SDES Group
Sustainable Development & Energy Systems

2 Washington Street, Suite 206
Dover, NH 03820

# Decision Grade Audit Report

For

Town of Washington, NH

Building:

## Police Station

SDES Group has provided this report at the request of the Town of Washington, NH. This Decision Grade Audit report was generated to identify energy inefficiencies of the Town's Police Station (hereinafter "the building") and to identify opportunities and projects, which if implemented, will reduce energy consumption and associated greenhouse gas emissions resulting from building operations.

In the event the Town of Washington would like to implement recommendations found within this report, SDES Group can provide further services associated with those efforts; including project management, installation of particular items, review/inspection of contracted installations, and a variety of other services.

**For questions regarding this report or requests for other services, please contact:**

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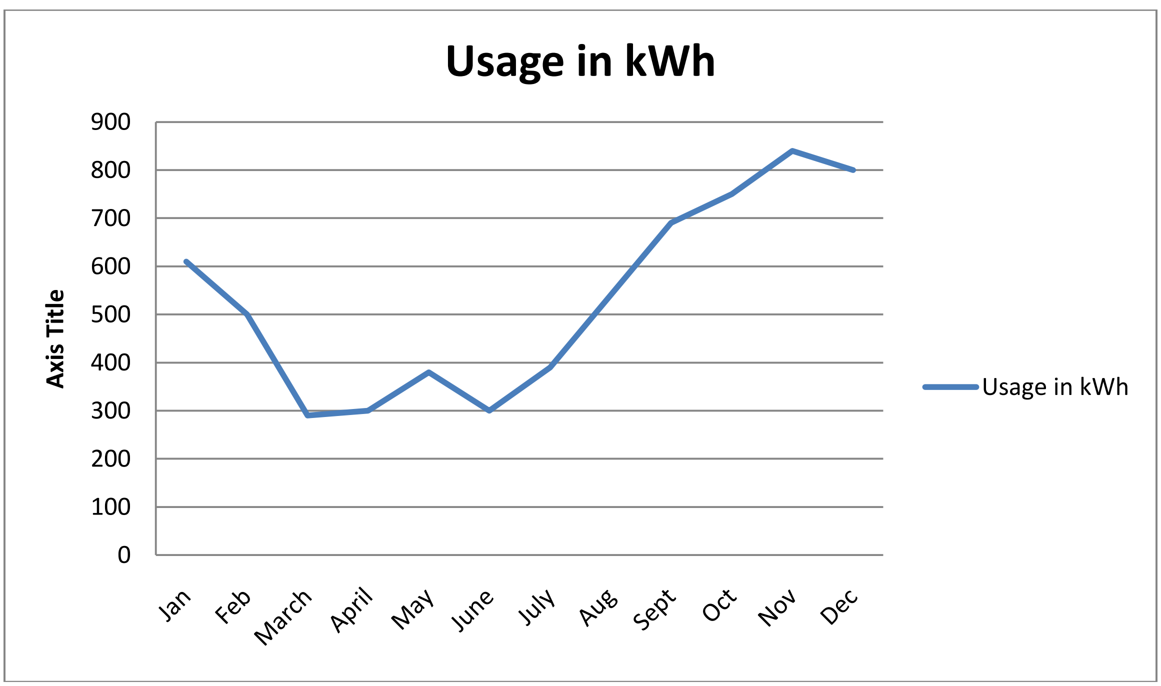
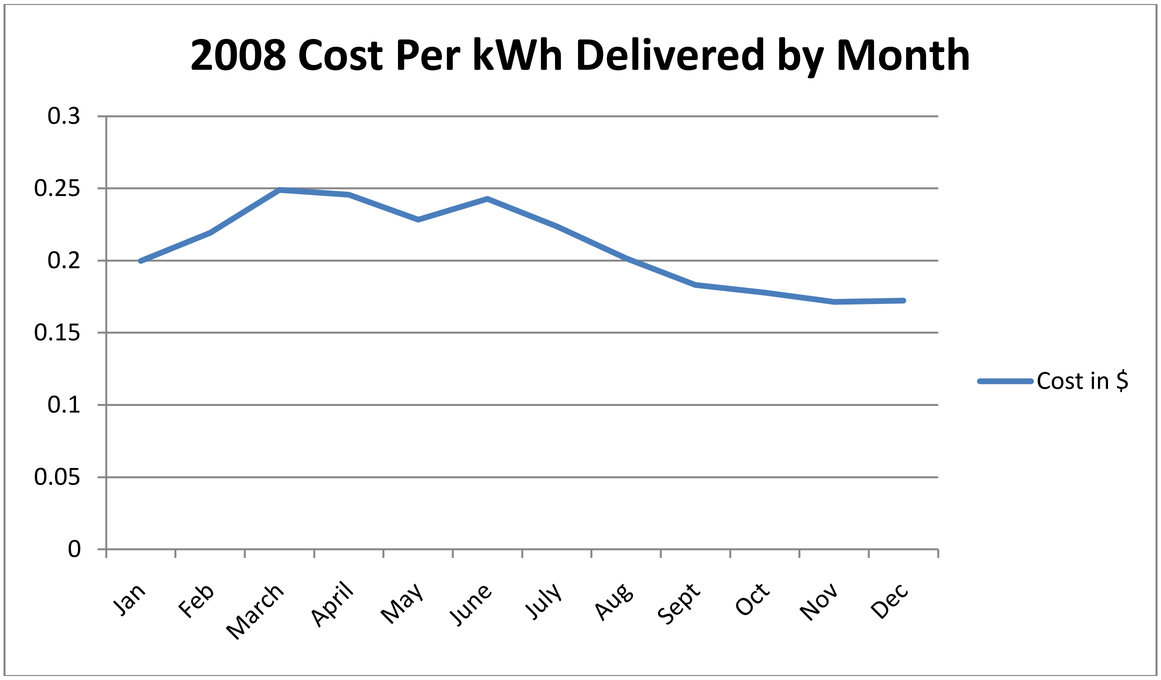
**Energy Data Collection:**

| Meter: Electricity | | | |
|---|---|---|---|
| **Building: Police Station** | | | |
| April 19, 2010 - 11:10:38 AM | | | |
| **Fuel Type:** Electricity, Grid Purchase (kWh (thousand Watt-hours))<br>**Space(s):** Police Station | | | |
| | | | |
| **Start Date** | **End Date** | **Energy Use** | **Cost - US Dollars** |
| 12/1/2008 | 12/31/2008 | 800 | $137.80 |
| 11/1/2008 | 11/30/2008 | 840 | $144.00 |
| 10/1/2008 | 10/31/2008 | 750 | $133.40 |
| 9/1/2008 | 9/30/2008 | 690 | $126.40 |
| 8/1/2008 | 8/31/2008 | 540 | $108.90 |
| 7/1/2008 | 7/31/2008 | 390 | $87.24 |
| 6/1/2008 | 6/30/2008 | 300 | $72.85 |
| 5/1/2008 | 5/31/2008 | 380 | $86.82 |
| 4/1/2008 | 4/30/2008 | 300 | $73.73 |
| 3/1/2008 | 3/31/2008 | 290 | $72.21 |
| 2/1/2008 | 2/29/2008 | 500 | $109.60 |
| 1/1/2008 | 1/31/2008 | 610 | $121.90 |

*Data retrieved from the EPA Portfolio Manager account for Washington, NH




*Graph generated based on data retrieved from the EPA Portfolio Manager account for Washington, NH.

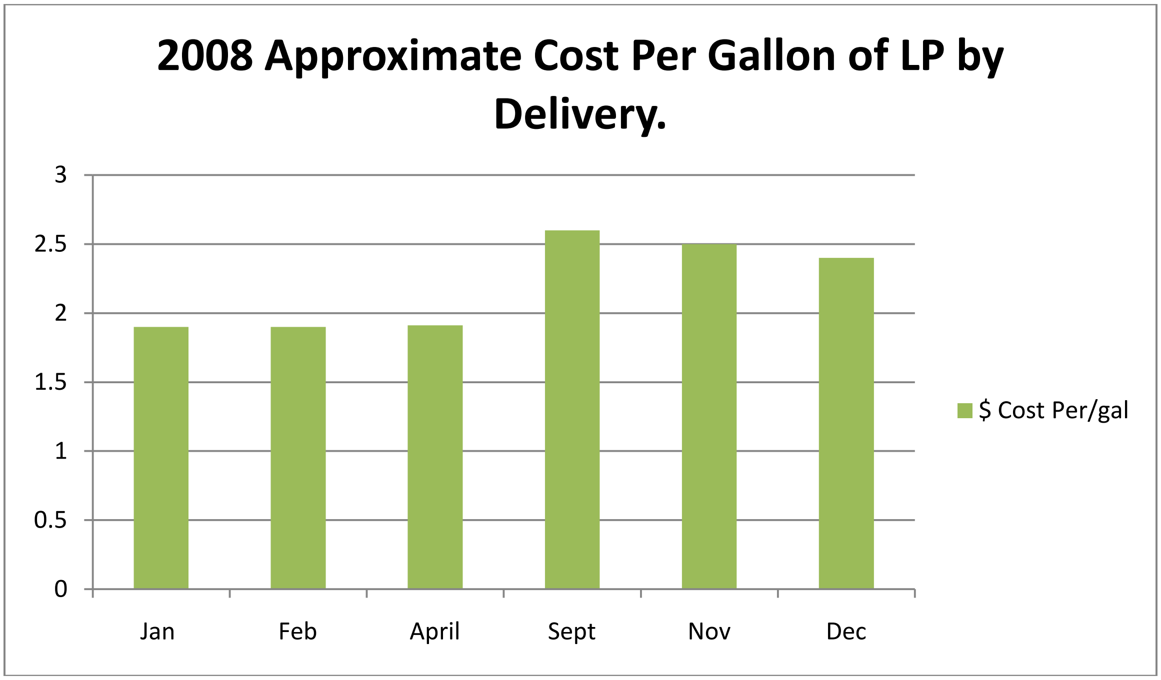



*Graph generated based on data retrieved from the EPA Portfolio Manager account for Washington, NH.

**Total 2008 kWh Usage:** 6,390kWh
**Total 2008 Electric Cost:** $1,274.85

| Meter: Heat | | | |
|---|---|---|---|
| **Building: Police Station** | | | |
| April 19, 2010 - 11:11:13 AM | | | |
| **Fuel Type:** Propane, No fuel generation method associated with fuel type (Gallons)<br>**Space(s):** Police Station | | | |
| | | | |
| **Start Date** | **End Date** | **Energy Use** | **Cost - US Dollars** |
| 12/1/2008 | 12/31/2008 | 244.3 | $586.10 |
| 11/1/2008 | 11/30/2008 | 119.8 | $299.40 |
| 10/1/2008 | 10/31/2008 | 0 | $0.00 |
| 9/1/2008 | 9/30/2008 | 82.5 | $214.40 |
| 8/1/2008 | 8/31/2008 | 0 | $0.00 |
| 7/1/2008 | 7/31/2008 | 0 | $0.00 |
| 6/1/2008 | 6/30/2008 | 0 | $0.00 |
| 5/1/2008 | 5/31/2008 | 0 | $0.00 |
| 4/1/2008 | 4/30/2008 | 281.1 | $537.60 |
| 3/1/2008 | 3/31/2008 | 0 | $0.00 |
| 2/1/2008 | 2/29/2008 | 268 | $508.90 |
| 1/1/2008 | 1/31/2008 | 567.3 | $1,077.00 |

*Data retrieved from the EPA Portfolio Manager account for Washington, NH



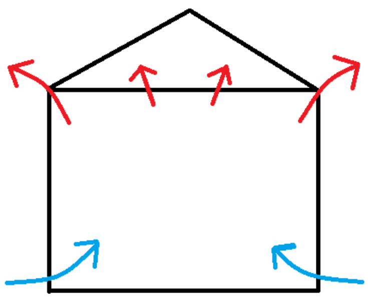

*Graph generated based on data retrieved from the EPA Portfolio Manager account for Washington, NH.

**Total gallons Delivered:** 1,563 gallons
**Total cost of LP:** $3,223.40

**Basics of Heat Loss:**

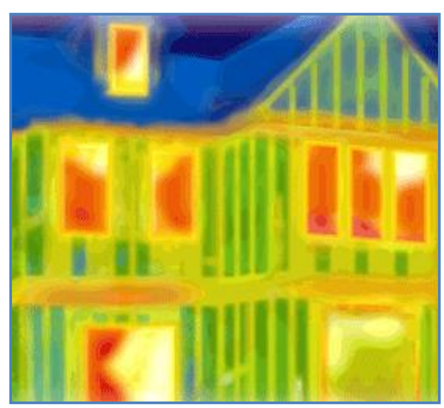
Though we are typically used to measuring heat in temperature, it can be measured in a variety of units. For the purpose of measuring how much heat is produced to condition a space, and how we measure the rate at which heat leaves a structure, we measure in British Thermal Units (BTU's). One BTU is about the same amount of heat produced from a kitchen match. Another good reference to have is that there are about 138,500 potential BTU's in 1 gallon of heating oil. During the winter months, we cannot keep BTU's from leaving our buildings. Hot always goes to cold, or, areas of high pressure are always trying to go to areas of low pressure. What we can do is try to slow the process. We do this by using an **air barrier** and **insulation** at the building envelope to create a thermal barrier.

Heat moves through and leaves a building by three different means; *convection, conduction, and radiation*. One way to think of **convective** heat loss is by air movement into and out of a structure. Typically, heated air leaves through the higher areas of a building, and cold air infiltrates through the lower areas. One of the forces causing this to happen is the "stack effect."

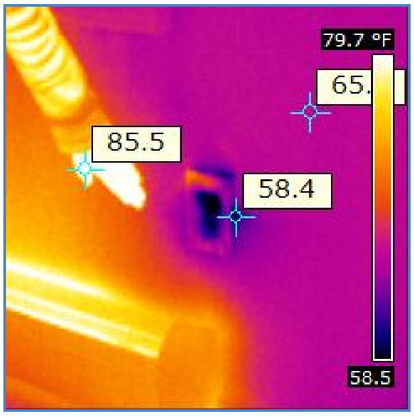


The stack effect describes, on a macro level, the natural way in which air moves through a building. As warmed air leaves through the upper levels of a building, cold air infiltrates through the lower sections. In most cases, this pulls air from less than desirable areas of a building, such as basements, crawl spaces and mechanical rooms, which are often damp and unmaintained. These spaces can be the source of exhaust fumes from heating equipment, mold and mildew, as well as a number of other air contaminants such as radon. Without an effective air barrier between the conditioned space and the attic, warm air will exit the building. For every 1 cubic foot of air that leaves a building, 1 cubic foot of air will infiltrate at a different location. Gaining control of the air movement through a building not only has a positive effect on efficiency, but contributes to increased comfort and improved indoor air quality.

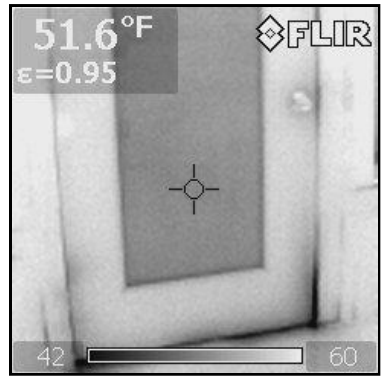
**Conduction** is the foremost way in which heat travels through a solid building material. At any point in the building envelope where there is a solid building material and no insulation, what is known as "**thermal bridging**" will occur. For example, a 2x6 inch wood stud in an exterior wall has an R-value, or insulative value, of about R-7, while the 5.5 inch fiberglass insulation in the wall cavity is rated at R-19. Solid material in the exterior wall of a typical structure built with 2 inch stock, 16 inches on center (O.C.) will usually make up 20-25% of the wall surface area. This, in combination with all of the doors and windows, means that a significant percentage of the building envelope has an R-value of less than 10. Even a wall with a high R-value cavity insulation such as spray foam is subject to these weak points in the thermal boundary. Employing methods to reduce or eliminate thermal bridging in our new and existing buildings will dramatically reduce energy costs and emissions over the



long term as we move towards a new generation of energy and environmental challenges.




**Radiant** heat loss describes how heat waves, or infrared radiation, pass through space from one surface to another within its view. For example, the heat from a hot cooper pipe will radiate towards cooler surfaces around it, like an exterior wall. The heat can then conduct through building materials to the exterior.




With regards to the building envelope, **gaining control of convective heat loss is the main priority, and usually the easiest to address through air sealing**. After this is done, increasing insulation levels, or R-value, of the building envelope is the next step to gain better control of conductive heat loss. In many cases, a large amount of a structure's radiant heat loss will be addressed with added insulation, either to ceilings, floors, walls, ductwork, or piping. Treating the whole building as a system, and addressing all the issues of heat loss will produce optimum savings and comfort.

**<u>Basics of Moisture Control:</u>**

The issue of moisture control in buildings is very complex and essential to maintaining structural durability and occupant health. The mismanagement of moisture can lead to a multitude of negative effects. Some of these are mold growth, poor indoor air quality, early materials and equipment degradation, and large negative health impacts on the people who live and work in our buildings.

The two basic forms of moisture in need of managing are bulk moisture (fluid), and water vapor. Two important ways to manage bulk moisture are to keep rain and ground water from entering our buildings, and to quickly fix any water leaks from sources within our buildings such as leaking pipes.

Managing relative humidity and water vapor is a challenge. At some points of the year, occupants want more humidity in the air to maintain comfort, and less in other times. For example, in the winter months we want more humidity indoors because it helps occupants experience greater comfort. In many situations, we increase the relative humidity mechanically with humidifiers. When indoor air is too dry during the winter, we feel colder, develop dry skin, and our upper respiratory can become dry causing discomfort.

Conversely, in the summer we want the air to be dry. Just as hot goes to cold, wet goes to dry. We cool ourselves by perspiring. As we produce this moisture on our skin, it evaporates into the air, drawing heat away from our bodies. The temperature of a room may not be very high, but if the relative humidity is high, we will feel hot because our perspiration is evaporating at a slower rate. Much of the comfort we achieve from using an air conditioning system (AC) is by removing the moisture from the air, allowing our skin to dry more quickly.

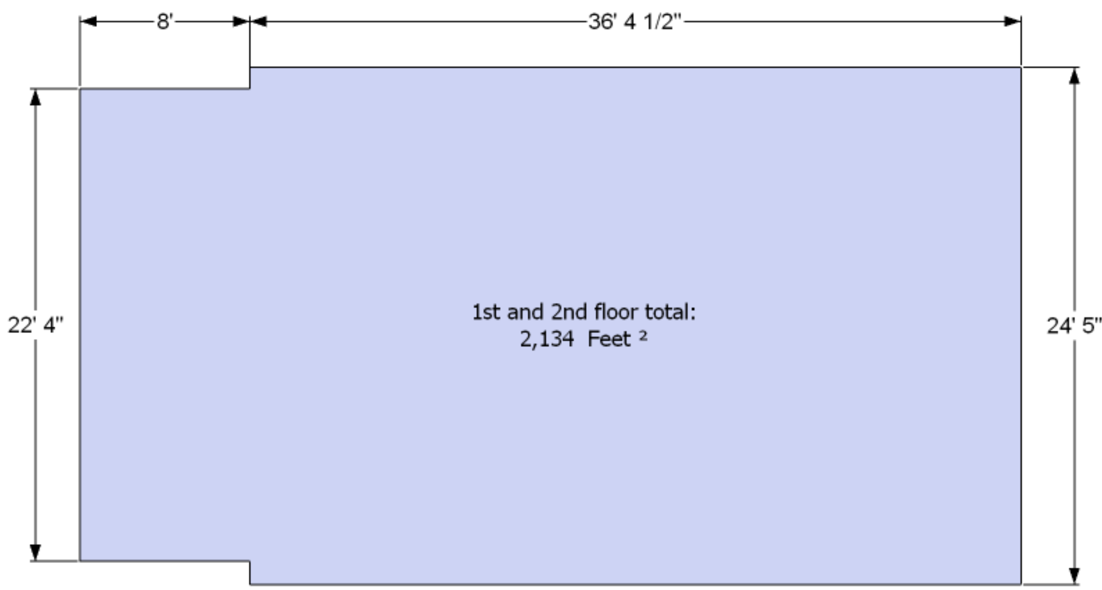
In the winter, there will always be some level of moisture in a heated and occupied space. We want this moisture, or water vapor, to stay within the occupied space for many reasons. Two of the most important reasons are to help occupants feel more comfortable, and to keep the water vapor from causing damage within the building envelope.

Just as BTU's conduct through solid materials, water vapor diffuses through solid materials. Some materials are more resistant to vapor diffusion, such as polyethylene, and so we use these to try and form a vapor barrier on the inside of the thermal boundary in an attempt to slow the amount of vapor diffusion. Small amounts of vapor traveling through a properly constructed building envelope will diffuse all the way to the exterior, and not cause any damage**. If a large amount of vapor is allowed to enter a wall cavity, the molecules will condense on the nearest cold surface.** When this happens, moisture can build up on the inside of the exterior wall sheathing, or on other surfaces. This will cause a number of problems including long term damage to insulation and structural components, as well as the promotion of mold growth.

It is important to try and identify any current moisture problems, and address them properly. This is always done by first finding and controlling the source of the moisture. Sometimes it can be quite difficult to see moisture damage, as it may be buried inside of wall cavities. It is also important to know that by making changes to a structure and its envelope, we can change the way, sometimes negatively, in which moisture affects the building.

**Building Description:**

This is a two story building built in the late 1800's, with a small addition built on the back side of the structure likely in the 1960's. It was originally a school house later converted into a police station. It is occupied for about 40 hours a week. The first floor is an open office space with two lavatories and a mechanical room. There is a large stairwell located in the front of the building that leads to the second floor where there is an additional lavatory, an exercise area, and a couple of storage closets.



**<u>Foundation/Crawl Space:</u>**

The original section of this building sits on a brick foundation. About two feet of this foundation is above grade. Figure 2 shows one particularly deteriorated section of the foundation. There are numerous vertical cracks through the brick which illustrate how the foundation has settled, or sunk, over the many years this building has been standing.

Figure 2

Figure 1

Figure 4

Figure 3

The addition on the back side of the building sits on a concrete block foundation. Some areas of this foundation have cracked blocks, and the mortar has separated between some of the blocks. See Figure 1. Figure 4 shows how one side of this foundation was coated with a type of cement mix. This was likely done to sturdy the foundation as this side probably started failing first.

We were able to look into the crawl space from several foundation vents, or access points. The approximately 1ft by 2ft openings where covered with half inch pieces of plywood. When removed, we discovered framed screens for each on the dirt floor. We recommend replacing the pieces of plywood with the screens during the warmer months for ventilation.

There is about two feet of space under the building before the dirt floor. The floor joists and decking boards appeared to be in great condition on the areas we were able to inspect. See Figure 3. This suggests that the space stays relatively dry, which is the goal for any basement or crawl space. There was no insulation found between this space and the first floor. This is a large inefficiency for a couple of reasons: first, that the heat of the first floor is conducting through the flooring material and lost to the cold dirt floor and foundation walls; second, the large amount of air infiltration from the crawl space to the conditioned space above contributing to the "stack effect" of this building. See an explanation of the stack effect below.

Figure 3 also reveals the unsealed and uninsulated duct work. This is a great inefficiency, and will be discussed more in the Mechanical section of this report.

<u>Recommendations:</u>

- A proper evaluation of the foundation by a mason or foundation specialist should be done. This building has been standing for a relatively long time. If it is to stand the test of many more years of service to the town, corrective measures, or possible replacements, are recommended.
- Insulate the underside of the first floor. This should be done with closed cell spray foam. The foam insulation will not only offer superior R-Value, but will air seal at the same time.
- Put down a vapor barrier over the dirt floor of the crawl space. Though the space seems to stay fairly dry, it would be beneficial to take steps to further protect the structure.

## Exterior Walls:

The exterior walls of the original building have wood clapboard siding, 1 inch sheathing boards, true 2x4 inch studs, and a lath and plaster interior finish. All of the wall cavities which we examined we found to be partially filled with a cream colored light weight powder. See Figure 5. After spending some time investigating as to what the substance may be, our best guess is that it is either Urea Formaldehyde foam insulation (UFFI) that has broken down over many years, or it is some type of insecticide.

Figure 5

UFFI was being installed in the 1970's into older buildings that had empty wall cavities. This was a two-part foam that had a consistency of shaving cream, expanded greatly, and served well to fill hard to reach spaces. This foam deteriorates over time, and can turn into a powdery substance. As it off gases over time, it loses its formaldehyde content. We spoke with several

individuals at the NH Department of Environmental Services (NHDES) who explained that if it is in fact UFFI, it can be treated as a non-toxic substance.
The following links provide more information about UFFI:
http://www.epa.gov/iaq/formalde.html
http://www.cpsc.gov/

There are types of insecticide that come in a powder form and are used to blow into wall cavities. If it is an insecticide, it was likely put there to prevent or eliminate carpenter ants, or even bees or wasps that could find the empty wall cavities an ideal space to occupy.

The exterior walls of the rear addition have wood clapboard siding, ½ inch plywood sheathing, 3 ½ studs, with a sheetrock interior finish. These walls have been insulated with R-11 fiberglass batt insulation.

Recommendations:

- Have the powder from in the exterior walls tested to confirm whether or not it is UFFI, or if it should be treated as a toxic material. If it is UFFI, we recommend removing the powder. This could likely be done with a high powered vacuum.
- After the wall cavities have been cleared, have an insulation contractor fill the empty cavities with cellulose insulation. The new insulation will not only add effective R-Value to the walls, but also aid in reducing convective air currents.
- If the powder is found not to be UFFI, and contains asbestos or other toxic substances, we recommend contacting NHDES for a list of NH companies who are certified to remediate the substance. After this has been done, refer to the above recommendation.

**Ceilings and Attic:**

There is a suspended ceiling above the first floor office which hides the original lath and plaster ceiling. There is about 2 feet of space above the suspended ceiling. The forced hot air heating system has two zones, one for the first floor (zone 1) and one for the second (zone 2). The first floor is the primary occupied space, and is maintained to higher temperatures than the second. For this reason, it is very important to air seal between the two floors. There are some minor penetrations for wiring and plumbing, with the major air passageway being around the unused chimney. Figures 6 and 7 exemplify just how easily conditioned air can pass from the first floor to the second, while Figures 8 and 9 reveal how this problem continues on the second floor, as the chimney is open from the second floor to the attic space.

Figure 6

Figure 7

Figure 9

Figure 8

The mechanical room, located in the rear addition, has sheetrock ceilings, with about three feet of space before the second floor joist. This ceiling is in disrepair, and has many passages that allow for upward air movement.

The second floor ceilings also provide for ample upward movement of air. There are some minor penetrations through the lath and plaster ceiling from lighting, ceiling fans, smoke detectors, etc. However there are currently several major paths from the conditioned space to the attic: the exposed chimney from Figure 8, the exposed lath in Figure 10, and the two access points to the attic space.

Figure 10

The attic has 3 inches of fiberglass batt insulation, with an average of about 5 ½ inches of old cellulose insulation on top. This space appears to be adequately ventilated.
The large stairwell to the front of the building has no heat registers, and there are doors which are kept closed from both the first and second floors. Both these doors should be treated like exterior doors and sealed with weather stripping to lessen air movement.

Recommendations:

- Repair the drywall of the mechanical room ceiling. Also, make sure that the access panel to the space above is sealed when not in use.
- Air seal the gaps around the chimney to stop air movement from the first floor to the second.
- Air seal any other penetrations that would allow for air movement from the first floor to the second.
- Apply weather stripping to the first floor door that leads to the stair well.
- Repair any damages to the second floor lath and plaster ceiling. This would include sealing any cracks where the plaster is cracked.
- Seal around the chimney so that air movement cannot occur from the second floor space to the attic.
- Seal any other penetrations from the second floor to the attic.
- We recommend achieving an R-60 in the attic. This can be done by adding loose fill cellulose insulation.

**Doors and Windows:**

There are four exterior doors in this building: two located in the front of the building, one exiting the mechanical room, and the forth is an emergency exit from the second floor. All but the mechanical room door are newer, fairly efficient models, and we do not recommend their replacement at this time. The mechanical room door is solid wood, does not shut very well, and needs to be sealed with weather stripping. This could be a good candidate for replacement, except that it is not located in an intentionally heated area; therefore, a full replacement is not a high priority.

All of the windows in this building are original, single pane, solid wood, and operable. They do not offer much insulative value, and are quite leaky.
There are older aluminum storm windows, though many of them do not operate properly, and some of the glass panes and metal framing are broken.

Recommendations:

- Make sure that all of the exterior doors shut well, and provide a good air seal.
- Replace the windows with a minimum of double pane, gas filled, low-e, vinyl or fiberglass replacement windows. If this is not to be done, replace the storm windows

with newer, more efficient units with the lowest rated air infiltration rate available (.05 CFM/ft or better).

If the recommended air-seal and insulation work is completed with care, it will be necessary to provide fresh air to the building. A blower door test would determine how tight the building is as a result of the efficiency upgrades, and help ensure that the ventilation system upholds to ASHREA standards for ventilation.

The most energy efficient way to provide fresh air in this case would be with an energy recovery ventilator (ERV). An ERV functions by removing a percentage of the stale air from the return plenum, and then introduces charged, fresh air to the return plenum right before the air-handler. In the winter, warm/stale air being removed from the building will charge the incoming fresh air with a heat exchanger located inside the ERV. Conversely, in the summer months the exhausted cool/stale air from the interior will cool down the hot/humid air from the exterior before entering the air-handler. An ERV has a desiccant wheel as well. This allows for the transfer of moisture. In the winter months, moisture in the exhaust air will be transferred to the incoming dry air to help maintain occupancy comfort. In the summer, dry/conditioned air from the interior will remove, at least a portion of, the moisture from the humid incoming air. See Figure 10.

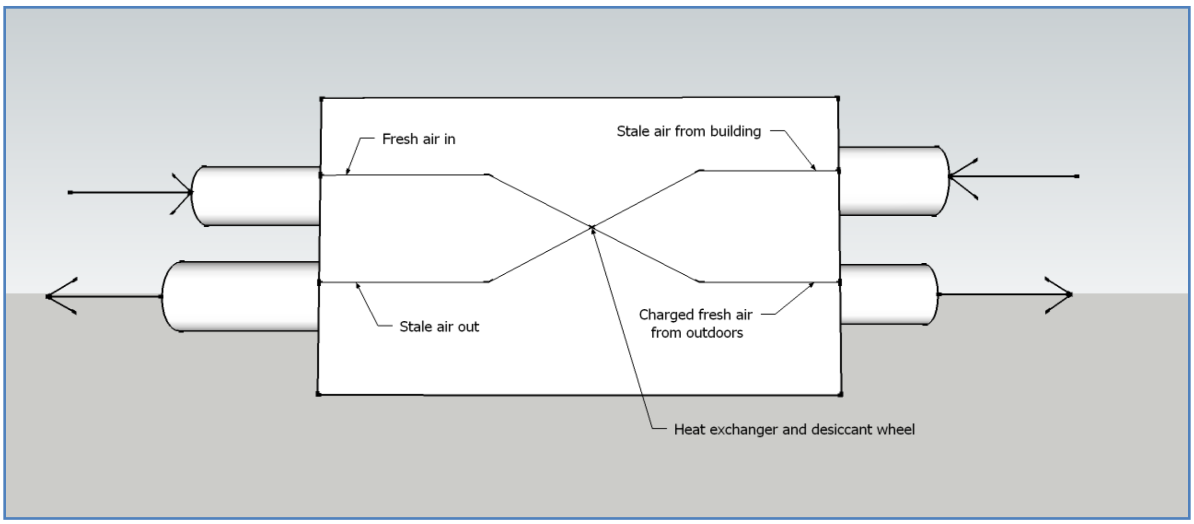



Figure 11

**Envelope Efficiency:**

The single largest area for improvement in building efficiency involves the building envelope. The best ways to increase an envelope's performance is to complete air sealing and insulation work. Although it could be a major undertaking to air seal and insulate the building, the resulting benefit would be equally significant.

From a building efficiency standpoint, air sealing and insulating can be thought of as a different species of project and investment when compared to items like heat systems, appliances, and alternative energy systems. In the case of the latter, these types of energy investments have a shelf life. A boiler may only last 20 years, or 40 years before possibly needing to replace a PV array, but building envelope efficiency has a lasting positive impact long after equipment needs to be replaced. This is an important consideration when factoring in the true life cycle cost of the implemented solution.

Air sealing/insulation and other building envelope projects are investments that are permanent, require little or no active maintenance, and will stand with the building during its lifetime. These investments secure baseline improvements that in turn provide a foundation for other investments. Lowering the amount of heat needed for a building is the best way to insure that new and efficient heating and cooling equipment provides the most savings.

**Mechanical:**

The building is heated with a liquid propane gas (LP) fired furnace with a rated combustion efficiency of 92.6%. There are more efficient gas furnaces available, though we do not recommend replacing the furnace at this time. When it comes time to replace this furnace, look for the most efficient equipment. Spending a little more upfront will be a wise investment with an obvious financial return.

The supply plenum runs from the top of the furnace and feeds the two zones ($1^{st}$ and $2^{nd}$ floor). All of the supply ducts run from a three foot tall mechanical space in the addition that separates the first and second floor. See Figure 12. From here, there are two main supply ducts that feed two registers located in the first floor ceiling. The remaining supply ductwork runs to the second floor. Though all of the supply ductwork runs within the thermal boundary, none of this ductwork has been air sealed or insulated. The purpose of a heating system's "distribution" component is to transport heat to where the heat is intended to go. Greater comfort and savings would be realized from air sealing and insulating these ducts.

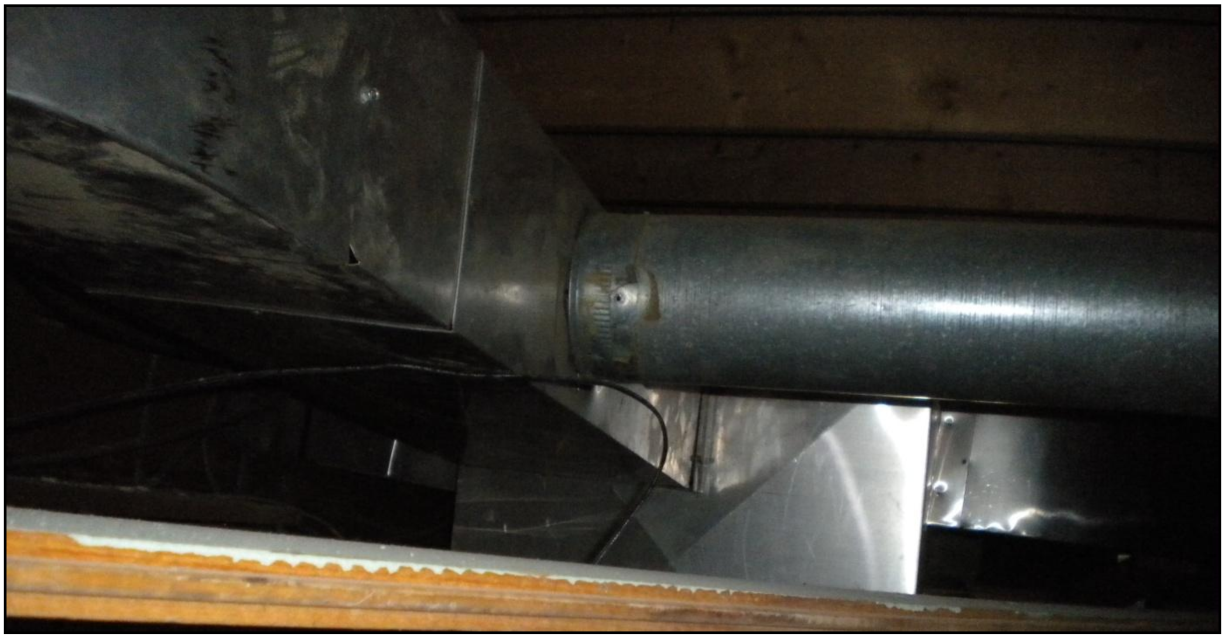


Figure 12

There are four return air grills, two located in the second floor, and two in the first. All of the return ductwork runs into the crawl space under the first floor before running to the return plenum which is located directly under the furnace. It appears as though the return plenum is open on one end to a square or rectangular hole on the mechanical room floor. The furnace seems to just sit on top of this opening with no seal, and relatively large gaps allow for the furnace to pull in air from the mechanical room. None of the return ductwork in the crawl space has been air sealed or insulated. This is problematic for a couple of reasons: first, the return air is being cooled before it arrives back at the furnace, resulting in inefficiency; second, the return ducts are pulling in air, dust and possibly other contaminants from the crawl space into the ductwork. This potentially unhealthy air is then distributed to the occupied areas of the building.

We were unable to see if the ducts house zone dampers. Mechanized zone dampers would work in conjunction with the two thermostats, and if working properly, would only open the duct work for the zone when there is a call for heat. Without properly functioning zone dampers, zone 2 could be receiving heat when the thermostat in zone 1 was the only thermostat calling.

Currently, the domestic hot water (DHW) is heated with a large, old, and relatively inefficient electric water heater. This tank is likely much larger than it needs to be, and none of the pipes have been insulated.

Recommendations:

- Continue the PVC supply air pipe and connect to the furnace. Doing this should allow for the mechanical room to be air sealed.
- Seal off the open chimney thimble in the mechanical room.
- Ask the service technician if they can confirm whether or not there are zone dampers, and whether or not they are functioning properly. If no mechanical zone dampers are present, have them installed along with new digital programmable thermostats.
- Air seal and insulate all of the supply ductwork. Sealing the ducts could be done with a metalized tape, though the use of mastic is preferred. It is not necessary to insulate these ducts to the degree as if they were running outside of the thermal boundary; a foil faced bubble wrap taped at the seams will suffice.
- Air seal and insulate the return ductwork in the crawl space. The preferred material for air sealing here is mastic. The insulation should be a minimum of R-8(installed) foil faced fiberglass duct insulation.
- Seal the gap between the return plenum and the furnace.
- Be sure to check, and replace as needed, the air filter in the furnace. This filter is not meant to clean the air for building occupants, but rather collect larger particles that could be harmful to the equipment. Doing this will help prolong the life of the equipment, as well as increase system efficiency.
- Replace the current DHW heater with an LP fired tankless hot water heater. Be sure to insulate all piping. The new heater would only heat the water when it is called for, in place of the current system which keeps an oversized tank of water to temperature year round.

**Electrical:**

The electric usage in this building is fairly low, and is indicative of a small office space with standard amount of computers, printers, fax machine, etc. It is important that any equipment that can be shut down is when not in use. Most office equipment we use today still draws electricity when the power is off. For this reason, it is important to plug these devices into smart power strips, and completely cut the power when they are not in use. Some smart power strips come with a small remote control on/off switch to avoid having to reach under a desk every time one wished to cut power.

The office space on the first floor and the main room on the second floor are lit with florescent tube fixtures. There are about 40 – T12 40watt florescent tubes in the building, as well as incandescent bulbs used in the lavatories and closets.

There are electrical space heaters used in the winter to help supplement the forced hot air system, as it is very difficult for the police officers to find a good comfort level with the building in its current condition. If the recommendations, previously mentioned in the report, for envelope and heat distribution efficiency are carried out, there will likely no longer be a need for supplemental heat.

Recommendations:

- Put all devices that use electricity on smart strips, and be sure to turn off the power trips when the equipment is not in use.
- Consult with a lighting specialist on performing a lighting upgrade. You may wish to contact your utility provider about financing options.
- Consider unplugging the water cooler/heater. At a minimum, turn off the hot water component, and use a variable temperature tea kettle when hot water is needed.

**Summary of Recommendations:**

- Repair the drywall of the mechanical room ceiling. Also, make sure that the access panel to the space above is sealed when not in use.
- Air seal the gaps around the chimney to stop air movement from the first floor to the second.
- Air seal any other penetrations that would allow for air movement from the first floor to the second.
- Apply weather stripping to the first floor door that leads to the stair well.
- Repair any damages to the second floor lath and plaster ceiling. This would include sealing any cracks where the plaster is cracked.
- Seal around the chimney so that air movement cannot occur from the second floor space to the attic.
- Seal any other penetrations from the second floor to the attic.
- We recommend achieving an R-60 in the attic. This can be done by adding loose fill cellulose insulation.

- A proper evaluation of the foundation by a mason or foundation specialist should be done. This building has been standing for a relatively long time. If it is to stand the test of many more years of service to the town, corrective measures, or possible replacements, are recommended.
- Insulate the underside of the first floor. This should be done with closed cell spray foam. The foam insulation will not only offer superior R-Value, but will air seal at the same time.
- Put down a vapor barrier over the dirt floor of the crawl space. Though the space seems to stay fairly dry, it would be beneficial to take steps to further protect the structure.
- Make sure that all of the exterior doors shut well, and provide a good air seal.
- Replace the windows with a minimum of double pane, gas filled, low-e, vinyl or fiberglass replacement windows. If this is not to be done, replace the storm windows with newer, more efficient units with the lowest rated air infiltration rate available (.05 CFM/ft or better).
- Have the powder from in the exterior walls tested to confirm whether or not it is UFFI, or if it should be treated as a toxic material. If it is UFFI, we recommend removing the powder. This could likely be done with a high powered vacuum.
- After the wall cavities have been cleared, have an insulation contractor fill the empty cavities with cellulose insulation. The new insulation will not only add effective R-Value to the walls, but also aid in reducing convective air currents.
- If the powder is found not to be UFFI, and contains asbestos or other toxic substances, we recommend contacting NHDES for a list of NH companies who are certified to remediate the substance. After this has been done, refer to the above recommendation.
- Consult with a ventilation specialist to ensure that the building is getting proper amounts of fresh air.
- Continue the PVC supply air pipe and connect to the furnace. Doing this should allow for the mechanical room to be air sealed.
- Seal off the open chimney thimble in the mechanical room.
- Ask the service technician if they can confirm whether or not there are zone dampers, and whether or not they are functioning properly. If no mechanical zone dampers are present, have them installed along with new digital programmable thermostats.
- Air seal and insulate all of the supply ductwork. Sealing the ducts could be done with a metalized tape, though the use of mastic is preferred. It is not necessary to insulate these ducts to the degree as if they were running outside of the thermal boundary; a foil faced bubble wrap taped at the seams will suffice.
- Air seal and insulate the return ductwork in the crawl space. The preferred material for air sealing here is mastic. The insulation should be a minimum of R-8(installed) foil faced fiberglass duct insulation.
- Seal the gap between the return plenum and the furnace.
- Be sure to check, and replace as needed, the air filter in the furnace. This filter is not meant to clean the air for building occupants, but rather collect larger particles that could be harmful to the equipment. Doing this will help prolong the life of the equipment, as well as increase system efficiency.
- Replace the current DHW heater with an LP fired tankless hot water heater. Be sure to insulate all piping. The new heater would only heat the water when it is called for, in

place of the current system which keeps an oversized tank of water to temperature year round.

- Put all devices that use electricity on smart strips, and be sure to turn off the power trips when the equipment is not in use.
- Consult with a lighting specialist on performing a lighting upgrade. You may wish to contact your utility provider about financing options.
- Consider unplugging the water cooler/heater. At a minimum, turn off the hot water component, and use a variable temperature tea kettle when hot water is needed.

**Conclusion:**

This report has identified many areas for improvement in this building. Implementing these recommendations will bring measurable results, helping this building adjust to current and future energy and environmental challenges.

It is very important that before any changes to the building are made that a building performance specialist is part of further developing any plan. We also recommend that this specialist be present at certain points for inspections of work. This will not only help ensure that the most energy savings are realized, but will be necessary to protect the health of the building. Should you have any questions regarding the recommendations provided in this report, please do not hesitate to contact us.