Energy Audit Report

To: Energy Committee
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Town Of Charlotte
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Date: 2/3/10

ENERGY AUDIT REPORT – CHARLOTTE TOWN HALL:

Date: 1/27/10

Weather: 33°F, mostly cloudy, calm

Executive Summary:

This energy audit was conducted with the goal of identifying deficiencies in the thermal envelope of the building. General lighting recommendations are also given. While the report details a number of findings, the key conclusions are as follows:

1. There is substantial heat loss through the acoustical tile ceiling in the east and west wings of the building. An air barrier needs to be installed.
2. The meeting room cathedral ceiling and knee wall insulation can be improved in the short term. However, some areas are more economical to address than others.
3. Window glazing makes up +/- 21% of the building exterior walls. This is an above average percentage and does contribute to heat loss and occupant discomfort. Full panel storm windows can be installed in the short term. Windows can be replaced in the long term, and we recommend reducing the glazing area to 15% or less.
4. Replace the T-12 light fixtures in the short term. Replace other light fixtures when replacement becomes economical. Add sensors and controls in the intermediate term.

Building Features:

The Charlotte Town Hall was built in 1995/1996 and occupies +/- 4,500 square feet of floor area. Construction is slab-on-grade with wood framing and an asphalt shingle roof.

Drawings indicate the 2 x 6 exterior walls are insulated with R-19 fiberglass batts, have a 6 mil poly vapor barrier on the interior, and a Tyvek wind barrier between the exterior sheathing and siding. Effective R-value is +/- R-15.

There is no dedicated attic access. We moved three ceiling tiles in the west wing in order to make our observations. We assume the attic conditions in the east wing are similar.

The attic of the east and west wings is insulated with R-38 fiberglass batts placed in between the attic floor joists. Plastic netting is installed to hold up the insulation, however, there are areas where the fiberglass batts are falling down. There is a no air or vapor barrier to separate the fiberglass insulation from the acoustical ceiling tile below. Heated air from the building can travel around the ceiling tiles and through the gaps along the ceiling joists and the various penetrations. Also, air entering the attic from the soffit vents can move around the insulation resulting in an effective R-value of 15.

The cathedral ceiling and kneewalls of the meeting hall are insulated with R-38 and R-19 fiberglass batts, respectively. The sheetrock ceiling and kneewalls provide a better air barrier than the ceiling tiles. However, the fiberglass is exposed in the attic thereby reducing its effectiveness to R-22 in the ceiling and R-11 in the kneewalls. The kneewalls also have a plastic vapor barrier installed between the sheetrock and the fiberglass batts.

Most of the windows are standard quality double hung insulated glass units. Drawings indicate the windows were specified to have low-e glass. Window glazing area is +/- 21% of the wall area, which is a high percentage.

Fuel Consumption:

Heat: Drawings indicate the Town Hall is heated with a +/- 200,000 BTU/hr oil boiler. Distribution is through insulated (1/2” thick) copper pipes to a baseboard radiator system. The boiler efficiency was tested at 84%. Additional service may bring the efficiency up to the maximum of 86-87%. There are programmable thermostats in the meeting hall and zoning/planning rooms and a standard thermostat in the clerk’s office.

Approximately 2,100 gallons of oil were consumed last heating season for a total heat load of 289.6 million BTU or 64,296 BTU/square foot. Data from the Department of Energy (DOE) 2003 Commercial Buildings Energy Consumption Survey (CBECS) for other buildings in the Northeast indicates that the Charlotte Town Hall oil usage is average based on square footage, above average based on year of construction, and above average compared to office buildings:

Building	Floor Area (ft^2)	Fuel Oil Use By Building Floorspace (gal./ft^2)	Year Constructed	Fuel Oil Use By Year Constructed (gal./ft^2)	Principal Building Activity	Fuel Oil Use By Principal Building Activity (gal./ft^2)
Charlotte Town Hall	4,500	0.47	1995/1996	0.47	Office	0.47
CBECS Northeast Average	1,001-10,000	0.50	1990-2003	0.08	Office	0.08

Reference: http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set12/2003html/c35.html

Our experience tells us that the Charlotte Town Hall oil consumption is well above average for a building of its size, use, and era.

Hot Water: We estimate that the sidearm hot water tank consumes +/- 188 gallons of oil per year or $465 at current rates. Your current system should adequately meet the needs of the building occupants. You may consider reducing the size of your hot water storage tank when it is due for replacement.

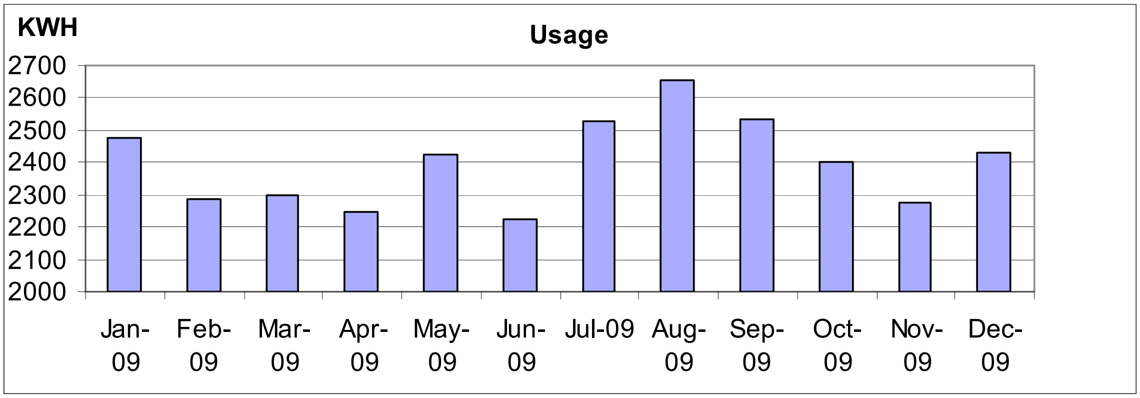
Conservation will help to manage costs. Inform occupants and visitors to by posting signs in the bathrooms and the kitchen. In the future you may consider a small solar collector since the roof faces south, although it is apparent that most of the hot water cost may be attributable to storage rather use. A smaller tank or on demand system will minimize storage costs.

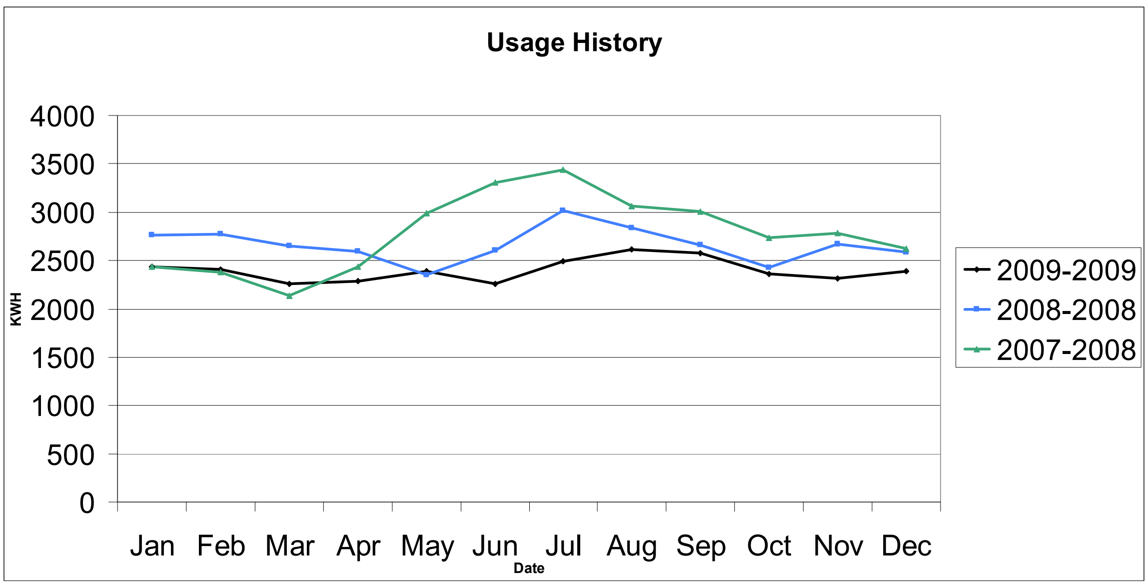
Air Conditioning: There are two air handling units located in the attic on either side of the vestibule and two condensing units on the west side of the building. Distribution is through an insulated (+/- R-5.4) duct system that passes through the attic space. There are two outdoor air intakes placed in the soffits. The air handlers appear to run on a timer during the heating season to provide fresh air inside the building. We recommend contacting your HVAC contractor to determine if the air handlers allow for heat or energy recovery. A heat recovery ventilator (HRV) or energy recovery ventilator (ERV) will allow fresh air intake while recapturing some of the heat from the conditioned air. We also recommend determining if the fresh air system senses carbon monoxide (CO) in the building. If not, we recommend installing plug in CO detectors in each wing and in the meeting hall area.

Electricity:

The Charlotte Town Hall used 28,779 kWh of electricity in 2009. This is slightly below the average of 33,500 kWh for a typical small business or office building of this size.
(http://www.efficiencyvermont.com/pages/Business/SavingEnergy/HighBills/SmallBusinessandOfficeBuil/)

Usage has decreased over the past three years. Consumption is highest during the summer months. Refer to the charts below:





The T-12 fixtures in the vestibule should be upgraded to high performance T-8 (HPT-8). Exit lights can be replaced with LED exit lights. Updating the T-8 fixtures to HPT-8, T-5 fluorescents, or LED fixtures will save electricity but may not be economic at this time. Efficiency VT provides rebates for updating lighting:
http://www.efficiencyvermont.com/pages/Business/RebateCenter/
http://www.efficiencyvermont.com/stella/filelib/2010_LightingRebateApplication_FINAL.pdf

Consider installing split ballast switching so that large room lighting may be controlled more efficiently. As an example, the switch that controls the vestibule lights also controls the meeting room soffit lights. Another important aspect of conservation is to manage and train building occupants to use less electricity. Put up signage reminding occupants to turn off equipment and lights when not in use. Occupancy sensors with manual overrides will help with this. Consider areas that may benefit from occupancy light sensors, such as the hallways, vault, kitchen, attic stair, meeting area, bathrooms, or other areas that are intermittently used. Reduce or eliminate latent loads by installing Smart strips.

Blower Door Test and Infrared Imaging:

Using air infiltration readings from two blower doors we were able to extrapolate a reading of 12,184 (+/- 2%) CFM at 50 Pascals of building pressure (CFM50). This translates to 1.38 CFM50 per square foot of building surface area, indicating a leaky building envelope for a building of this era. A large fraction of the air leakage is due to the lack of an air barrier in the ceiling plane of the two wings.

Building	**CFM50/ft² building surface area**
Super tight new construction	0.10
Very tight new construction, seen in some recent specifications	0.25
Reasonably tight new or recent construction (+/- 35 years)	0.50
Fairly leaky construction	1.00
Approximate U.S. average for commercial buildings	0.93
Charlotte Town Hall built in 1995/1996	1.38

Infrared images were taken during building depressurization and clearly show air leakage pathways. Air leaks and areas in need of thermal repairs are listed below in the Recommendations section and detailed in the attached photographs.

RECOMMENDATIONS:
The following list includes both short term and long term solutions to reducing utility costs and the carbon footprint of your building. We have put an asterisk next to the most pressing items. Please email us if you care to discuss priorities or have questions.

1. *Add an air barrier above the acoustical tile ceiling:
    a. Remove the acoustical tile ceiling. Replace the ceiling when finished with b. and c. below. $6,400.
    b. Install fire taped sheetrock to the bottom of the floor joists to cover the fiberglass insulation and create an air barrier. $5,750.
    c. Air seal all wall plates, pipe holes, wire chases, light openings, junction boxes, duct housings sprinkler head openings, heat diffusers, and miscellaneous openings. Pay particular attention to the upper perimeter of the exterior wall in the ceiling plane and interior wall plates. $1,280.
    d. Save +/- 18% of heat costs.

2. *Reduce heat loss at the cupola:
   a. Seal off the cupola and install a ceiling. Insulate to R-50. $2,650. Save +/- 2% of heat costs.
   OR,
   b. Air seal the cupola: Install storm windows over the fixed windows and air seal in place. Air seal any gaps and cracks in the cupola walls and roof. $6,500. Save +/- 1% of heat costs.

3. Reinsulate the meeting room kneewalls and cathedral ceiling.
   a. *Reinsulate the north and south kneewalls between the meeting room ceiling and the cupola: Remove the fiberglass. Install 3" of closed-cell spray foam insulation. $850. Save +/- 1% of heat costs.
   b. Reinsulate the meeting room cathedral ceiling: Remove the fiberglass. Install 5" of closed-cell spray foam insulation. $11,650. Save +/- 4% of heat costs.
   c. *Reinsulate the kneewalls above the vestibule: Remove the fiberglass. Install 3" of closed-cell spray foam insulation. $750. Save +/- 1% of heat costs.
   d. Reinsulate the meeting room kneewalls: Remove the fiberglass and plastic vapor barrier. Install 3" of closed-cell spray foam insulation. $2,750. Save +/- 2% of heat costs.

4. Blower Door Directed Air Sealing: It is recommended to perform up to 16 hours of blower door directed air sealing of: door weatherstripping, exterior wall siding transition to concrete, exterior wall building transitions, bathroom fan dampers, and window jamb pockets. $960. Save +/- 1% of heat costs.

5. In the future, replace the windows with fiberglass framed, triple glazed units. Make sure the jambs are fully insulated during the replacement process. Reduce glazing area to 15% by eliminating some low priority windows. Budget $1,000 per opening, total 28 windows. Save +/- 7% of heat costs. In the interim, install full panel storm windows ($225 each) and save +/- 3% of heat costs.

6. In the future, add foundation insulation at the exterior slab wall where possible to reduce heat loss. Install 2" of extruded polystyrene insulation to all above grade foundation areas and join to the existing below grade insulation (if present). Protect the above grade insulation with a non-water sensitive material (ex. stucco). $30 per square foot. Save +/- 7% of heat costs.

7. In the future, when re-siding or remodeling:
   a. Add a layer of 2' rigid foam to the exterior walls. Improve the effective R-value from R-15 to R-25. Save +/- 6% of heat costs.
      OR
   b. Replace all fiberglass wall insulation with foam or cellulose with a thermal break to R-30. Save +/- 8% of heat costs.

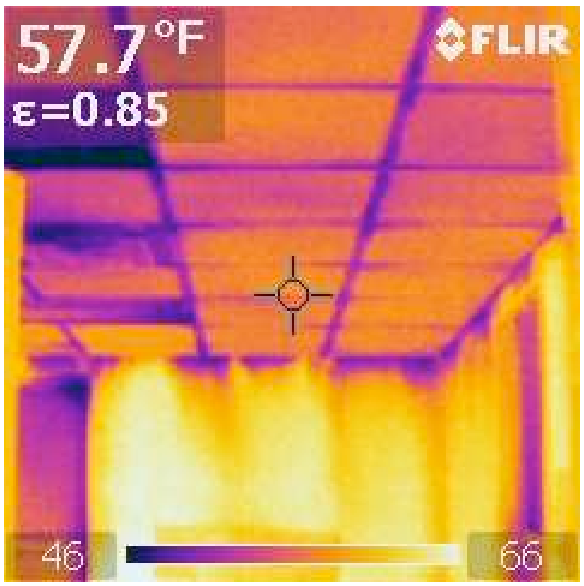
8. Solar PV:
   a. A roof mounted photovoltaic system could be installed for approximately $6 per watt.
   b. A photovoltaic (PV) tracking system could be installed for approximately $10 per watt.

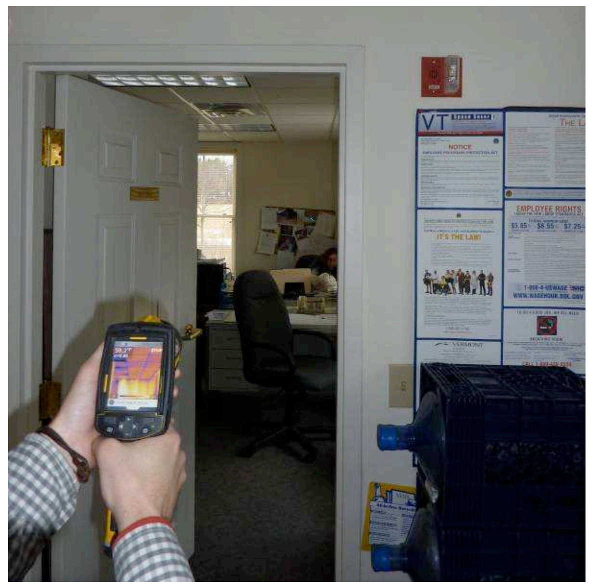
9. Air Conditioning / Ventilation Recommendations: Repairs/adjustments to the system should follow the thermal envelope improvements. It may be possible to reduce the size of the equipment once the heating and cooling load is reduced.
   a. Install ductless mini-splitters and discontinue use of the air conditioning duct system.
      OR
   b. Replace the air handlers with energy recovery ventilators (ERV) in order to provide fresh air intake and recapture energy from the conditioned building air. +/- $5,000 per unit.
   c. Insulate all ductwork in the unconditioned attic space with spray foam to R-24.

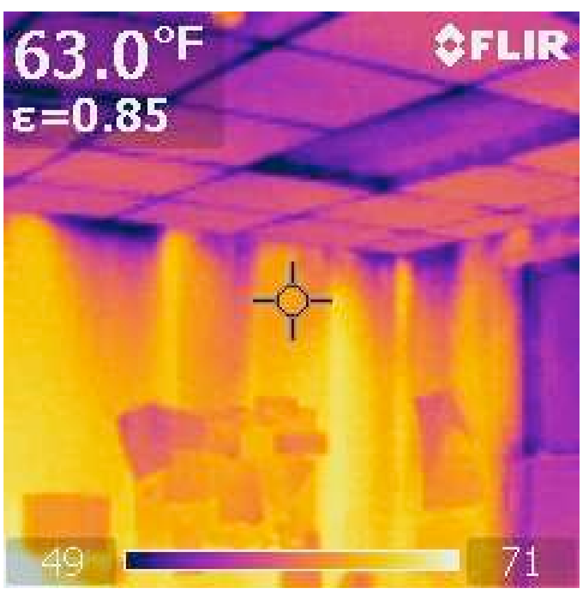
Building Interior Depressurized

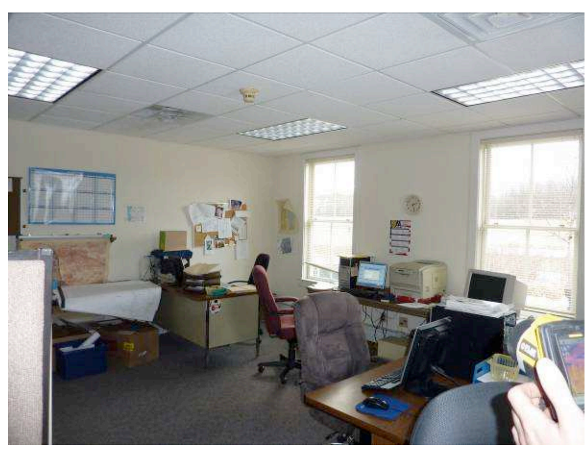
Note: During depressurization, cold air is being drawn in through gaps in the building envelope. Under normal building operation heat would be leaving through these pathways.

Although the attic spaces of the east and west wings are insulated, they are not air sealed. Air can easily pass between the ceiling and attic spaces. Heat loss can be seen through the acoustical ceiling tile, especially where the ceiling intersects the exterior wall. An air barrier needs to be installed.

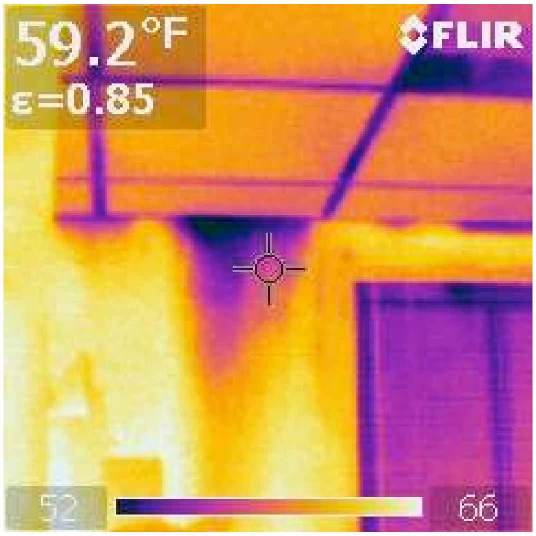


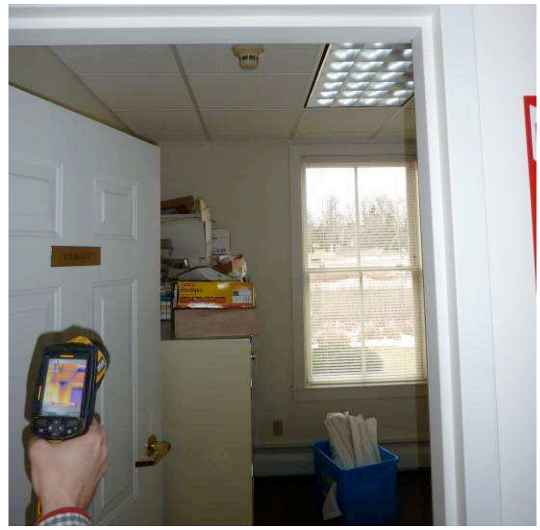


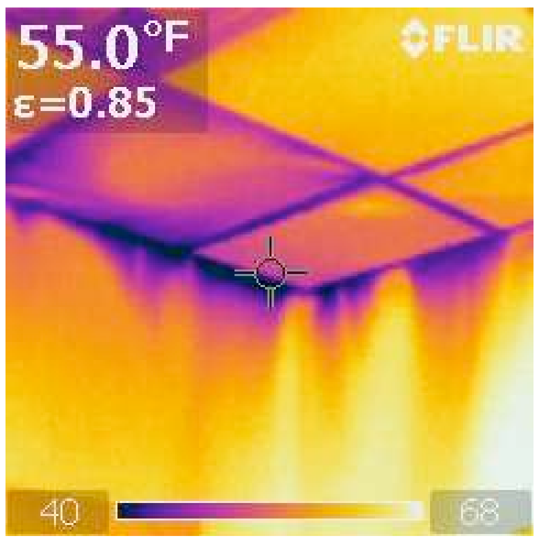


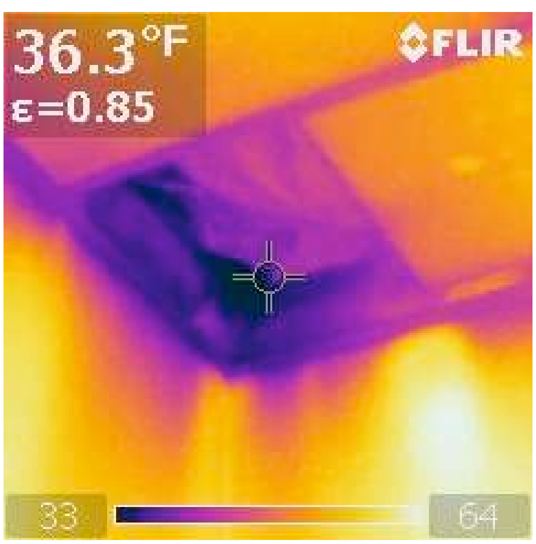


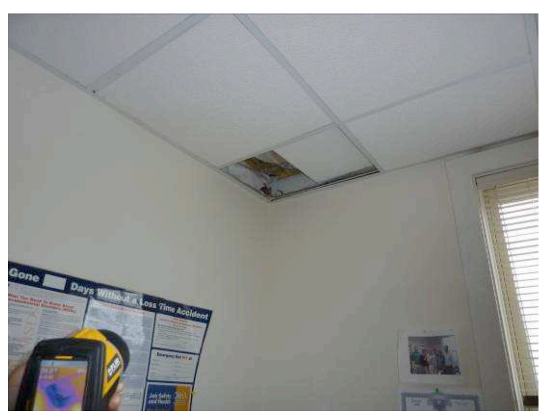
More examples of heat loss through the acoustical ceiling tile.





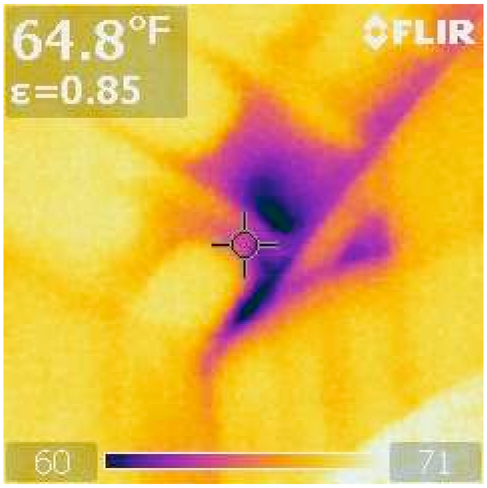


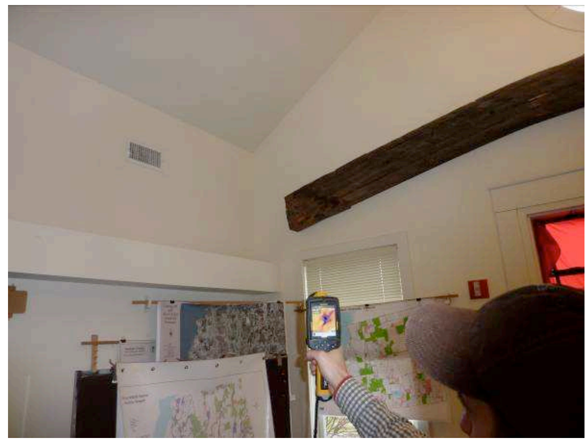


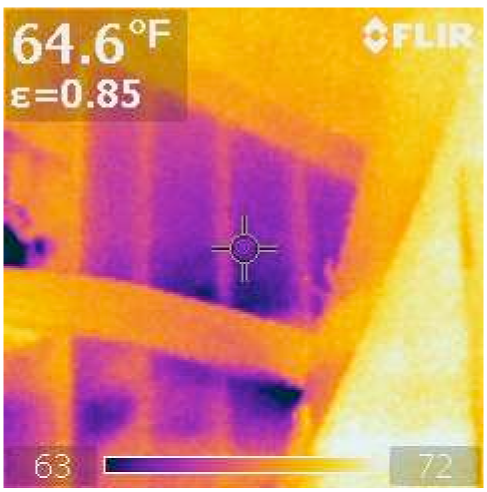


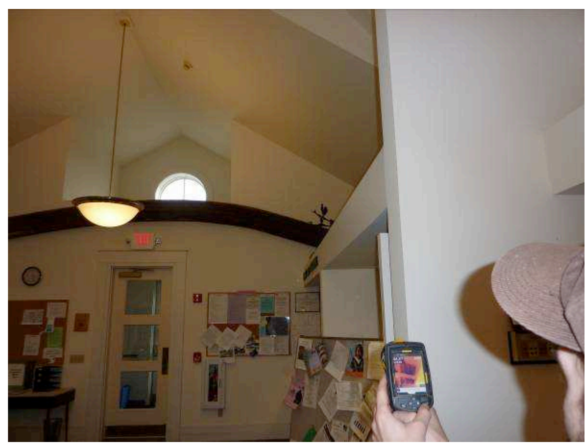
Visual inspection shows the absence of an air barrier above the acoustical ceiling tile. The fiberglass batts are held up with netting but in some areas they are falling down. Air can easily pass through the batts as shown by smoke pencil testing (bottom left).

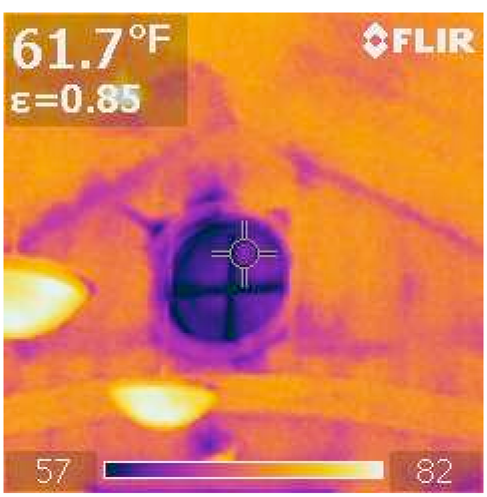
The sheetrock ceiling and kneewalls of the meeting hall provide a functioning air barrier. However, cold air from the attic can pass through the fiberglass insulation and reduce its effectiveness. Fixing the attic areas over the east and west wings are a higher priority, however, more effective insulation can be installed in the meeting hall ceiling and kneewalls. Sheetrock penetrations should be air sealed.



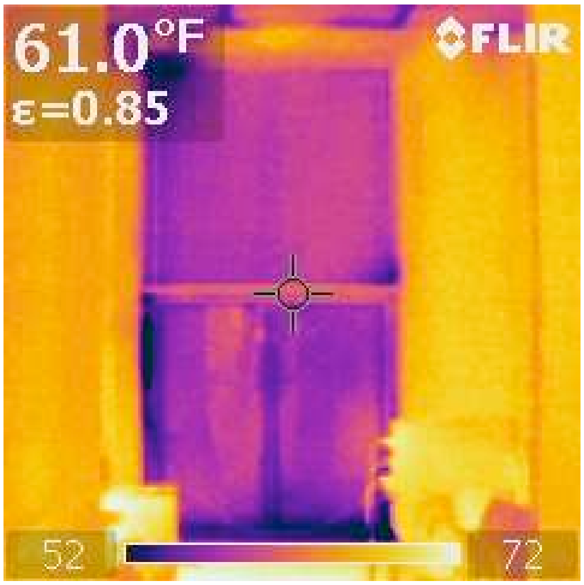




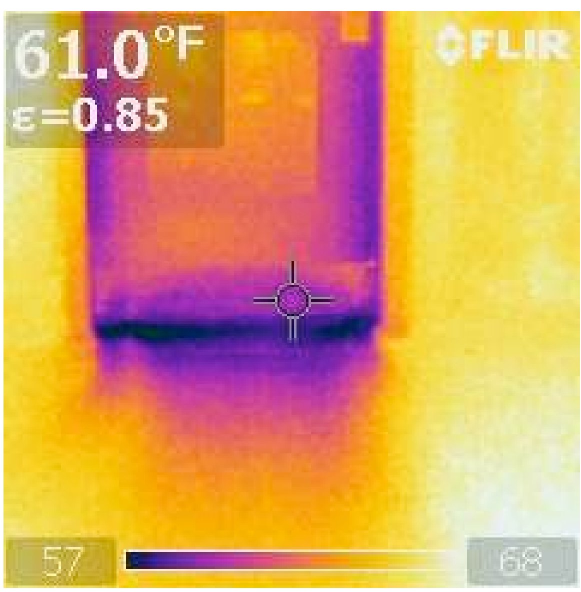




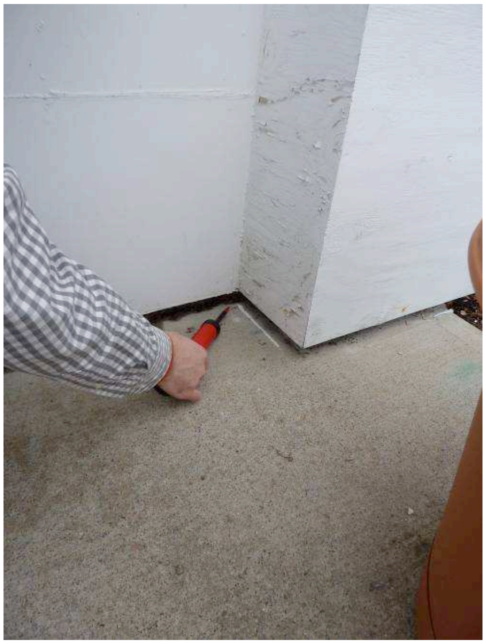
Windows are a source of heat loss. The glazing area of this building is +/- 21%, which is above average. Air leakage through the window jamb pockets can be reduced through air sealing. Windows units can be replaced and glazing area reduced in the future. Full panel storm windows can be installed in the interim.

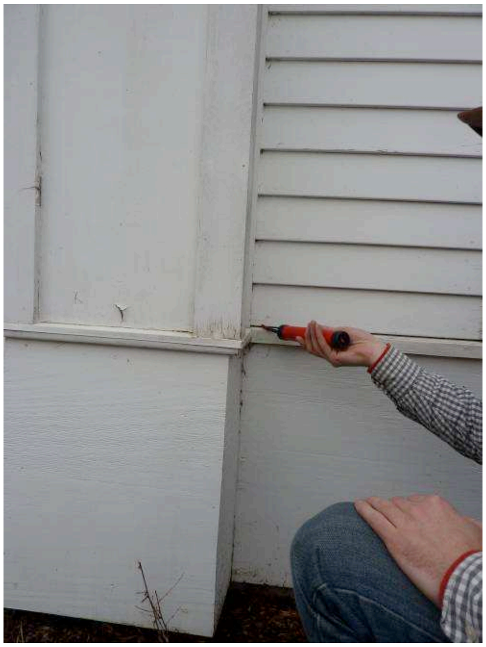


Like windows, doors are a source of heat loss. We recommend maintaining the weatherstripping on all exterior doors.

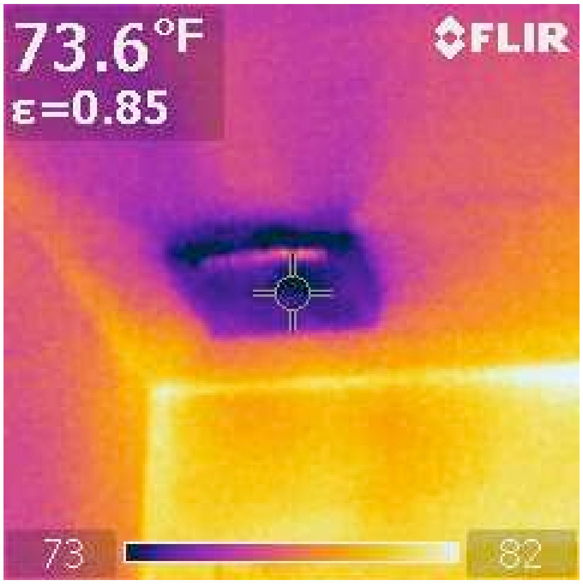


Air leakage is present at exterior wood to concrete seams and building transitions. These areas should be air sealed.





The bath fan dampers may not be installed or functioning properly. Dampers reduce heat loss when the fan is not operating.



There is heat loss at the slab edge. Rigid insulation can be added in the future.

The air conditioning ductwork is covered with R-5.4 insulation. Despite this, there are distribution losses that result from locating the ductwork in an unconditioned attic space.

Information and Resources:

1. www.epa.gov, www.energystar.gov
2. VT Agency of Natural Renewable Energy Project Grants, www.anr.state.vt.us
3. Vermont Energy & Climate Action Network, SERG-info@valley.net
4. www.efficiencyvermont.com / www.veic.com
5. www.10percentchallenge.org
6. VT Clean Energy Development Fund:

   Anne Margolis
   Clean Energy Development Fund Manager
   VT Dep. of Public Service
   112 State Street
   Montpelier, VT 05620-2601
   (802) 828-4017
   anne.margolis@state.vt.us
7. Vermont Economic Development Authority, www.veda.org