual energy usage by category for electrical and heating fuel. The actual electrical consumption of 21,630 kWh/yr is slightly greater than the model prediction of 21,400 kWh/yr.

Table 19: Model Predicted Baseline Electrical Usage

Electric Category	Annual Usage (kWh x 1,000)
Space Cooling	3.92
DHW	0.33
Ventilation Fans	1.09
Pumps & Aux	1.31
Exterior Lights	0.77
Plug Loads	9.24
Area Lights	4.75
Total Predicted:	21.40
Total Actual:	21.63

Actual heating fuel consumption for the building is 224.6 MBtu while the predicted usage is slightly higher at 228.0.

Table 20: Model Predicted Heating Fuel Usage

Electric Category	Annual Usage (MBtu)
Space Heating	222.36
Hot Water	5.60
Total Predicted:	227.95
Total Actual	224.62

The energy modeling results are depicted graphically by a monthly bar graph (Figure 17) which breaks down the energy consumption for electricity and gas consumption separately by category. For example, “Area Lighting” is relatively consistent throughout the year while “Space Cooling” consumes a variable amount of electricity depending on the time of year and consumes a considerable percentage in the cooling months of July and August.

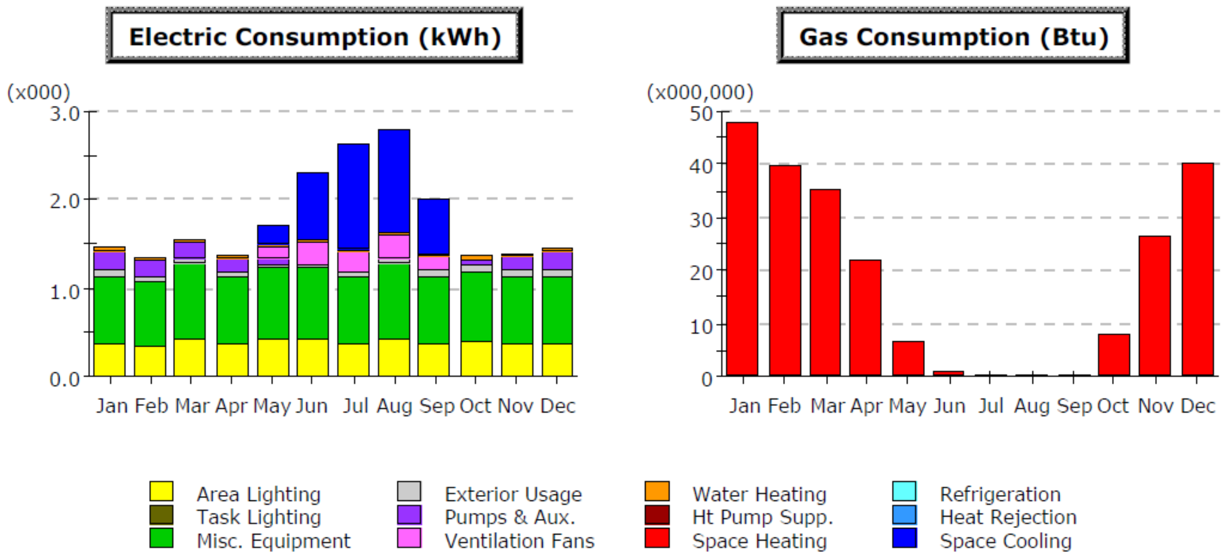


Figure 17: Monthly Energy Use by Category

F. FACILITY BENCHMARKING

ENERGY STAR for Commercial Buildings

The SAU was benchmarked using the EPA's ENERGY STAR® Portfolio Manager for Commercial Buildings. This benchmarking program accounts for building characteristics, regional climatic data, and user function. It then ranks a building within its defined category amongst all other buildings entered in the program to date. The defining metric is the building Energy Use Intensity (EUI). If a building scores at or above the 75^{th} percentile within its category then it becomes eligible for ENERGY STAR® certification pending an on-site validation review by a licensed Professional Engineer. Currently the program does not have categories for every commercial building type but they can still be entered into the program and checked against similar buildings to determine where the building ranks compared to the current national average. The average energy intensity for every building type category is constantly changing and theoretically is it reducing as more efficient buildings are constructed and existing buildings implement energy efficiency measures. Therefore, buildings that currently meet the eligibility requirements may not be eligible next year when they apply for annual re-certification.

The School Administrative Unit 41 is defined as an "Office" use building in the ENERGY STAR® program. Utility data for electric and heating fuel for the preceding twelve (12) months was input into the benchmarking program. Table 21 presents the annual energy use (through February 2012) and Table 22 presents a summary of the Statement of Energy Performance (SEP) benchmarking results. The SEP is presented in Appendix G.

Table 21: Annual Energy Consumption

Energy	Site Usage (kBtu)
Electric – Grid	73,802
Fuel Oil	224,623
Total Energy:	298,425

Table 22: SEP Benchmarking Summary

Location	Site EUI (kBtu/ft²/yr)	Source EUI (kBtu/ft²/yr)
Hollis School Administrative Unit 41	37	58
National Median (Office)	82	131
	% Difference:	-55%
	Portfolio Manager Score:	95

Compared to the office buildings that have entered data into Portfolio Manager to date, the SAU facility energy use is considerably lower than the national average. The source EUI for the SAU building is 58 kBtu/ft²/yr while the national average is 131 kBtu/ft²/yr, meaning it uses 55% less energy than the average Service building. This is largely attributable to the lack of mechanical ventilation equipment at the facility. Due to the absence of mechanical ventilation equipment the SAU 41 Administrative Facility is not eligible for ENERGY STAR® certification.

G. RECOMMENDATIONS

Energy Conservation Measures

Based on the observations and measurements of the SAU, several energy conservation measures (EEMs) are proposed for consideration (Tables 23 to 25). These recommendations are grouped into three tiers based on the cost and effort required to implement the EEM. EEMs are ranked within each tier based on the capital cost for implementation versus the net estimated energy cost savings.

Tier I EEMs are measures that can be quickly implemented with little effort for no or little cost. They include routine maintenance items that can often be completed by facility maintenance personnel and changes in occupant behavior or building operation. Tier II items generally require contracted tradesmen to complete but can generally be implemented at low cost and within operating building maintenance budgets. EEMs that require large capital expenditure and budgetary planning (one year or greater) are categorized as Tier III measures.

Simple payback is calculated for the proposed EEMs. The cost to implement the measure is estimated based on current industry labor and equipment costs and the annual cost savings represents the reduced costs for energy savings. The net energy and cost savings for smaller EEMs is based on the estimated reduction of the associated energy consumption as defined in the model and equipment inventory. Using these costs, the payback period is then calculated as the number of years at which the capital cost of implementation equals the accumulated energy cost savings. Other qualitative considerations that do not influence the Simple Payback Method calculation but should be considered by the owner during the decision-making process include:

- Occupant comfort.
- Relative operation and maintenance requirements.
- Remaining useful life of equipment and systems to be replaced.

Energy cost savings are based current cost of electricity at $0.14 per kWh (PSNH) and the current price of oil of $3.98 per gallon. (NHOEP March 27, 2012)

Tier I Energy Efficiency Measures

Tier I EEMs are measures that can be quickly implemented with little effort for zero or little cost (Table 23). They include routine maintenance items that can often be completed by facility maintenance personnel, and changes to occupant behavior or building operation. Nine (9) Tier I EEMs are recommended.

The building envelope has a number of gaps which allows thermal transfer between the interior and exterior. Tier I recommendations include closing all storm windows during the heating period and sealing and insulating the open basement window and addition openings in the basement. Powering down electronic equipment when not in use will reduce the plug load consumption. Current heating controls allow occupants to manually set temperatures and installing a programmable thermostat would increase the efficiency of heating allowing it to shut off when unoccupied at night and turn on before occupied in the morning. This would also reduce fluctuations in temperatures.

The refrigerator in the kitchen is an old inefficient unit which is recommended to be replaced with an ENERGY STAR® rated unit. Illumination densities are excessive throughout the building and can be reduced with the use of task lighting and removal of some overhead units. A substantial amount of energy is lost through the attic and adding rigid insulation and weather sealing to the door would retain energy in the working spaces. All windows and doors revealed some measure of energy loss and sealing these would limit the thermal transfer between the interior and exterior.

Table 23: Tier I Energy Efficiency Measures

EEM No.	EEM Description	Investment	Annual Cost Savings	Payback (yrs.)	SIR
T1-1	Close all storm windows in the building during heating periods.	$0	$450	0	-
T1-2	Power down all electric equipment when not in use. Install power strips on large consuming items.	$70	$300	0.2	43
T1-3	Seal and insulate open basement window and addition openings in basement foundation wall.	$650	$400	1.6	19
T1-4	Replace clock-face manual thermostats with 7-day programmable units and optimize heating setpoints and schedule consistent with occupancy.	$300	$750	0.4	18
T1-5	Insulate all hot water piping in basement.	$200	$160	1.3	12
T1-6	Install rigid insulation and weather-stripping on the third floor attic door.	$150	$45	3.3	9.0
T1-7	Replace the dated refrigerator with an ENERGY STAR® rated model.	$500	$150	3.3	4.5
T1-8	Reduce lighting densities throughout the building with added task lighting and removal of overhead fixtures.	$350	$80	4.4	2.7
T1-9	Air-seal all doors and windows. Install new weather-stripping at jambs and thresholds. Caulk trim and moldings.	$1,200	$254	4.7	1.5

Tier II Energy Efficiency Measures

Tier II items generally require contracted tradesmen to complete but can be implemented at low cost and within operating building maintenance budgets. Five (5) recommended Tier II EEMs are presented in Table 24.

Table 24: Tier II Energy Efficiency Measures

EEM No.	EEM Description	Investment	Annual Cost Savings	Payback (yrs.)	SIR
T2-1	Install a thermostatically controlled solar powered attic roof fan to reduce heating loads in summer months.	$850	$350	2.4	4.1
T2-2	Install 4-mil polyurethane sheeting barrier and 2" foil-faced polyisocyanurate insulation (R-14) on bottom of floor joists of wing addition and tape-seal joints. Apply spray-foam polyurethane insulation around sill interior.	$2,312	$280	8.3	2.4
T2-3	Install 2" rigid polyisocyanurate insulation (R-14) on interior basement walls and tape-seal joints.	$2,448	$220	11.1	1.8
T2-4	Install interior lighting controllers to reduce lighting density and runtime (photosensors, dimming controls, motion sensors, timers).	$1,600	$180	8.8	1.7
T2-5	Replace indirect hot water heater with an electric tankless demand hot water heater.	$2,519	$210	12.0	1.3

(1) Tier II EEM investment costs include fees for design & engineering, construction management, and a 15% cost contingency.

The attic is a poorly conditioned space. Installing a thermostatically controlled solar powered fan would operate at no cost and would properly ventilate the space during the summer months. The floors of the north and west addition space above the crawl spaces are poorly insulated and adding rigid insulation would provide proper insulation and reduce thermal losses. The hot water heater capacity is estimated to exceed the building demand resulting in excess energy produced; a tankless demand unit would meet demand requirements and reduce energy use. Adding rigid insulation to the basement walls of the original building would reduce energy loss through these walls. Light densities are high throughout the building and lights were noted to be on when the room also received ample sunlight. Adding lighting controls would optimize the runtime and densities thereby reducing energy consumption.

Tier III Energy Efficiency Measures

EEMs that require large capital expenditure and budgetary planning (one year or greater) are categorized as Tier III measures. Four (4) Tier III EEMs are provided in Table 25 for the SAU facility.

Table 25: Tier III Energy Efficiency Measures

EEM No.	EEM Description	Investment	Annual Cost Savings	Payback (yrs.)	SIR
T3-1	Remove attic flooring in original building and install blown cellulose insulation in the floor joists, cover with 4-mil polyurethane sheeting air barrier, add 1" polyisocyanurate rigid insulation w/ tape-sealed joints, and cover with 5/8" plywood T&G floor decking.	$6,799	$1,550	4.4	4.6
T3-2	Insulate wall cavities with blown in cellulose. Add 4" of cellulose to the addition attic floor.	$28,911	$1,650	17.5	1.1
T3-3	Replace all older window units with high thermal efficiency fiberglass frame double-pane units (29). Fill cavities with spray-foam insulation and caulk all gaps and moldings.	$18,709	$750	24.9	1.0
T3-4	Replace window air-conditioning units with several split condenser wall mounted units w/ minimum SEER of 20.	$14,663	$850	17.3	1.0

(2) Tier III EEM investment costs include fees for design & engineering, construction management, and a 15% cost contingency.

If the attic space is to continue to function as storage, the most efficient way to insulate the area would be to remove the floorboards in the attic and blow cellulose which would essentially separate the second floor from the attic so energy is better retained in the useable areas of the building. Wall cavities lack in insulation throughout and blowing cellulose in these lacking areas would reduce the energy loss. While some windows have been replaced with double-pane units it would be beneficial to replace all windows with double-pane units to create a more efficient building envelope. The window AC units are energy intensive units and are not the most efficient way of cooling spaces. Replacing the ten (10) units with several split condenser units with a SEER of over 20 would be a more efficient and comfortable way of cooling the facility.

The energy cost savings and resulting payback are based upon each independent measure implemented for the building in its current condition and function. There are interdependencies among measures that will affect the net realized energy savings. For example, replacing lighting fixtures with lower energy units reduces heat load to the building thereby requiring more heating fuel to compensate for the loss in heat from the inefficient light fixtures. Also, many of the larger capital Tier III EEM projects may include some of the smaller dependent Tier I and II EEMs.

Capital costs are provided for budgetary planning only. They are estimated based on current industry pricing for materials and labor. A detailed cost estimate should be developed prior to appropriating capital funds for the more costly measures.

EEMs Considered but not Recommended

The following measures were identified as part of the building evaluation but are not recommended as best-value EEMs. Considerations include the cost feasibility and payback term and occupant comfort concerns.

1. A lighting retrofit project was recently completed (2011) and replacing the modern fixtures with higher efficiency units is not cost practical at this time.
2. The boiler is a new and efficient unit and it is not recommended it be replaced at this time.
3. Replace existing heating registers with modern control valves and fintube heating units would not provide a reasonable payback. However, this should be completed as part of any renovation projects to improve system control and distribution.

O&M Considerations

O&M and considerations are provided for existing systems and for proposed EEMs. They are intended to provide best-value practices for the building manager and to identify any O&M requirements for the proposed EEMs.

1. The building is in need of a major renovation. All systems should be improved as part of the renovation which will reduce future O&M requirements.

Indoor Air Quality Measures

Based upon the measured indoor air quality in the Hollis School Administrative Unit 41, 8 of 10 areas were below the EPA CO_2 recommended threshold of 1,000 ppm. CO_2 concentrations ranged between 227 and 1,069, with a building average of 592 ppm. No exchange air ventilation equipment is installed at the SAU 41 Administration building (code compliance issue). Passive ventilation is provided by operating doors and windows and envelope leakage.

Recommended exchange air ventilation systems include an energy recovery ventilation system with demand CO_2 controls.

Renewable Energy Considerations

While renewable energy systems generally require a higher capital investment, they provide a significant reduction in the consumption of non-renewable fossil fuel energies. Other obvious benefits include a reduction in ozone depleting gas emissions (as measured by CO_2 equivalency), otherwise referred to as the "carbon footprint". Renewable energy systems also reduce the reliance upon fossil fuels derived from foreign nations and mitigate pricing fluctuations in a volatile and unpredictable market.

Evaluating the practicality of a renewable energy system for a specific facility should consider several facility specific variables including:

- Geographical location.
- Building orientation.
- Adjacent and abutting land features.
- Site footprint and open space.
- Building systems configuration and condition.
- Local zoning or permitting restrictions.
- Currently available financial resources (grants, utility provider rebates, tax incentives).

Table 26 provides a summary description of the more common and proven renewable energy technologies. The Table also provides a preliminary feasibility assessment for implementing each technology at the SAU facility. Additionally, each renewable energy technology is scored and graded based on technology and facility specific characteristics. Appendix H presents the criteria used to develop the score and grade for each renewable energy technology. A more rigorous engineering evaluation should be completed if the Town is considering implementing any renewable energy system.

Table 26: Renewable Energy Considerations

Renewable Energy System	System Description & Site Feasibility
Biomass Heating Systems	System Description: Biomass heating systems include wood chip fueled furnaces and wood pellet fueled furnaces. For several reasons, wood chip systems are generally practical only in large scale applications. Wood pellet systems can be practical in any size. Wood chip systems are maintenance intensive based on the market availability and procurement of woodchip feedstock and variability of woodchip characteristics (specie, size, moisture content, bark content, Btu value) which affect the operating efficiency of the furnace and heating output. They require a constant feed via a hopper and conveyor system and feed rates must vary according to feedstock Btu value and heating demand. For these reasons they typically require full-time maintenance and are practical only in large scale applications. Wood pellet systems are much less maintenance intensive and feedstock availability and consistency is less of an issue. Both systems reduce the dependency on fossil-fuels and feedstock can be harvested locally.
Score: 79%	***Site Feasibility:*** ***A conventional pellet boiler unit may be a practical heating system for the building however, this requires additional effort for procurement of pellets, storing pellets, periodic filling the pellet hopper during the heating season, and emptying the ash. There are new systems with automated feed and ash removal systems that could be a practical application at the SAU.***
Geothermal Heating & Cooling	System Description: Geothermal heating systems utilize solar energy residing in the upper crust of the earth. Cooling is provided by transferring heat from the building to the ground. There are a variety of heating/cooling transfer systems but the most common consists of a deep well and piping loop network. All systems include a compressor and pumps which require electrical energy. Geothermal systems are a proven and accepted technology in the New England region. Site constraints and building HVAC characteristics determine the practicality.
Score: 79%	***Site Feasibility:*** ***Heating is currently supplied by hydronic heating equipment that would be compatible with a ground-source water heat pump system however distribution systems may need to be upgraded. There is sufficient land space to install the well and closed-loop piping system.***
Ground-Mounted Solar Photovoltaic Systems	System Description: A ground-mounted PV system is composed of the same solar collector panels used for a roof-mount system. The collectors are mounted on a frame support system on the ground verses a roof structure. This is advantageous when roof framing cannot accommodate the increased load of the collector panel and the ease of installation and access for maintenance and repair.
Score: 78%	***Site Feasibility:*** ***There is a small amount of ground space open at the SAU where a small-sized (5kW-15kW) system could be installed. This would require a design and permitting process with the local utility for a grid-tie connection. Current utility incentives and renewable energy grants would help offset the capital cost for the system.***
Solar Domestic Hot Water	System Description: Solar domestic hot water (DHW) systems include a solar energy collector system which transfers the thermal energy to domestic water thereby heating the water. These are typically used in conjunction with an existing conventional DHW system as a supplemental water heating source. Because of the high capital cost, solar DHW systems are only feasible for facilities that have a relatively high demand for DHW.
Score: 75%	***Site Feasibility:*** ***Based on the limited demand for domestic hot water, a solar hot-water system may be a practical consideration for the building. The capital cost could be offset with substantial utility rebates and incentives. The system could provide primary DHW during summer months when demand is low. In colder months, it would provide secondary heating.***
Wind Turbine Generator	System Description: Wind turbine generators (WTGs) simply convert wind energy into electrical energy via a turbine unit. WTGs may be pole mounted or rooftop mounted however system efficiency improves with increased elevation. Due to cost and site related constraints, WTG technology in New England is only practical for select sites. Constraints include local geographical and manmade features that alter wind direction, turbulence, or velocity. Other technology constraints include local variability of wind patterns and velocity. Additionally, WTGs require permitting (local, state, FAA) and local zoning that may restrict systems due to height limitations, and/or, visual detraction of the local landscape. Presently, WTG technology is not widely used in New England based on the relatively high capital cost compared to the energy savings.

Score: 68%	***Site Feasibility:*** *There is adequate site space to install a small (<5kW) to mid-sized pole-mounted wind turbine. However, considering the relatively low mean wind speeds in the region, a WTG unit may not be a cost practical consideration.*
Roof-Mounted Solar Photovoltaic Systems	System Description: Photovoltaic (PV) systems are composed of solar energy collector panels that are electrically connected to DC/AC inverter(s). The inverter(s) then distributes the AC current to the building electrical distribution system. Surplus energy is sent into the utility grid via net metering and reimbursed by the utility at a discounted rate. The capital investment cost for PV systems is high but the technology is becoming increasingly more efficient thereby lowering initial costs. The building is in the need of replacement. It its recommended that is be addressed before solar panels are installed.
Score: 68%	***Site Feasibility:*** *There is a small amount of south facing roof space which could accommodate a small-sized (5kW-15kW) system. This would require a design and permitting process with the local utility for a grid-tie connection. Current utility incentives and renewable energy grants would help offset the capital cost for the system. A structural evaluation of the roof framing system would be required to ensure that it could accommodate the increased loading. The existing electrical systems may require upgrade especially if the PV system is interconnected to the grid.*
Solar Thermal Systems	System Description: Similar to a roof-mounted solar PV system, solar thermal systems are most commonly installed on rooftops. These systems utilize solar energy for heating of outdoor air. The most common application is for pre-heating of outdoor air used for air exchanges systems in buildings. This reduces the heating fuel required to maintain setpoint temperatures in interior spaces.
Score: 61%	***Site Feasibility:*** *There is currently no installed ventilation equipment on the building.*
Combined Heat & Power (CHP)	System Description: Combined heat and power (CHP) systems are reliant on non-renewable energies. Systems are composed of a fossil-fuel powered combustion engine and electrical generator. Electrical current is distributed to the building distribution system to reduce reliance on grid supplied electricity. Byproduct thermal energy derived from the combustion engine is recovered and used to heat the building (this is generally considered to be renewable energy). Another benefit of CHP systems is that they provide electrical energy during power outages in buildings that do not have emergency power backup. Larger CHP units require a substantially large fuel supply and if natural gas is not available then a LPG tank must be sited.
Score: 59%	***Site Feasibility:*** *Considering the relatively small electric and heating demand for the SAU, a CHP may not be cost practical. There is no natural gas within the Town and costs associated with the infrastructure development for a large propane tank would be high. CHP systems also require intensive maintenance and have a low expected service life.*

H. ENERGY EFFICIENCY INCENTIVE AND FUNDING OPPORTUNITIES

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of municipal and school buildings through financial incentives and technical support. Some of the currently available programs are presented herein however building managers are encouraged to explore all funding and incentive opportunities as some programs end and new programs are developed. For a current listing of advertised programs and initiatives, visit www.dsireusa.org.

New Hampshire Public Utilities Commission

New Hampshire Pay for Performance

This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive # 1: Is based on the area of conditioned space in square feet. Incentive #2: Per kWh saved and Per MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per kWh saved and Per MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $300,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

New Hampshire Public Utilities Commission's Renewable Energy Rebates

The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority

New Hampshire Community Development Finance Authority Revolving Loan Fund

The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

- Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
- Improvements to HVAC equipment and air exchange;
- Installation of renewable energy systems;
- Improvements to lighting, equipment, and other electrical systems; and
- Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH)

Commercial (Electric) Energy Efficiency Incentive Programs

This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HV AC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programsand-Incentives.aspx

SmartSTART

The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple – pay nothing out of pocket to have energy efficiency products and services installed in your building. The Smart Start program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves. This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit: http://www.psnh.com/SaveEnergyMoney/For-BusinesslMunicipal-Smart-Start-Program.aspx

Clean Air - Cool Planet

Community Energy Efficiency

CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of New Hampshire, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergypian.net. A groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast http://www.cleanair-coolplanet.orglfor_communities/index.php.

APPENDIX A

Photographs

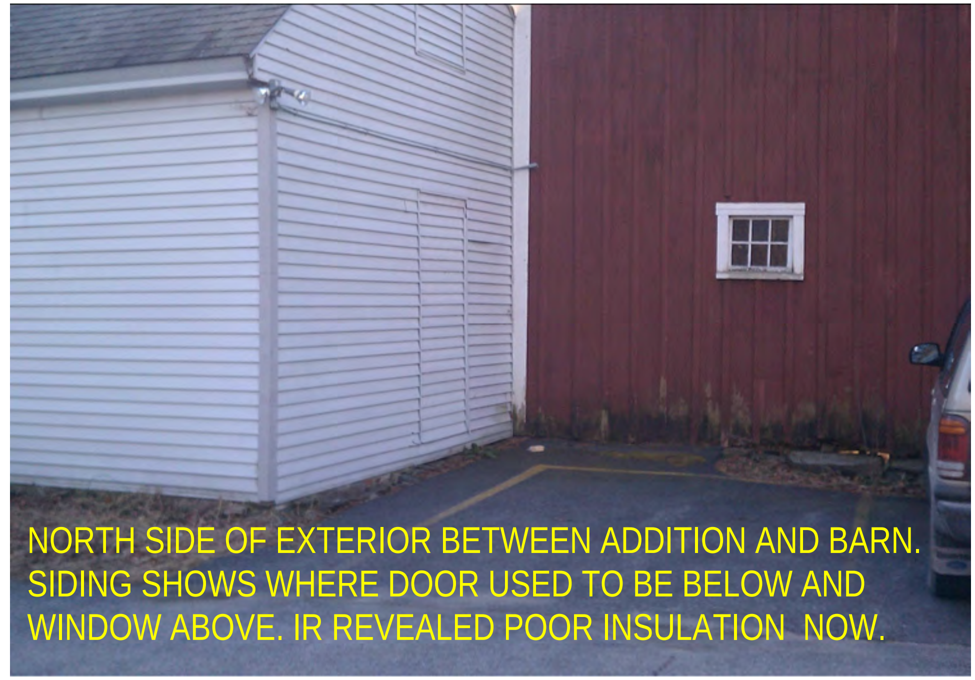

SOUTH SIDE OF EXTERIOR


EAST SIDE OF EXTERIOR


MAIN ENTRANCE AT SOUTH SIDE OF EXTERIOR


EAST SIDE OF EXTERIOR


NORTH SIDE OF FACILITY AT EMPLOYEE PARKING LOT AND ENTRANCE


NORTH SIDE OF EXTERIOR BETWEEN ADDITION AND BARN. SIDING SHOWS WHERE DOOR USED TO BE BELOW AND WINDOW ABOVE. IR REVEALED POOR INSULATION NOW.


NORTH SIDE EMPLOYEE ENTRANCE


NORTH SIDE OF EXTERIOR


SOUTHEAST CORNER OF BUILDING


STORAGE / FILE DOOR TO BACK STAIRWELL

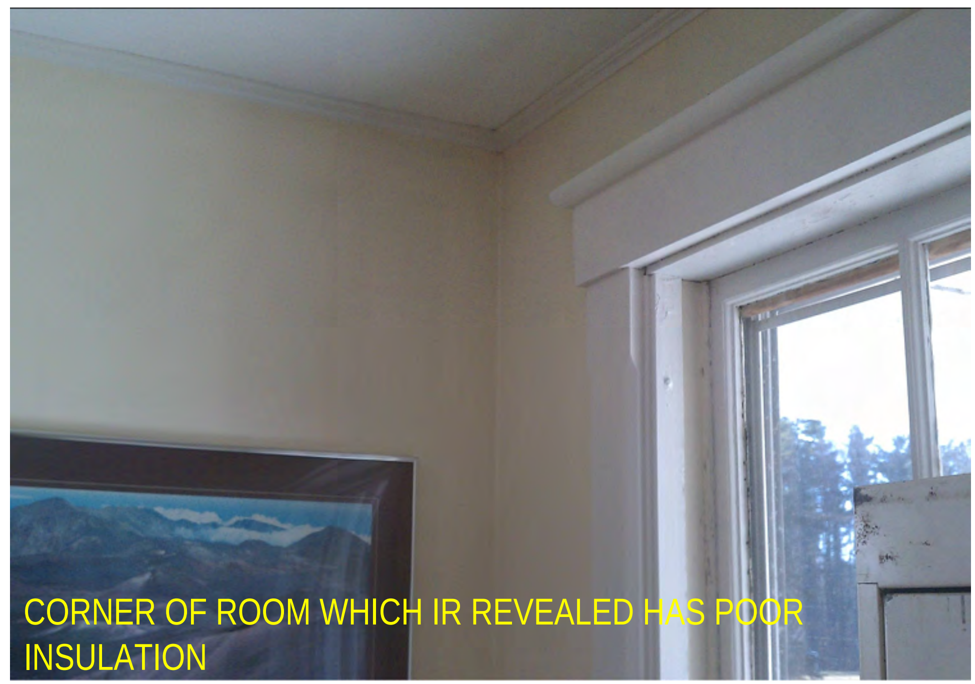

NORTH SIDE OF EXTERIOR AT SEPARATION BETWEEN ORIGINAL BUILDING AND ADDITION


WALL OF STORAGE ROOM WHERE IR REVEALED INSULATION POOR WHERE EXTERIOR DOOR ONCE WAS


BASEBOARD RADIATOR IN SECRETARY'S OFFICE


UNINSULATED HOT WATER PIPES IN FIRST FLOOR HALLWAY


PHOTOCOPIER BY MAIN LOBBY AREA


CORNER OF ROOM WHICH IR REVEALED HAS POOR INSULATION


NORTH SIDE ENTRANCE FOR EMPLOYEES


RADIATOR IN FIRST FLOOR HALLWAY

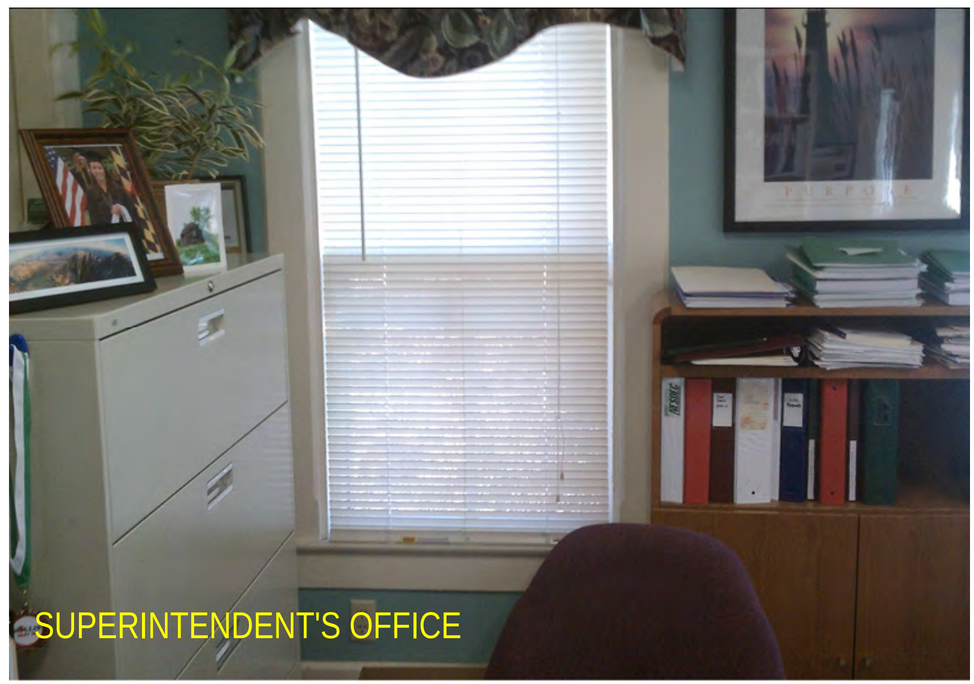

BASEBOARD HEATING IN THE HALLWAY

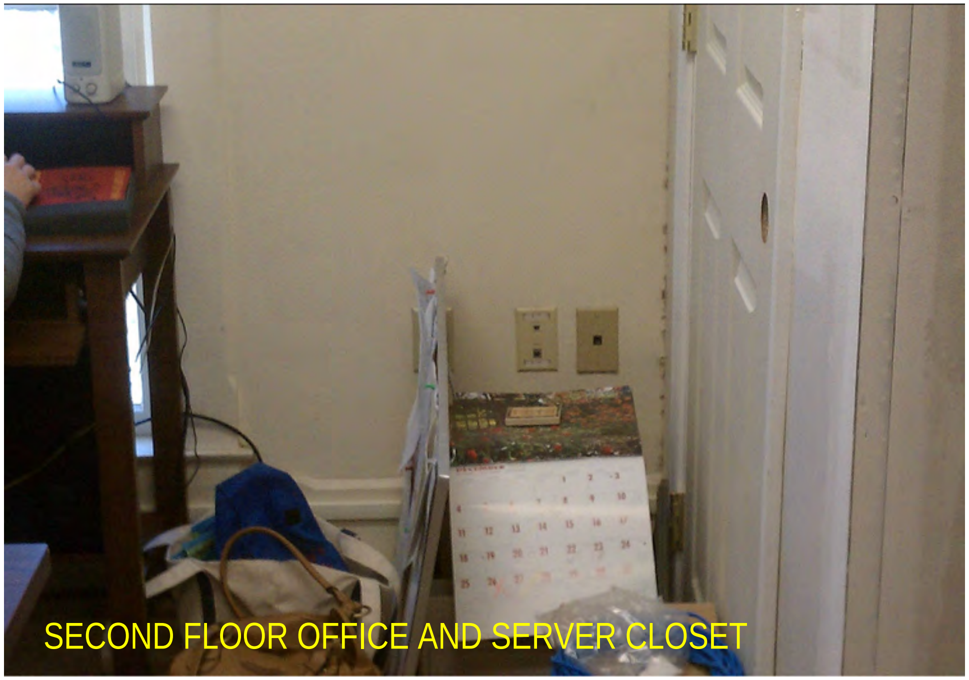

FIRST FLOOR MEETING ROOM


RADIATOR IN SUERINTENDENT'S OFFICE

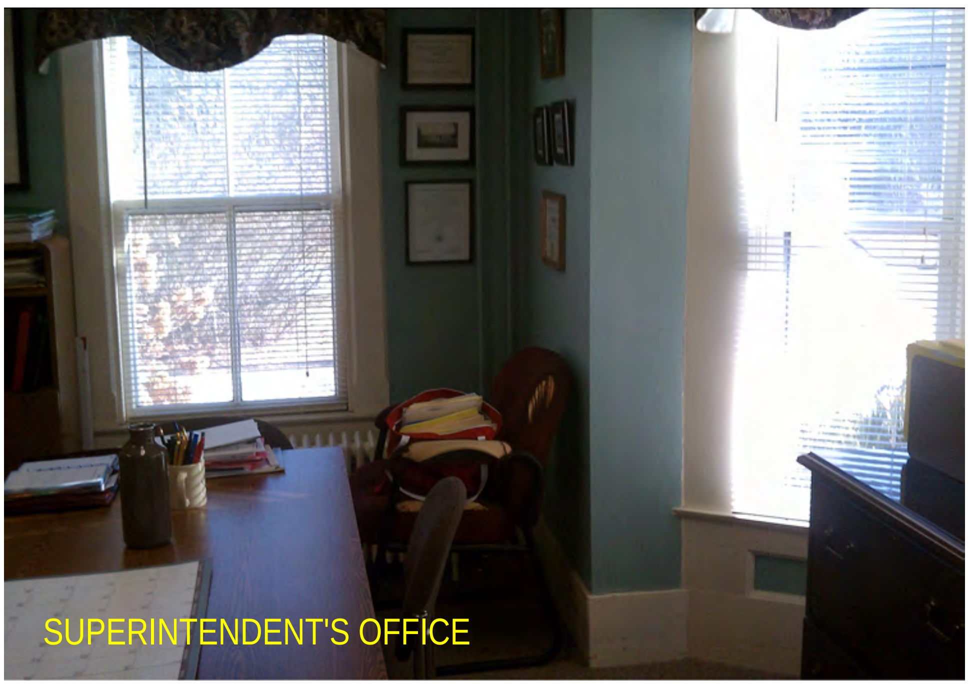

RADIATOR IN BUSINESS ADMINISTRATORS OFFICE

FIRST FLOOR EXIT AT BOTTOM OF MAIN STAIRS


SUPERINTENDENT'S OFFICE

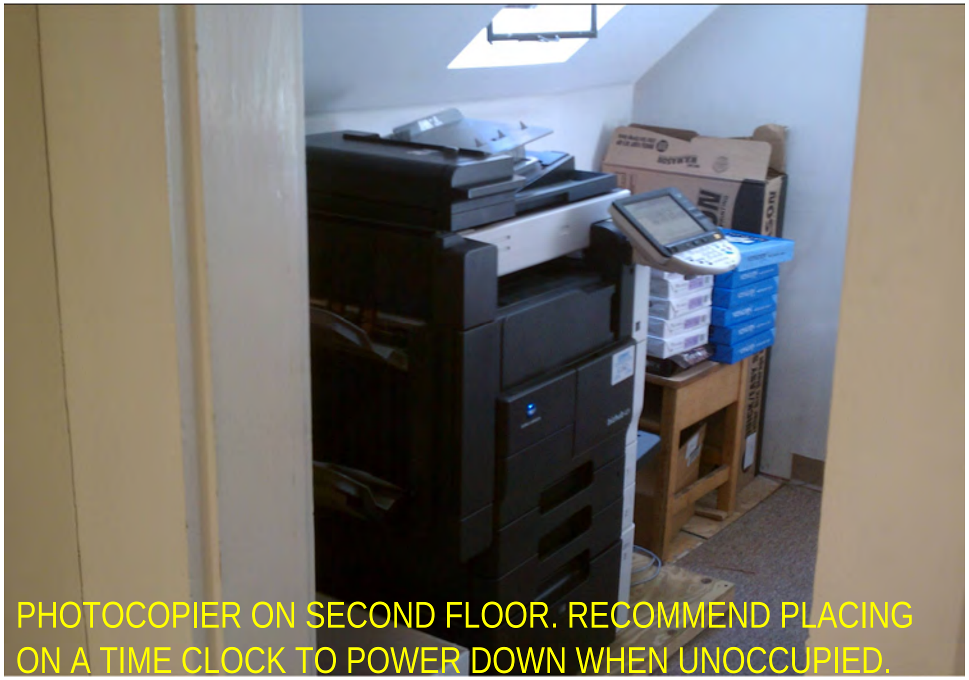

SECOND FLOOR OFFICE AND SERVER CLOSET


SERVER EQUIPMENT


SUPERINTENDENT'S OFFICE

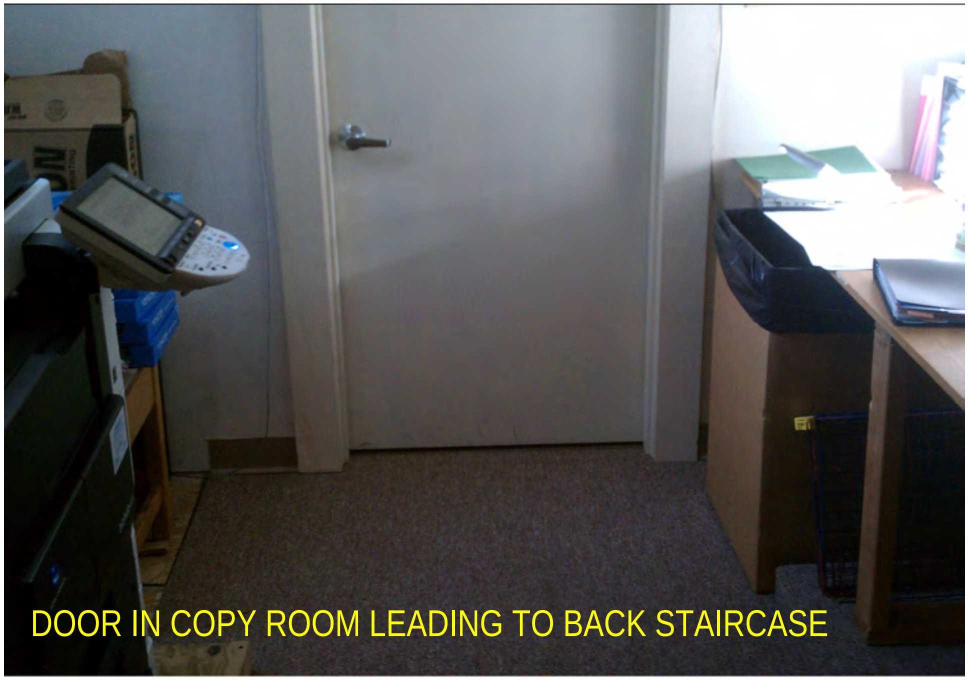
SERVER COMPUTER MONITOR RUNNING. RECOMMEND POWERING DOWN ALL ELECTRONICS WHEN NOT IN USE.


SECOND FLOOR SOUTHEAST CORNER OFFICE


PHOTOCOPIER ON SECOND FLOOR. RECOMMEND PLACING ON A TIME CLOCK TO POWER DOWN WHEN UNOCCUPIED.


AC UNIT CONSTANTLY RUNNING FOR SERVER EQUIPMENT. RECOMMEND REPLACING WITH A MORE EFFICIENT UNIT.


TWO PRINTERS IN SECOND FLOOR OFFICE


DOOR IN COPY ROOM LEADING TO BACK STAIRCASE


DOOR IN ATTIC BETWEEN ORIGINAL AND ADDITION SPACES.


WINDOW NOT SEALED TIGHT IN COPY ROOM ALLOWING THERMAL TRANSFER.


WINDOWS IN EAST ATTIC SPACE


WINDOW IN THE WEST ATTIC SPACE


ADDITION ATTI C SPACE STORAGE AND CEILING.


STORAGE IN THE ATTIC


WINDOW AND UNINSULATED WALL IN THE ADDITION ATTIC SPACE

PARTIAL INSULATION IN ADDITION ROOF. RECOMMEND INSULATING ATTIC FLOOR TO REMOVE ATTIC FROM CONDITIONED ENVELOPE.

SPACE ABOVE ORIGINIAL ATTIC SHOWS POOR INSULATION DISPERSEMENT. RECOMMEND BLOWN CELLULOSE.

ROOF OF ORIGINAL BUILDING IN ADDITION SPACE

SPACE BELOW ORIGINAL ROOF IN ADDITION SPACE. RECOMMEND BLOWN CELLULOSE INSULATION.


COLUMN IN WEST ATTIC SPACE.


SIGNS OF WATER DAMAGE IN WEST ATTIC CEILING.


UN-SEALED WINDOW IN SPACE ABOVE WEST ATTIC


SIGNS OF WATER DAMAGE IN WEST ATTIC CEILING.

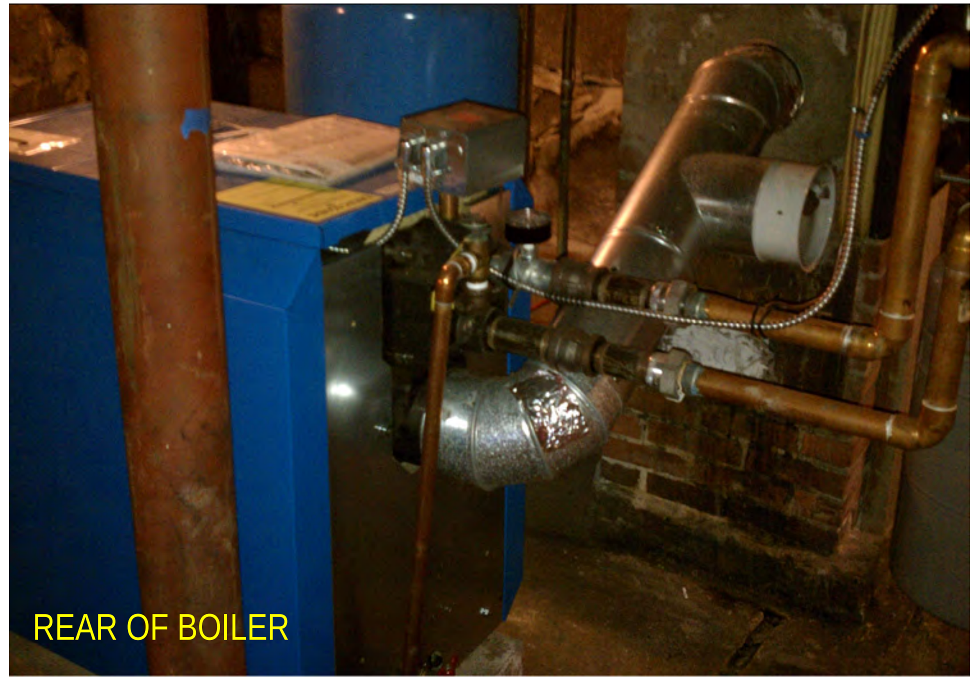

BASEMENT SPACE WITH UNINSULATED PIPES ABOVE.
RECOMMEND INSULATING ALL HOT WATER PIPES.


HEATING ZONE CONTROLS


DOOR LEADING TO BASEMENT FROM HALLWAY.
RECOMMEND AIR-SEALING DOOR TO LIMIT THERMAL
TRANSFER BETWEEN SPACES.

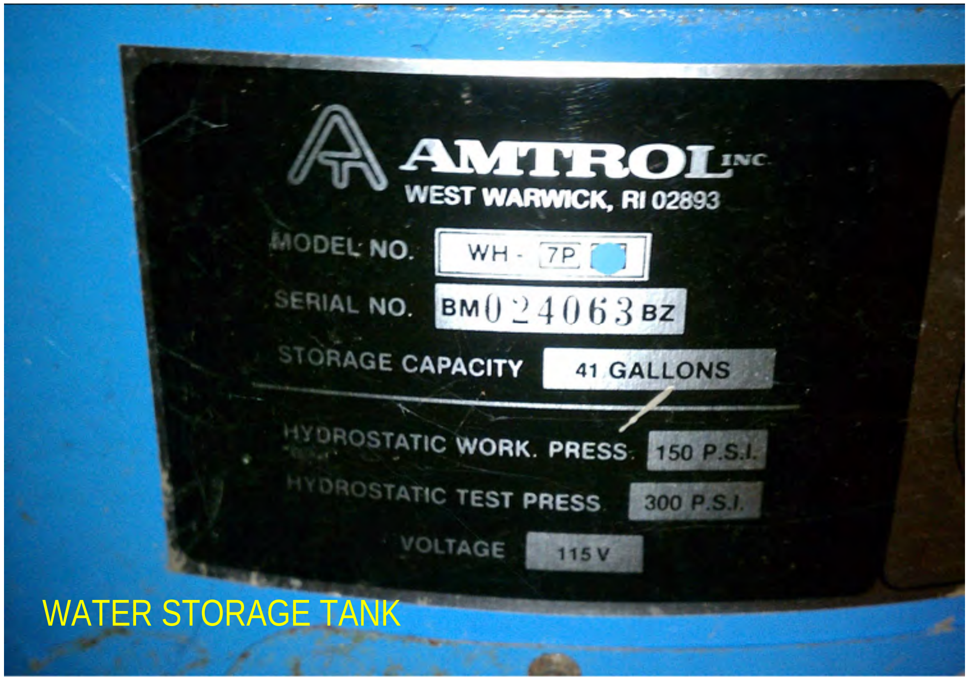

BASEMENT SPACE WITH UNINSULATED PIPES ABOVE.
RECOMMEND INSULATING ALL HOT WATER PIPES.

HEATING ZONE CONTROLS


REAR OF BOILER

HEATING ZONE CONTROLS

HEATING ZONE CONTROLS

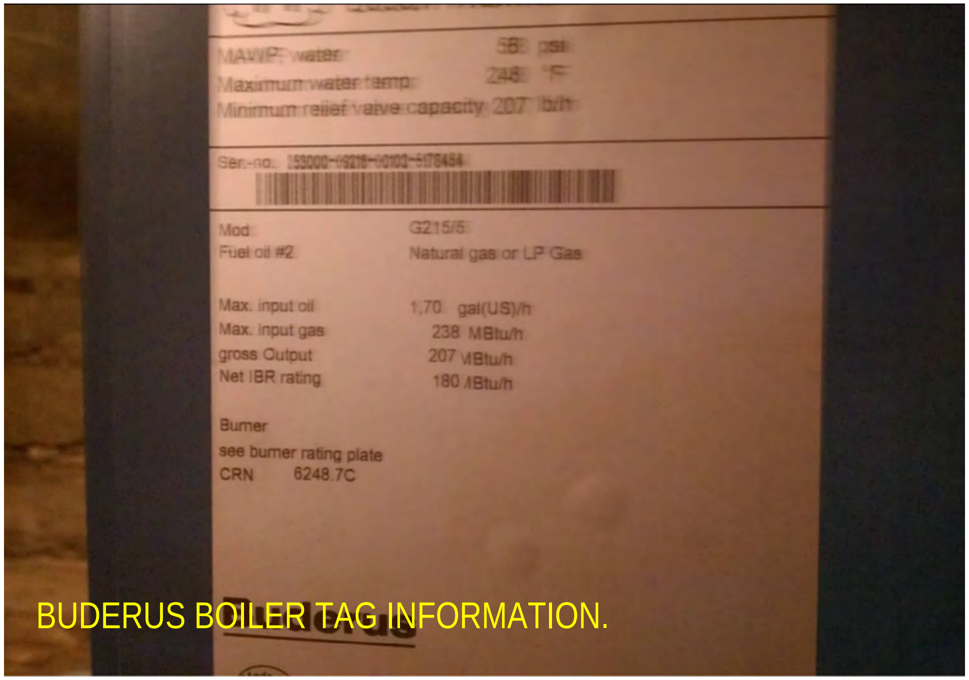


WATER STORAGE TANK


BASEMENT DOOR LEADING TO STAIRS TO EXTERIOR. RECOMMEND CLOSING AND SEALING.


WATER STORAGE TANK WITH UNINSULATED PIPES. RECOMMEND INSULATING ALL HOT WATER PIPES.

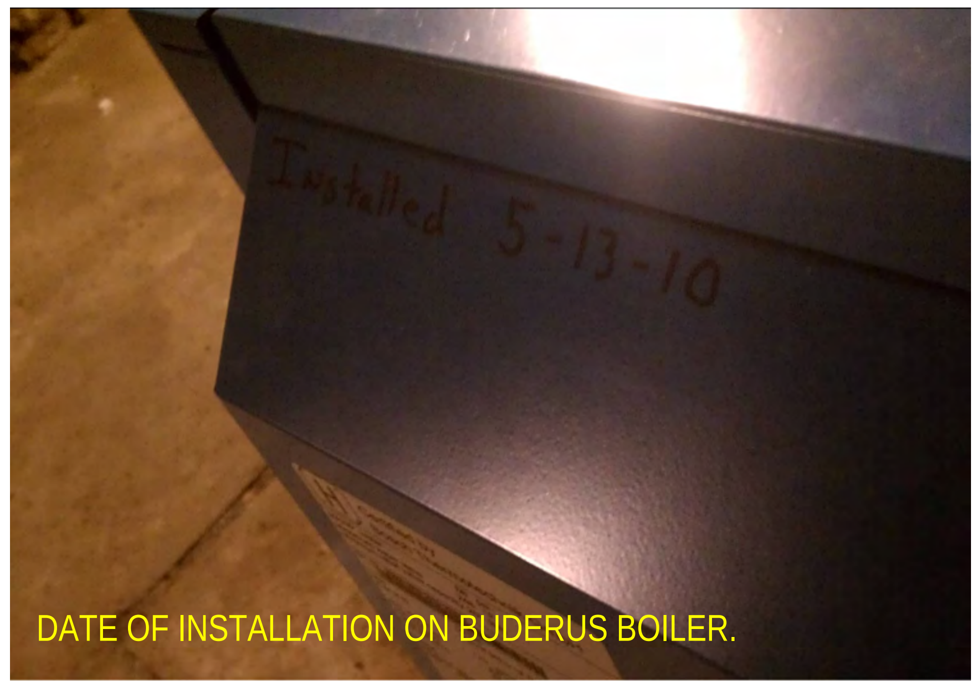

PLANKS COVERING OPEN SPACE IN BASEMENT FLOOR



BUDERUS BOILER TAG INFORMATION.


EXTROL EXPANSION TANK IN BASEMENT

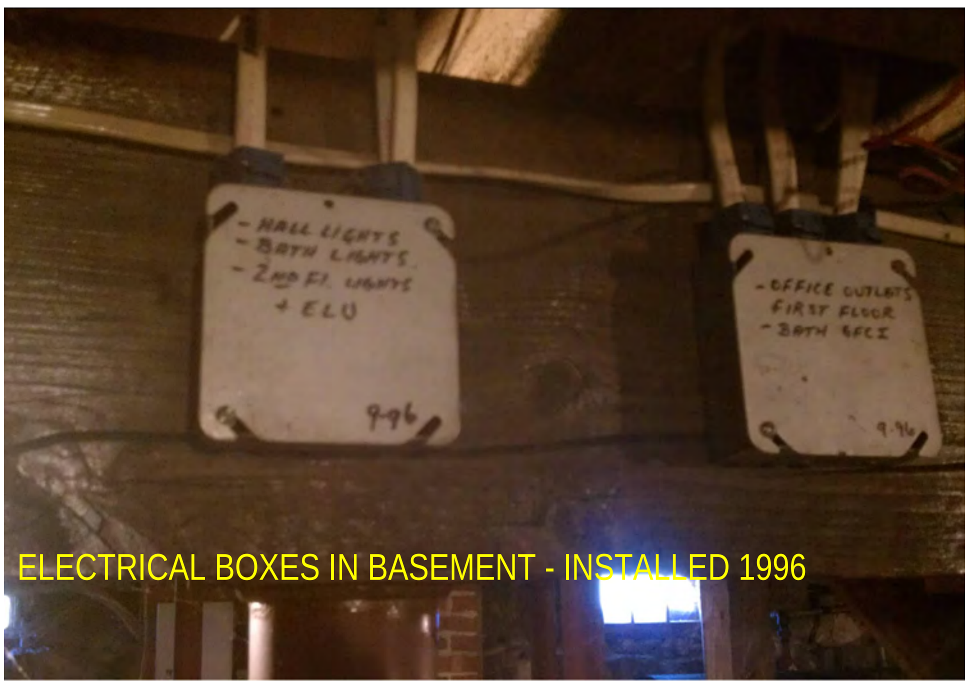
BUDERUS BOILER.



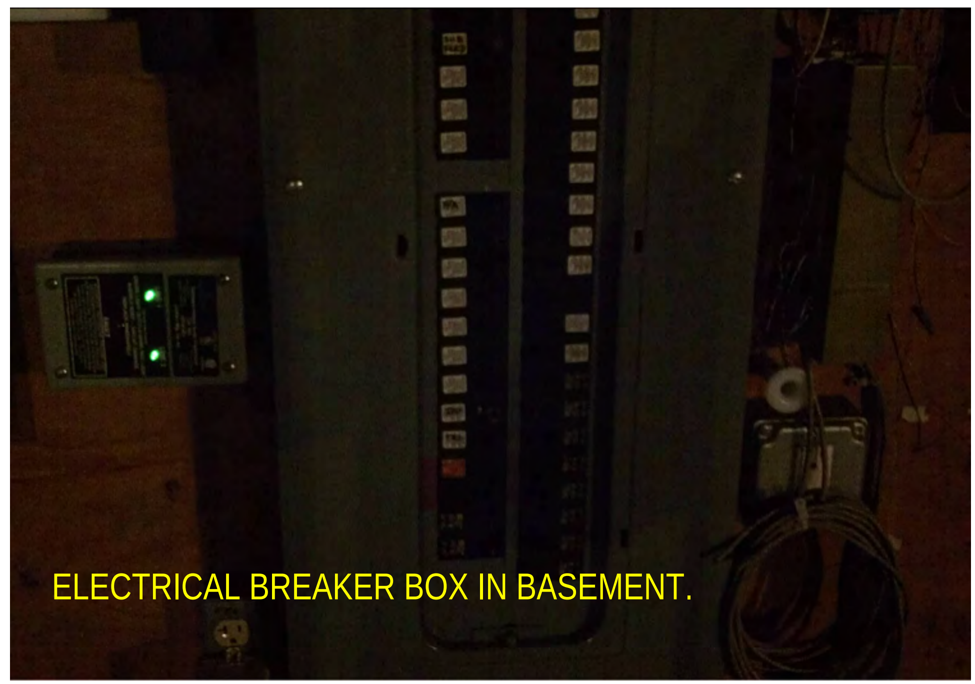
DATE OF INSTALLATION ON BUDERUS BOILER.

OPENING IN WALL BETWEEN ORIGINAL BASEMENT AND SPACE BELOW ADDITION. RECOMMEND SEALING GAP.

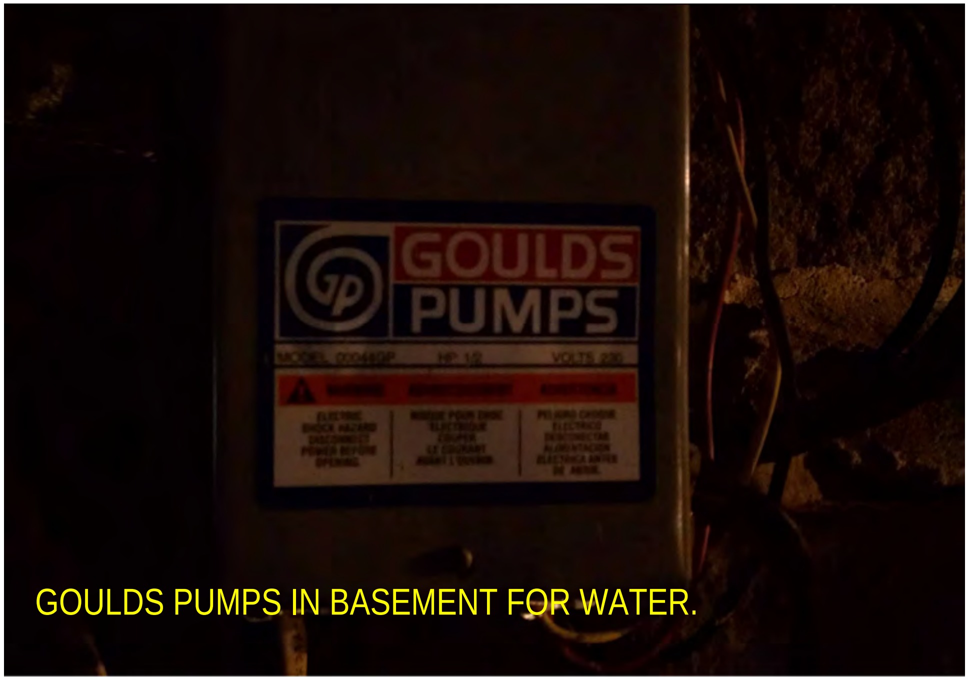
OIL STORAGE TANK.



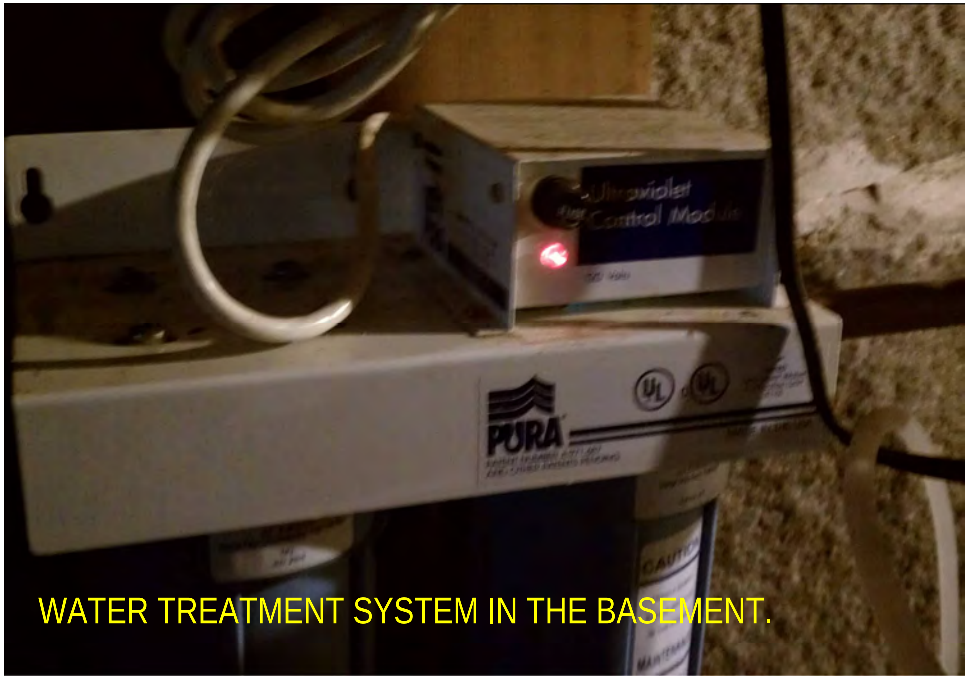
ELECTRICAL BOXES IN BASEMENT - INSTALLED 1996



ELECTRICAL BREAKER BOX IN BASEMENT.



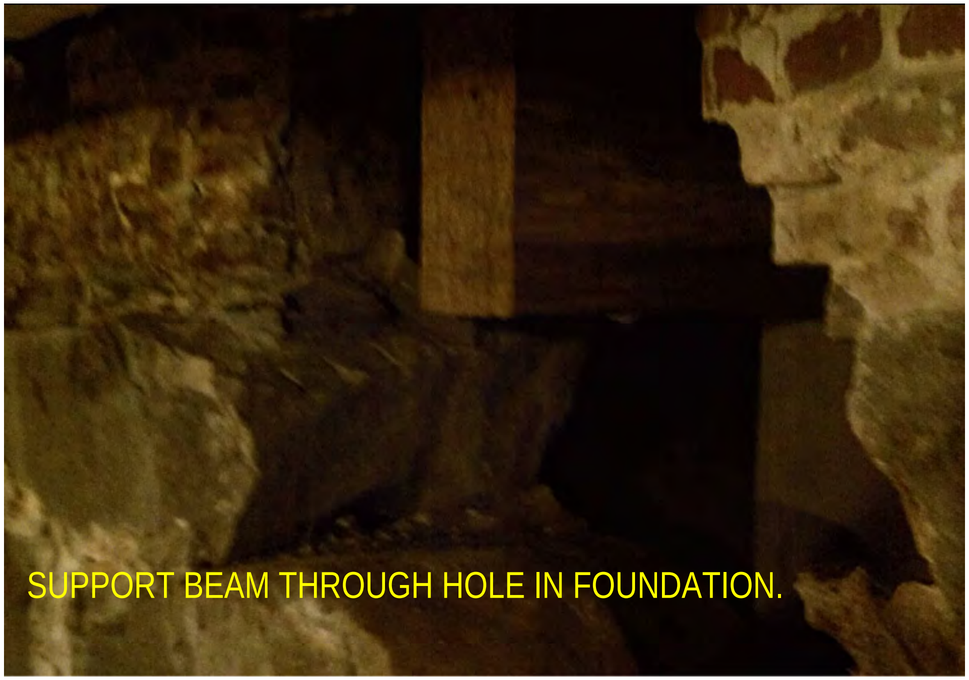
GOULDS PUMPS IN BASEMENT FOR WATER.



WATER TREATMENT SYSTEM IN THE BASEMENT.

WATER PRESSURE TANK IN BASEMENT.

WATER SHUTOFF LABELED.



SUPPORT BEAM THROUGH HOLE IN FOUNDATION.

FROM OF SAU BUILDING.

SUPPORT BEAM BELOW BASEMENT STAIRS.

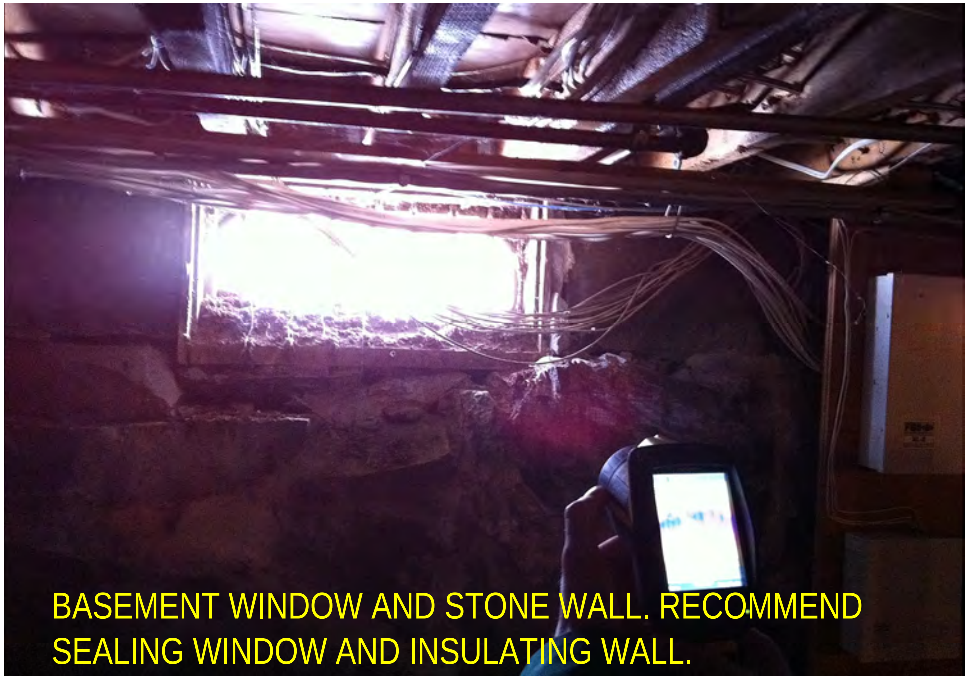
BARN SPACE USED FOR STORAGE.


LIGHT FIXTURE IN FILE/STORAGE ROOM.


WINDOW FRAME OF FIRST FLOOR BACK HALLWAY.


WINDOW FRAME IN ENTRANCE LOBBY.


CONFERENCE ROOM AT NORTH SIDE OF BUILDING.



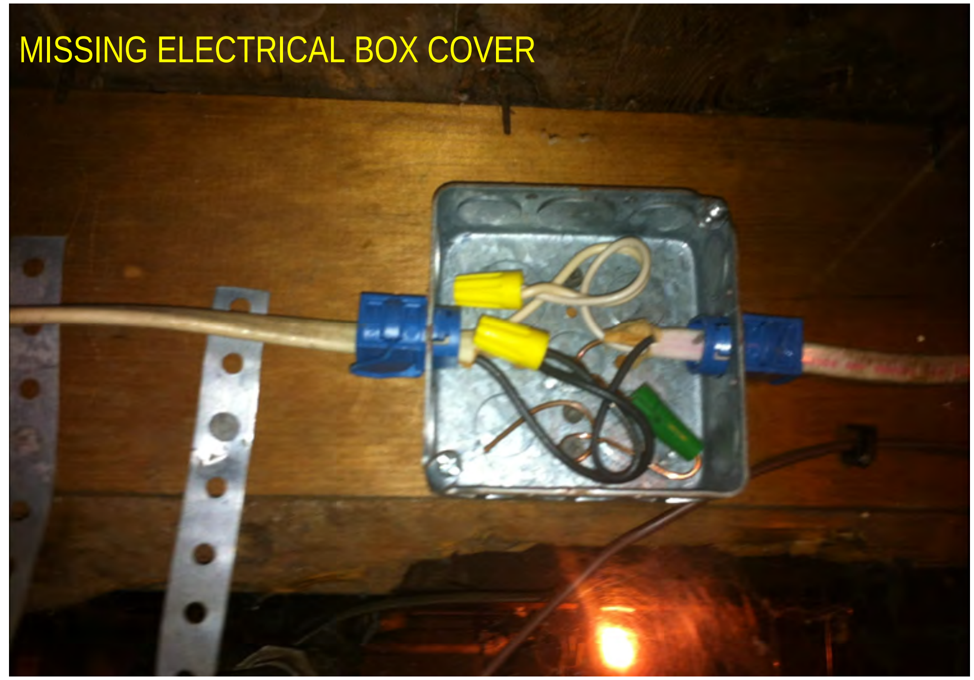
BASEMENT WINDOW AND STONE WALL. RECOMMEND SEALING WINDOW AND INSULATING WALL.

EXPOSED WIRING AND OPENING IN FOUNDATION. RECOMMEND SEALING FOUNDATION WALL AND INSULATING.

FIRST FLOOR BATHROOM

CONCRETE BASEMENT WALL BENEATH ADDITION SPACE. RECOMMEND INSULATING.


EXPOSED WIRING IN THE BASEMENT.


MISSING ELECTRICAL BOX COVER


SUPPORT BEAM IN THE BASEMENT


POOR INSULATION IN SPACE ABOVE WEST ATTIC.
RECOMMEND CELLULOSE INSULATION IN ATTIC FLOOR.


EXPOSED WIRING IN THE BASEMENT.


ELECTRICAL SOCKET WITH EXPOSED WIRES IN BASEMENT


WATER FILTRATION SYSTEM IN THE BASEMENT.


EXPOSED WIRING IN THE BASEMENT.

OPEN WINDOW IN SECOND FLOOR OFFICE. RECOMMEND CLOSING STORM WINDOWS DURING HEATING SEASON.

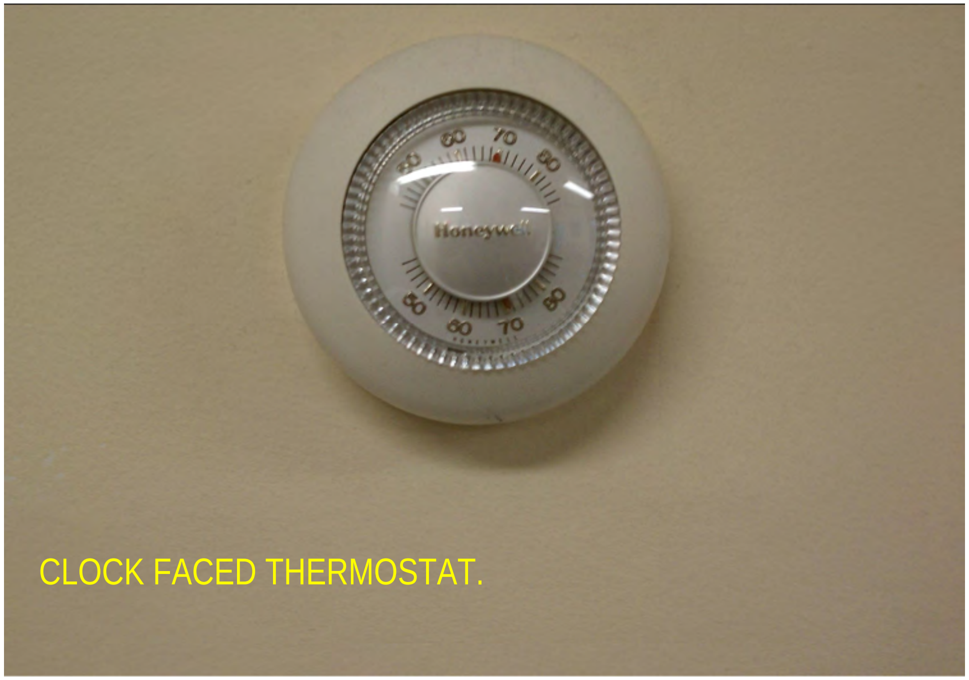
WINDOW AC UNIT INSTALLED ALL YEAR. RECOMMEND REPLACING WITH ENERGY STAR RATED MODEL AND REMOVING DURING HEATING SEASON.

KITCHEN SPACE ON SECOND FLOOR. RECOMMEND REPLACING REFRIGERATOR WITH ENERGY STAR RATED MODEL.

DIGITAL THERMOSTAT.


SECOND FLOOR OFFICE SPACE.


OPEN WINDOW IN SECOND FLOOR OFFICE.



CLOCK FACED THERMOSTAT.


ATTIC SPACE ABOVE ENTRANCE LOBBY.


ATTIC SPACE ABOVE ENTRANCE LOBBY WITH BOARDED UP WINDOW. IR REVEALED POOR SEAL.


BATT INSULATION AND EXPOSED WIRING IN THE ATTIC SPACE.


BATT INSULATION ABOVE REAR STAIRCASE.


SECTION OF ROOF IN ADDITION ATTIC SPACE

ELECTRICAL METER AT SOUTHEAST CORNER.


BATT INSULATION ABOVE REAR STAIRCASE.


STONE FOUNDATION BELOW ADDITION SPACE.


STAIRS LEADING TO BASEMENT FROM EXTERIOR.


ON-SITE WELL FOR WATER SUPPLY.


GUTTER DRAIN AT FRONT OF BUILDING NOT CONNECTED.


FOUNDATION AND SUPPORTS OF BARN

APPENDIX B

Thermal Imaging Survey Reports

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

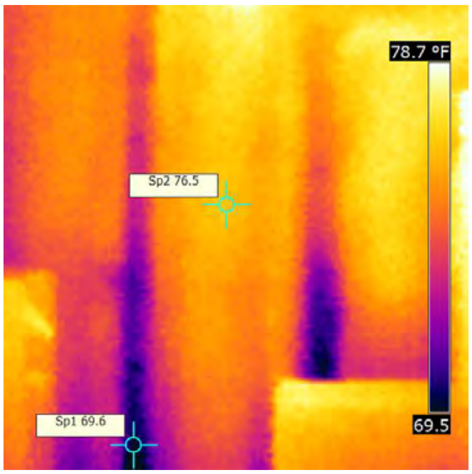


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:42:53 AM
Image Name	IR_2161.jpg
Emissivity	0.96
Reflected apparent temperature	70.0 °F
Object Distance	7.0 ft

Text Comments

Description

IR of the exterior wall in the file storage room reveals thermal breaching at the studs. Recommend insulating wall cavities with blown in cellulose. Refer to EEM T3-2 for cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

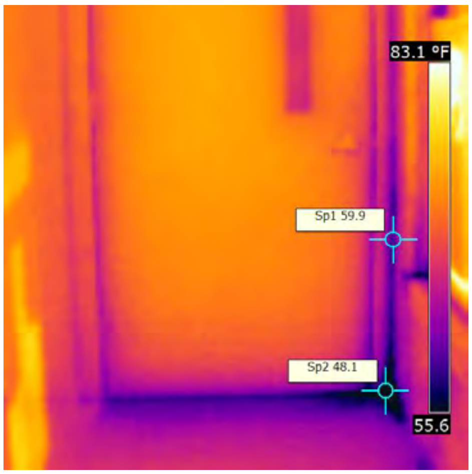


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:43:24 AM
Image Name	IR_2162.jpg
Emissivity	0.96
Reflected apparent temperature	47.0 °F
Object Distance	7.0 ft

Description

IR of file storeroom doorway leading to back staircase shows signs of thermal transfer underneath door as well as in corner at seam between wall and door frame. Recommend air-sealing the door to limit transfer. Refer to EEM T1-9 for cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

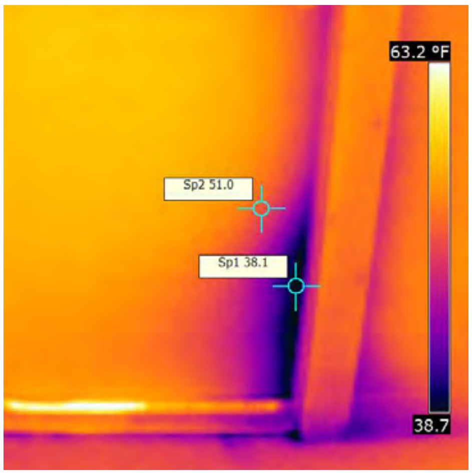


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:44:11 AM
Image Name	IR_2163.jpg
Emissivity	0.96
Reflected apparent temperature	37.0 °F
Object Distance	4.0 ft

Text Comments

Description

File storeroom door to back staircase shows signs of thermal breaching at the bottom of the door. Recommend air-sealing door to limit thermal transfer. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

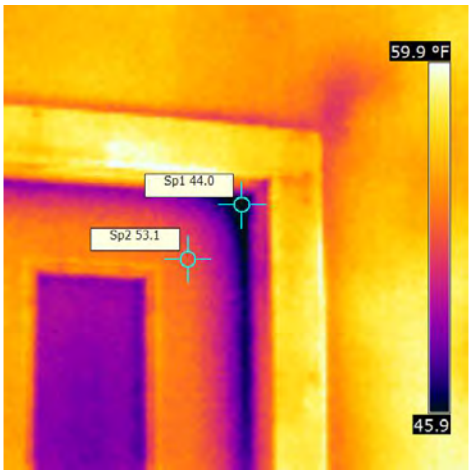


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:44:37 AM
Image Name	IR_2164.jpg
Emissivity	0.96
Reflected apparent temperature	43.0 °F
Object Distance	4.0 ft

Description

File storeroom door to back staircase shows signs of thermal breaching at the top of the door. Recommend air-sealing to limit thermal transfer. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

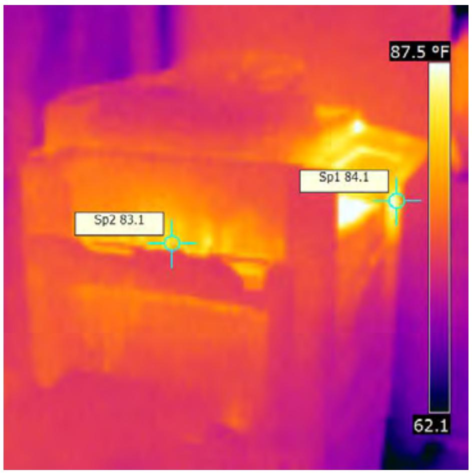


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:46:54 AM
Image Name	IR_2165.jpg
Emissivity	0.96
Reflected apparent temperature	84.0 °F
Object Distance	5.0 ft

Text Comments

Description

Photocopier produces thermal energy and consumes a considerable amount of energy, even in standby. Recommend putting copiers on a timeclock to power down when the building is unoccupied. Refer to EEM T1-2 for associated cost and savings of powering down.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

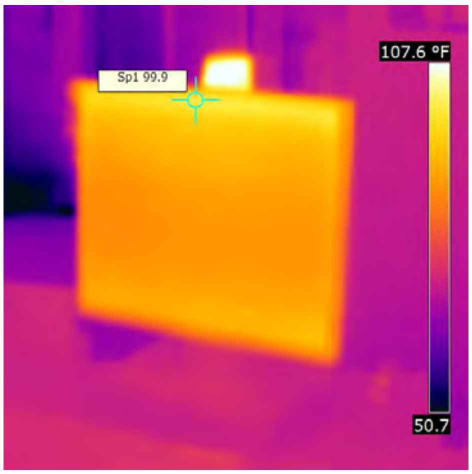


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:49:43 AM
Image Name	IR_2167.jpg
Emissivity	0.96
Reflected apparent temperature	101.0 °F
Object Distance	3.0 ft

Text Comments

Description

IR of running computer screen reveals thermal energy produced. Recommend powering down all electronics when not in use. Refer to EEM T1-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

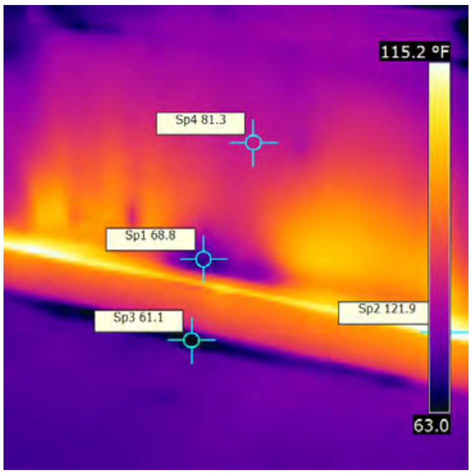


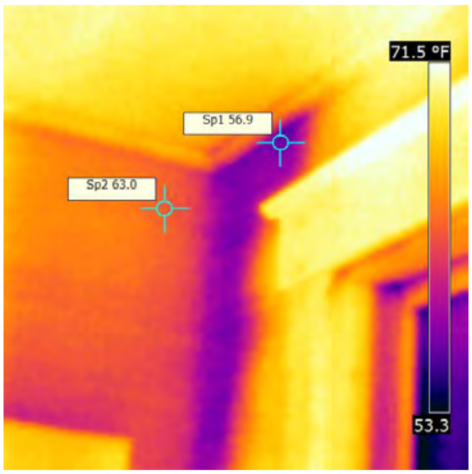
Image and Object Parameters		Text Comments
Camera Model	B-CAM Western S	
Image Date	1/4/2012 9:50:19 AM	
Image Name	IR_2168.jpg	
Emissivity	0.96	
Reflected apparent temperature	60.0 °F	
Object Distance	6.0 ft	

Description

IR of wall behind secretary's desk reveals where thermal energy is being emitted from baseboard radiator as well as cold spots underneath and behind areas of the radiator where heat is not well distributed.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



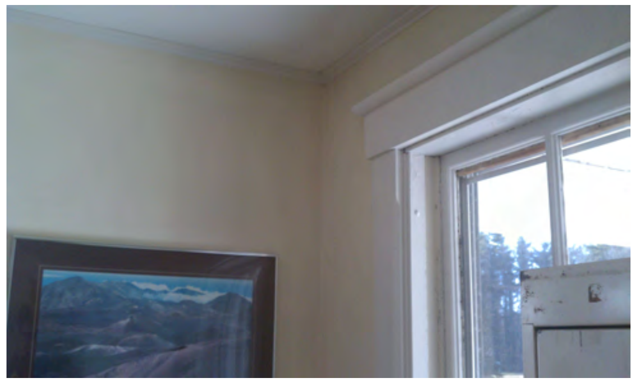


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:51:05 AM
Image Name	IR_2169.jpg
Emissivity	0.96
Reflected apparent temperature	56.0 °F
Object Distance	5.0 ft

Text Comments

Description

Corner of the secretary's office reveals poor or missing insulation allowing thermal transfer. Recommend injecting blown cellulose in the cavitiy. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

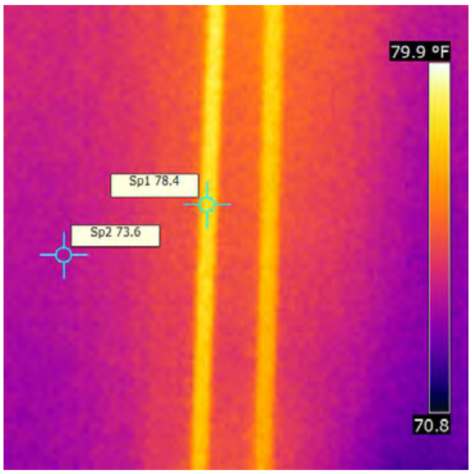


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:51:31 AM
Image Name	IR_2170.jpg
Emissivity	0.96
Reflected apparent temperature	79.0 °F
Object Distance	3.0 ft

Text Comments

Description

Uninsulated hot water pipes in the hallway reveal thermal transfer. Recommend insulating all hot water pipes. Refer to EEM T1-5 for associated cost and savings of insulating hot water pipes.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

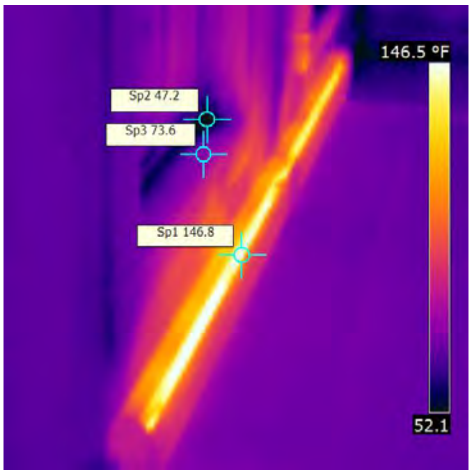


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:52:14 AM
Image Name	IR_2171.jpg
Emissivity	0.96
Reflected apparent temperature	46.0 °F
Object Distance	6.0 ft

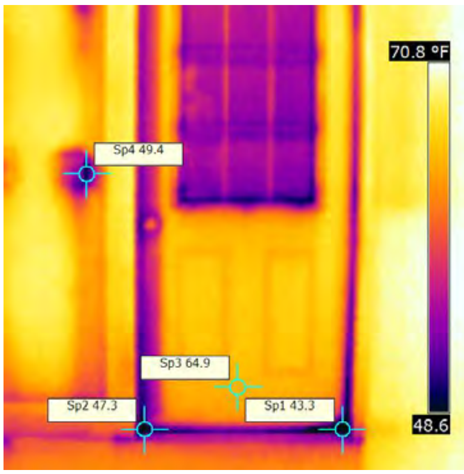
Text Comments

Description

IR of back hallway reveals high thermal transfer at the baseboard radiator as well as poor sealing at the corner of the window. Refer to EEM T1-9 for the cost and savings of air-sealing measures.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



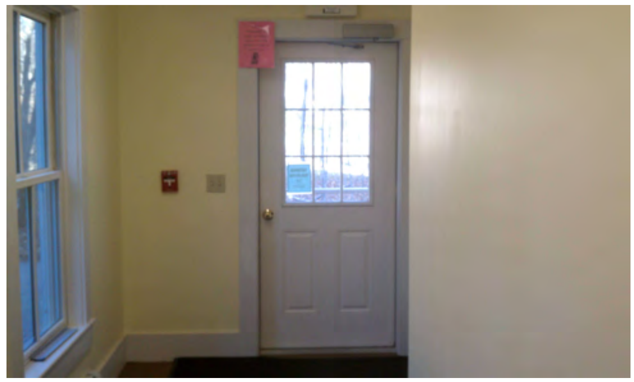


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:52:45 AM
Image Name	IR_2172.jpg
Emissivity	0.96
Reflected apparent temperature	42.0 °F
Object Distance	8.0 ft

Text Comments

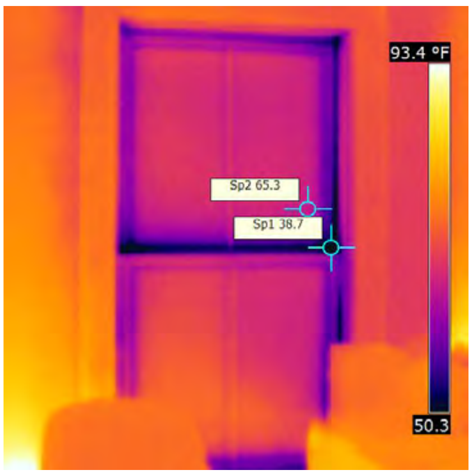
Description

IR of rear entrance shows thermal breaching around door seal, especially at the corners, as well as around the door window. Thermal transfer also occurring around light switch. Recommend air-sealing the door. Refer to EEM T1-9 for cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



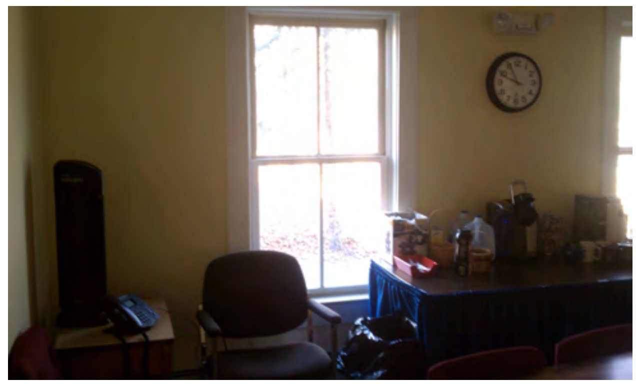


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:53:19 AM
Image Name	IR_2174.jpg
Emissivity	0.96
Reflected apparent temperature	37.0 °F
Object Distance	8.0 ft

Text Comments

Description

Window in back conference room shows significant signs of thermal breaching at the seal. Recommend sealing all windows and doors with weather striping. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

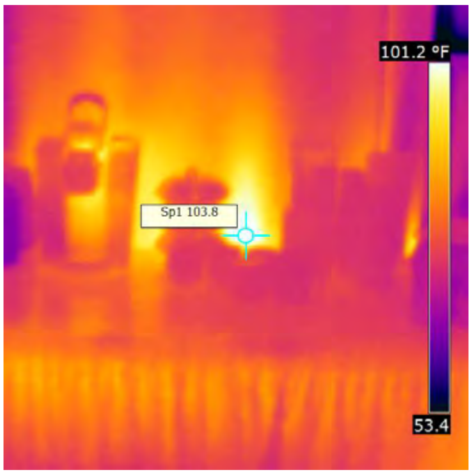


Image and Object Parameters	
Camera Model	B-CAM Western S
Image Date	1/4/2012 9:53:52 AM
Image Name	IR_2175.jpg
Emissivity	0.96
Reflected apparent temperature	105.0 °F
Object Distance	7.0 ft

Text Comments

Description

Thermal energy is emitted from the radiator behind the food table resulting in inadequate heat dispersion. Recommend keeping all baseboard radiators unblocked.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

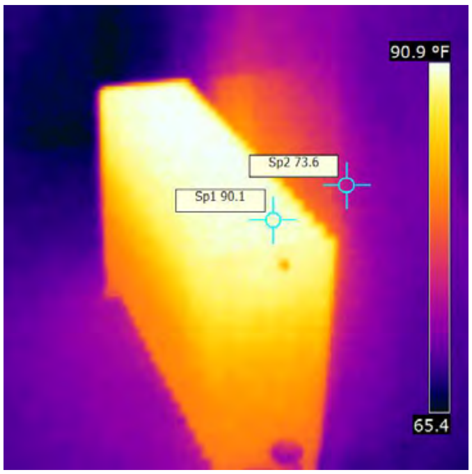


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:54:45 AM
Image Name	IR_2176.jpg
Emissivity	0.96
Reflected apparent temperature	91.0 °F
Object Distance	4.0 ft

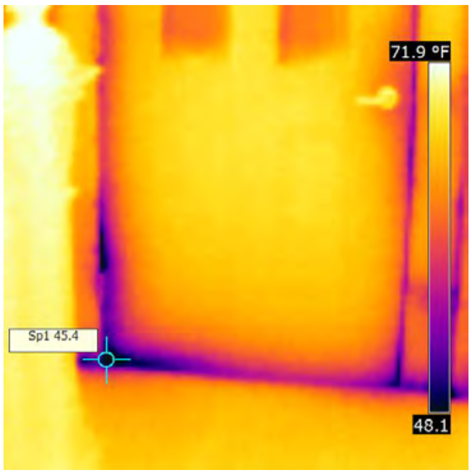
Text Comments

Description

Hallway radiator shows thermal energy produced.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



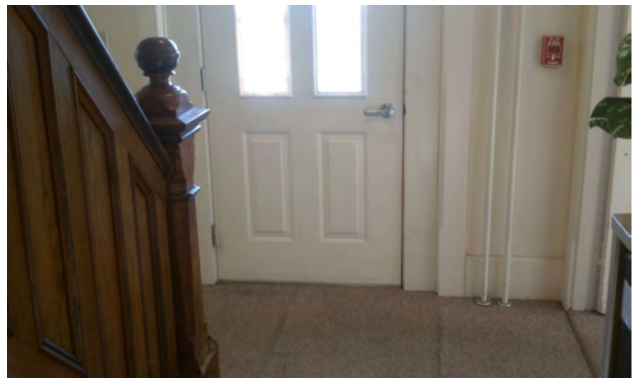


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:55:08 AM
Image Name	IR_2177.jpg
Emissivity	0.96
Reflected apparent temperature	44.0 °F
Object Distance	6.0 ft

Description

Seal around doorway at the bottom of the stairs reveals thermal transfer occurring. Recommend air-sealing all windows and doors. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

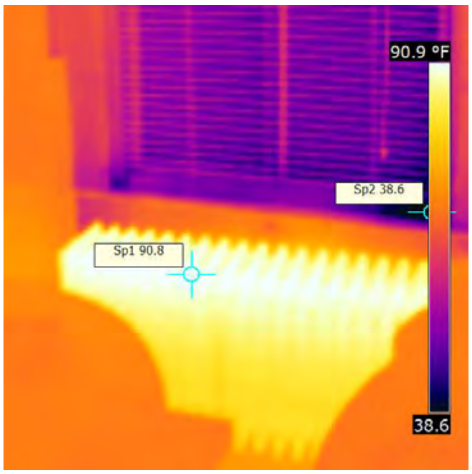


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:56:22 AM
Image Name	IR_2179.jpg
Emissivity	0.96
Reflected apparent temperature	37.0 °F
Object Distance	5.0 ft

Text Comments

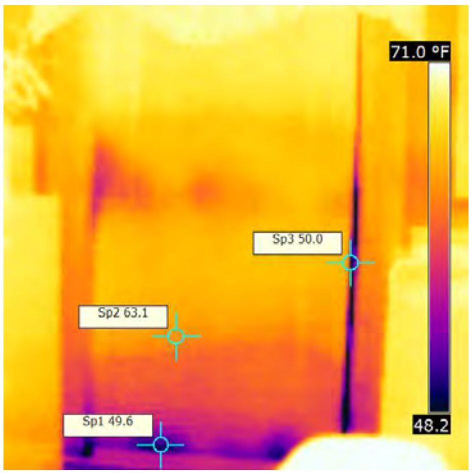
Description

IR of superintendent's office reveals heat emitted by radiator as well as thermal transfer through window frame. Recommend air-sealing the window to limit the thermal energy produced by the radiator to be lost. Refer to EEM T1-9 for cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



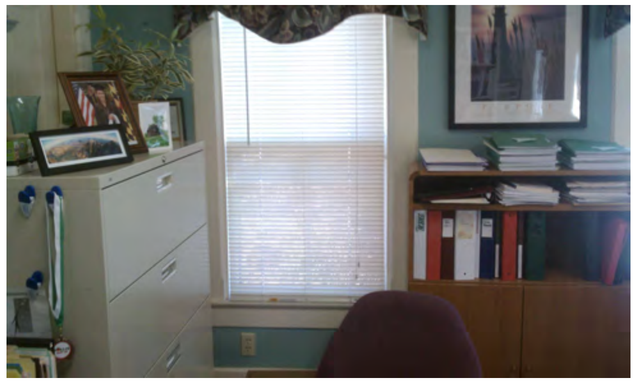


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:57:14 AM
Image Name	IR_2180.jpg
Emissivity	0.96
Reflected apparent temperature	49.0 °F
Object Distance	6.0 ft

Text Comments

Description

IR of window with blinds closed reveals thermal energy retained by closed shades and thermal transfer between shade and window. Recommend closing all storm windows as well during the heating period. Refer to EEM T1-1 for savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

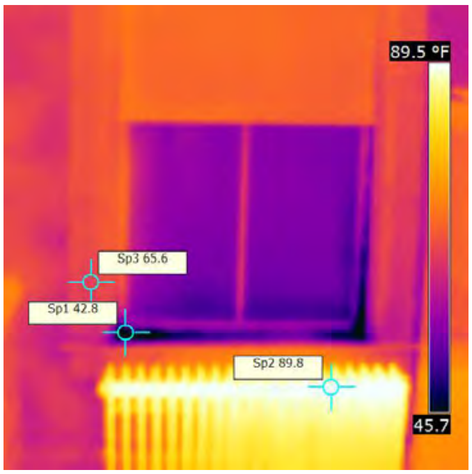


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:58:11 AM
Image Name	IR_2181.jpg
Emissivity	0.96
Reflected apparent temperature	42.0 °F
Object Distance	5.0 ft

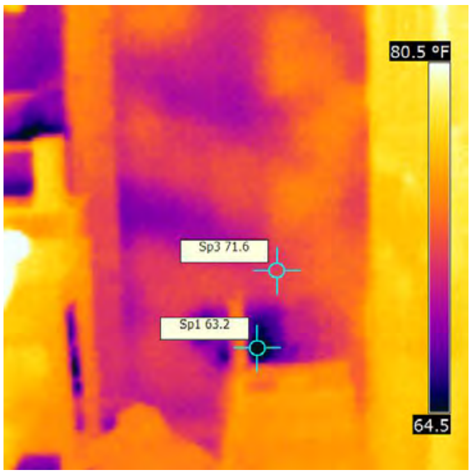
Text Comments

Description

Business Administrrators office IR reveals thermal energy emitted from radiator as well as poor seal and thermal transfer around window frame, allowing thermal energy produced to be lost. Recommend air-sealing all windows and doors. Refer to EEM T1-9.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



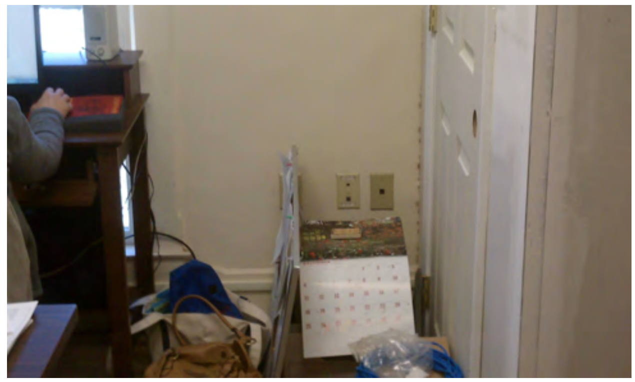


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 9:59:19 AM
Image Name	IR_2183.jpg
Emissivity	0.96
Reflected apparent temperature	63.0 °F
Object Distance	6.0 ft

Text Comments

Description

Upstairs wall IR reveals areas with different thermal properties indicating an uneven dispersement of insulation. Recomend insulating wall cavities with blown cellulose. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

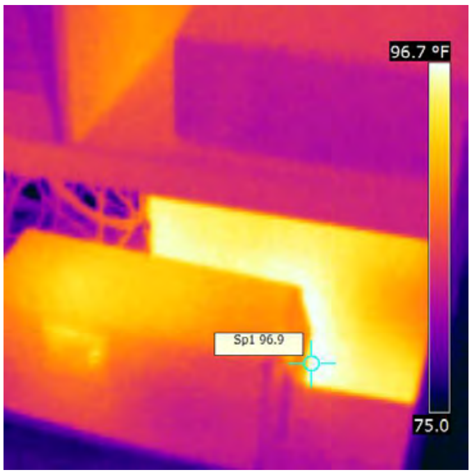


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:00:09 AM
Image Name	IR_2184.jpg
Emissivity	0.96
Reflected apparent temperature	98.0 °F
Object Distance	4.0 ft

Text Comments

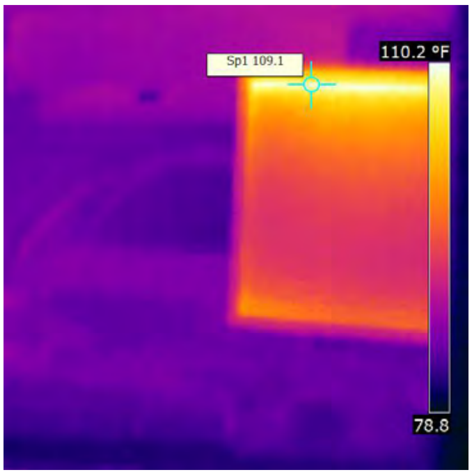
Description

Computer server equipment in the closet runs constantly resulting in thermal energy produced. An AC unit is powered constantly to help regulate the temperature in the closet.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



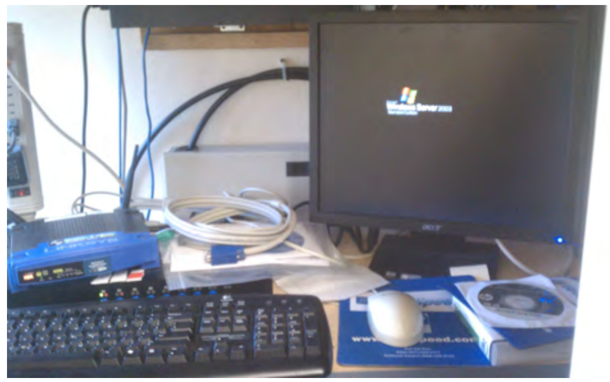


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:00:21 AM
Image Name	IR_2185.jpg
Emissivity	0.96
Reflected apparent temperature	110.0 °F
Object Distance	3.0 ft

Text Comments

Description

The computer monitor for the server equipment is left on constantly as well even though it is rarely used. Recommend turning off monitor when not in use. Refer to EEM T1-2 for associated savings of powering down equipment.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

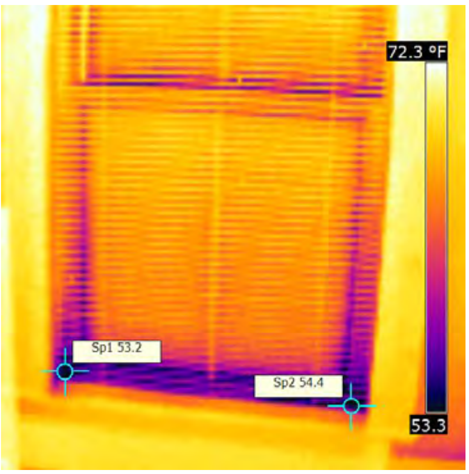


Image and Object Parameters		Text Comments
Camera Model	B-CAM Western S	
Image Date	1/4/2012 10:02:20 AM	
Image Name	IR_2189.jpg	
Emissivity	0.96	
Reflected apparent temperature	53.0 °F	
Object Distance	6.0 ft	

Description

Office window with open blinds shows thermal transfer through blinds and around window frame. Recommend air-sealing all windows and doors. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

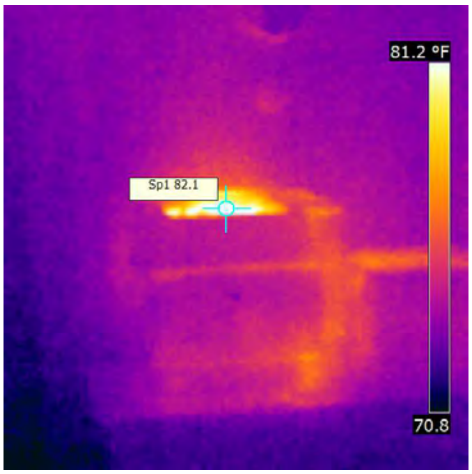


Image and Object Parameters		Text Comments
Camera Model	B-CAM Western S	
Image Date	1/4/2012 10:02:47 AM	
Image Name	IR_2190.jpg	
Emissivity	0.96	
Reflected apparent temperature	83.0 °F	
Object Distance	8.0 ft	

Description

Office printer creates thermal energy when powered on. Recommend powering down all electronic equipment when not in use or setting on a timer. Refer to EEM T1-2 for associated cost and savings of powering down electronic equipment.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

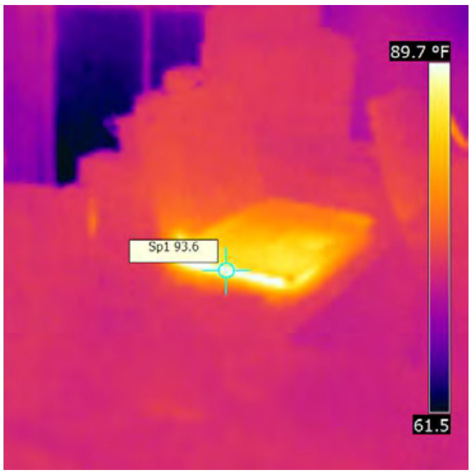


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:04:31 AM
Image Name	IR_2192.jpg
Emissivity	0.96
Reflected apparent temperature	95.0 °F
Object Distance	5.0 ft

Text Comments

Description

Laptop emitts thermal energy when running. Recommend air-sealing all electronic equipment when not in use. Refer to EEM T1-2 for associated savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

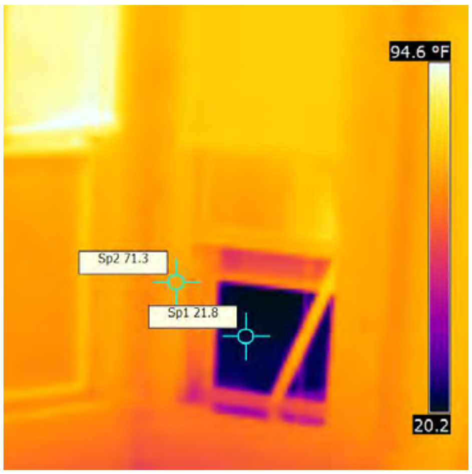


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:05:07 AM
Image Name	IR_2194.jpg
Emissivity	0.96
Reflected apparent temperature	20.0 °F
Object Distance	7.0 ft

Description

A second window was opened upstairs to create thermal transfer due to uncomfortable temperatures. Recommend closing all storm windows and air-sealing all windows. Refer to EEM T1-1 for closing windows and EEM T1-9 for air-sealing.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

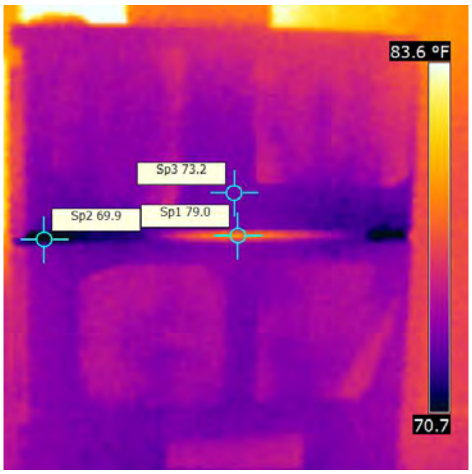


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:05:39 AM
Image Name	IR_2195.jpg
Emissivity	0.96
Reflected apparent temperature	70.0 °F
Object Distance	5.0 ft

Text Comments

Description

IR of refrigerator in the kitchen reveals a poor seal and thermal transfer to occur. Recommend replacing refrigerator with an Energy Star model. Refer to EEM T1-7 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

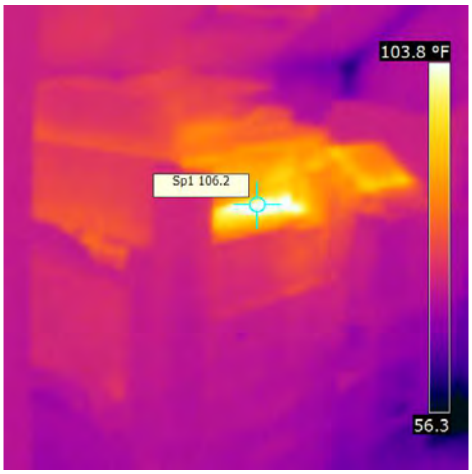


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:06:50 AM
Image Name	IR_2196.jpg
Emissivity	0.96
Reflected apparent temperature	108.0 °F
Object Distance	4.0 ft

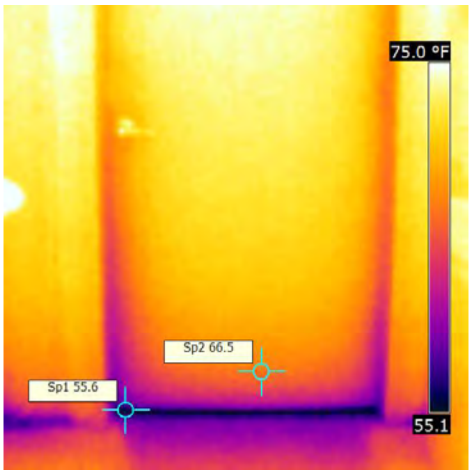
Text Comments

Description

Photocopier upstairs reveals thermal energy produced when powered on, even when not in use. Recommend setting photocopiers on timer strips and powering down all electronics when not in use. Refer to EEM T1-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



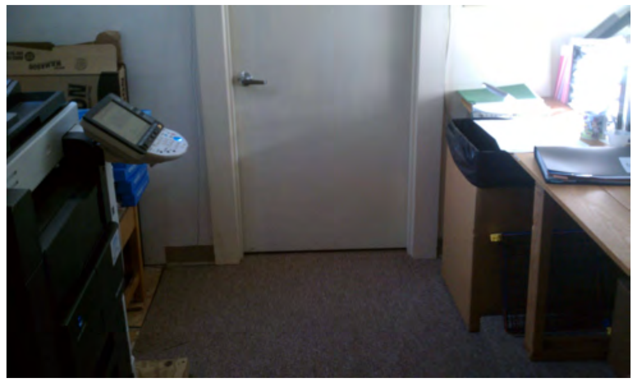


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:08:20 AM
Image Name	IR_2198.jpg
Emissivity	0.96
Reflected apparent temperature	55.0 °F
Object Distance	5.0 ft

Text Comments

Description

Doorway leading from upstairs copy room to back staircase shows sings of thermal breaching underneath. Recommend air-sealing door to create better thermal barrier between spaces.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

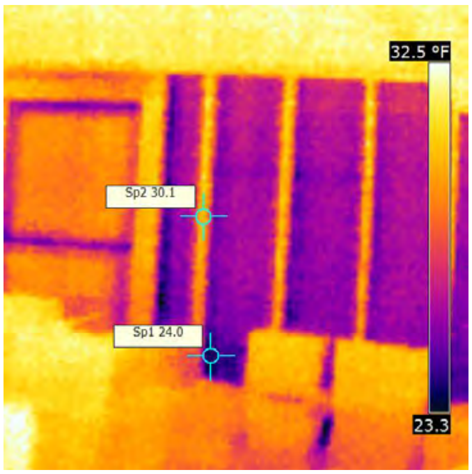


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:10:52 AM
Image Name	IR_2201.jpg
Emissivity	0.96
Reflected apparent temperature	22.0 °F
Object Distance	15.0 ft

Text Comments

Description

Uninsulated wall in attic reveals thermal breaching. Recommend insulating wall cavities with blown in cellulose and adding 4" of cellulose to the addition attic floor. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

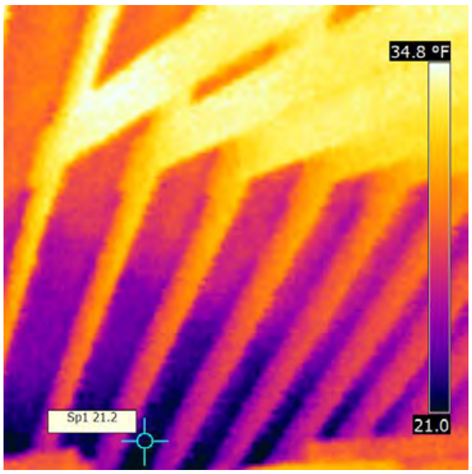


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:11:17 AM
Image Name	IR_2202.jpg
Emissivity	0.96
Reflected apparent temperature	19.0 °F
Object Distance	15.0 ft

Text Comments

Description

Uninsulated ceiling in the addition attic reveals thermal breaching. Recommend air sealing floor to separate attic from conditioned envelope. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

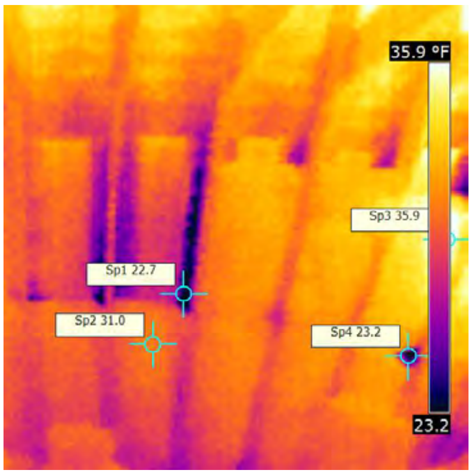


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:12:12 AM
Image Name	IR_2204.jpg
Emissivity	0.96
Reflected apparent temperature	20.0 °F
Object Distance	15.0 ft

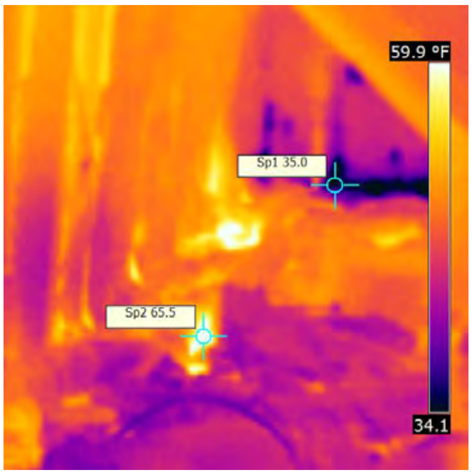
Text Comments

Description

Partially insulated attic ceiling reveals thermal transfer and different thermal properties where insulation is and is not present. Recommend air sealing floor to separate attic from conditioned envelope. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



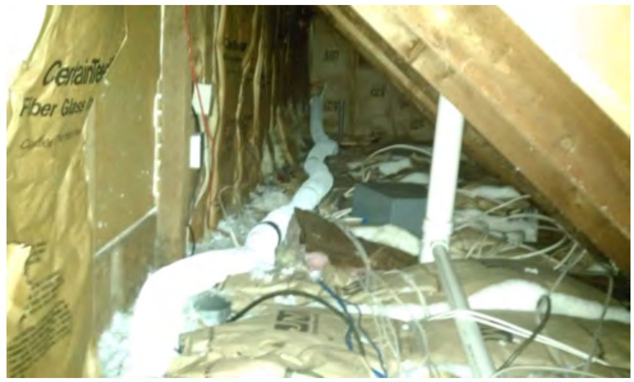


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:13:09 AM
Image Name	IR_2205.jpg
Emissivity	0.96
Reflected apparent temperature	34.0 °F
Object Distance	12.0 ft

Text Comments

Description

IR of one of attic crawlspace reveals different thermal transfers due to varying installed insulations. Recommend air sealing floor to separate attic from conditioned envelope. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

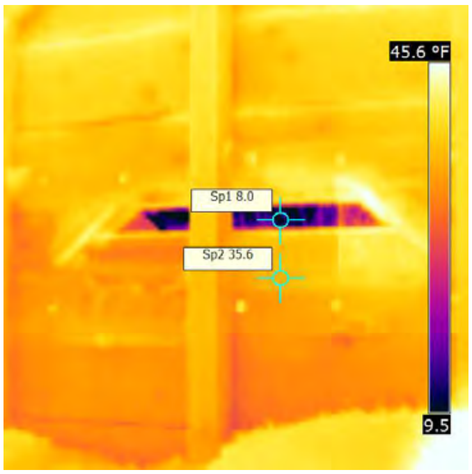


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:15:41 AM
Image Name	IR_2206.jpg
Emissivity	0.96
Reflected apparent temperature	34.0 °F
Object Distance	5.0 ft

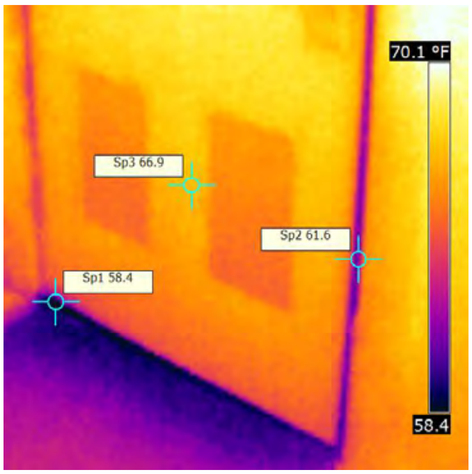
Text Comments

Description

Top attic crawlspace window is not sealed allowing for significant thermal transfer.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



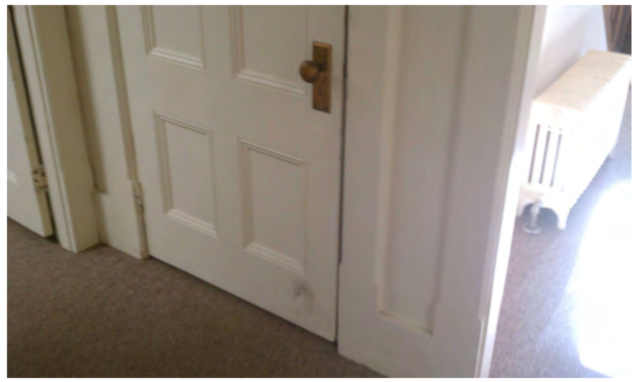


Image and Object Parameters		Text Comments
Camera Model	B-CAM Western S	
Image Date	1/4/2012 10:21:14 AM	
Image Name	IR_2209.jpg	
Emissivity	0.96	
Reflected apparent temperature	58.0 °F	
Object Distance	4.0 ft	

Description

IR of door leading to basement reveals thermal transfer between door and frame. Recommend air sealing door to separate basement from conditioned envelope. Refer to EEM T1-9 for cost and savings of air-sealing.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

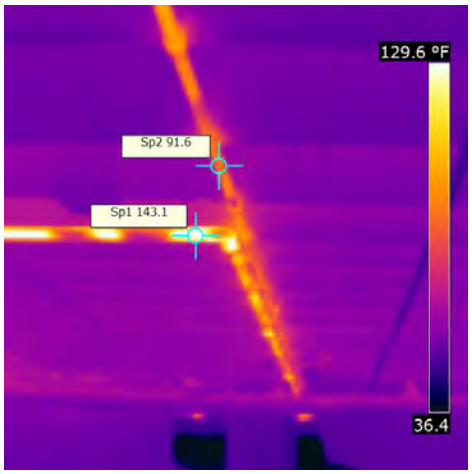


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:22:51 AM
Image Name	IR_2212.jpg
Emissivity	0.96
Reflected apparent temperature	145.0 °F
Object Distance	6.0 ft

Text Comments

Description

IR of uninsulated hot water pipes in the basement reveals thermal transfer through pipes. Recommend insulating all hot water pipes to retain that energy. Refer to EEM T1-5 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

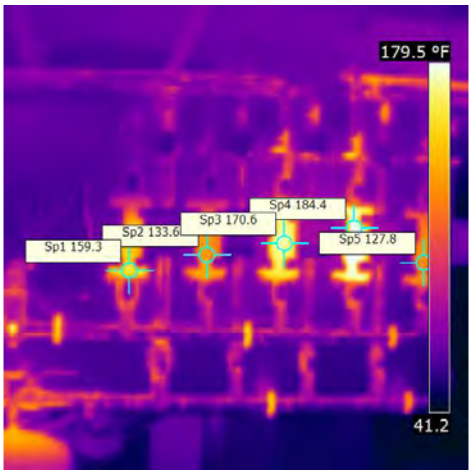


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:23:43 AM
Image Name	IR_2213.jpg
Emissivity	0.96
Reflected apparent temperature	147.0 °F
Object Distance	7.0 ft

Text Comments

Description

Heating zone controls in the basement reveal thermal transfer which indicate which zone is producing the most thermal energy. 1st floor entryway BB zone 4 produced the most energy at the time.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:25:14 AM
Image Name	IR_2214.jpg
Emissivity	0.96
Reflected apparent temperature	174.0 °F
Object Distance	4.0 ft

Text Comments

Description

Back of new boiler reveals thermal transfer around and through pipes.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

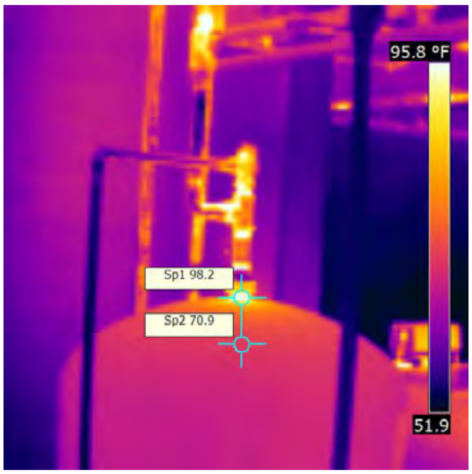


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/4/2012 10:25:42 AM
Image Name	IR_2215.jpg
Emissivity	0.96
Reflected apparent temperature	71.0 °F
Object Distance	5.0 ft

Text Comments

Description

IR of water heater and pipes in basement reveal thermal transfer. Recommend insulating all hot water pipes and replacing hot water heater with an electric tankless unit. Refer to EEM T1-5 for insulating pipes and T2-5 for replacing hot water heater.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

Image and Object Parameters		Text Comments
Camera Model	B-CAM Western S	
Image Date	1/4/2012 10:32:53 AM	
Image Name	IR_2216.jpg	
Emissivity	0.96	
Reflected apparent temperature	114.0 °F	
Object Distance	6.0 ft	

Description

IR of uninsulated hot water pipe in ceiling of basement reveals thermal transfer. Recommend insulating all hot water pipes. Refer to EEM T1-5 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:24:44 AM
Image Name	IR_2373.jpg
Emissivity	0.96
Reflected apparent temperature	36.0 °F
Object Distance	12.0 ft

Text Comments

Description

IR of front door reveals thermal transfer betwen door and frame. Recommend air-sealing all windows and doors. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

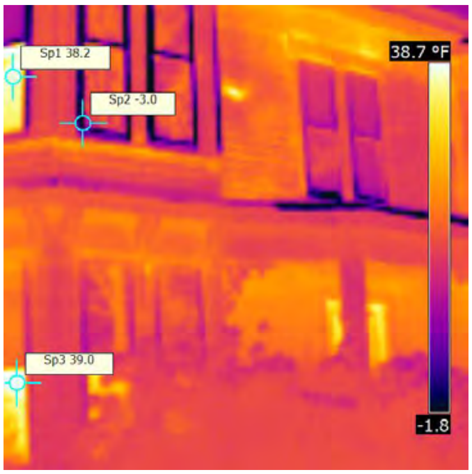


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:25:10 AM
Image Name	IR_2374.jpg
Emissivity	0.96
Reflected apparent temperature	37.0 °F
Object Distance	15.0 ft

Text Comments

Description

Thermal transfer through window frames and open windows. Recommend closing all storm windows during heating season, air-sealing all windows and replacing older windows with double-pane units. Refer to EEM T1-1, T1-9 and T3-3, respectively.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

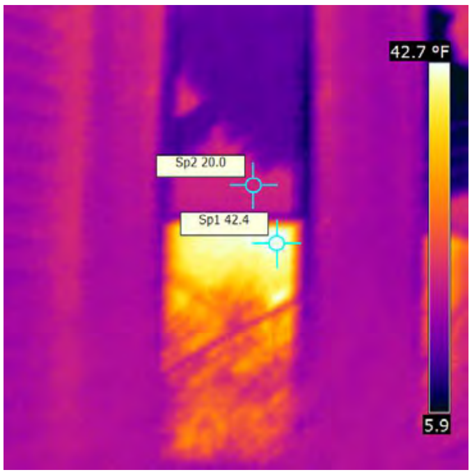


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:25:38 AM
Image Name	IR_2375.jpg
Emissivity	0.97
Reflected apparent temperature	17.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of first floor open window reveals thermal transfer. Recommend closing all storm windows during heating season and air-sealing all windows. Refer to EEM T1-1 and T1-9 for cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

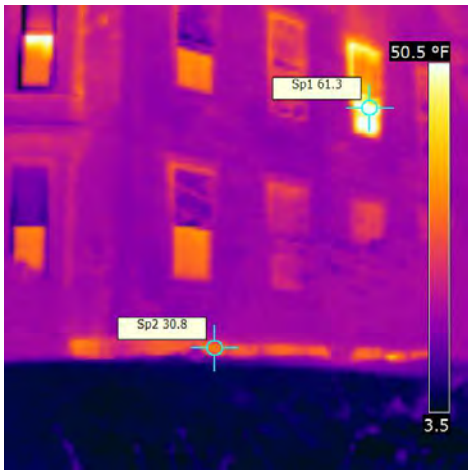


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:28:37 AM
Image Name	IR_2378.jpg
Emissivity	0.96
Reflected apparent temperature	28.0 °F
Object Distance	20.0 ft

Text Comments

Description

IR of the front of the building reveals different thermal transfer properties between siding, windows, frames, open windows and concrete foundation. Recommend closing storm windows and insulating basement walls. Refer to EEMs T1-1 and T2-3.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

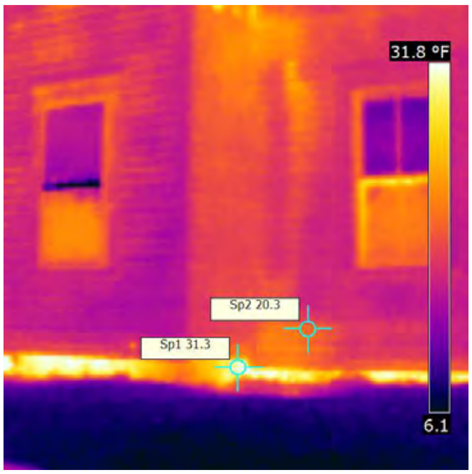


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:29:15 AM
Image Name	IR_2380.jpg
Emissivity	0.96
Reflected apparent temperature	29.0 °F
Object Distance	15.0 ft

Description

Concrete foundation allows for thermal transfer. Recommend insulating basement walls and sealing gap in basement between original building and addition to better seal envelope. Refer to EEM T1-3 and T2-3.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

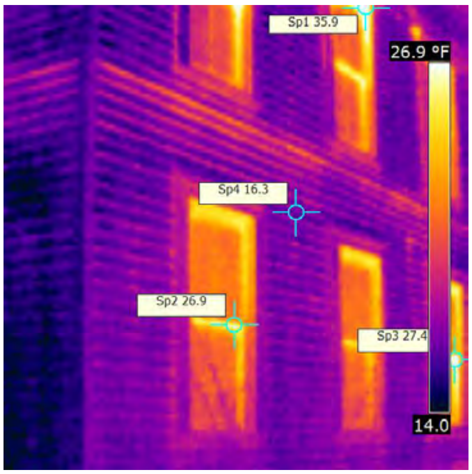


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:29:28 AM
Image Name	IR_2381.jpg
Emissivity	0.96
Reflected apparent temperature	25.0 °F
Object Distance	15.0 ft

Text Comments

Description

Side of the building IR reveals thermal trasnsfer between windows and frames. Recommend air-sealing all windows and doors to limit thermal transfer. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

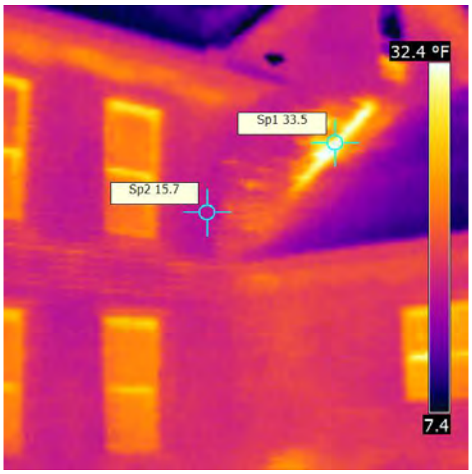


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:30:08 AM
Image Name	IR_2384.jpg
Emissivity	0.96
Reflected apparent temperature	32.0 °F
Object Distance	25.0 ft

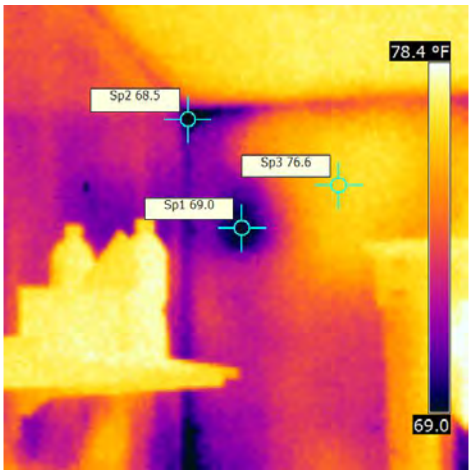
Text Comments

Description

IR of the rear of the building reveals thermal transfer through the exterior wall as well as window frames. Recommend adding blown cellulose insulation to the cavity walls and air-sealing windows. Refer to EEM T3-2 and T1-9.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



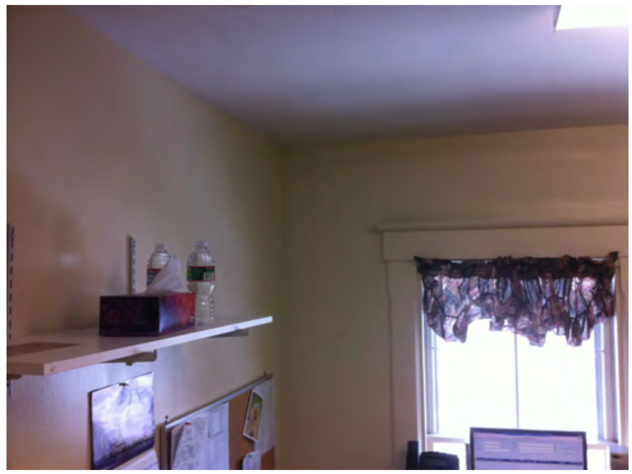


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 11:16:05 AM
Image Name	IR_2434.jpg
Emissivity	0.96
Reflected apparent temperature	69.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of wall reveals thermal transfer at seam between walls and ceiling as well as through spot on wall (dark spot) due to poor or missing insulation. Recommend blown cellulose insulation in the wall. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

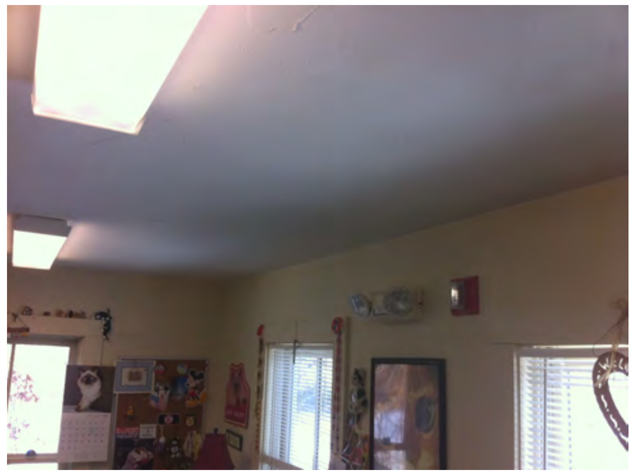


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 11:16:52 AM
Image Name	IR_2436.jpg
Emissivity	0.96
Reflected apparent temperature	68.0 °F
Object Distance	12.0 ft

Text Comments

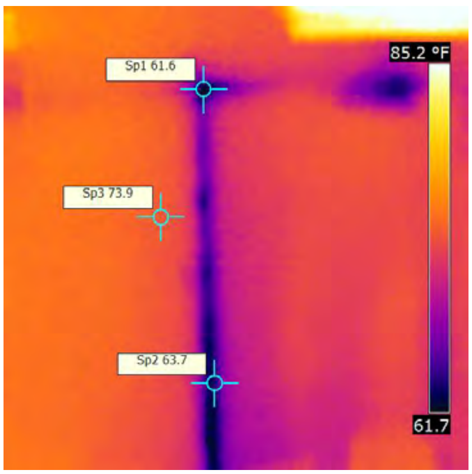
Description

IR of 2nd floor office ceiling reveals thermal transfer between wall and ceiling. Recommend insulating the attic floor (above ceiling) to limit thermal transfer. Refer to EEM T3-1.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



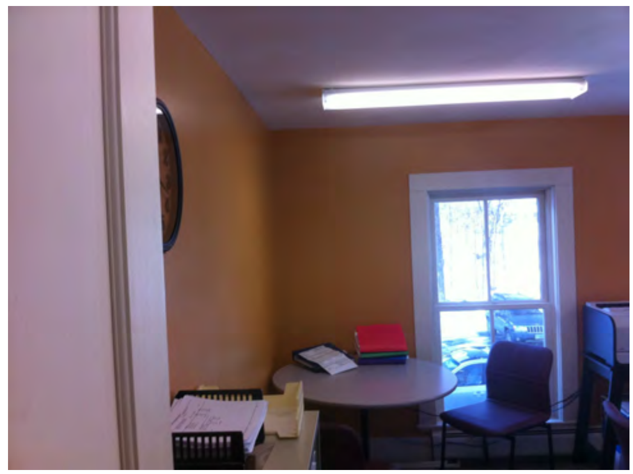


Image and Object Parameters		Text Comments
Camera Model	B-CAM Western S	
Image Date	1/20/2012 11:17:32 AM	
Image Name	IR_2438.jpg	
Emissivity	0.96	
Reflected apparent temperature	61.0 °F	
Object Distance	7.0 ft	

Description

IR of another upstairs office wall reveals thermal transfer at seam between walls. Recommend adding blown cellulose insulation to the wall cavities. Refer to EEM T3-2 for associated cost and savings.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

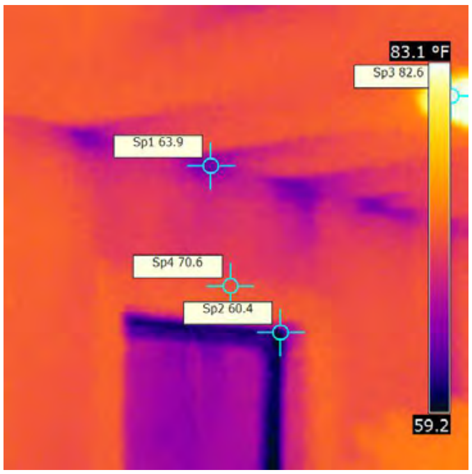


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 11:17:57 AM
Image Name	IR_2439.jpg
Emissivity	0.96
Reflected apparent temperature	60.0 °F
Object Distance	10.0 ft

Text Comments

Description

Window frame and seam between wall and ceiling show signs of thermal transfer. Overhead light (upper right) also creates thermal energy when powered on. Recommend air-sealing all windows and doors and adding insulation to the attic floor above.

Inspection Report

Report Date	5/22/2012		
Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

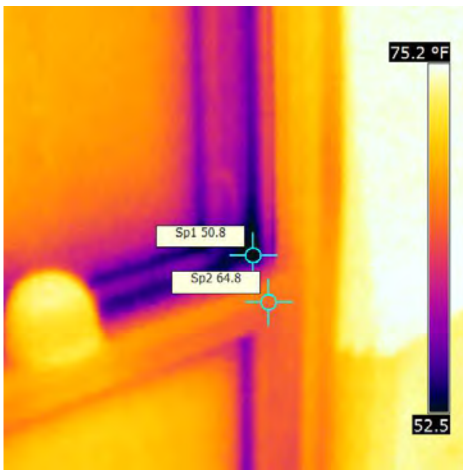


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 11:18:42 AM
Image Name	IR_2440.jpg
Emissivity	0.96
Reflected apparent temperature	50.0 °F
Object Distance	3.0 ft

Text Comments

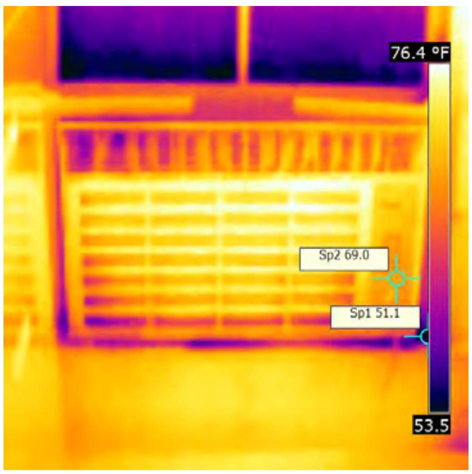
Description

IR between windows reveals air gap and thermal transfer occurring. Recommend air-sealing all windows and doors. Refer to EEM T1-9 for associated cost and savings.

Inspection Report

Report Date	5/22/2012

Company	Acadia Engineers and Constructors	Customer	School Administrative District 41 Office
Address	90 Main Street, Newmarket, NH 03857	Site Address	4 Lund Lane, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



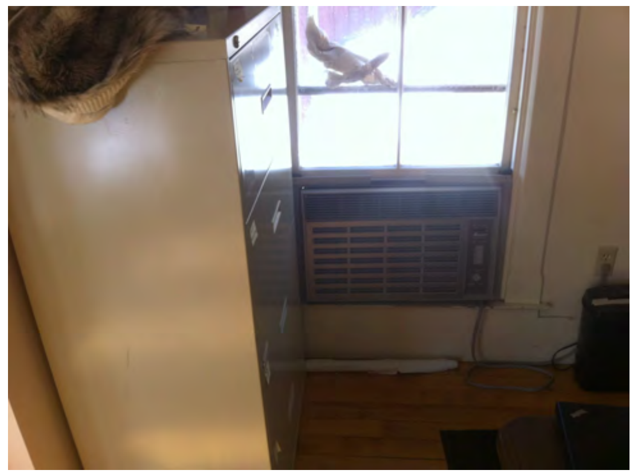


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 11:27:21 AM
Image Name	IR_2444.jpg
Emissivity	0.96
Reflected apparent temperature	50.0 °F
Object Distance	4.0 ft

Text Comments

Description

Window AC unit reveals poor seal around unit and thermal transfer occurring. AC unit has low efficiency rating. Recommend replacing with a split-condenser unit. Refer to EEM T3-4.

APPENDIX C

Indoor Metering Data

INDOOR METERING DATA

Facility:	Location:	Date	Ambient Outdoor:
SAU 41 Building	Hollis, NH	01/04/12	Temp= 25 RH= 35 CO2= 315

Location /Use Description	Time	Occupied	Air Quality			Lighting Densities	Notes
			Temp (°F)	RH (%)	CO2 (ppm)	Vert (FC)	
Receptionist office	838	Y	66.7	13.7	227	44	
Conference room	840	N	66.2	14.9	250	32	Poor heat distribution, main office warm, next room cold. Superintendent office cold. Summertime use window AC Units, downstairs warm, upstairs way too hot. Old drafty windows.
1st fl. NE corner office	846	Y	66.3	16.7	423	56	
Superintendent office	850	N	68.1	12.1	367	38	
2nd fl. Bathroom	853	N	71.2	17.7	475	26	
2nd fl. East office	855	Y	74.6	13.9	712	59	Warm in morning, cools down during
2nd fl. SE office	901	Y	75.5	14	700	61	
2nd fl. South office	904	Y	76.6	11.3	651	68	
Kitchen	907	N	77.5	10.5	611	39	
Back stairs	910	N	64.4	10.1	532	5	
2nd fl. NE office	917	Y	74.1	15.3	999	61	
2nd fl. NW office	921	Y	73.4	16.1	1,069	62	
1st fl. South office	933	Y	72.1	13.9	677	47	Cold in morning, hot in evening
Averages:			**71.3**	**13.9**	**592**		

APPENDIX D

Lighting Fixture Inventory

LIGHTING FIXTURE INVENTORY

Facility:		Location:				Date:	
SAU 41 Building		Hollis, NH				01/04/2012	
Location /Use Description	**Fixture**	**Watts/fixture**	**Qty**	**Controls**	**Total watts**	**Est. Hr/Wk**	**Est. KWH Consumption/Yr**
Attic	CFL	12	2	Switch	24	0.5	1
Upstairs Bath	CFL	12	3	Switch	36	10	19
Back Stairs	CFL	17	3	Switch	51	2	5
Basement	CFL	17	6	Switch	102	0.5	3
Upstairs Copy Room	CFL	17	1	Switch	17	5	4
Upstairs Hall	CFL	17	1	Switch	17	40	35
Exterior	CFL	34	3	Switch	102	61	324
Attic	Inc.	40	1	Switch	40	0.5	1
Exterior	Inc.	60	1	Switch	60	61	190
Attic	Inc.	75	1	Switch	75	0.5	2
Exit	LED	3	8	Always On	24	168	210
Bathroom	T8	28	1	Switch	28	10	15
Betsy's Office	T8	56	2	Switch	112	40	233
Conference Room	T8	56	4	Switch	224	25	291
Copy Room	T8	56	1	Switch	56	40	116
Corner Office	T8	56	2	Switch	112	40	233
Downstairs	T8	56	2	Switch	112	40	233
Front Office	T8	56	2	Switch	112	40	233
Front Office	T8	56	1	Switch	56	40	116
Hallway	T8	56	3	Switch	168	40	349
Janet's Office	T8	56	2	Switch	112	40	233
Judy and Debbie Office	T8	56	4	Switch	224	40	466
Kelly's office	T8	56	4	Switch	224	40	466
Kitchen	T8	56	1	Switch	56	25	73
Main Office	T8	56	4	Switch	224	40	466
Mrs. Grady Office	T8	56	2	Switch	112	40	233
Storage Room	T8	56	3	Switch	168	1	9
Superintendent Office	T8	56	2	Switch	112	40	233
Exterior	Wallpack	150	1	Photocell	150	61	476
Totals:			**71**		**2,910**		**5,268**

APPENDIX E

Mechanical Equipment Inventory

BOILER DATA SHEET

Facility:		Location:				Date:	
SAU 41 Building		Hollis, NH				01/04/2012	
Location /Use Description	**Manufacturer**	**Model Number**	**Qty**	**Year**	**Capacity (mbh)**	**Efficiency**	**Est. kWh/yr**
Basement/Heating and DHW	Buderus	G2215/5	1	2009	238	87	1,580

APPENDIX F

Plug Load Inventory

PLUG LOAD INVENTORY

Facility:	Location:	Date:
SAU 41 Building	Hollis, NH	01/04/2012

Location /Use Description	Category	Description	Watts/ fixture	Qty	Total watts	Est. Hr/Wk	Est. kWh/Yr	Notes
Closet	AS - Small Appliance	Vacuum	200	1	200	1	10	
Conference Room	AS - Small Appliance	Coffee Maker Keurig	700	1	700	1	36	
Throughout	AS - Small Appliance	Window AC	600	10	6,000	8	2,496	
Kitchen	AS - Small Appliance	Coffee Maker	700	1	700	1	36	
Kitchen	AS - Small Appliance	Microwave	800	2	1,600	2	166	
Kitchen	AS - Small Appliance	Toaster	1,000	1	1,000	1	26	
Upstairs Closet	AS - Small Appliance	Vacuum	200	1	200	1	10	
Server Room	AS - Small Appliance	Window AC	700	1	700	75	2,730	
Betsy's Office	CD - Desktop Computer	Computer Desktop	90	1	90	40	187	
Downstairs	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Front Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Janet's Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Judy and Debbie Office	CD - Desktop Computer	Computer Desktop	90	2	180	50	468	
Kelly's Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Main Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Middle Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Mrs. Grady's Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	AC
Superintendent Office	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Server Room	CD - Desktop Computer	Computer Desktop	90	1	90	50	234	
Betsy's Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Downstairs	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Front Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Janet's Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Judy and Debbie Office	CM - Computer Monitor	Computer Monitor LCD	15	2	30	50	78	
Kelly's Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Main Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Middle Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Mrs. Grady's Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Superintendent Office	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Server Room	CM - Computer Monitor	Computer Monitor LCD	15	1	15	50	39	
Corner Office	CN - Notebook Computer	Computer Laptop	35	1	35	50	91	AC
Janet's Office	CN - Notebook Computer	Computer Laptop	35	1	35	50	91	
Superintendent Office	CN - Notebook Computer	Computer Macbook	20	1	20	4	4	
Betsy's Office	EL - Electronics	iPod Radio	10	1	10	25	13	
Judy and Debbie Office	EL - Electronics	iPod Radio	10	1	10	25	13	
Conference Room	FN - Fan	Standing Fan	20	1	20	5	5	
Judy and Debbie Office	FN - Fan	Desk Fan	20	2	40	5	10	
Middle Office	FN - Fan	Fan	20	1	20	5	5	
Mrs. Grady's Office	MI - Musical/Audio Eqpt	Speakers	10	1	10	10	5	
Copy Room	OE - Office Equipment	Mail Scale	5	1	5	1	0	

Kelly's Office	OE - Office Equipment	Shredder	200	1	200	1	10
Copy Room	PC - Photocopier	Photocopier	1,440	1	1,440	10	749
Upstairs Copy Room	PC - Photocopier	Photocopier	1,440	1	1,440	10	749
Copy Room	PR - Computer Printer	Printer Laser Jet	300	1	300	6	94
Judy and Debbie Office	PR - Computer Printer	Printer Laser Jet	300	2	600	6	187
Kelly's Office	PR - Computer Printer	Printer Laser Jet	300	2	600	6	187
Kitchen	RS - Standard Refrigerator	Refrigerator Full	800	1	800	70	2,912
Janet's Office	SH - Space Heater	Space Heater	1,100	1	1,100	10	572
Closet	VE - Video Equipt/Projector	Projector Screen	240	1	240	1	12
		Totals:		**64**	**19,285**		**14,452**

APPENDIX G

ENERGY STAR® Statement of Energy Performance

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
SAU41 Admin Building

Building ID: 1747016
For 12-month Period Ending: February 29, 2012[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: March 26, 2012

Facility
SAU41 Admin Building
4 Lund Lane
Hollis, NH 03049

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1960
Gross Floor Area (ft²): 8,096

Energy Performance Rating[2] (1-100) 95

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	73,802
Fuel Oil (No. 2) (kBtu)	224,623
Natural Gas - (kBtu)[4]	0
Total Energy (kBtu)	298,425

Energy Intensity[4]	
Site (kBtu/ft²/yr)	37
Source (kBtu/ft²/yr)	58

Emissions (based on site energy use)	
Greenhouse Gas Emissions ($MtCO_2e$/year)	25

Electric Distribution Utility
Public Service Co of New Hampshire [Northeast Utilities]

National Median Comparison	
National Median Site EUI	82
National Median Source EUI	131
% Difference from National Median Source EUI	-55%
Building Type	Office

Stamp of Certifying Professional

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

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

Certifying Professional
N/A

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

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	SAU41 Admin Building	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	Office	Is this an accurate description of the space in question?		☐
Location	4 Lund Lane, Hollis, NH 03049	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 a hospital, k-12 school, hotel and senior care facility) nor can they be submitted as representing only a portion of a building.		☐

SAU 41 Admin Building (Office)

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Gross Floor Area	8,096 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.		☐
Weekly operating hours	40 Hours	Is this the total number of hours per week that the Office 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	11	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. The normal worker density ranges between 0.3 and 5.3 workers per 1000 square feet (92.8 square meters)		☐
Number of PCs	10	Is this the number of personal computers in the Office?		☐
Percent Cooled	50% or more	Is this the percentage of the total floor space within the facility that is served by mechanical cooling equipment?		☐
Percent Heated	50% or more	Is this the percentage of the total floor space within the facility that is served by mechanical heating equipment?		☐

ENERGY STAR® Data Checklist
for Commercial Buildings

Energy Consumption

Power Generation Plant or Distribution Utility: Public Service Co of New Hampshire [Northeast Utilities]

Fuel Type: Electricity		
Meter: SAU41 Admin Building-elec (kWh (thousand Watt-hours)) **Space(s):** Entire Facility **Generation Method:** Grid Purchase		
Start Date	**End Date**	**Energy Use (kWh (thousand Watt-hours))**
02/01/2012	02/29/2012	1,480.00
01/01/2012	01/31/2012	1,490.00
12/01/2011	12/31/2011	1,460.00
11/01/2011	11/30/2011	1,460.00
10/01/2011	10/31/2011	1,750.00
09/01/2011	09/30/2011	1,970.00
08/01/2011	08/31/2011	2,640.00
07/01/2011	07/31/2011	2,320.00
06/01/2011	06/30/2011	2,050.00
05/01/2011	05/31/2011	1,560.00
04/01/2011	04/30/2011	1,700.00
03/01/2011	03/31/2011	1,750.00
SAU41 Admin Building-elec Consumption (kWh (thousand Watt-hours))		**21,630.00**
SAU41 Admin Building-elec Consumption (kBtu (thousand Btu))		**73,801.56**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**73,801.56**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Fuel Oil (No. 2)		
Meter: SAU41 Admin Building (Gallons) **Space(s):** Entire Facility		
Start Date	**End Date**	**Energy Use (Gallons)**
02/01/2012	02/29/2012	325.00
01/01/2012	01/31/2012	425.50
12/01/2011	12/31/2011	167.50
11/01/2011	11/30/2011	123.30
10/01/2011	10/31/2011	0.00
09/01/2011	09/30/2011	0.00
08/01/2011	08/31/2011	0.00
07/01/2011	07/31/2011	0.00
06/01/2011	06/30/2011	160.50
05/01/2011	05/31/2011	0.00

04/01/2011	04/30/2011	208.70
03/01/2011	03/31/2011	209.10
SAU41 Admin Building Consumption (Gallons)		**1,619.60**
SAU41 Admin Building Consumption (kBtu (thousand Btu))		**224,623.13**
Total Fuel Oil (No. 2) Consumption (kBtu (thousand Btu))		**224,623.13**
Is this the total Fuel Oil (No. 2) consumption at this building including all Fuel Oil (No. 2) 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
SAU41 Admin Building
4 Lund Lane
Hollis, NH 03049

Facility Owner
N/A

Primary Contact for this Facility
N/A

General Information

SAU41 Admin Building	
Gross Floor Area Excluding Parking: (ft²)	8,096
Year Built	1960
For 12-month Evaluation Period Ending Date:	February 29, 2012

Facility Space Use Summary

SAU 41 Admin Building	
Space Type	Office
Gross Floor Area (ft²)	8,096
Weekly operating hours	40
Workers on Main Shift	11
Number of PCs	10
Percent Cooled	50% or more
Percent Heated	50% or more

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 02/29/2012)	**Baseline** (Ending Date 04/30/2008)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	95	94	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	37	40	61	N/A	82
Source (kBtu/ft²)	58	65	97	N/A	131
Energy Cost					
$/year	$ 8,545.93	$ 7,197.78	$ 14,131.16	N/A	$ 19,106.62
$/ft²/year	$ 1.06	$ 0.89	$ 1.75	N/A	$ 2.37
Greenhouse Gas Emissions					
$MtCO_2e$/year	25	27	41	N/A	56
$kgCO_2e/ft^2$/year	3	3	5	N/A	7

More than 50% of your building is defined as Office. Please note that your rating accounts for all of the spaces listed. The National Median column presents energy performance data your building would have if your building had a median rating of 50.

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

APPENDIX H

Renewable Energies Screening Worksheets

RENEWABLE ENERGY SCREENING SUMMARY

Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

RE Technology	Score (out of 70 pts.)	Grade	Notes/Comments
Biomass Heating	55.5	79%	Pellet feed system recommended.
Geothermal Heating/Cooling	55.5	79%	Closed-loop GSHP system.
Ground Photovoltaic	54.5	78%	Small system 5kw - 15kw.
Solar DHW	52.5	75%	DHW demand should be confirmed.
Wind Turbine Generator	47.5	68%	Permit requirements are height dependent.
Roof Photovoltaic	47.5	68%	Small system 5kw - 15kw.
Solar Thermal	42.5	61%	Medium-temperature system.
Combined Heat & Power	41.5	59%	75kW system.

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Biomass Heating Systems (wood, chips, pellets)**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4	Well demonstrated technology. Some woodchip and pellet feed units are newer technology.
2	Expected service life/durability	4	Expected service life is 20 yrs.
3	Geographical considerations	3	Limited fuel in Southern NH.
4	Energy demand	4	Heating energy is moderately high in the building.
5	Facility/systems conditions	5	Woodchips/pellets could be stored in the basement.
6	Facility/systems compatibility	5	Woodchips/pellets could be stored in the basement.
7	Permitting constraints	5	No special permits required.
8	Abutter concerns	4	Systems are located inside building. Wood or chip feedstock located outside could be a concern.
9	Capital investment	4.5	Low capital cost.
10	O&M requirements	4	Wood and woodchip units require constant attending and feedstock must be sourced. Pellet systems with hoppers are less intensive and feedstock is commercially available.
11	Financial incentives	2.5	Limited incentives.
12	Owner initiatives	4	Owner is interested in renewable options.
13	CO2e emissions	3.5	Biomass does emit CO2 but the net reduction from the oil system will be significant.
14	Public awareness/education	3	Limited public use. Information could be displayed in the building so users are aware of biomass heating system.
	Total Score:	**55.5**	
	Total Possible Score:	**70**	
	Grade:	**79%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Geothermal Heating & Cooling**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	Well demonstrated technology but does require engineering design.
2	Expected service life/durability	4.5	Well field and loop system has +50 year service life. Equipment has +20 yr service life.
3	Geographical considerations	4.5	Abundant geothermal energy reserves.
4	Energy demand	3	Heating and cooling energy consumption is high.
5	Facility/systems conditions	4	System could utilize existing hydronic system. However existing system not most efficient.
6	Facility/systems compatibility	4	System could utilize existing hydronic system. However existing system not most efficient.
7	Permitting constraints	5	No special permitting required for a closed-loop system (open-loop would require state permit and is not recommended).
8	Abutter concerns	5	Abutters with water supply wells can be sensitive to geothermal wells but a closed-loop system will have no impact.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	4.5	Very low O&M except routine equipment maintenance.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4.5	The building currently uses a high amount of oil.
14	Public awareness/education	3	Limited public use. Information could be displayed in the building so users are aware of geothermal system.
	Total Score:	**55.5**	
	Total Possible Score:	**70**	
	Grade:	**79%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offic	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Ground-Mounted Solar PV**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Well demonstrated technology with more efficient panel systems in development.
2	Expected service life/durability	3	Expected service life of collector panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	4	Moderate electrical demand.
5	Facility/systems conditions	4.5	Building is older but system can easily be moved/rewired as needed.
6	Facility/systems compatibility	5	South-facing land available for small system.
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	4.5	Facility slightly set back from abutting properties and main road.
9	Capital investment	3	High capital cost.
10	O&M requirements	3.5	Vegetative cutting and panel replacement.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4.5	Owner is open to renewable options.
13	CO2e emissions	4.5	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	4.5	Limited public use but visible from main road.
	Total Score:	**54.5**	
	Total Possible Score:	**70**	
	Grade:	**78%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Solar Domestic Hot Water**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4	Well demonstrated technology although system design and function can vary.
2	Expected service life/durability	3	Expected service life of heating panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	4	Expected DHW demand is low.
5	Facility/systems conditions	4	System could utilize existing DHW tank.
6	Facility/systems compatibility	4	System could utilize existing DHW tank.
7	Permitting constraints	5	No special permitting required.
8	Abutter concerns	5	Low visibility/impact.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	3.5	Panel replacement and normal DHW system maintenance.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	3.5	Moderate reduction of electric use based on DHW demand.
14	Public awareness/education	4	Limited public use but visible from main road.
	Total Score:	**52.5**	
	Total Possible Score:	**70**	
	Grade:	**75%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Wind Turbine Generator**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	A well demonstrated technology but proper site selection is critical.
2	Expected service life/durability	3.5	Some turbine units have proven unreliable (design flaws). Selection of a reputable manufacturer is critical.
3	Geographical considerations	3	Limited wind energy but a feasibility study is required.
4	Energy demand	3	Electric energy consumption is moderate.
5	Facility/systems conditions	2.5	Building and systems are older.
6	Facility/systems compatibility	2.5	Building and systems are older.
7	Permitting constraints	3	Special permits are required depending on the height of the pole-mounted turbine. Roof-mounted turbines may be practical however they provide less energy.
8	Abutter concerns	2.5	Pole-mounted turbines have a large visual impact.
9	Capital investment	3.5	Moderate capital cost.
10	O&M requirements	3.5	Routine maintenance required. Units are subject to damage from elements.
11	Financial incentives	3	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	5	High visibility.
	Total Score:	**47.5**	
	Total Possible Score:	**70**	
	Grade:	**68%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Roof-Mounted Solar PV**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Well demonstrated technology with more efficient panel systems in development.
2	Expected service life/durability	3.5	Expected service life of collector panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	3	Moderate grid electrical demand.
5	Facility/systems conditions	2.5	Building and systems are old.
6	Facility/systems compatibility	2.5	Building and systems are old.
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	4	Facility slightly set back from abutting properties and main road.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	3.5	Increased roof maintenance and panel replacement.
11	Financial incentives	3	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4.5	Electrical source energy in NH has lower than average CO2 emissions.
14	Public awareness/education	3.5	Limited public use but visible from main road.
	Total Score:	**47.5**	
	Total Possible Score:	**70**	
	Grade:	**68%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	School Administrative Unit 41 Offic	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

Technology: **Solar Thermal HVAC**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	3.5	Well demonstrated technology but supply limited. More efficient than regular PV.
2	Expected service life/durability	4	Expected service life of system is 20 years.
3	Geographical considerations	3	Limited solar availability in New England.
4	Energy demand	2	No installed Ventilation
5	Facility/systems conditions	2	No installed Ventilation
6	Facility/systems compatibility	2	No installed Ventilation
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	4	Facility slightly set back from abutting properties and main road.
9	Capital investment	2	High capital cost.
10	O&M requirements	3	Vegetative cutting for ground mount, roof maintenance for roof mount, panel replacement.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	4	Limited public use but visible from main road.
	Total Score:	**42.5**	
	Total Possible Score:	**70**	
	Grade:	**61%**	

RENEWABLE ENERGY SCREENING WORKSHEET

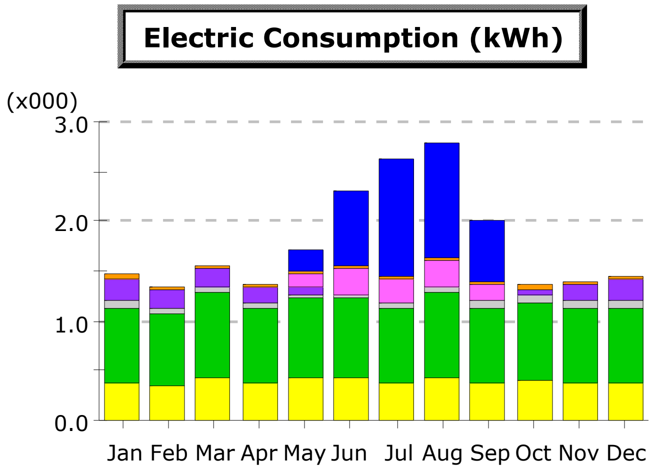
Building/Facility:	School Administrative Unit 41 Offices	Location:	Hollis, NH
Gross Area (sf):	8,096	Date:	3/27/2012
Use Category:	Office	EUI (kBtu/sf/yr):	58
Heating Fuel(s):	No. 2 Oil	PM Grade:	95
Heating System(s):	Hydronic	Cooling System(s):	Window AC

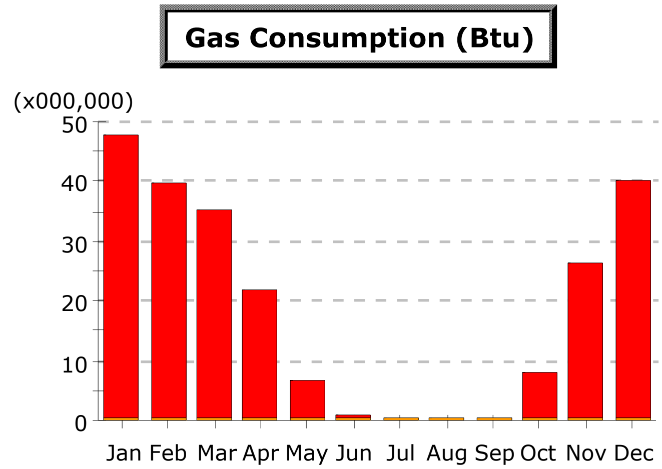
Technology: **Combined Heat & Power System**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Smaller CHP units are relatively new technology. Larger units (+75kW) are more reliable.
2	Expected service life/durability	3.5	Expected service life for a small CHP unit is 10 yrs. Large CHPs have a 20 yr. service life.
3	Geographical considerations	3	NH has a low electrical energy cost.
4	Energy demand	3	Electric energy consumption is moderate.
5	Facility/systems conditions	3	Building and systems are older.
6	Facility/systems compatibility	1	No renewables currently on site.
7	Permitting constraints	5	No special permits required.
8	Abutter concerns	5	Modern CHPs are relatively quiet and would be inside of the building.
9	Capital investment	2	High capital cost.
10	O&M requirements	2	Frequent maintenance required. Large system manufacturers require that they complete maintenance for warranty validation.
11	Financial incentives	2	Limited incentives.
12	Owner initiatives	4	Owner is open to renewable options
13	CO2e emissions	1	CHPs consume a large amount of fuel and emissions relative to the re-used energy.
14	Public awareness/education	2	Limited Public use.
	Total Score:	**41.5**	
	Total Possible Score:	**70**	
	Grade:	**59%**	

APPENDIX I

eQUEST® Energy Efficiency Measure Modeling





Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	0.20	0.75	1.20	1.15	0.62	-	-	-	3.92
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.33
Vent. Fans	-	-	-	-	0.14	0.26	0.24	0.27	0.18	-	-	-	1.09
Pumps & Aux.	0.23	0.20	0.20	0.16	0.06	0.00	-	-	0.00	0.07	0.18	0.21	1.31
Ext. Usage	0.08	0.06	0.07	0.06	0.05	0.04	0.05	0.07	0.07	0.07	0.07	0.08	0.77
Misc. Equip.	0.75	0.70	0.84	0.74	0.81	0.80	0.75	0.84	0.74	0.78	0.74	0.75	9.24
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.38	0.36	0.44	0.38	0.42	0.42	0.38	0.44	0.38	0.40	0.38	0.38	4.75
Total	1.46	1.35	1.56	1.37	1.70	2.30	2.64	2.79	2.02	1.35	1.40	1.44	21.40

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	47.28	39.12	34.57	21.30	6.17	0.41	-	-	0.21	7.61	26.05	39.64	222.36
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	0.51	0.50	0.59	0.51	0.50	0.45	0.38	0.41	0.38	0.43	0.44	0.48	5.60
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	47.79	39.62	35.16	21.81	6.68	0.86	0.38	0.41	0.58	8.04	26.50	40.12	227.95

APPENDIX J

Cost Estimates

BUDGETARY COST ESTIMATE

Facility: **SAU-41**
Date: **3/27/2012**

EEM	Design + Engineering	Installed Cost				Construction Management	Contingency (15%)	Total Investment
		Pricing Unit	Price	Qty	Subtotal			
Remove attic flooring in original building and install blown cellulose insulation in the floor joists, cover with 4-mil polyurethane sheeting air barrier, add 1" polyisocyanurate rigid insulation w/ tape-sealed joints, and cover with 5/8" plywood T&G floor decking.	$500	SQFT	$4.10	1,200	**$ 4,920**	$492	$887	**$6,799**
Install 4-mil polyurethane sheeting barrier and 2" rigid polyisocyanurate insulation (R-14) on bottom of floor joists of wing addition and tape-seal joints. Apply spray-foam polyurethane insulation around sill interior.	NA	SQFT	$2.15	850	**$ 1,828**	$183	$302	**$2,312**
Replace indirect hot water heater with an electric tankless demand hot water heater.	$100	EA	$800	1	**$ 800**	$80	$147	**$1,127**
Install 2" rigid polyisocyanurate insulation (R-14) on interior basement walls and tape-seal joints.	NA	SQFT	$2.15	900	**$ 1,935**	$194	$319	**$2,448**
Replace all older window units with insulated frame double-pane units.	NA	EA	$350	29	**$ 10,150**	$1,015	$1,675	**$12,840**
Insulate wall cavities with blown in cellulose. Add 4" of cellulose to the addition attic floor.	$500	SQFT	$2.80	8,000	**$ 22,400**	$2,240	$3,771	**$28,911**
Replace window air-conditioning units with several split condenser wall mounted units w/ minimum SEER of 20.	$1,200	EA	$2,100	5	**$ 10,500**	$1,050	$1,913	**$14,663**
Replace existing heating registers with modern control valves and fintube heating units.	$1,200	EA	$20,000	1	**$ 20,000**	$2,000	$3,480	**$26,680**

APPENDIX K

Blower Door Test

Summary of Recommended Air Sealing and Enclosure Upgrade Strategies

1. Weather-stripping on all windows and gasket seals on all doors. (T1-9) Replacing single pane Windows (T3-5) makes sense to me in cases where the sashes are in poor condition, but only as a whole unit replacement with quality/tight fitting sashes so the rough openings can be air sealed as well. Air leakage around the newer windows Effectively makes them as poor performers as the original windows. I think the money might be better spent at the ceiling/roof uprades.
1. Seal basement windows (T1-4)
2. (T2-2)I typically recommend installing rigid foam on foundation walls (as you suggest in T2-4) as opposed to the floor in accordance with current best building science practices; but either way, I recommend Spraying a minimum of 3" closed cell foam in rim joists in both basement and crawlspace for effectively managing air, vapor, and heat transfer
4. In regards to T1-8 and T3-1: the business manager told us that he very much wants to finish the two 3rd floor rooms as offices. He said he was thinking of portioning interior spaces as was done over the 'connector' one floor but I recommend the following: gut the existing slopes – plaster and insulation; strap the rafters with horizontal 2x4's and spray 6" closed cell foam directly on the roof sheathing, wrapping the rafter edges with 1.5" foam for a continuous coverage and eliminate thermal bridging. (sheetrock). (see slides for both slope sides and recommendations for flat ceiling above.
5. Attic over one floor offices (seen last week for first time). Please refer to pages 3-8. Essentially Remove fiberglass around stairwell and walls and replace with 3" continuous closed cell foam – dense packing Slopes and little flat ceiling. On floor – remove decking and all material – surgerical air seal all penetrations or if on plaster, Spray 1-2" continuous skim coat which creates a monolithic air/vapor and thermal barrier as well As providing support for cellulose and blow in
12" cellulose. Be sure to spray over top plates and up sheathing on jack wall. Install ridge vents and a louvered vent opening At end wall (where window once existed).

Blower Door Test Results - following page are the results narrative template used in reports

Attic door closed Blower door test results:
8912CFM50
16.80ACH50
1.06 CFM50 ft2 surface area

With attic door open, ACH50 nearly the same though
With additional 1500CFM through air leakage from areas
Outside thermal envelope

Estimates:
Annual Average Infiltration Rate: .98ACH
Winter: 1.8ACH
Summer .90 ACH

Blower Door Test & Results

Measuring Air Infiltration and the Air Barrier

Convective and Conductive Heat Losses and Moisture Transfer

Summary: The blower door test indicates that uncontrolled air infiltration in your building is responsible for a significant portion of heat loss and therefore oil electricity. Aggressive air sealing will improve thermal comfort, reduce air dryness, reduce energy use and therefore both heating and cooling costs.

Test Results:

Building with Attic Door Closed: 8912CFM50

Means that a measured 8912 cubic feet of air per minute was pulled thorough leaks and gaps in the air barrier when the house was under pressure at -50 pascals with respect to outside. With the attic door opened, the results were 11475CFM50 but due to adding extra volume the ACH50 was only slightly higher than results below. Bringing those offices into conditioned space only heightens the need for aggressive air sealing strategies.

Air Change per Hour Rate at -50pa: 16.80 ACH50

This means that at -50 pas (as if a 20mph wind was blowing on all sides of the house at once) the air would completely almost 17 times every hour. The math: CFM50 x 60 / building volume

Standard Construction practices is generally between 7 and 9.5 ACH50.

Energy Star's limit was 5ACH50 and is now 3ACH50 along with the 2012 IECC. High Performance Homes under 1ACH50

Estimated Annual Air Change Rate: .98ACH   Winter: 1.8   Summer: .9

This is an estimate for natural conditions – without the blower door. Annual average is about what one looks for adequate ventilation – when in fact in winter, there is far more uncontrolled air infiltration than needed. In winter, you use oil to heat the air which is replaced by outdoor air every 40 minutes or so.

Estimated cost of air leakage: **$N/A**

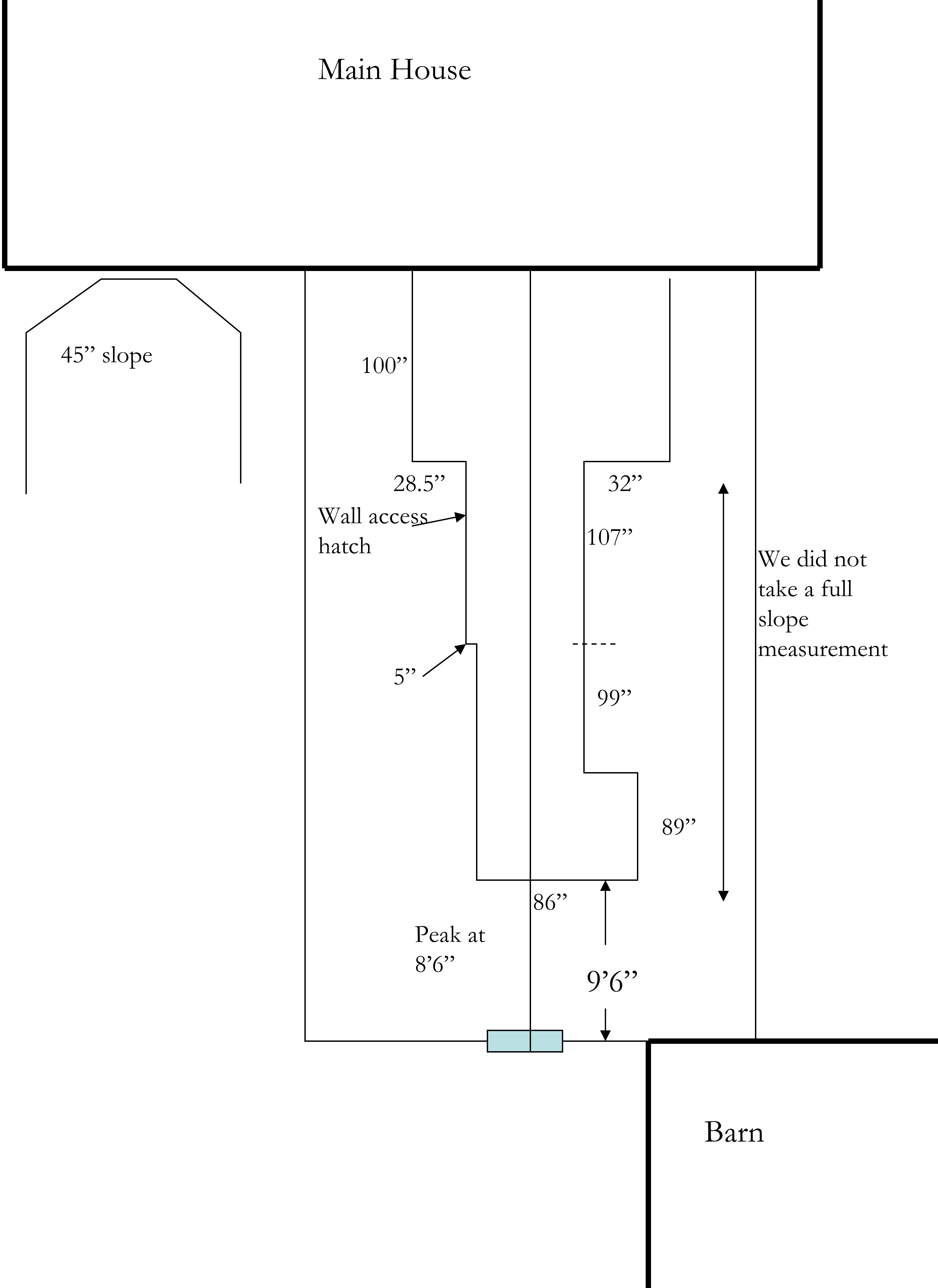
Leakage Area (Canadian EqLA @10pa) N/A

Total size of hole if add all cracks and gaps together

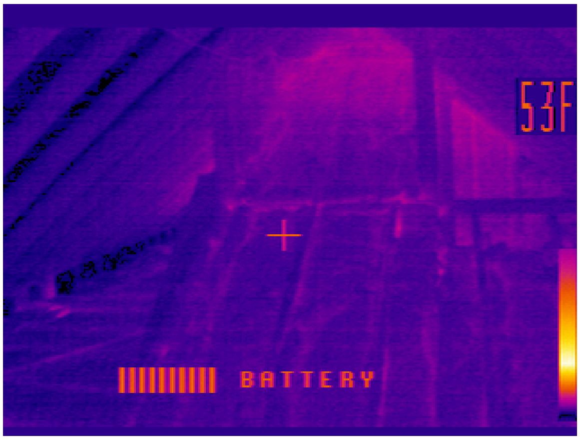
Minneapolis Leakage Ratio: **1.06 CFM50 per ft2 surface area**

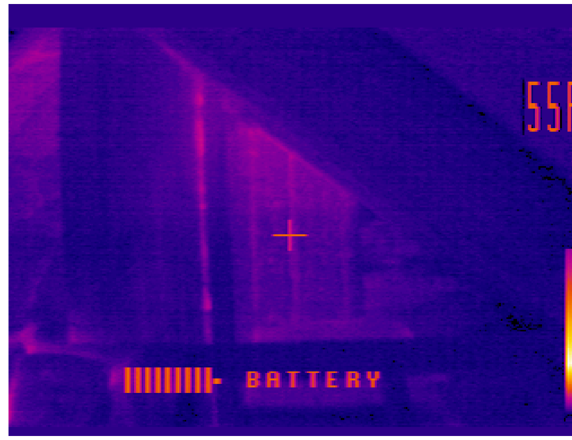
This is using the CFM50 relative to the surface area of the above grade shell or envelope, since heat loss is based on surface area not volume. Army Corps of Engineers require .25 CFM50/ft2 shell and high performance homes typically shoot for less than .1CFM50/ft2.

Building size estimates (includes basement): Floor area: 3,656ft2; Volume; 31,823; Shell surface area: 8,400ft2

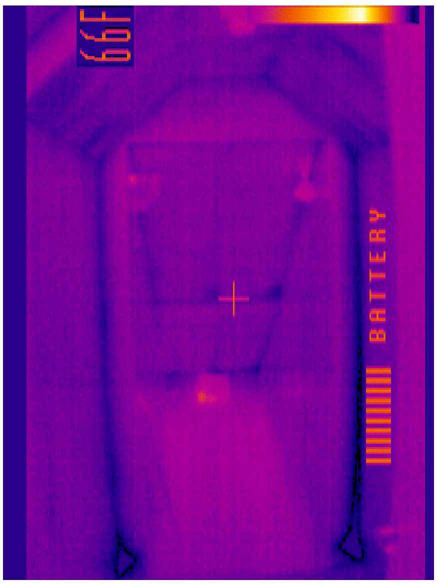

Main House
45" slope
100"
28.5"
32"
Wall access hatch
107"
We did not take a full slope measurement
5"
99"
89"
86"
Peak at 8'6"
9'6"
Barn

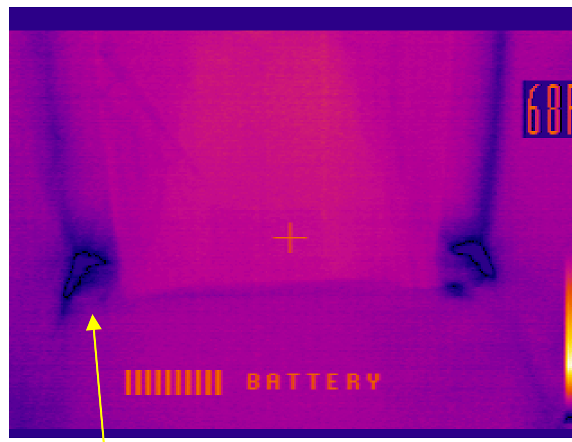
Connector Attic (not seen on original assessment visit)

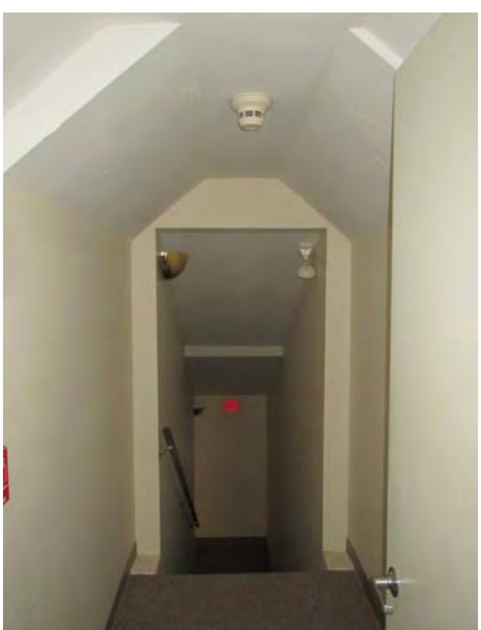


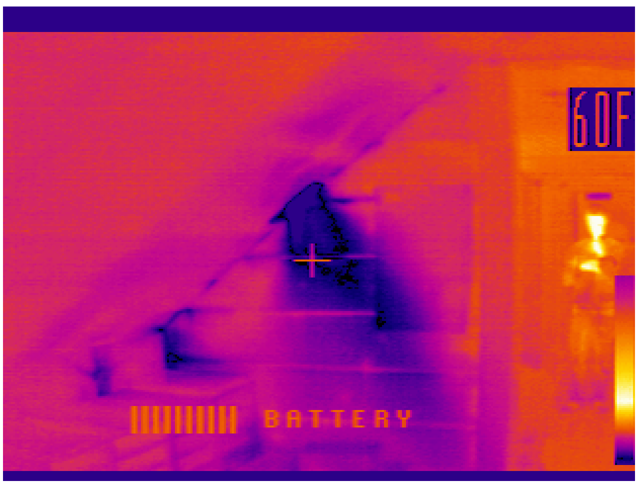


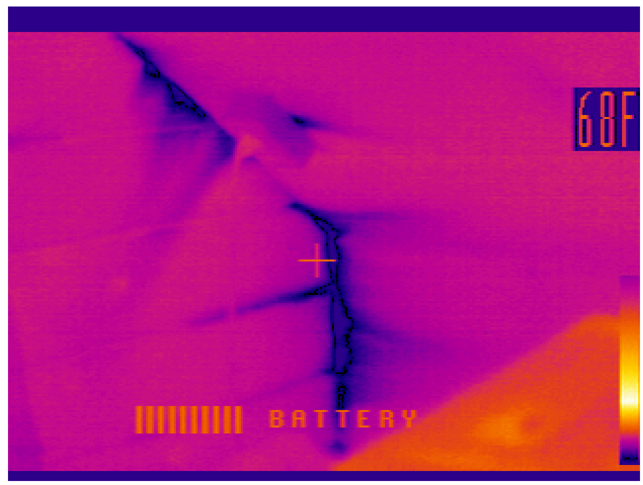
I recommend removing fiberglass and spraying 3" continuous closed cell spray foam against sheet rock of entire assembly AND over studs to eliminate thermal bridging and impact if (when) foam shrinks – as well as assure an air (and moisture) barrier, Air leakage and compromised insulation values at ceiling and walls of stairwell.

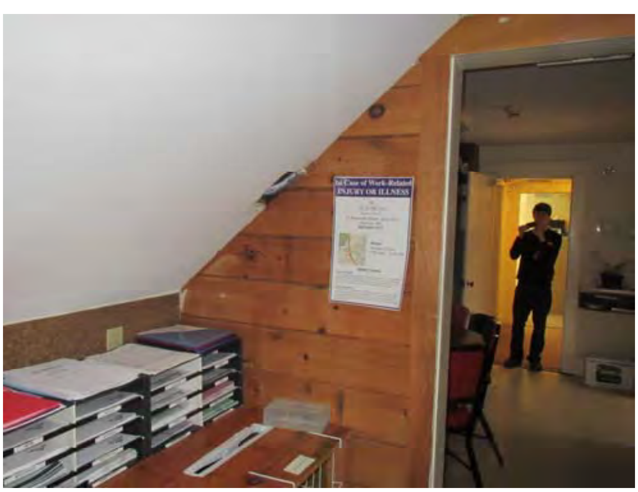


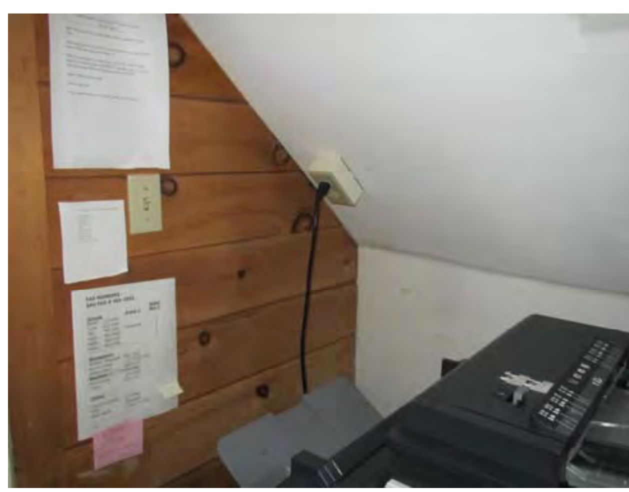




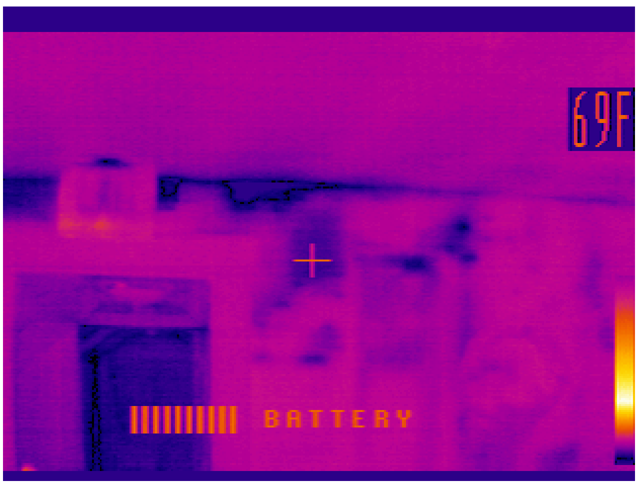

60F
BATTERY

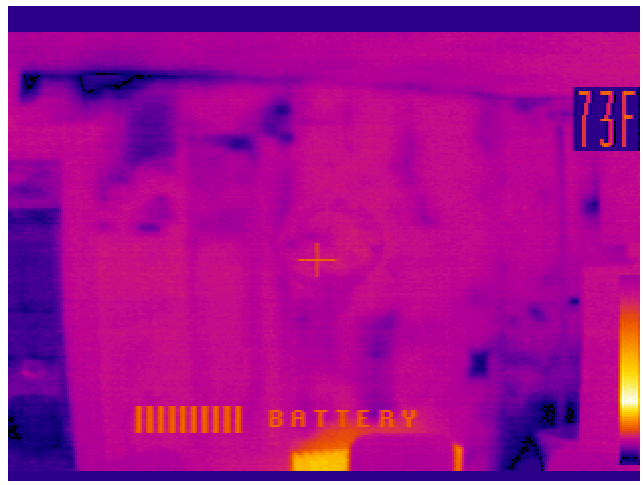

68F
BATTERY

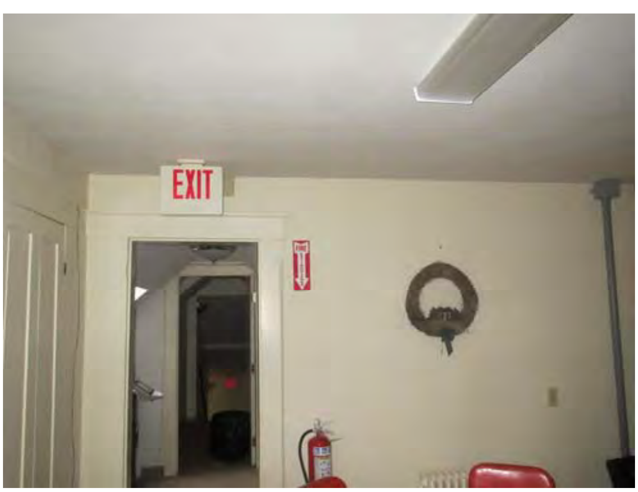




If bringing 3rd floor into thermal envelope, the issues with these wall / ceiling deficiencies go away





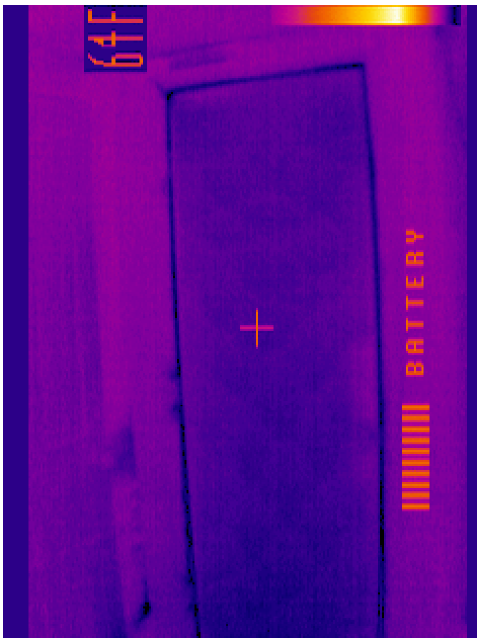


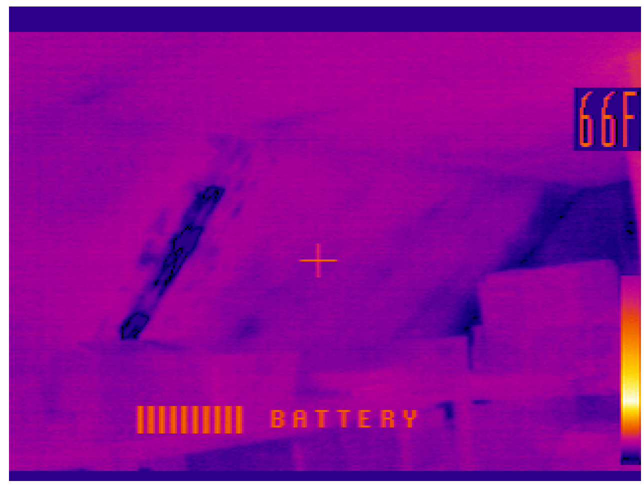
Pull fiberglass and dense pack these 45" slopes and blow 18" on flat above

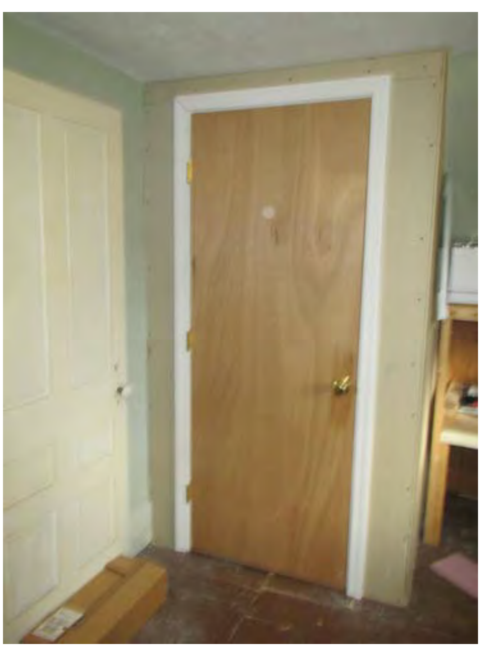
Foam over top plates

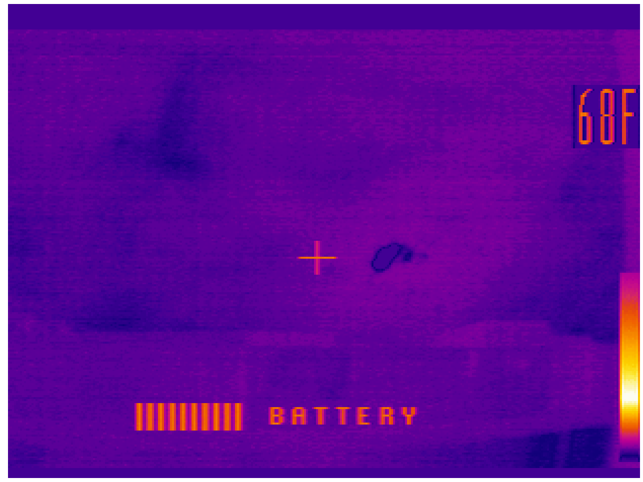
A lot of material but air movement at penetrations and spotty insulation. Facilities guy didn't know about this attic now wants it for storage – but I'd remove decking, target air seal and add 10" cellulose. Also install louvered vent on gable wall and open soffit vents (remove vinyl/metal over soffit)

Main Attic – Business Manager said
he wants to finish off as offices

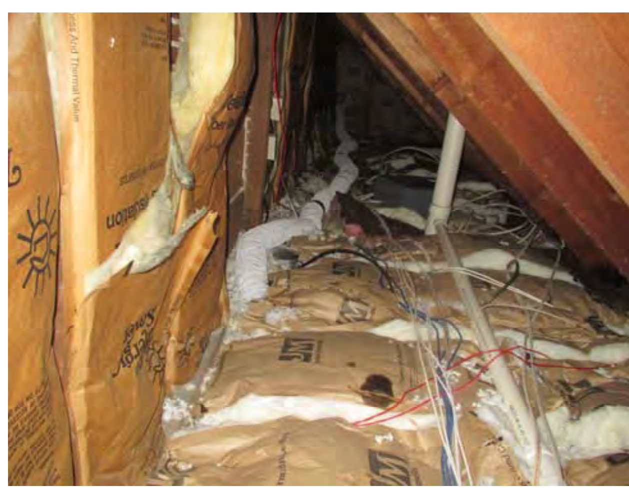








I recommend continuous foam on these slopes, - bays and over rafters. And installing an insulated "slope door" to continue the plane.

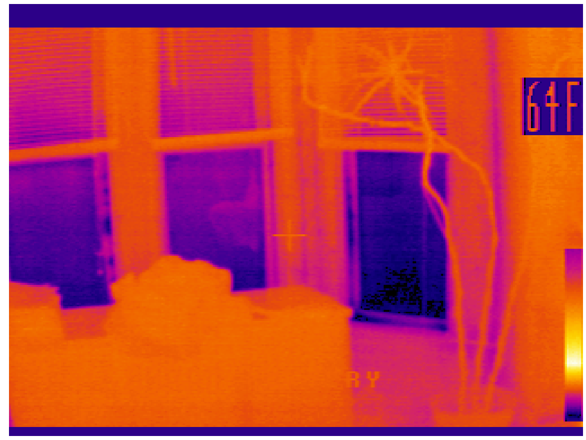


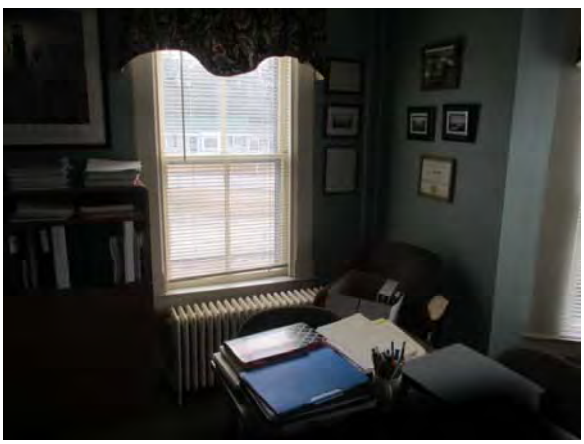
Can remove insulation on unconditioned slopes, spray closed cell foam over perimeter top plates and connect (wrap up to) propa vents for continuous air barrier

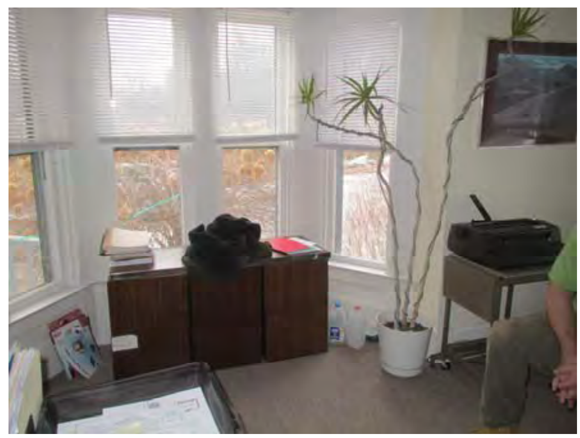
Ceiling below showed large insulation voids around here – recommend foaming down to top plate under old roof – and dense packing cellulose in voids under plywood. Best long term practice would include pulling up this plywood, cross framing 6" – replacing fg batts with dense pack cellulose under replaced decking – OR laying 2" XPS or foil faced polyiso just as you recommended in T3-1 (except without the plastic liner – which places a moisture trapping barrier in between insulation layers with high risk of getting punched with air holes.

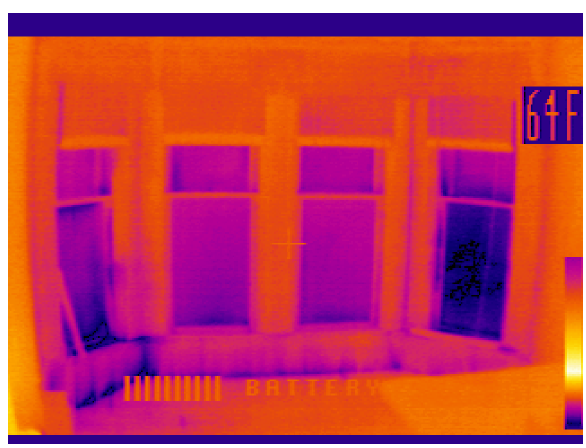
For the 10' (?) flat ceiling above new offices – remove all existing material; skim coat 1-2" closed cell foam and blow in 12" cellulose. Enlarge hatch opening, attach 4" rigid foam board under plywood for weight and gasket seal

Some Original window sashes in rough shape but replacements also leak air – as does floor/wall connection.

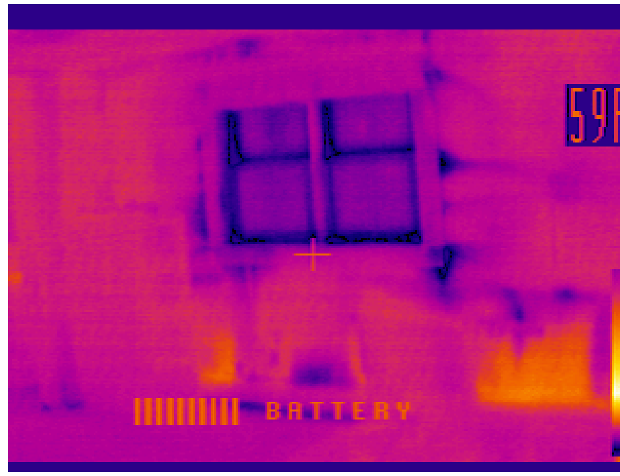


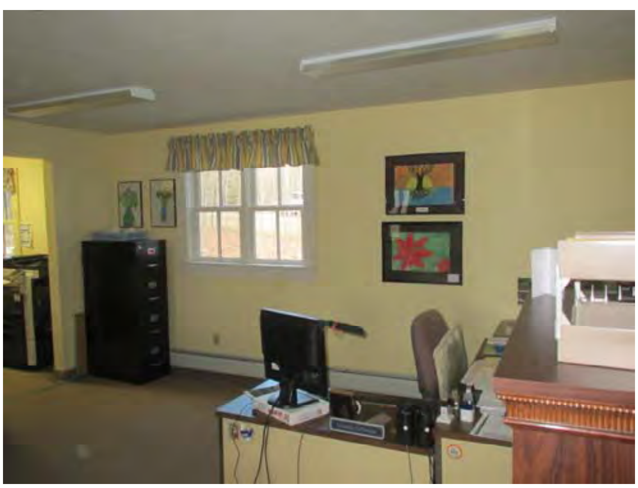






Air sealing at band joists can be problematic – unless



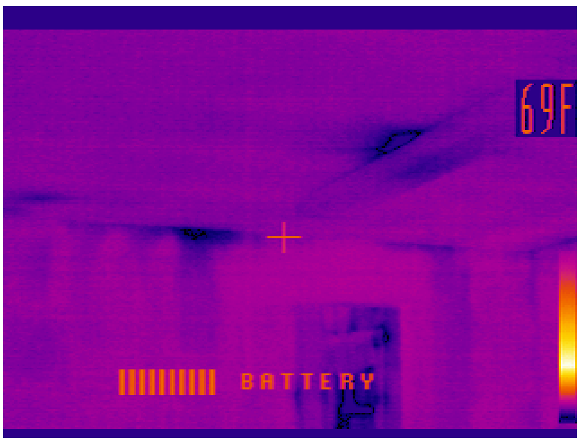


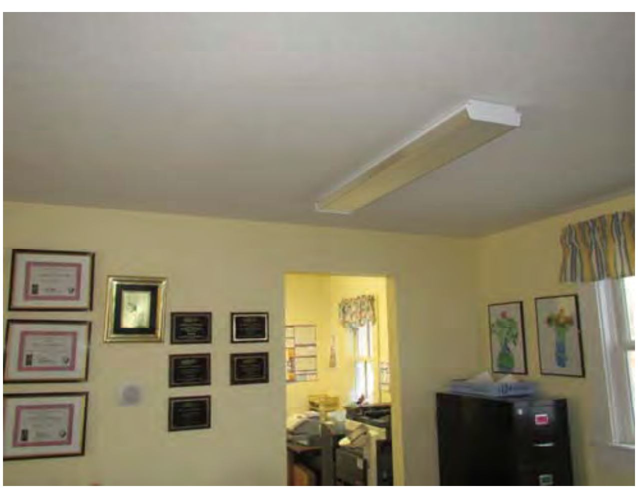
At -30 pascals

Newer windows leak at sashes and rough openings as much or more than old single pane

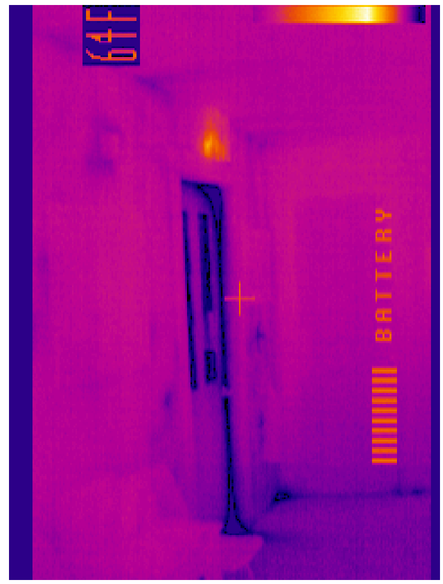
A Silicone bead along the edges of the trim can help, but the best strategy is to remove the trip and use a low expansion foam around the entire unit. These images are also helpful explaining the importance of details and air sealing when installing new windows or a caution against replacements without air sealing.   Evidently they have a plan to order replacement windows for the remaining single pane.

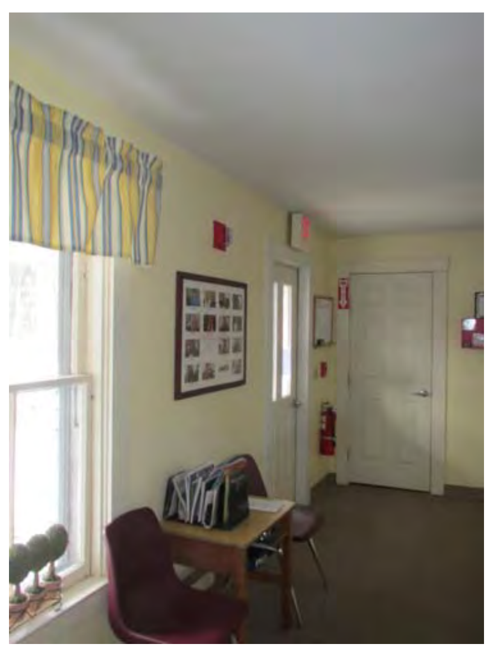
Light and interior wall ceiling penetrations



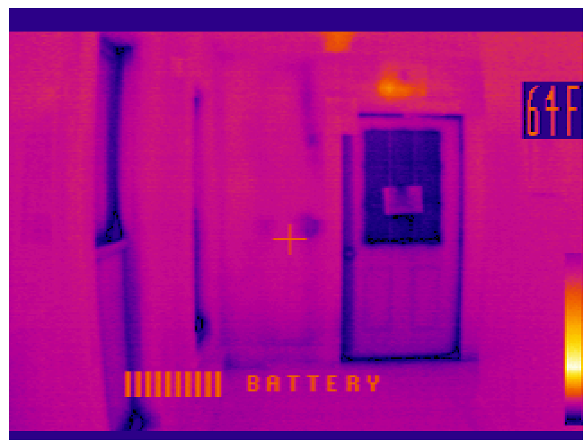


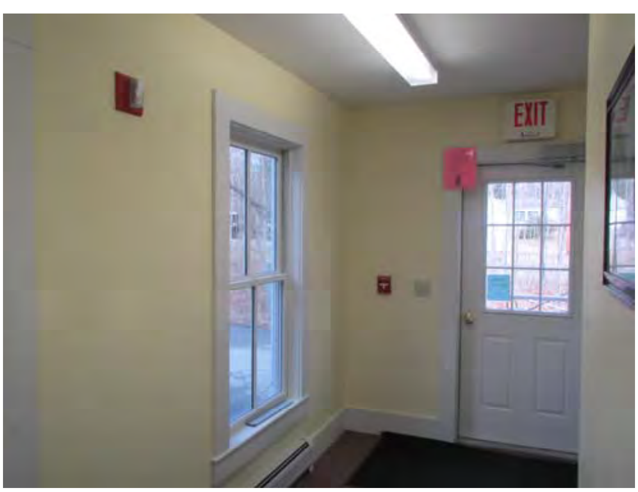
All doors need gasket weather-stripping

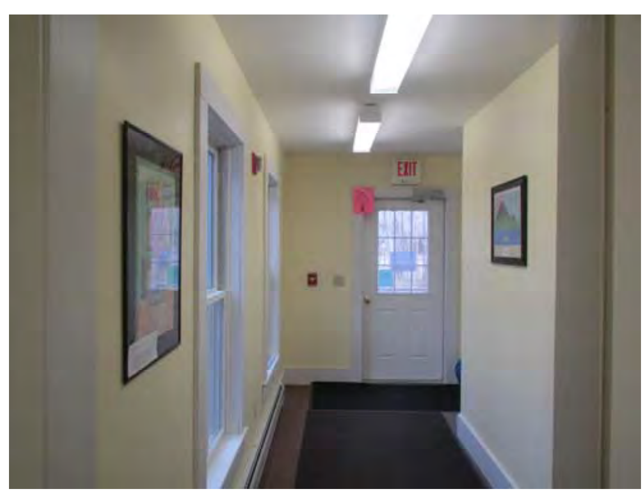




Again, newer windows leak plenty of air – all doors need weatherstripping







Remove A/C in winter if not replace with mini split heat pump