Town Garage

ANNUAL ENERGY USE SUMMARY

Heating Fuel
5122 Gallons LP

Electricity 21,120 Kwh

Note that there are two aspects to reducing energy use: Conservation and Efficiency. Upgrading the envelope and thermostat settings conserve energy by reducing the amount needed for comfort. Upgrading equipment and distribution systems improve the efficiency of how energy is delivered.

Building Energy Metric: British Thermal Units (Btu) can be used as a measurement for all energy - in terms of each sources' heat output. Btu's per square foot is often the way building energy use is discussed. For example the 2030 Challenge calls for carbon neutral buildings by 2030 and uses this metric to establish reduction goals by building type. (http://www.architecture2030.org)

Oil: 5122 gallons x 91,500 Btu's/gallon = 468,633,00 Btu's or **469MMBtus**

Electricity :21120KWH x 3412 Btu/kwh = 76,061,440 **Btus or 76MM Btu's**

Total Energy in Btu's = 545MBtu's / 11,250 FT2 = 48.4 KBtu/ft2

At this facility, I think the biggest potential gains can be made with the ventilation systems. it is worth exploring the possibility of using a heat recovery unit(s) to provide the general ventilation

In a repair garage where vehicles are operated inside the building (for more than simply driving them in and out), local exhaust is required by code – meaning in this case, a vehicle exhaust system.

In addition, the general ventilation system must be capable of providing 1.5 CFM/Sq Ft of outside air, which it appears they probably do achieve with the propeller exhaust fans and duct-sock make-up units.

The biggest issue with this at this facility would be the dust on the exhaust side. We would want to have extra filtration and have it easily accessible for changing filters. I would also recommend that they explore the idea of using a waste-oil heater. I think one of these could be added fairly easily to the recirculation unit they have. If they are having to pay to dispose of waste oil, these are a great way to reduce heating cost and practically eliminate waste oil disposal costs.(* I presume the waste oil from this garage is used in the Transfer Station?? If not, I would concur with Scott – and this may be a better use for it- MD)

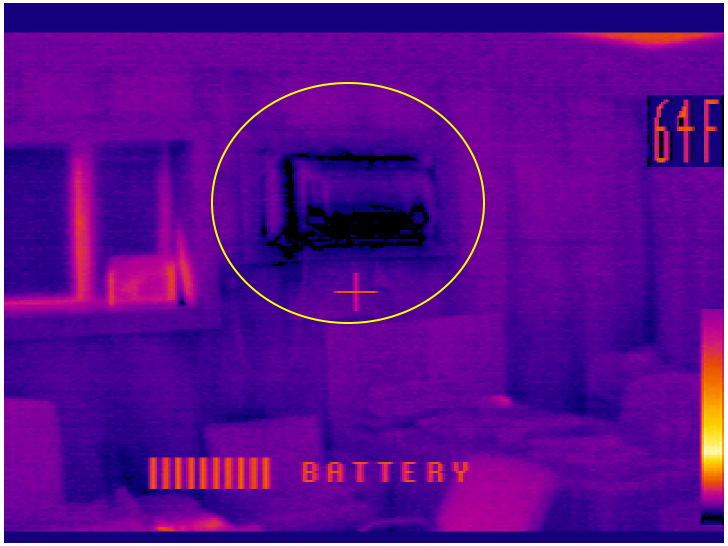
(Venmar). However, I also got some actual run data showing the heat transfer effectiveness would only be 54.7% The installed cost for these units would be in the neighborhood of $50,000. Using all the same assumptions and 54.7% efficiency), you get a savings of 769 gallons of LP gas per year, which is $2306 per year at $3.00/gallon, which gives a simple payback of 21.7 years

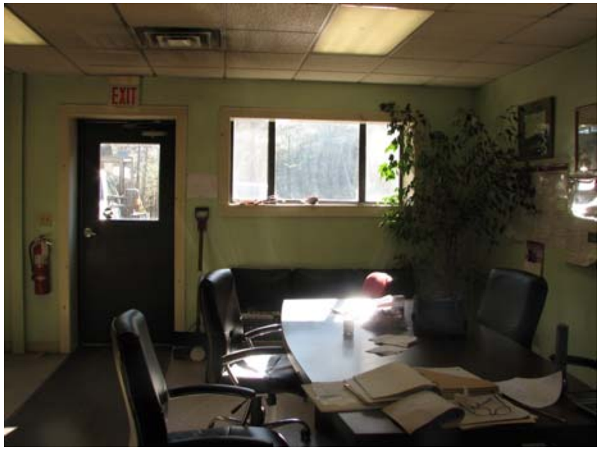
From this information, it is clear that one would need to sit down with the client and review many factors such as engine sizes, engine types (gas or diesel), how long engines are typically run, at what RPM they are run, etc., to be able to determine what they need for equipment. (Recommendation is that) a vehicle exhaust system be installed to code, but it would need to be engineered based on their specific needs

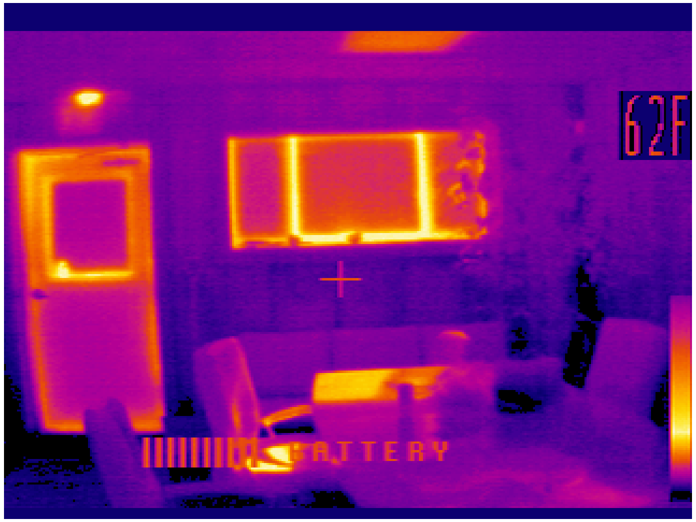
- Scott Hening

I recommend hiring Hening Energy Strategies for engineering consultations prior to grant submittal. MD

Remove a/c for winter or at least seal and cover with insulated cover.







Fiberglass batts behind this thick layer of poly is not an ideal assembly, but very costly to re-do. Several areas have roof leaks, so as the leak is repaired, I recommend removing the damaged fiberglass and using spray foam directly under the metal decking for as large an area as can be afforded. Eventually, a foamed deck – above or below – is recommended.

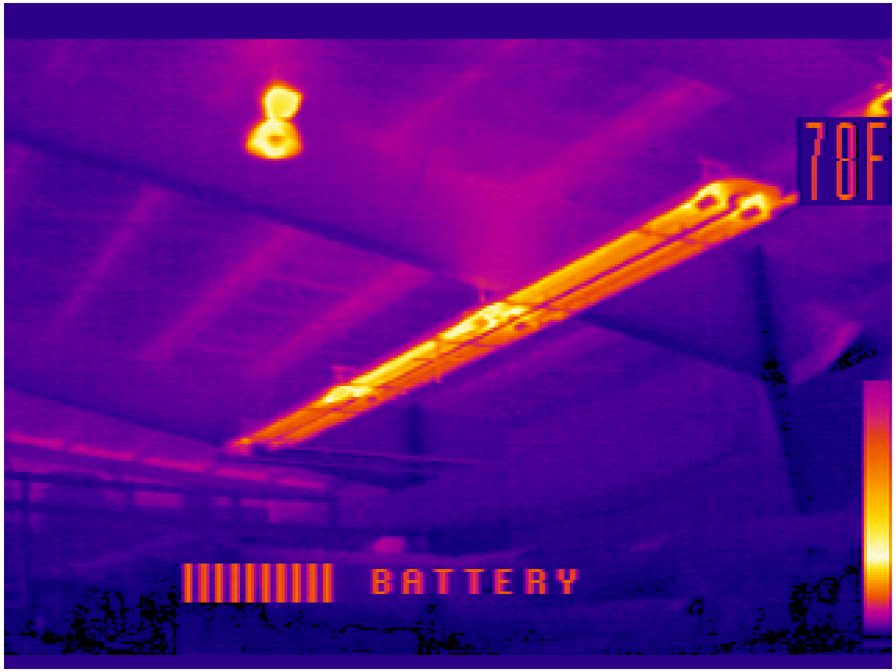
This part of the roof is below the storage space so easily accessible.

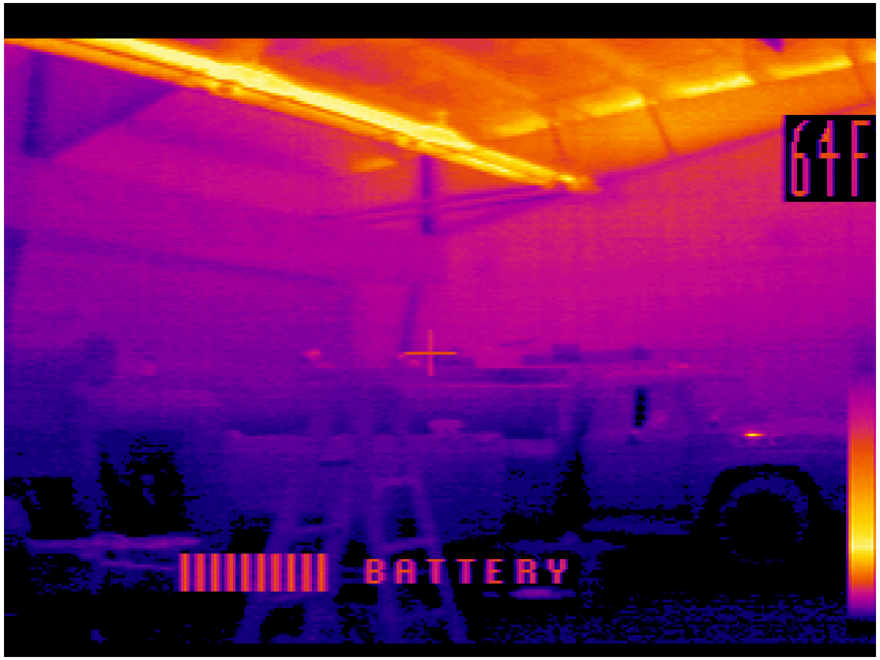
This pattern strongly suggest pooling water – likely from a roof leak.


Foam is good against cold metal as air/moisture and thermal barrier.


Fiberglass is an excellent performing filter – effective R value of this ceiling: R6-10.

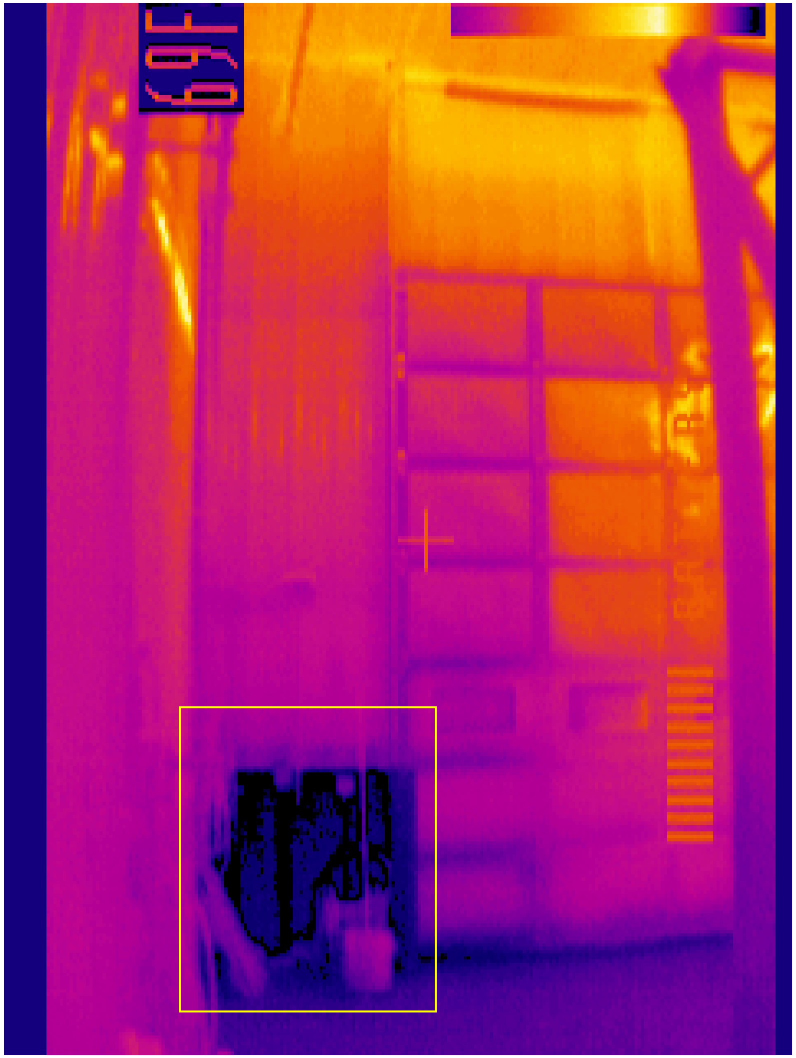
Solatronics' propane fired infra red heat tubes are considered the 2nd best / most appropriate heating technology for garage bays and warehouses (radiant floor is #1). Interesting to note that upper areas still warmer, but these units had just come on.

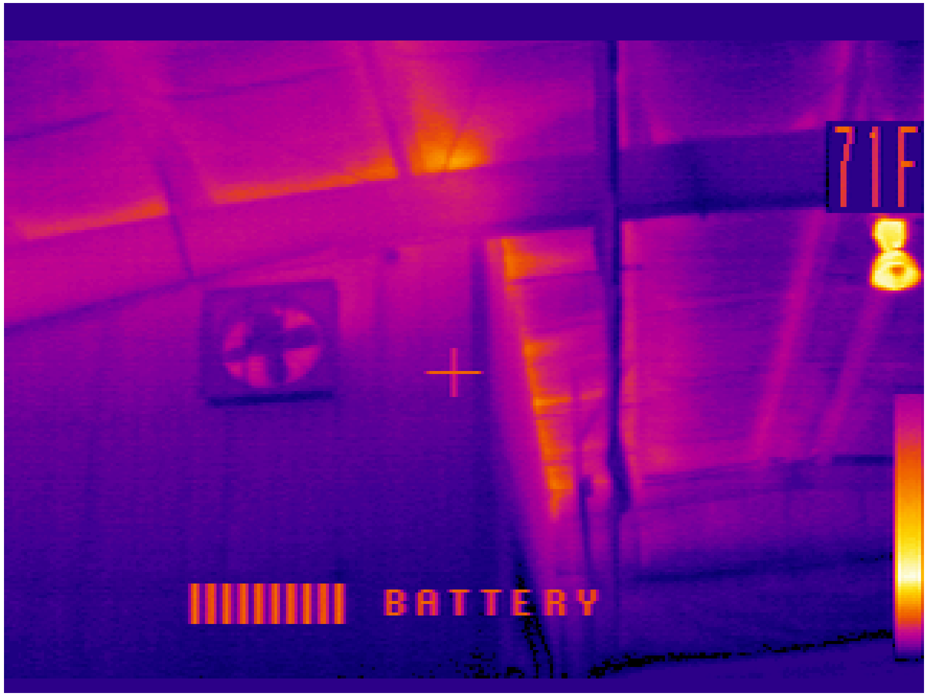




64F
BATTERY

Another large opportunity lies in the uninsulated exposed foundation wall – approximately 1000 square feet at R1.





71F
BATTERY

Police Station

ANNUAL ENERGY USE SUMMARY

Note that there are two aspects to reducing energy use: Conservation and Efficiency. Upgrading the envelope and thermostat settings conserve energy by reducing the amount needed for comfort. Upgrading equipment and distribution systems improve the efficiency of how energy is delivered.

Building Energy Metric: British Thermal Units (Btu) can be used as a measurement for all energy - in terms of each sources' heat output. Btu's per square foot is often the way building energy use is discussed. For example the 2030 Challenge calls for carbon neutral buildings by 2030 and uses this metric to establish reduction goals by building type. (http://www.architecture2030.org)

Oil: 2033 gallons x 91,500 Btu's/gallon = 186,019,500 Btu's or **186MMBtus**

Electricity : 19,750 KWH x 3412 Btu/kwh =67,387,00 **Btus or 67MM Btu's**

Total Energy in Btu's = 253MBtu's / 4248FT2 = 59.6KBtu/ft2

Blower Door Test & Results
Measuring Air Infiltration and the Air or Pressure Barrier
Convective and Conductive Heat Losses and Moisture Transfer

Whole Building: 11,113FM50

Air Change per Hour Rate at -50pa: 16.52ACH50
This means that at -50pa (as if a 20mph wind was blowing on all sides of the building at once) the air would completely change **over 16 times every hour**. The math: CFM50 x 60 / building volume. Standard Residential Construction practices is generally between 7 and 9ACH50 and 2009 IECC sets 7ACH50 limit. Energy Star's limit is 5ACH50. High Performance Homes under 1ACH50. Currently no standard for non residential buildings.

Estimated Annual Air Change Rate: .76 ACH Winter: 1.17ACH Summer: .65 ACH

Conditions vary ACH day to day, but throughout the year the outdoor climate impacts indoors considerably. On average in winter, you are heating the air which is replaced by outdoor air every hour or so.

Estimated cost of envelope air leakage: $2979 at $3.50 gallon or approx 40% of heating bill

Leakage Area (Canadian EqLA @10pa)1147 in2 or 7.96sq feet

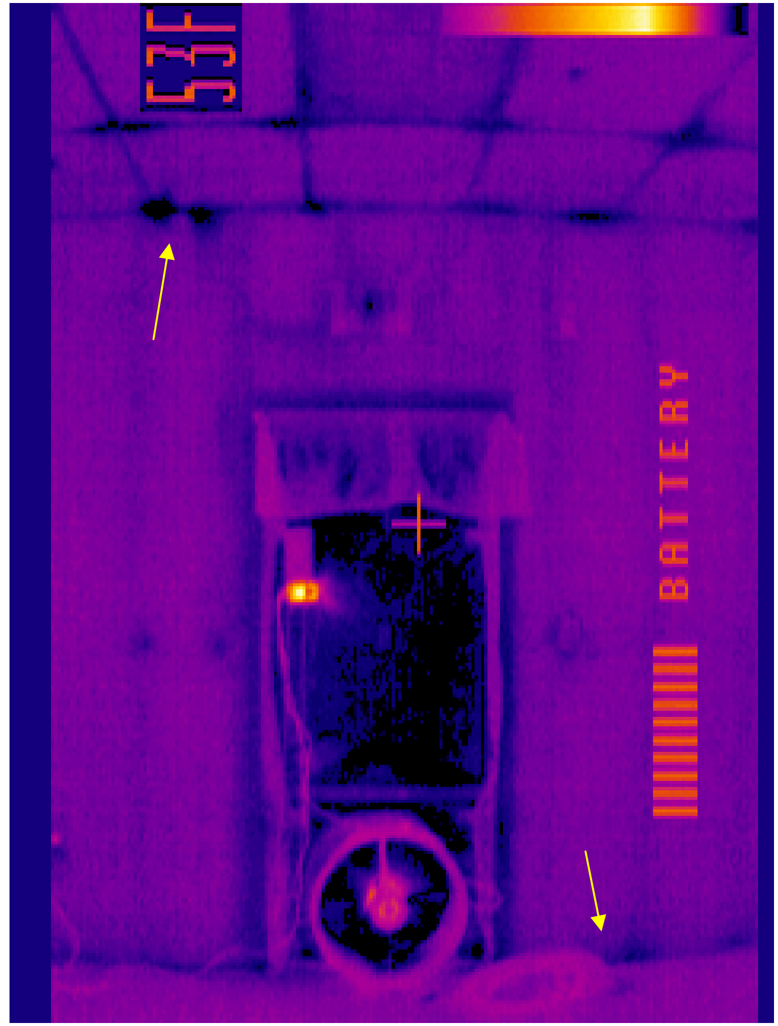
Total size of hole if add all cracks and gaps together

Minneapolis Leakage Ratio: 1.3 CFM50 per ft2 of envelope surface area

This is using the CFM50 relative to the surface area of the shell or envelope, since heat loss is based on surface area not volume.

Walls are 2x6 at 16"OC with 5.5" fiberglass batts. They appear to be installed in direct contact with the studs and hold up fairly well under pressure meaning there is little air moving thorough the cavity, apart from around window openings, outlet boxes, and the top and bottom plates.

The buildings most noticeable issue energy use wise is the lack of an air barrier at the ceiling plane.



With the building at -19pa, the fan pulled 5800cfm of air thorough cracks and gaps in the envelope.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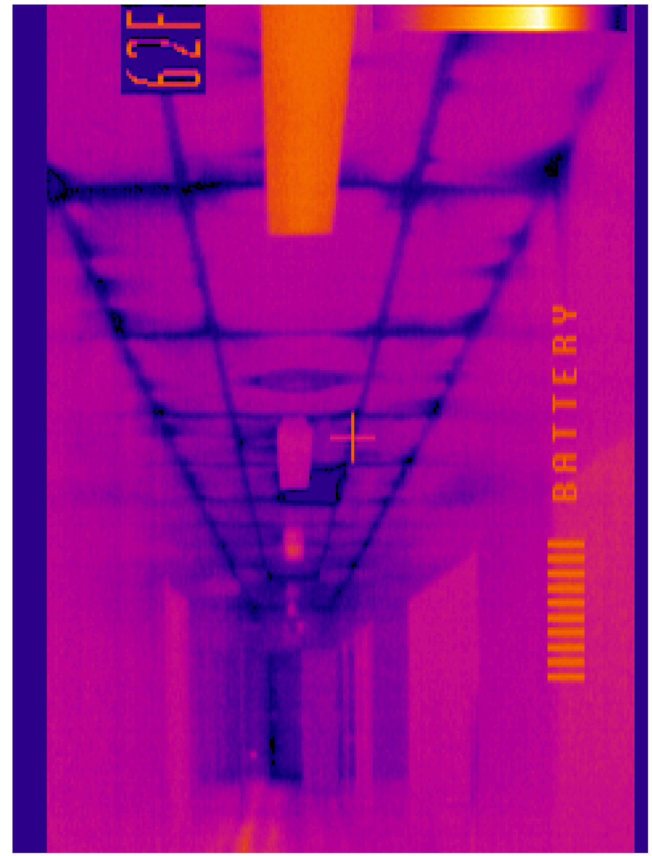
BATTERY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BATTERY

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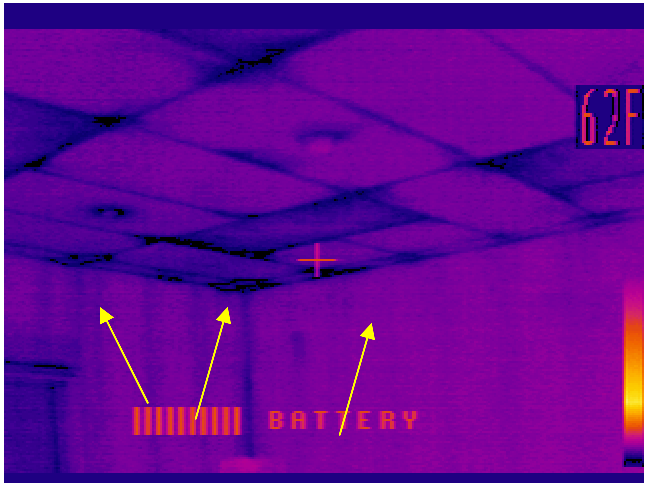
Interior
Wall
BATTERY



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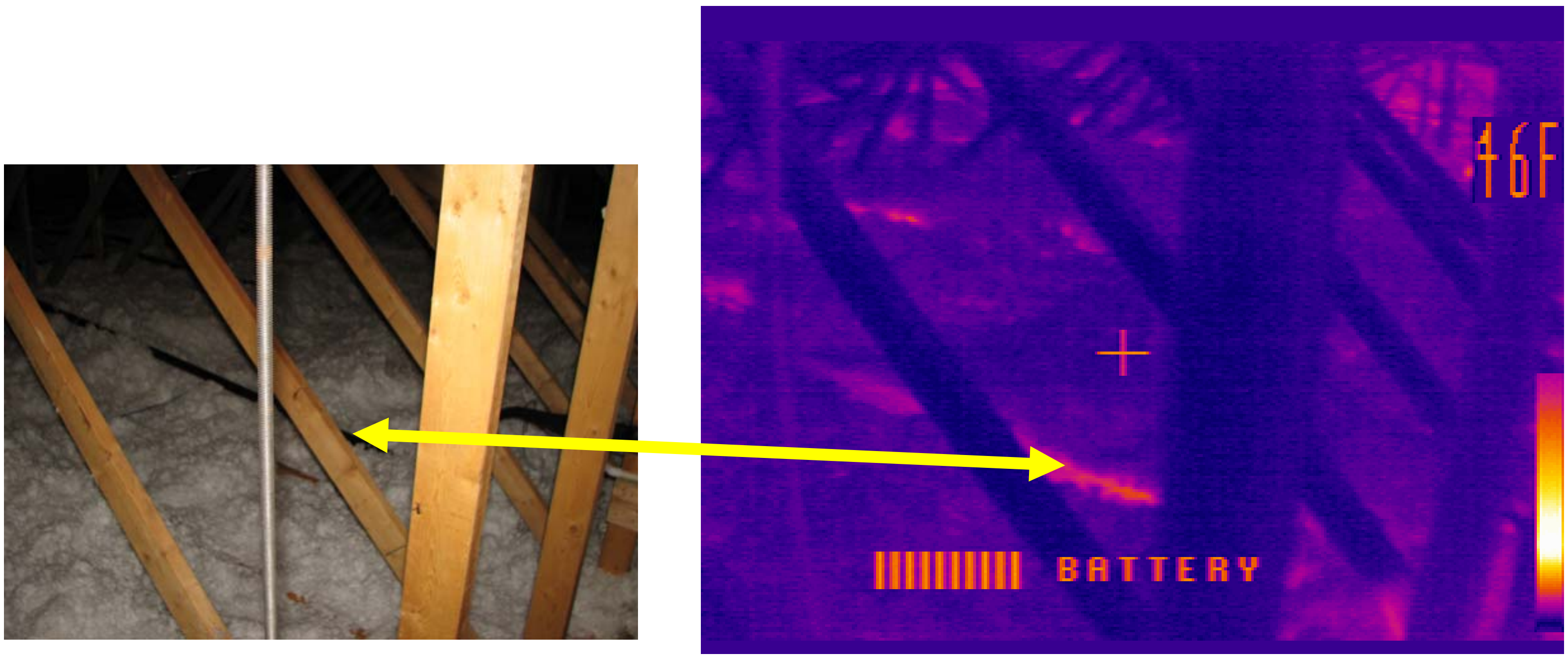
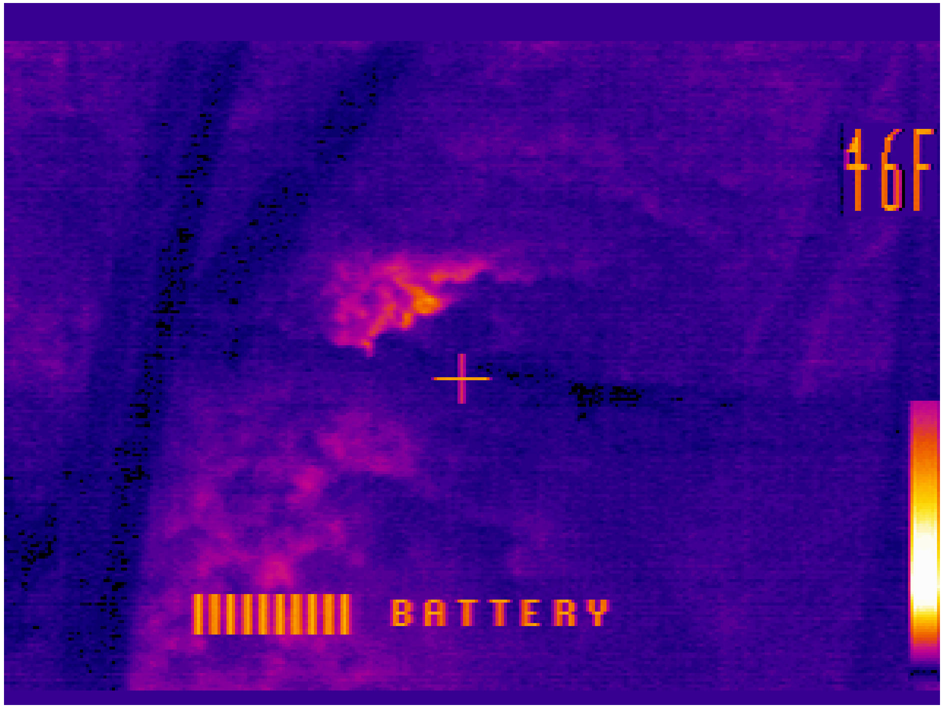
BATTERY

The fan was not running in these next IR images taken up in the attic. All those bright colors indicate heat loss into the attic, some thorough conduction do to minimal insulation or thermal bridging as heat moves to cold, some as warm air rising thorough holes in the ceiling, and at least one line as a hot water pipe, though it is unclear why this pipe has hot water in it at this time of year. Intended or not, it is losing heat into the attic.

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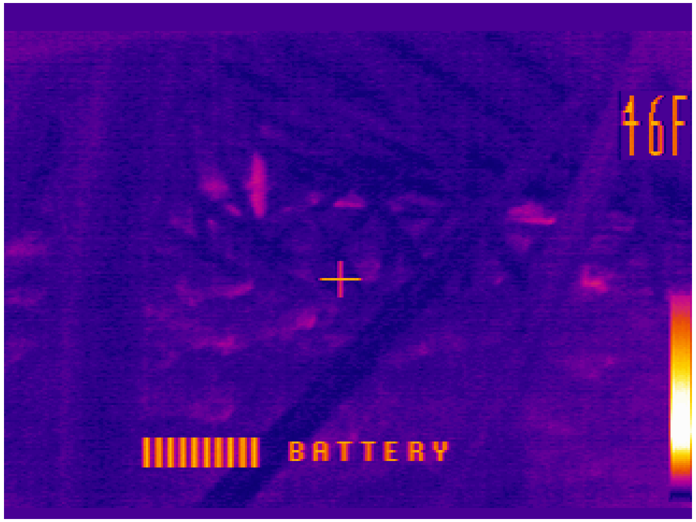
BATTERY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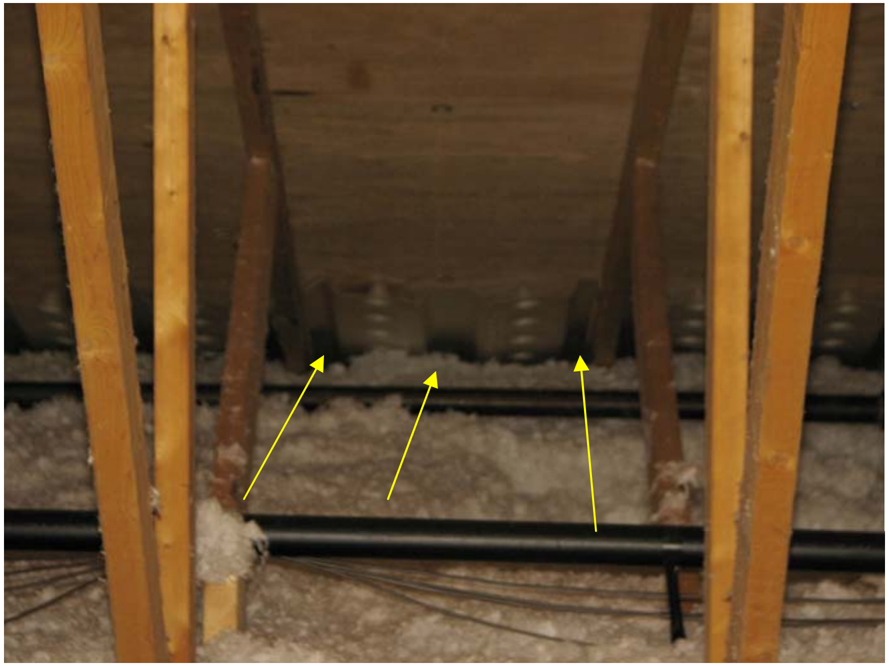
BATTERY

46F
BATTERY

Roof vents are a good thing here, but there should be a foamed or caulked seal between the soffit and above the top plate and separating the air chase from the attic insulation.



Establishing an air barrier at the ceiling level is key to reducing heat loss by convection and conduction, but very difficult in this assembly as wiring, ducts, lights, and everything else has been installed in such a way that there is no straightforward way to seal off the attic floor – Drop ceiling tiles are a good way to create a maintenance chase, but can only work well if the ceiling above is sheet rocked or somehow forming an air barrier.

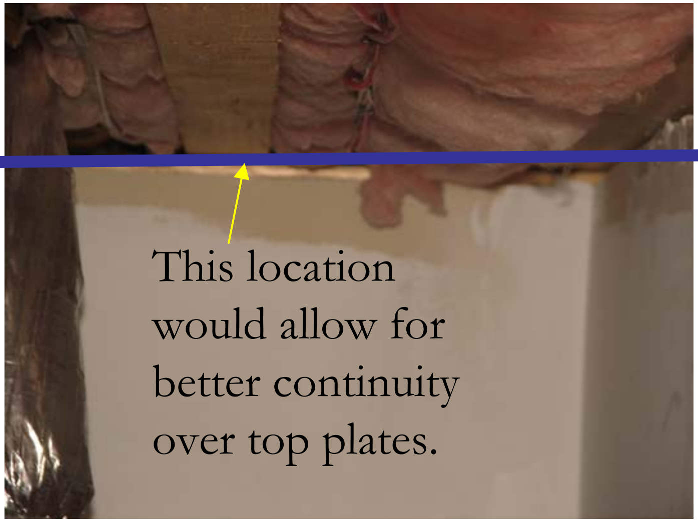
Removing this fiberglass may allow access to above the top plate for a foam dam –for both air sealing and adding Rvalue above the walls. Both these goals will reduce ice dams.

Where to establish the air barrier? Either way, the fiberglass batts and blown material will need to be removed – then either fasted and seam seal ¼ plywood (lighter) on top of the trusses, sealing all penetrations and blowing in 16 inches cellulose – or taking down the drop ceiling and securing rigid, seam and penetrations sealed material to the strapping – and again blowing in material back on top. The VERY first place to start – and to do if nothing else – is seal off this access hatch and install a gasketed thermodome. This is by far the single largest hole, though the sum total of all the other cracks and gaps allow more air flow.

Next would be above the top plates and individual penetrations.
But, a comprehensive air barrier is the only real solution.

I have added $35,000 as a line item for establishing a continuous air barrier and blowing in cellulose to achieve an R50 ceiling. This is based on the general cost for removing existing insulation, air sealing, and adding 16” cellulose and a very *rough guestimate* on installing dry wall or plywood and moving wires ect. All of this would have been FAR less expensive during original construction and something to consider in future projects when the budget needs to be trimmed. Cutting costs for an effective air, moisture and thermal barriers during construction will always end up costing much more to fix later; or in annual operations.

Air barrier location.

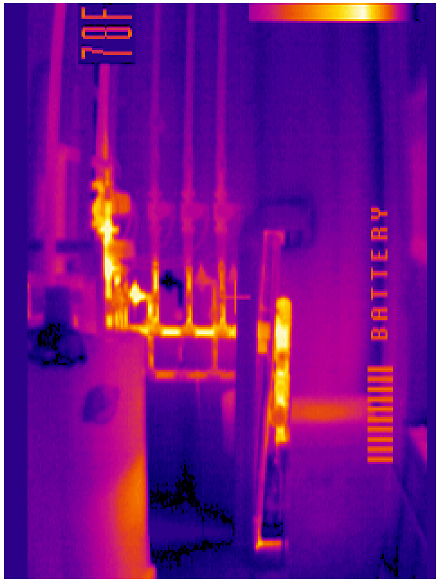


Note the pathway where insulation has been trampled and compressed reducing its performance further. Building walkways can alleviate this ongoing disturbance.

Heating equipment is a Weil McLean Gold CV propane, non condensing, but sealed combustion, boiler rated at 87%AFUE. Unknown whether it is true modulating and connected to outdoor reset, or whether lower water temps are, or can be, used for floor radiant pipes. The boiler is relatively new, appears in good condition and therefore not a good candidate for replacement.

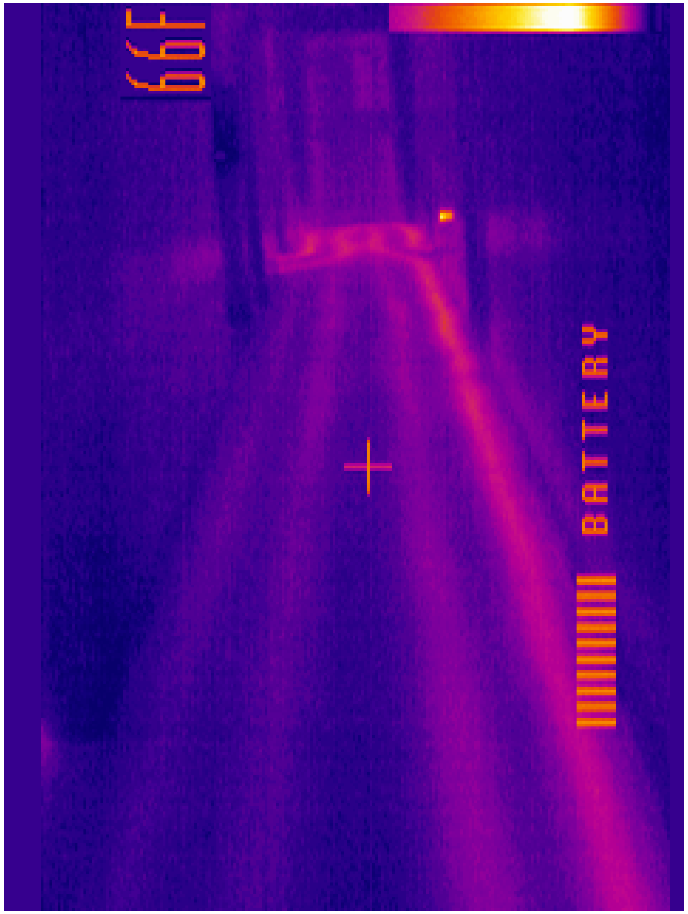
However, a condensing boiler would gain in efficiencies and at 175KBtu's - this boiler is greatly oversized for the building. After air sealing, it will be far more than double the size needed. At some point then, replacing it with a properly sized 97%AFUE or greater, condensing boiler, or explore even better technologies at that time, is advised.

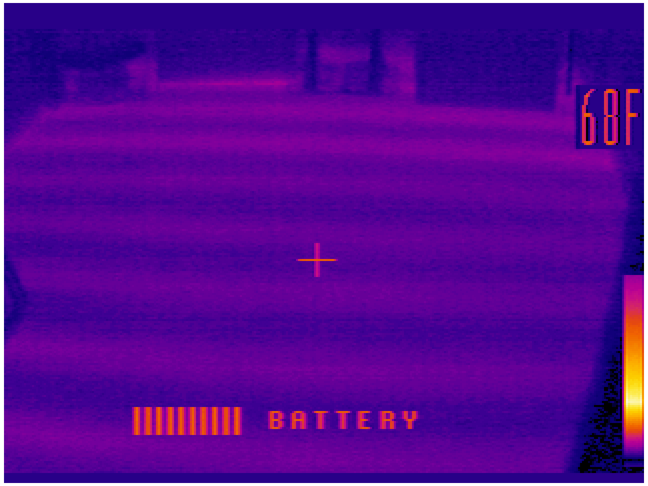
Bradford hot water tank uses preheated water from boiler and appears adequate.



Programmable thermostats for the four zones may be of some advantage though radiant floor heating does not lend itself well to fluctuations in temperature settings. With air sealing and improved insulation in the ceiling, the building will be much warmer and thermostats will be able to be lowered.

Radiant flooring pipes.

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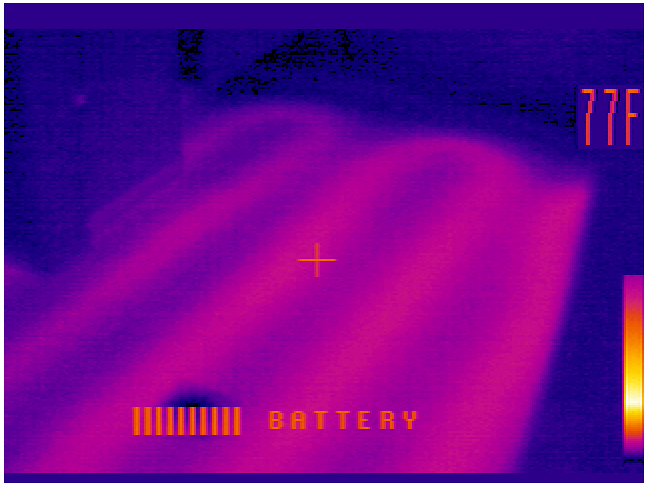
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BATTERY

While non invasive techniques used for this assessment did not reveal any moisture issues, it is only a matter of time before these holes breaks in the exterior surface leak water enough to cause damage. When its time to re-side the building, it would be a good opportunity to continue improving the air barrier and reduce thermal bridging. As it appears there is a layer of poly on the interior, between the studs and

drywall (but this should be confirmed), it is important not to use an impermeable material on the exterior so that moisture may become trapped. Adhering 1 ½ to 2 inches of a semi impermeable rigid foam board, however, would accomplish the energy upgrade. Securing vertical furring into the studs thorough the foam board creates a drainage plane and drying space and gives something to secure siding too.

Fire Station

ANNUAL ENERGY USE SUMMARY

Heating Fuel
817 Gallons

Electricity (not provided)
7,290 Kwh

Note that there are two aspects to reducing energy use: Conservation and Efficiency. Upgrading the envelope and thermostat settings conserve energy by reducing the amount needed for comfort. Upgrading equipment and distribution systems improve the efficiency of how energy is delivered.

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Oil: 817 gallons x 138,500 Btu's/gallon = 113,154,500 Btu's or **113MMBtus**

Electricity :7,290KWH x 3412 Btu/kwh = 24,873,480 **Btus or 25 MM Btu's**

Total Energy in Btu's = 113 + 25 = 138MMBtu's / 4691FT2 = 29.4KBtu/ft2

Blower Door Test & Results
Measuring Air Infiltration and the Air or Pressure Barrier
Convective and Conductive Heat Losses and Moisture Transfer

Whole Building: 7141CFM50
Means that **7141 cubic feet of air per minute** would be pulled thorough leaks and gaps in the air barrier when the building was under pressure at -50 pascals with respect to outside. In fact, the building could not reach -50 with only fan, so this is an estimated number based on a table of "Can't Reach 50 Factors".

Air Change per Hour Rate at -50pa: 8.84ACH50
This means that at -50 pas (as if a 20mph wind was blowing on all sides of the building at once) the air would completely change **almost 9 times every hour**. The math: CFM50 x 60 / building volume

Standard Residential Construction practices is generally between 7 and 9ACH50 and 2009 IECC sets 7ACH50 limit.

Energy Star's limit is 5ACH50. High Performance Homes under 1ACH50. Currently no standard for non residential buildings.

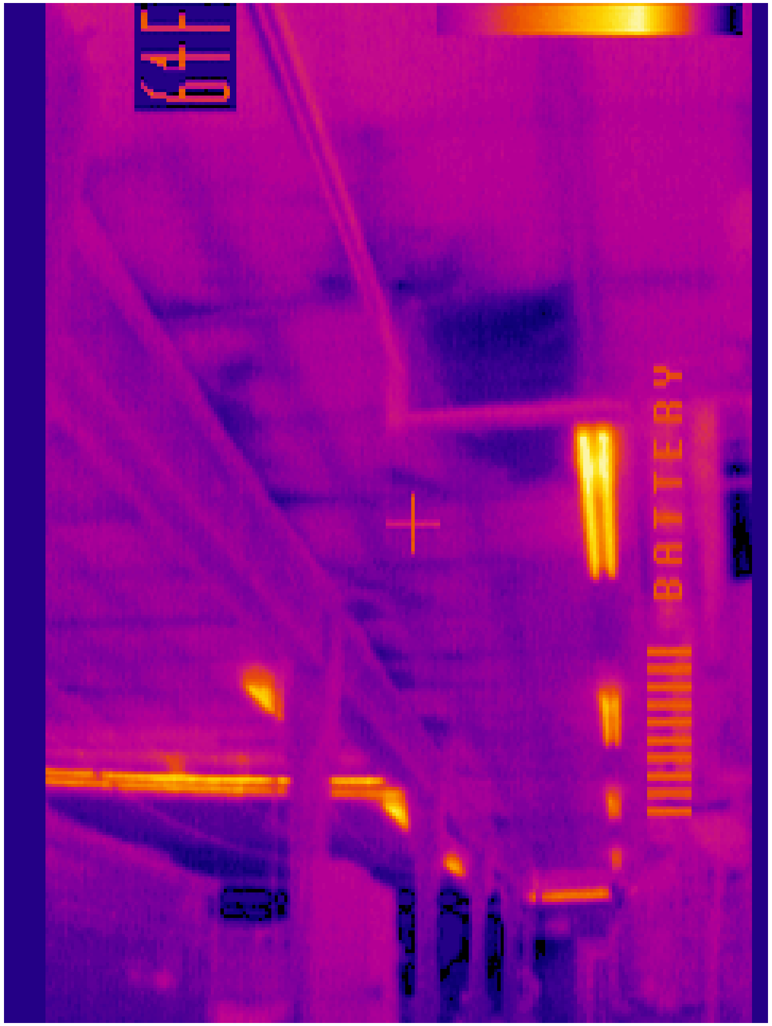
Estimated Annual Air Change Rate: .63 ACH Winter: .97ACH Summer: .5 ACH
Conditions vary ACH day to day, but throughout the year the outdoor climate impacts indoors considerably. On average in winter, you are heating the air which is replaced by outdoor air almost once every hour.

Estimated cost of envelope air leakage: $1769 at $3.50 gallon or approx 16% of heating bill

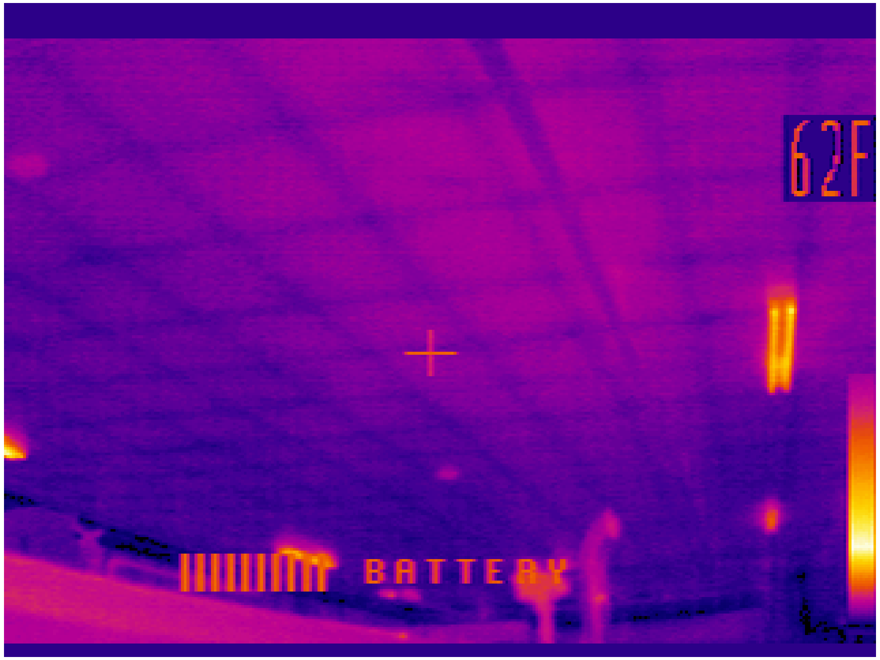
Leakage Area (Canadian EqLA @10pa)963 in2 or 6.7sq feet
Total size of hole if add all cracks and gaps together

Minneapolis Leakage Ratio: .79 CFM50 per ft2 of envelope surface area
This is using the CFM50 relative to the surface area of the shell or envelope, since heat loss is based on surface area not volume.

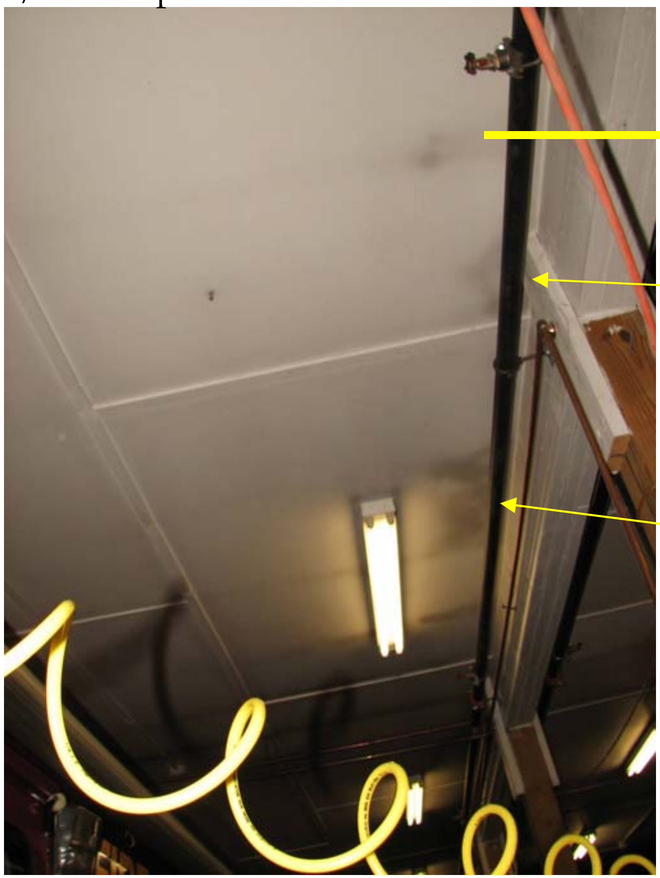
Some of the ceiling is under the room upstairs and minimally insulated, but open to the larger attic. These pockets of coolth and air leakage should be sealed at this ceiling plane, though it may make more sense to seal off/insulate the area at the perimeter in the attic, as opposed to adding more insulation.

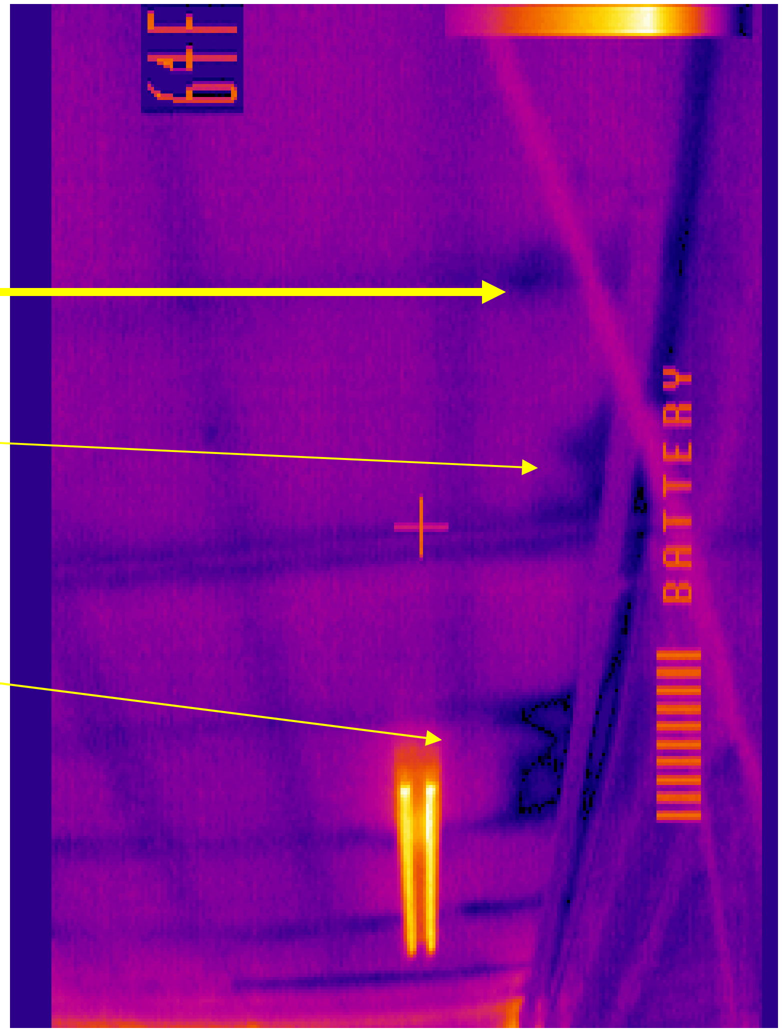


This ceiling is under an outside attic – thermal bridging and minimal insulation are fairly easy upgrade opportunities.

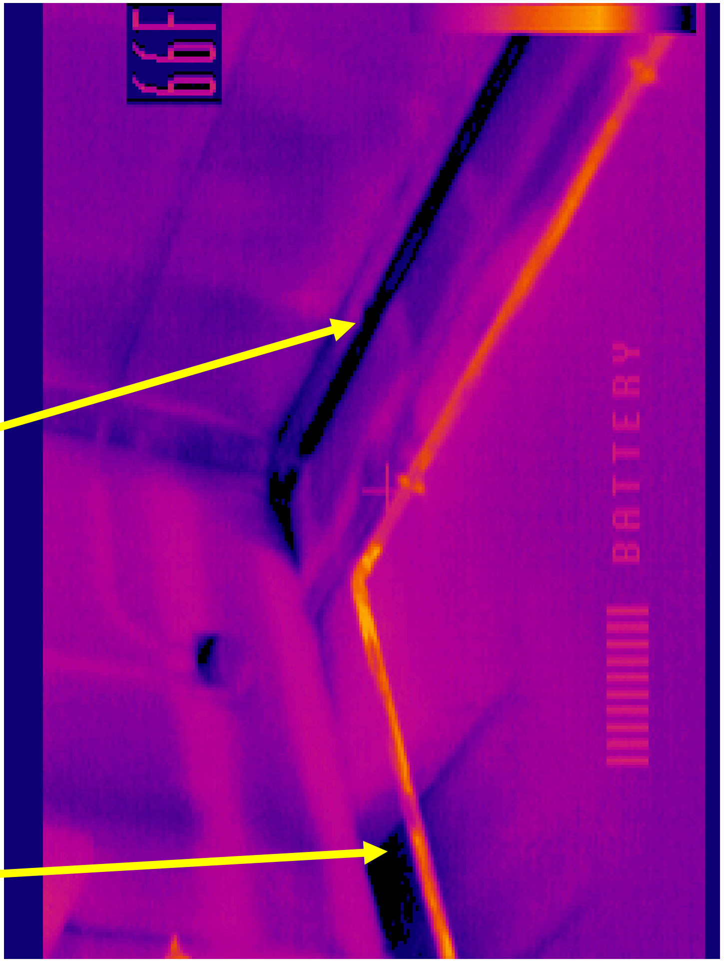


Darkest spots indicate cold outside air from attic washing thorough insulation – and exfiltration warm air under normal conditions…note the same patterns in the visual images indicating moisture and/or dirt particles.





As always, air sealing ceilings is key!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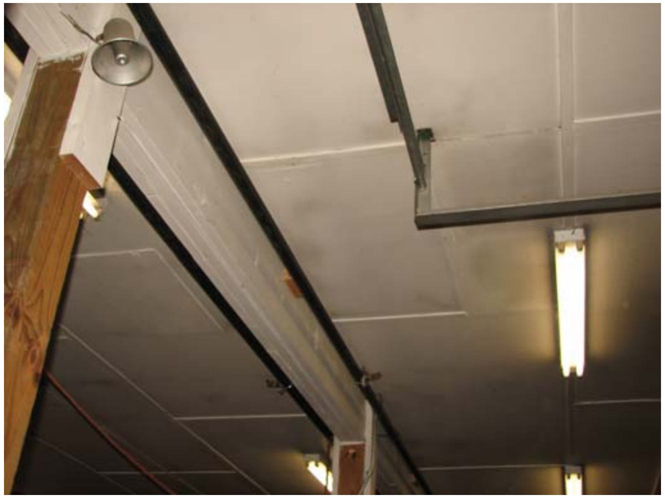
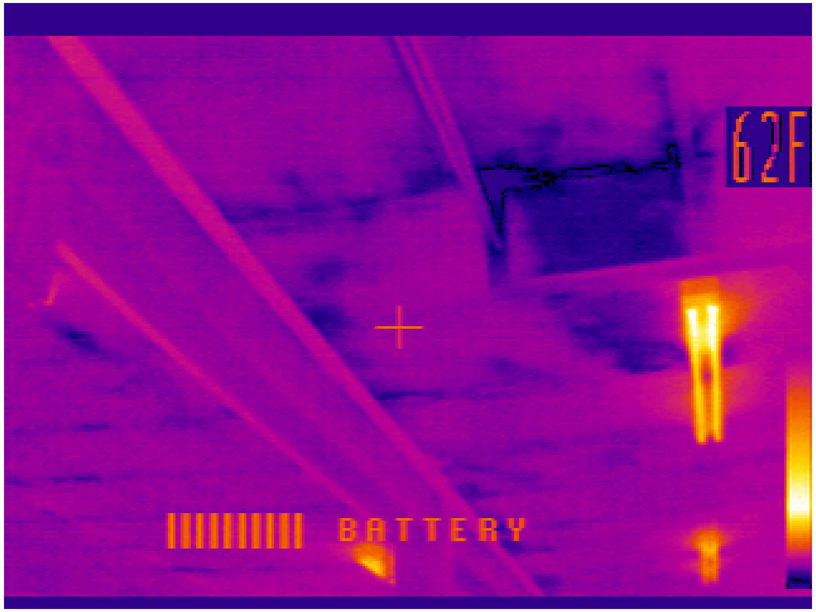
BATTERY

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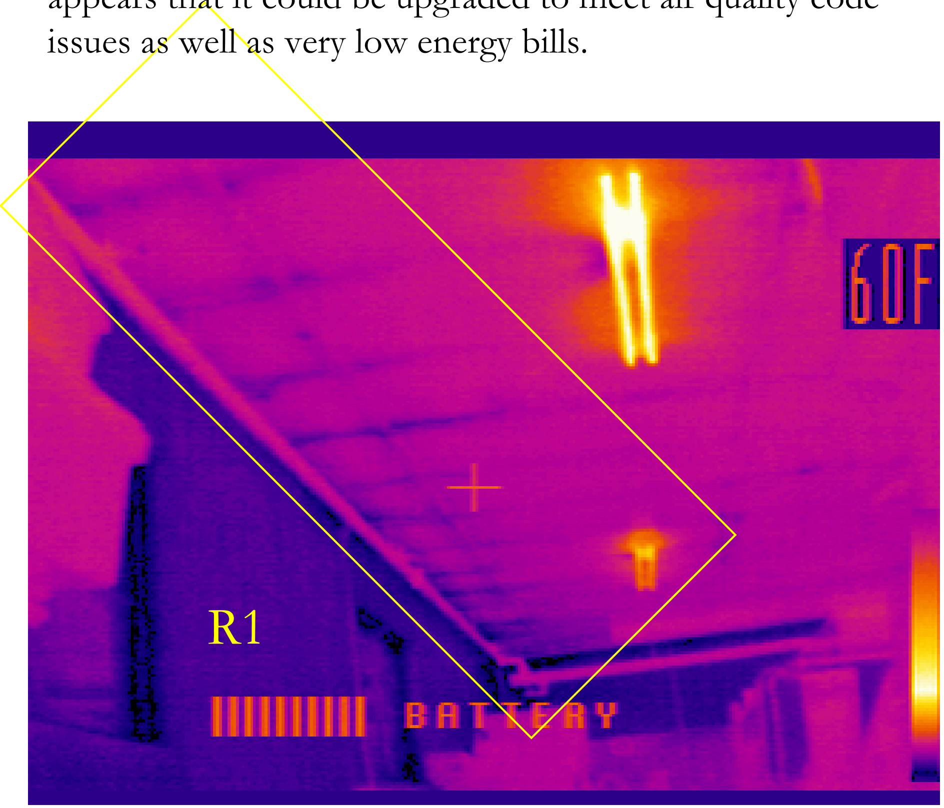
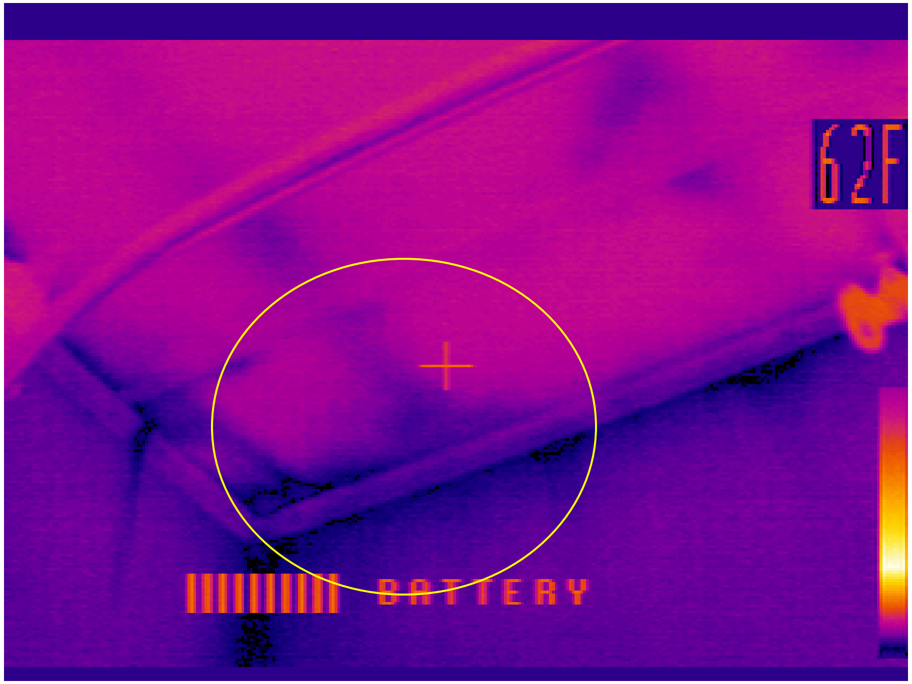
BATTERY

While air infiltration plays a large role in heat loss, the uninsulated concrete block walls have almost twice the heating load which is unusual! Insulating these walls on the outside similarly to prior descriptions would be advised for any energy retrofit and if the building is to remain heated and in use. In addition, adding substantial insulation in the attic would be recommended.

Costs have not been included due to the hope for a new fire station. Costs for R20 walls should be in the neighbored of $20,000. Ventilation and exhaust systems will be the far higher expense. If the building is an adequate size however, it appears that it could be upgraded to meet air quality code issues as well as very low energy bills.

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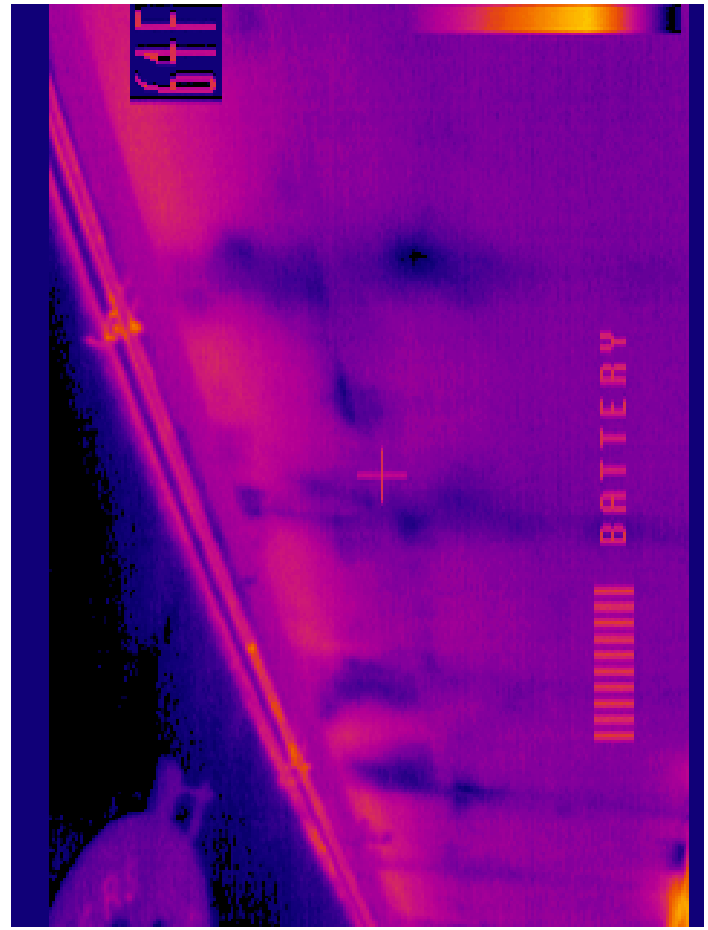
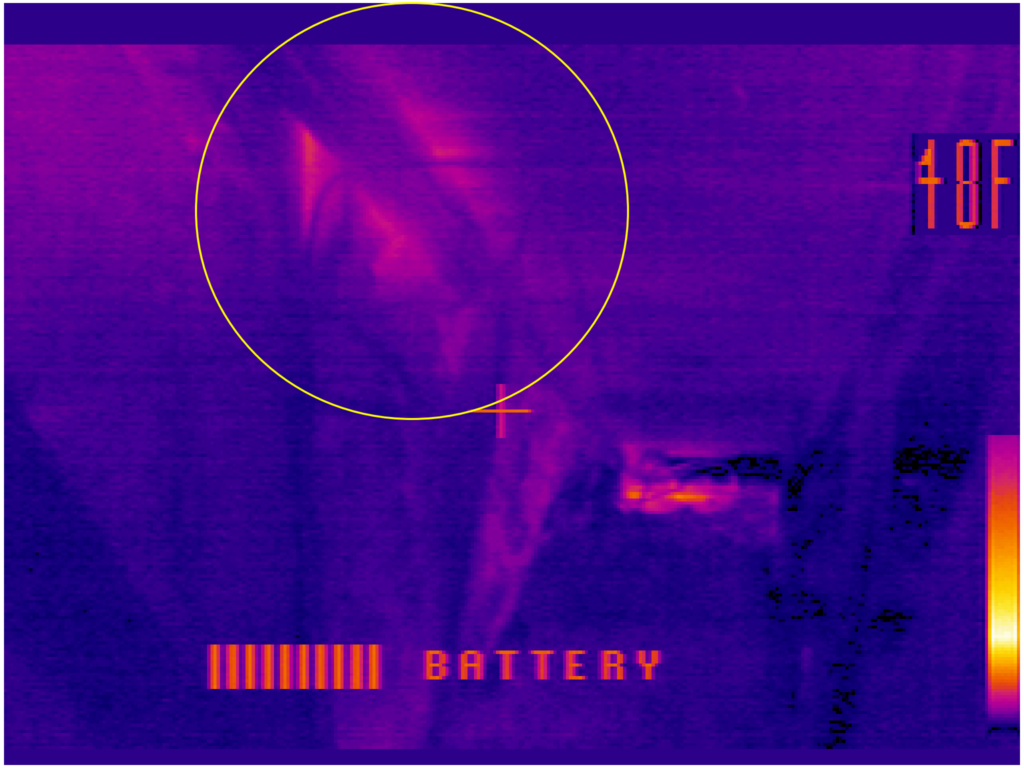
BATTERY

Add pipe insulation!

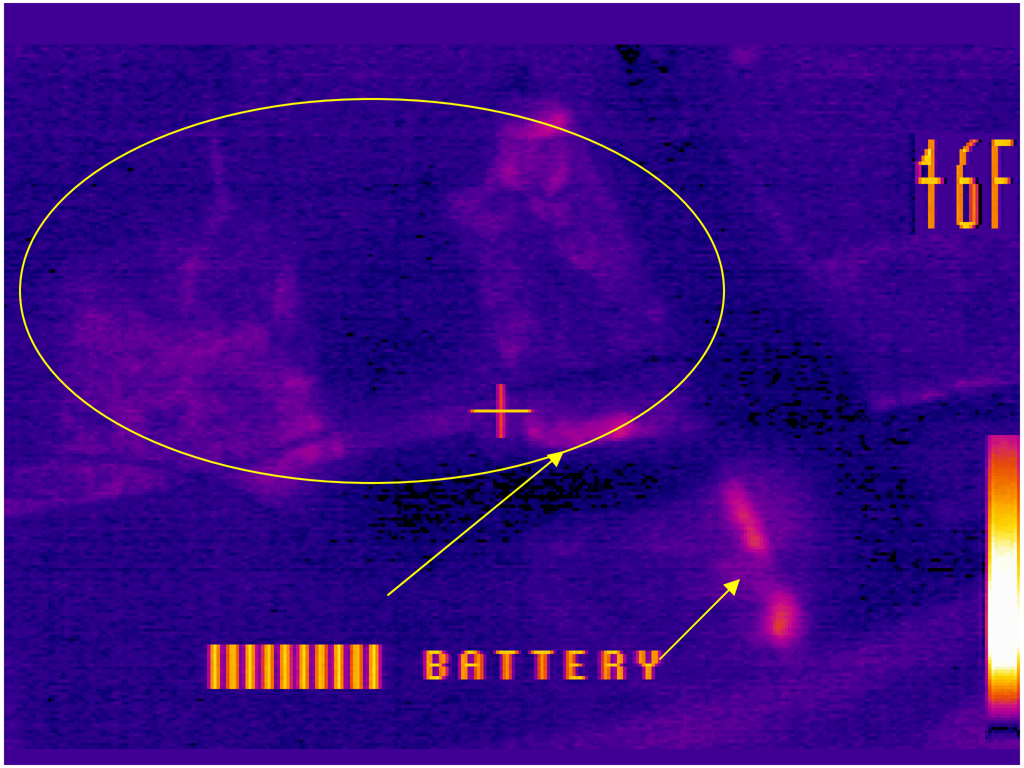


Extensive air sealing is recommended throughout the ceiling plane in the two attic areas and at the perimeter of the room. For optimal performance, removing fiberglass, air sealing and adding 15” blown cellulose and dense pack in the vertical walls then 2” foil faced polyiso, as with other buildings, is recommended. However, this building is unique because of its limited and sporadic use and relatively low thermostat settings during those times means that relative fuel consumption is lower. Also, more importantly, there is talk of a building a new fire station.

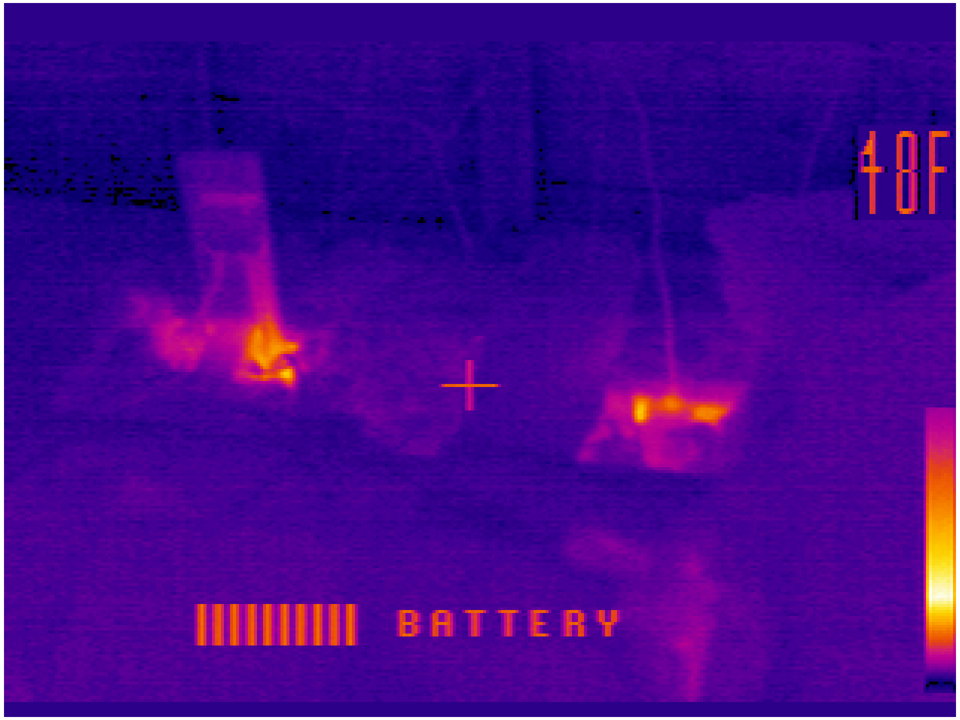


Therefore, for the present planning purposes, thorough air sealing is all that is recommended. IF, plans for a new building are delayed for more than a year or two, then more extensive insulation upgrades would be advised: in the attic, meeting room walls and ceiling, and even more – a minimum 3" rigid foam on the exterior of the block walls. There are a number of products which include metal or other siding which would be appropriate for a fire station wall.

Air sealing and adding even minimal insulation will at least reduce heat loss in the areas shown in IR!



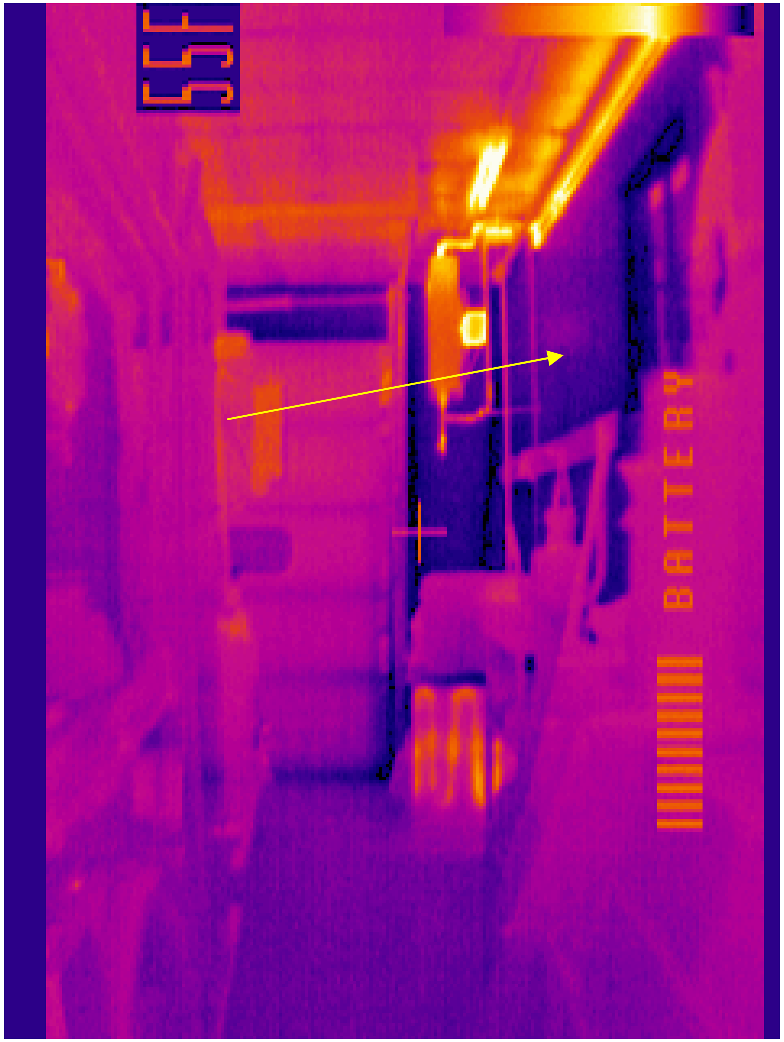
These very bright colors are hot wires, still the holes they go through in the ceiling could be sealed!



This is complicated to portray, but the meeting room is essentially suspended over the former roof and this truss system with minimal insulation. However, the access area is less than a foot so the most practical approach may be to seal off that area and air seal and insulate the perimeter.

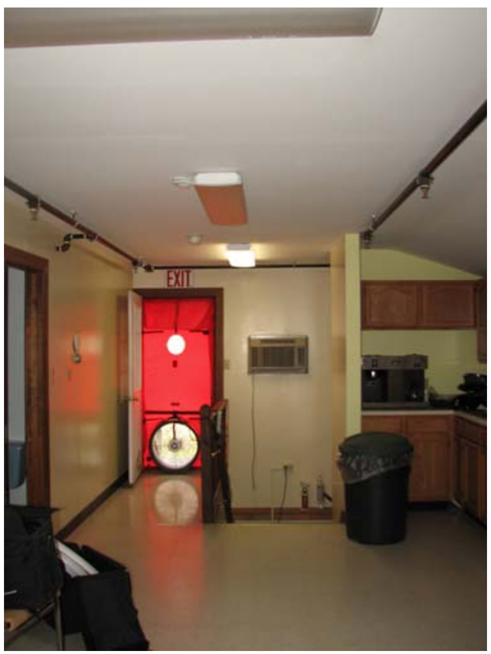
If this area is sealed off, it will be very important to air seal the ceiling below to reduce moisture ladened air from entering this tiny attic area.

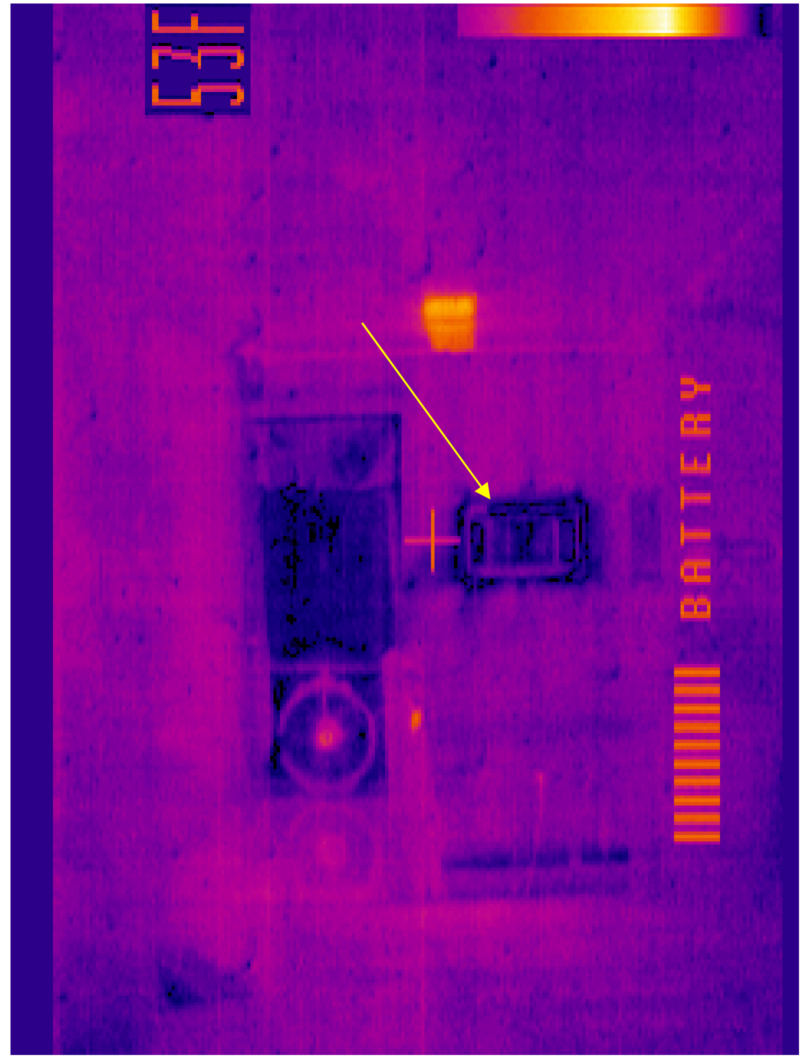
Heat loss thorough the concrete block walls is very high.

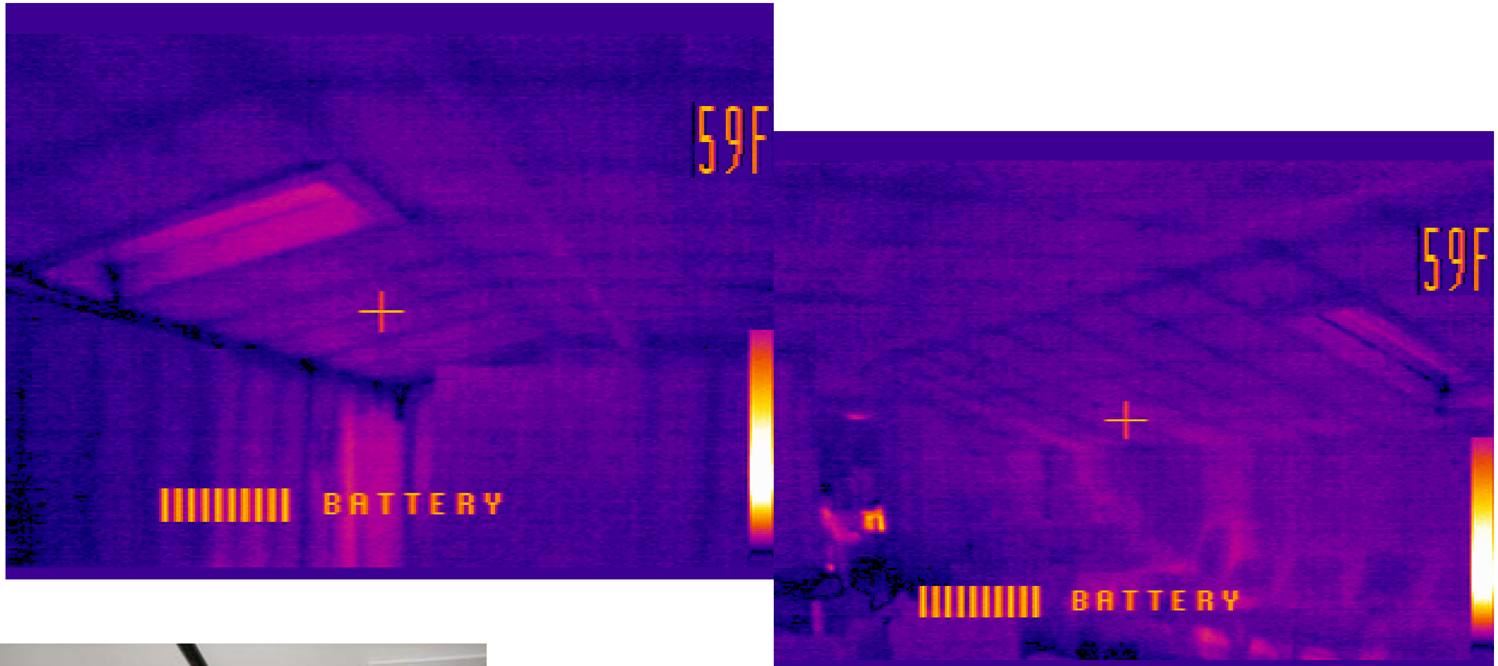


With deep overhangs, it would be fairly simple to adhere any one of a number of pre-finished insulated panels on the exterior of the building achieving R20 to R40. If there is a longer term commitment to the building, these upgrades, as well as proper ventilation of CO and moisture, with heat recovery, is recommended.

Remove AC unit in winter or at least cover with gasketed and insulated AC cover.



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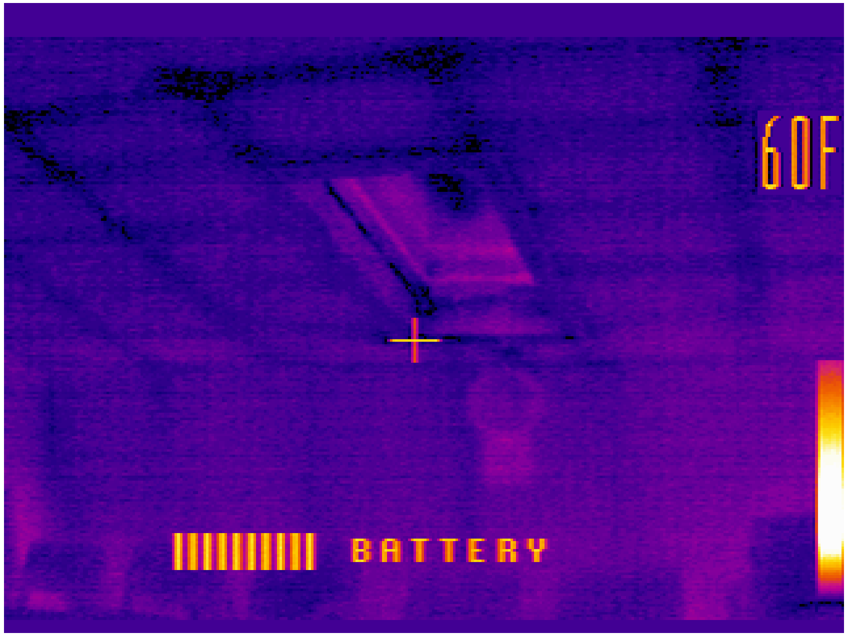
BATTERY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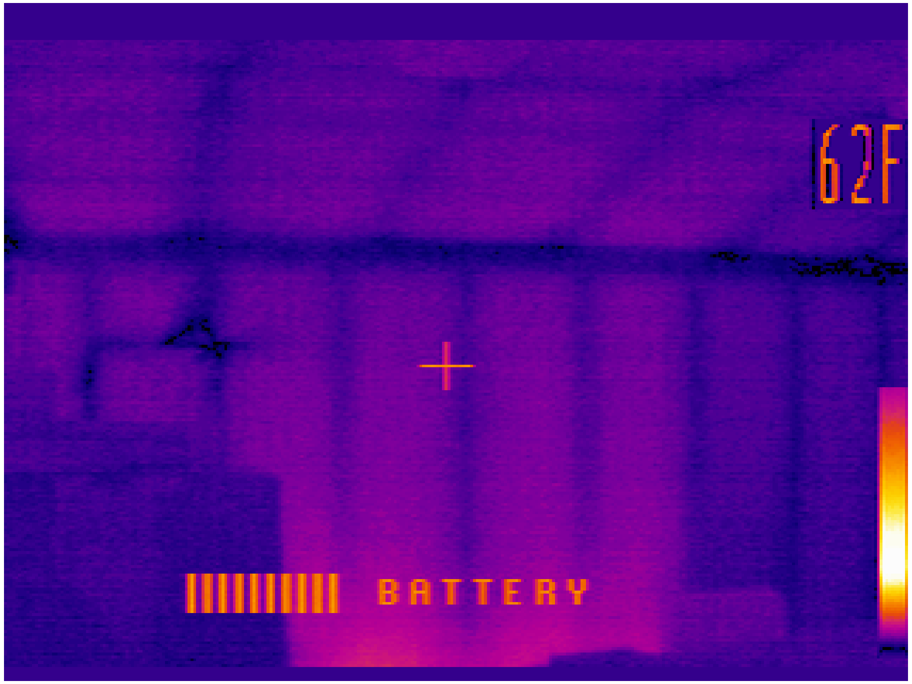
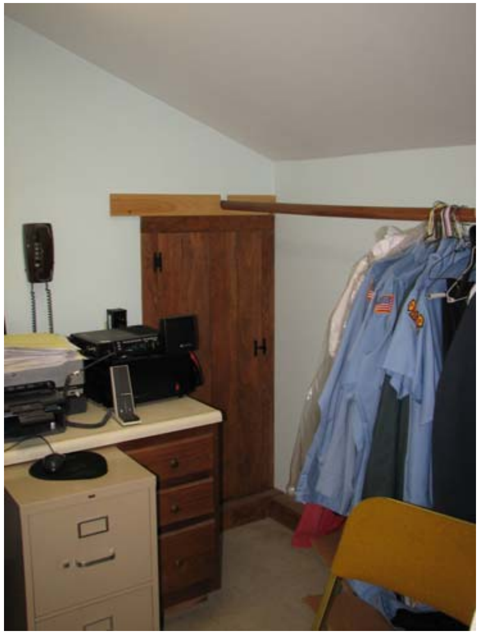
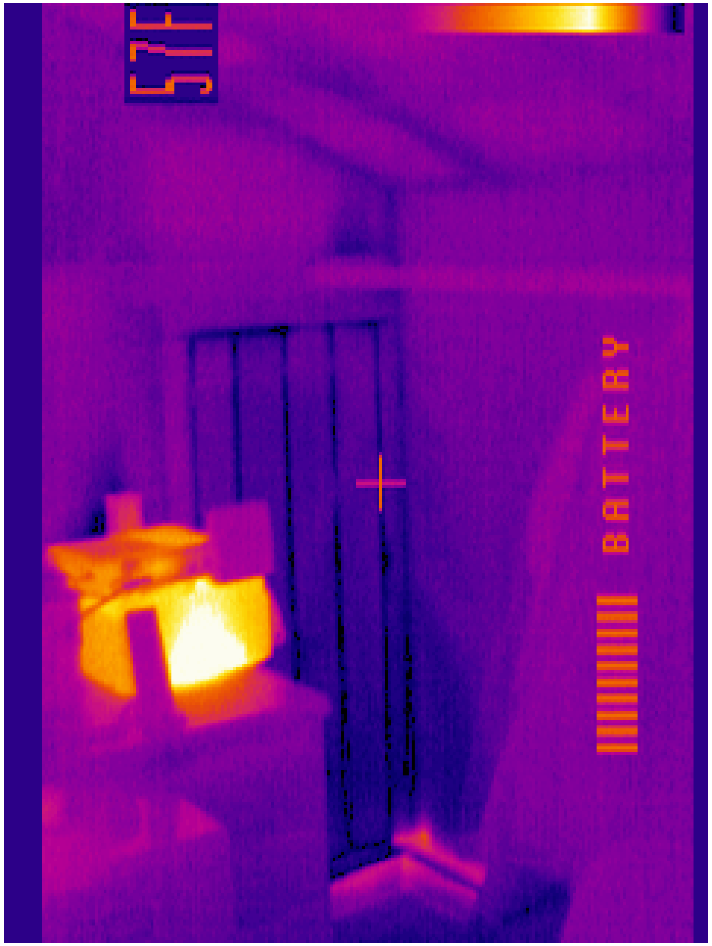
BATTERY


62F
BATTERY

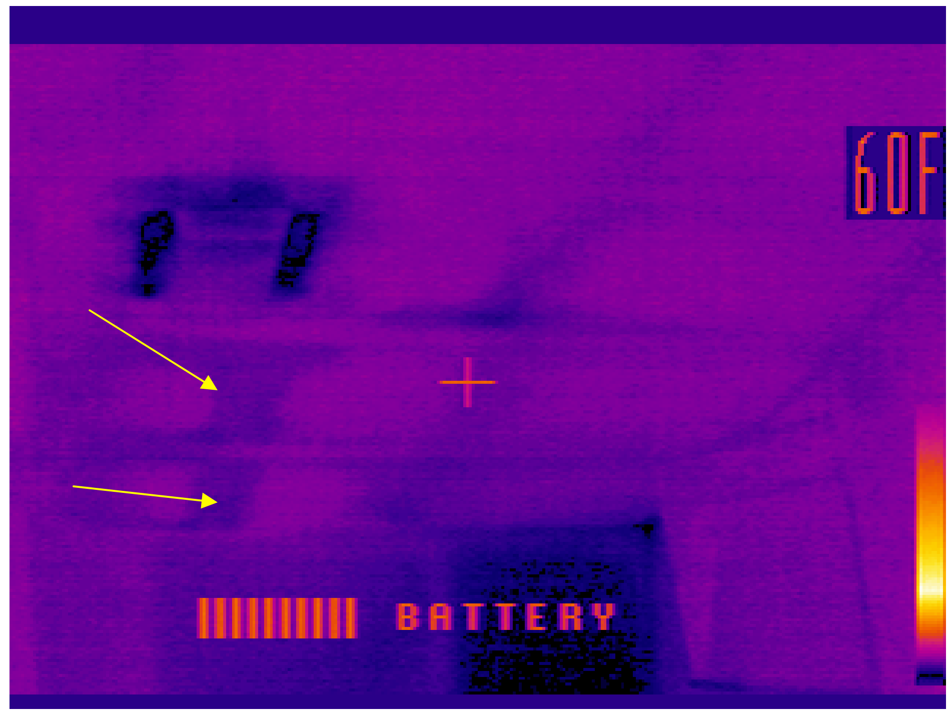
Seal attic hatch and add 2” rigid foam.





Patterns below the fan suggest that warmer air exfiltrates thorough the fan, condensed and now impacts the performance of the fg below.

Even if moisture is not involved, these are areas of more significant heat loss.



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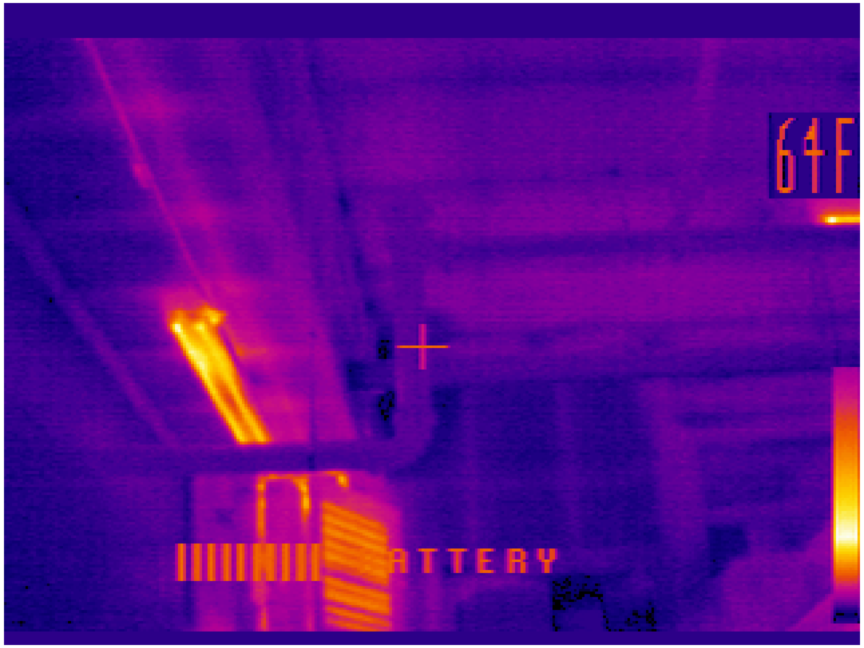
BATTERY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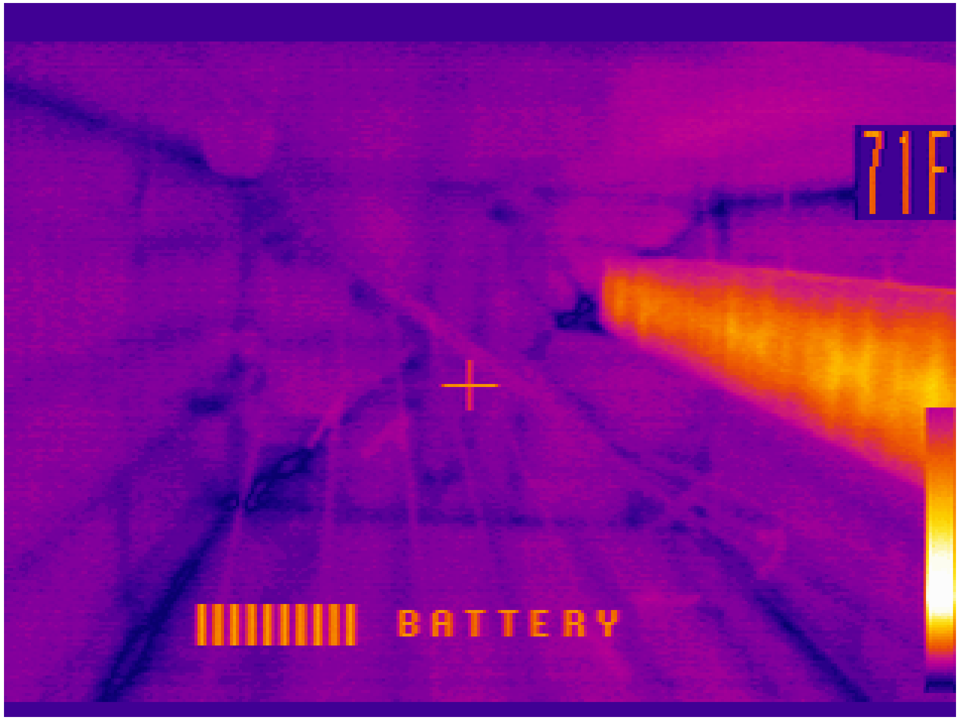
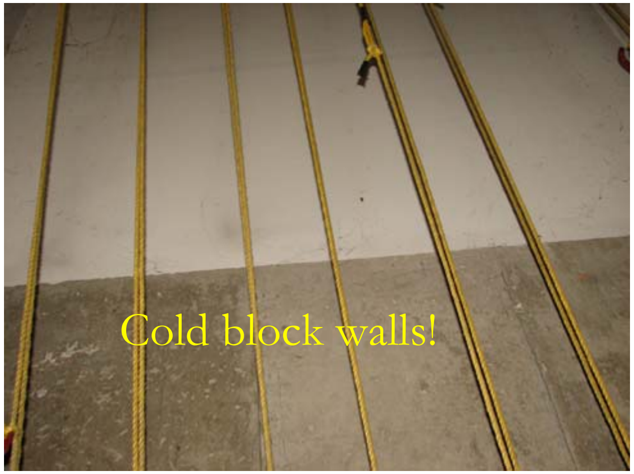
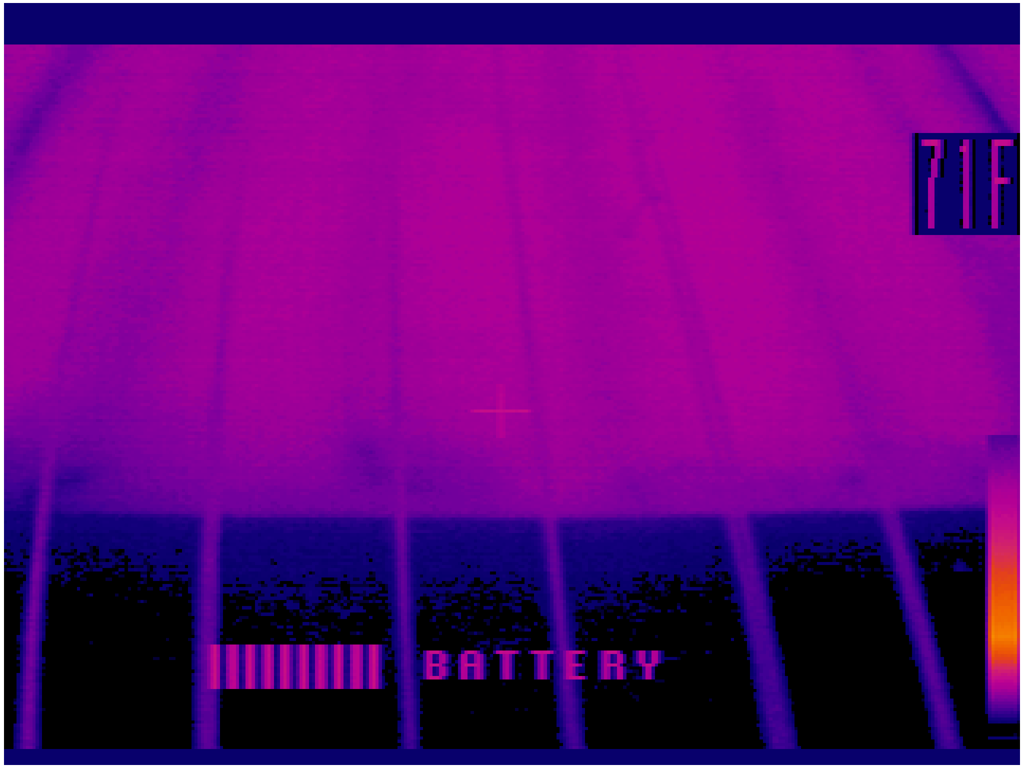
ATTERY

This appears to dry the hoses, however it seems that an exhaust fan at the top which had a tight seal when closed, would not only speed up drying but remove the moisture from the building more effectively and quickly.




Cold block walls!

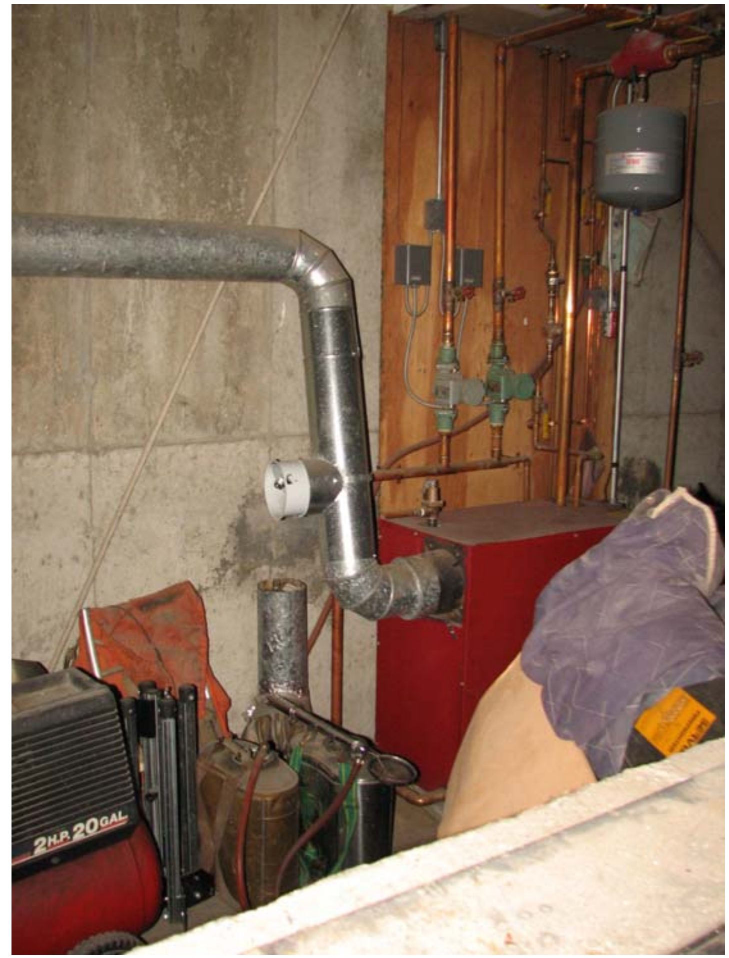

71F
BATTERY

Heating Equipment

The Smith boiler has a capacity of 217MBH, far larger than this building would require with a thorough air sealing and block walls insulated. And is operating around 84% efficiency. Again, if a commitment is made to this building and energy upgrades, replacing this boiler might be advised at that time as well. There are three zones which is adequate for the building's use.

The most efficient way to heat a fire station or garage type buildings is with radiant floor heating with low water temps. Overhead, propane fired infra red heaters would be next.

Hot water usage is minimal and so installing a tank less water heater, while more efficient, is not recommended at this time.



Transfer Station

ANNUAL ENERGY USE SUMMARY

Heating Appliances







Kerosene
934 Gallons

Used Oil
?

Electric Resistance ?

Electricity 18,731 Kwh

Note that there are two aspects to reducing energy use: Conservation and Efficiency. Upgrading the envelope and thermostat settings conserve energy by reducing the amount needed for comfort. Upgrading equipment and distribution systems improve the efficiency of how energy is delivered.

Building Energy Metric: British Thermal Units (Btu) can be used as a measurement for all energy - in terms of each sources' heat output. Btu's per square foot is often the way building energy use is discussed. For example the 2030 Challenge calls for carbon neutral buildings by 2030 and uses this metric to establish reduction goals by building type. (http://www.architecture2030.org)

Kerosene: 934 gallons x 18,500Btu's/gallon = 17,279,000 Btu's or **17 MMBtus**

Used Oil: UNKNOWN

Electricity:18,731KWH x 3412 Btu/kwh = 63,910 **Btus or 64 MM Btu's**

Total Known Energy in Btu's = 81MMBtu's / 1800FT2 = 45KBtu/ft2 ?

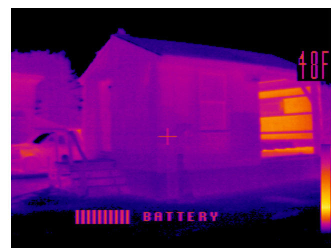
Four sources of heat – the only warm places are the bathroom and the ceiling.

More electric resistance to heat the 120 ft2 office building.

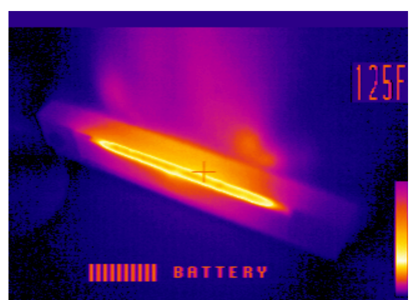
Kerosene hot air near ceiling, no ducts

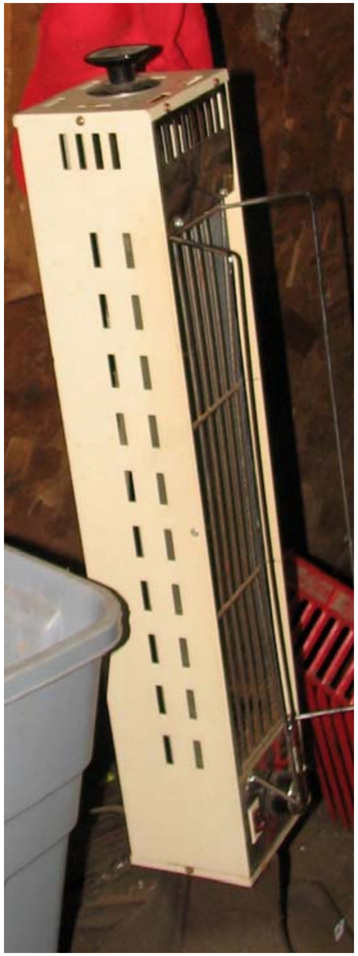
Waste oil hot air

Thermostat in 50's



Electric Resistance

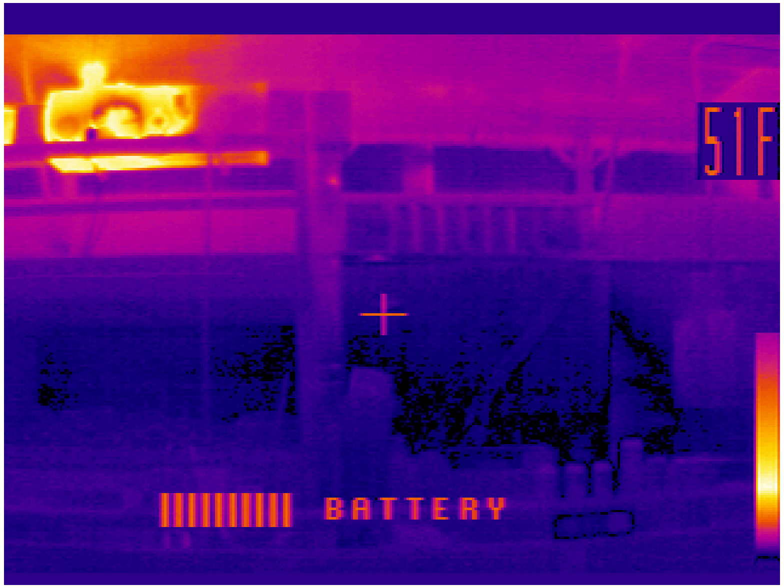




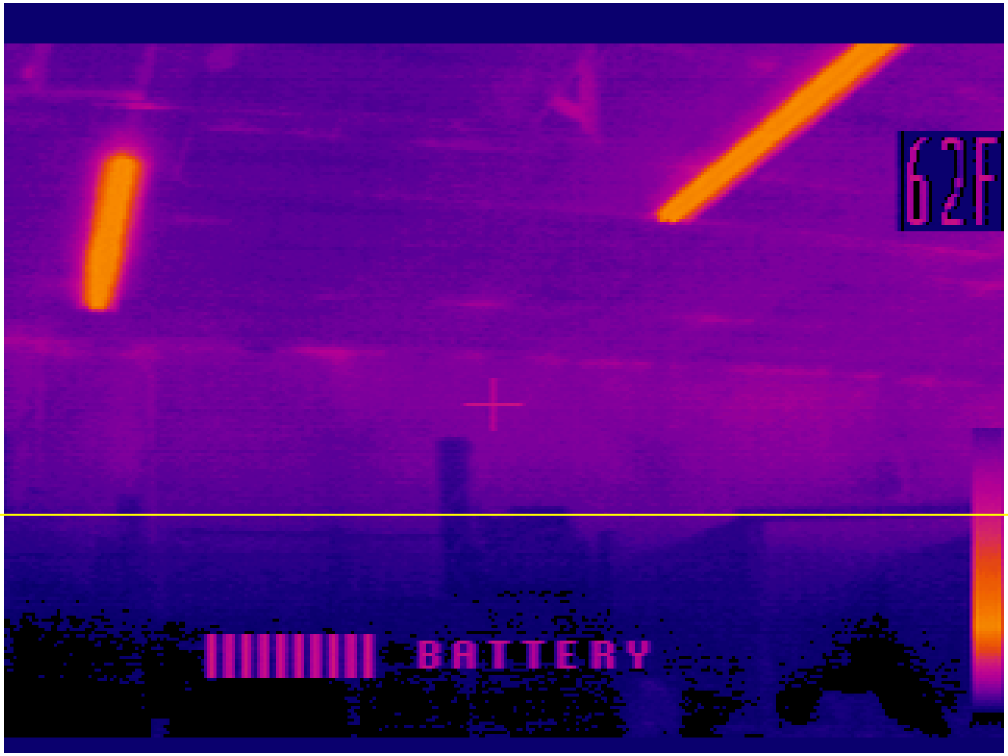
Without measuring the specific plug load, it is impossible to know how many KWH's are used for heating. Nor is it known how many gallons of used oil burned in this heater, nor how much greenhouse gas is emitted because of any of them. We can know, however, that these sources of heat matter, and reducing the heat loss of the building will save energy, money, and environmental impacts.

Distribution is of greater significance in this building as both hot air furnaces are located above 8 feet high and do not have duct work to blow the air to where the people are – so the ceiling is warm and the heavier cold air stays low. Installing ducts or a ceiling fan would help distribute the warm air but may not increase comfort unless the building were air sealed as much of the air being moved would be mixed with outdoor cold air.

Propane fired infra red heating units radiate heat to people and to the floor where the slab can act as thermal storage. Just as in the town garage, this would be far more efficient, provide the greatest comfort and help eliminate the need for electric resistance back up.

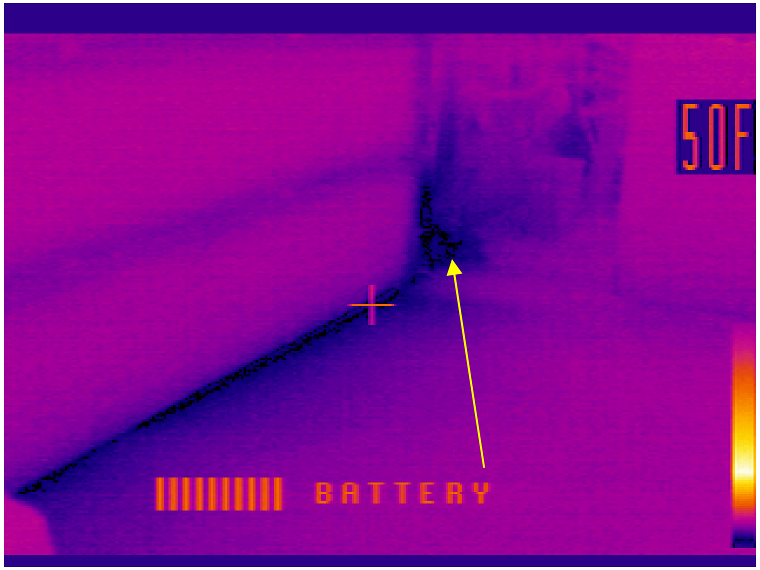


There was not access to above the ceiling but fiberglass batts are suspected above the ceiling and in the walls without a continuous air barrier thereby reducing their effectiveness considerably.



A blower door test was not conducted but IR clearly shows areas of air infiltration: doors, windows, seams in the wall and ceilings.

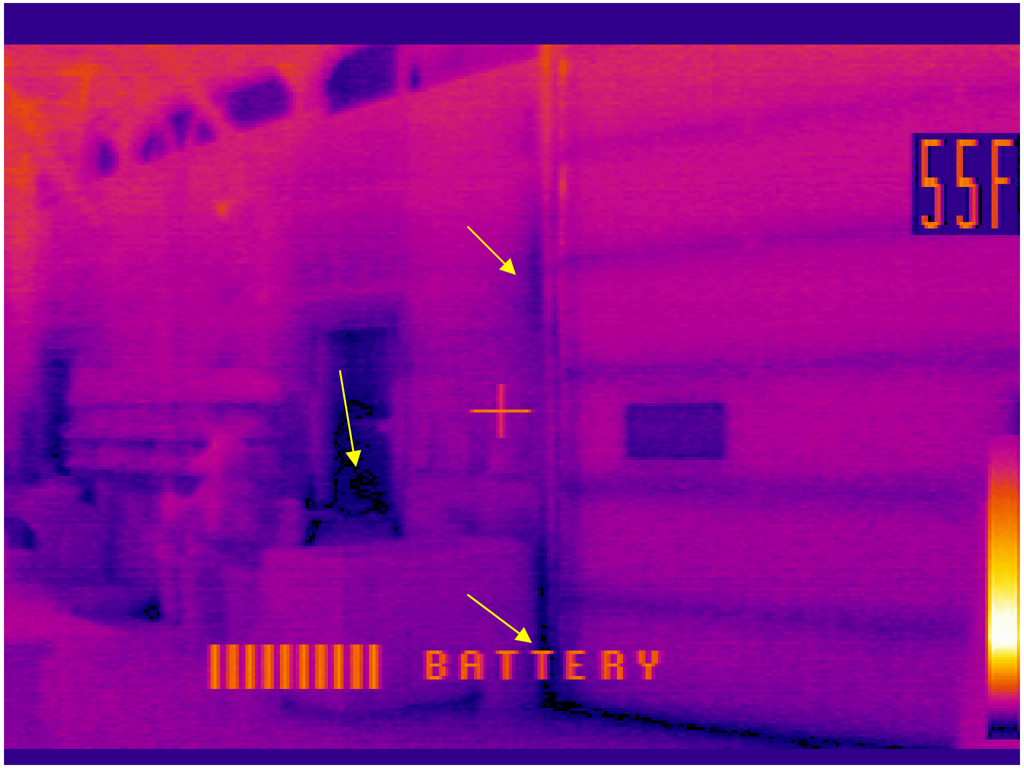
One of the largest sources of infiltration was a sliding door in the back of the building which led to the shed. During my site visit, several gentlemen came in to measure it with the intent of walling it in soon.




EXIT


51F
BATTERY

Glazing offers natural light but at the expense of heat loss.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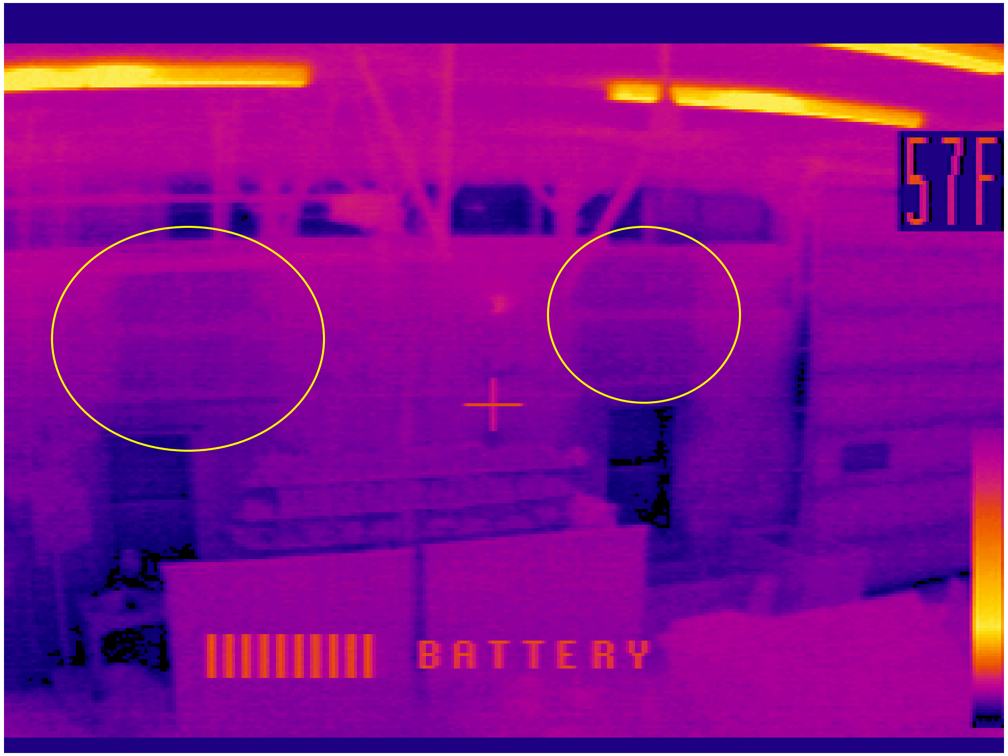
BATTERY

Some wall areas are void of insulation and some are likely insulated but the batts have greater diminished value.



Note the edges of what used to be pink fiberglass: now gray with soot and dust as dirty warm air easily passes to the outside by convection. While more expensive, the best insulating material to use against metal is closed cell urethane foam. The risk of condensation makes fiber based materials inappropriate.

Transfer Station Recommended Strategies

1. Gasket and caulk all windows, entrance door, perimeter ceiling framing, and both garage doors.

2. Spray 2" foam on all exposed metal surfaces and cover with fire rated material. (Note, fiberglass batts may be substituted for expense as it is used throughout the building. However, in an ideal world, all fg would be removed and closed cell foam used exclusively in this situation. Cellulose does not belong in contact with a cold exterior metal surface.

3. Install double paned interior storms on single pane lighting valences near ceiling. Gasket seal into place.

4. Conduct general air sealing throughout the exterior wall and ceiling area.

5. Add 10" cellulose on top of batts above ceiling.

6. Install hanging plastic strips over shed addition door way while residents are using the building. Make sure all seams are sealed shut.

These improvements should reduce the heating load of the building by more than half. Estimated Costs: $17,2,00

For increasing effectiveness and efficiency of heating equipment:

1.Ban use of electric space heaters.

2. Put bathroom heater on probation and set to thermostat to keep bathroom pipes above 40 degrees only. The room was 78 on the day of my site visit. – keep as back up, but hopefully it will no longer be necessary.

3. Install ducts on kerosene heater to direct heat towards key area and to blow down into the room.

4. Consult with a designer of propane fired infra red heaters and install at least 2 radiant pipes over key areas where people work.

E


48F
BATTERY

Old Fire Station

ANNUAL ENERGY USE SUMMARY

Heating Fuel 152 Gallons

Electricity 459 Kwh

Note that there are two aspects to reducing energy use: Conservation and Efficiency. Upgrading the envelope and thermostat settings conserve energy by reducing the amount needed for comfort. Upgrading equipment and distribution systems improve the efficiency of how energy is delivered.

Building Energy Metric: British Thermal Units (Btu) can be used as a measurement for all energy - in terms of each sources' heat output. Btu's per square foot is often the way building energy use is discussed. For example the 2030 Challenge calls for carbon neutral buildings by 2030 and uses this metric to establish reduction goals by building type. (http://www.architecture2030.org)

Oil: 152 gallons x 138,500 Btu's/gallon = 21,052,000 Btu's or **21MMBtus**

Electricity : 459KWH x 3412 Btu/kwh = 1,566,108**Btus or 1.5 MM Btu's**

Total Energy in Btu's = 22.5 MBtu's /665FT2 = 33.8KBtu/ft2

Blower Door Test & Results

Measuring Air Infiltration and the Air or Pressure Barrier

Convective and Conductive Heat Losses and Moisture Transfer

Whole Building: 4720CFM50

Means that **4720 cubic feet of air per minute** would be pulled thorough leaks and gaps in the air barrier when the building was under pressure at -50 pascals with respect to outside.

Air Change per Hour Rate at -50pa: 31.44ACH50 *

This means that at -50 pas (as if a 20mph wind was blowing on all sides of the building at once) the air would completely change **over 31 times every hour**. The math: CFM50 x 60 / building volume

Standard Residential Construction practices is generally between 7 and 9ACH50 and 2009 IECC sets 7ACH50 limit.

Energy Star's limit is 5ACH50. High Performance Homes under 1ACH50. Currently no standard for non residential buildings.

Estimated Annual Air Change Rate: 1.97 ACH Winter: 2.23ACH Summer: 1.25 ACH

Conditions vary ACH day to day, but throughout the year the outdoor climate impacts indoors considerably. On average in winter, you are heating the air which is replaced by outdoor air almost once every hour.

Estimated cost of envelope air leakage: **$250 at $3.50 gallon**

Leakage Area (Canadian EqLA @10pa) 487 in2 or 3.4sq feet

Total size of hole if add all cracks and gaps together

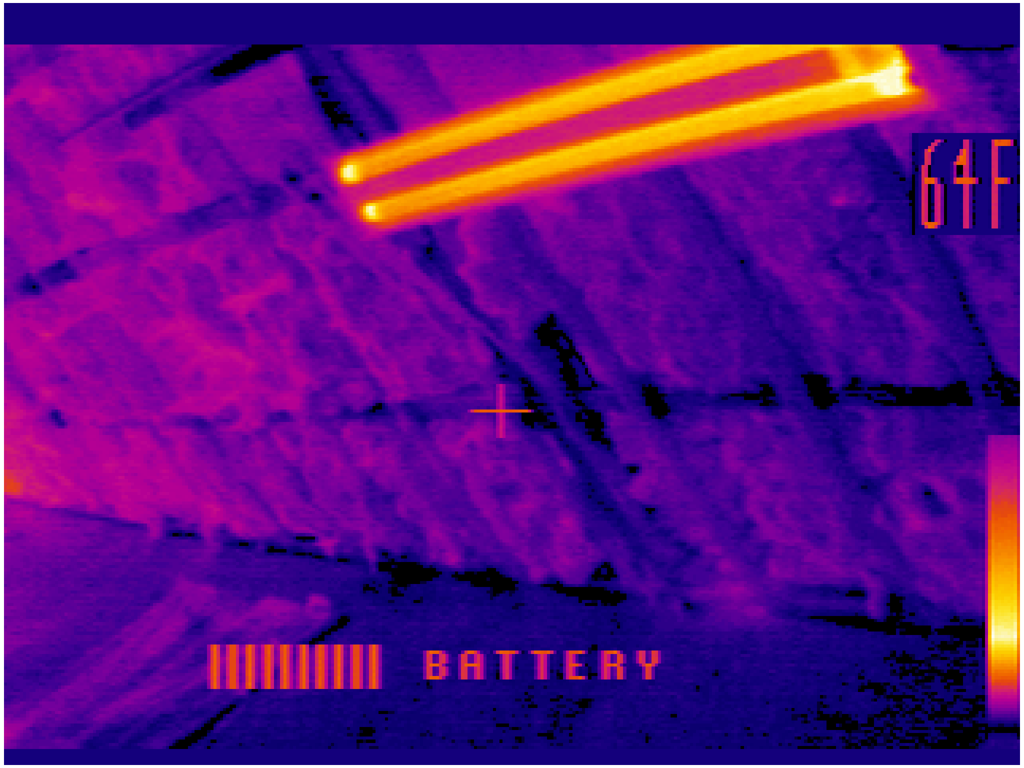
Minneapolis Leakage Ratio: **2.22 CFM50 per ft2 of envelope surface area**

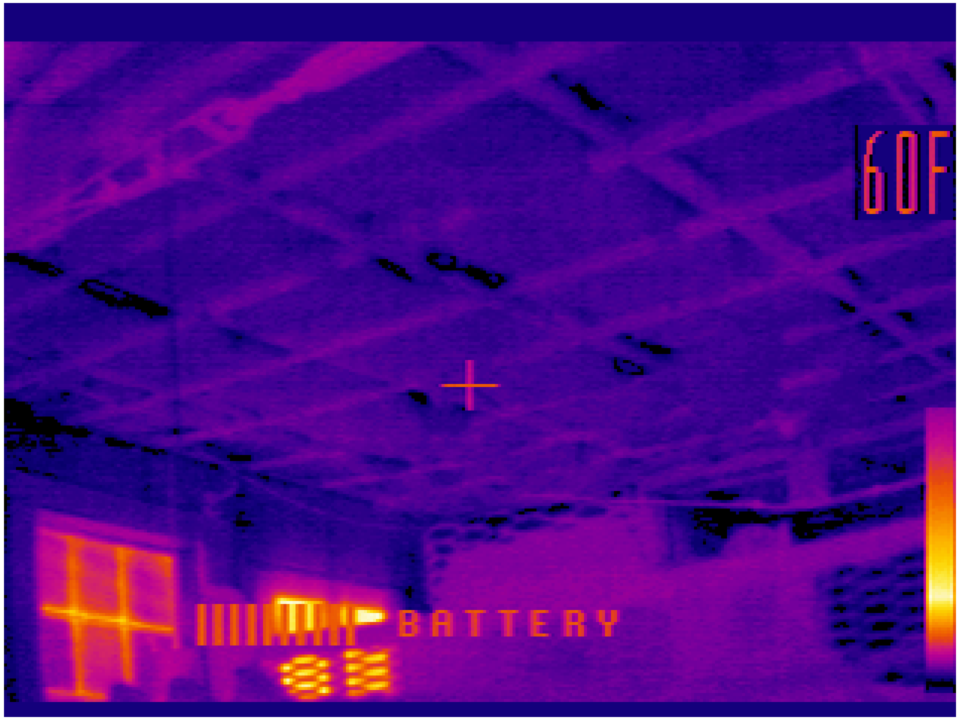
This is using the CFM50 relative to the surface area of the shell or envelope, since heat loss is based on surface area not volume.

*small buildings can often be a little misleading simple because of their small volume! This high ACH50 would drop in half if we used the whole building. No matter the perspective, it STILL has a lot of air leakage.

The side door is approx R1 and while less than 1% of the wall's surface area, is clearly a significant source of heat loss, as are the windows.

Air leakage thorough the old door, windows and garage door is significant, though there is also a tremendous amount of air leakage thorough the ceiling.

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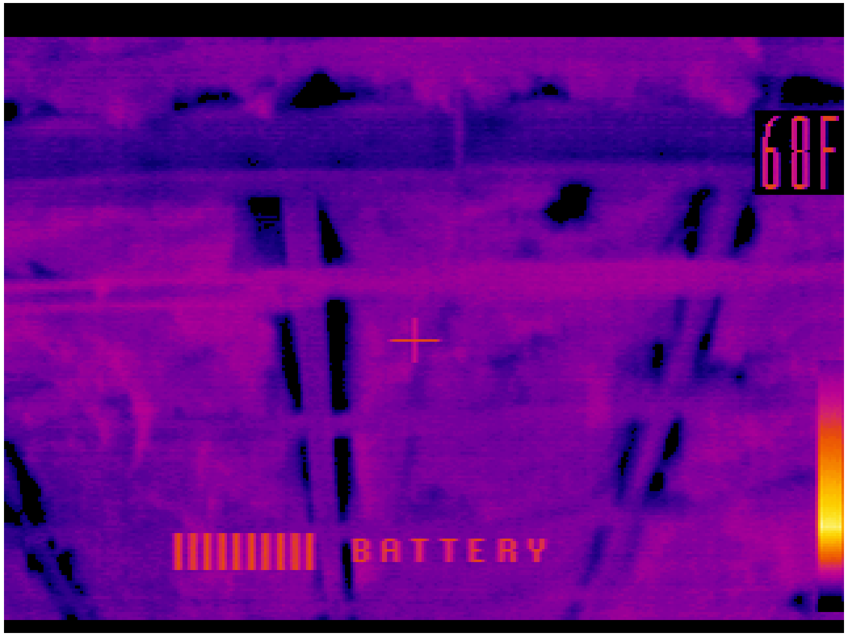
BATTERY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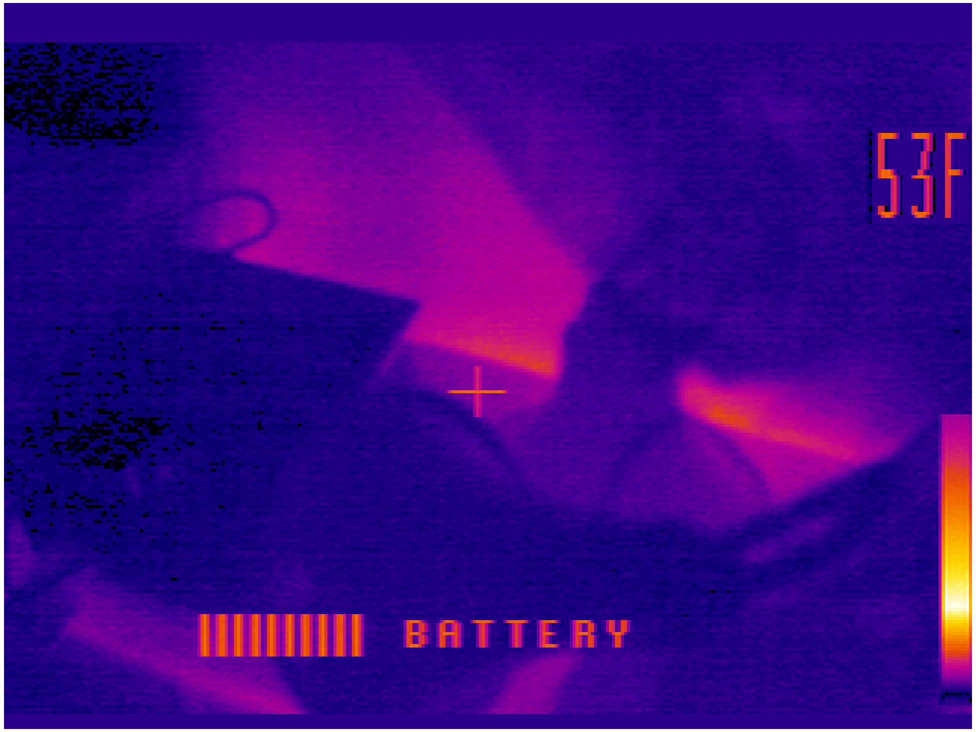
BATTERY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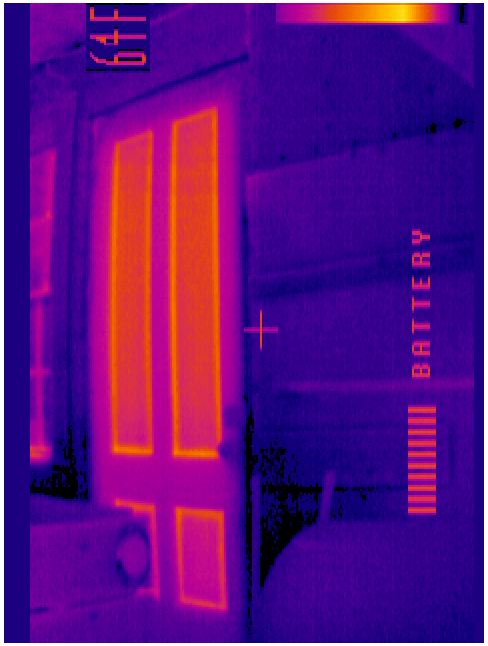
BATTERY

Attic storage area outside the thermal envelope.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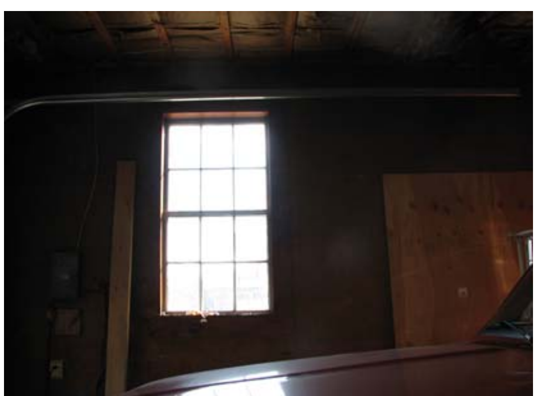
BATTERY


69F
BATTERY



There appears to be some insulation in some parts of the wall.

Just as with the newer fire station, the fuel consumption is relatively little and use of this building sporadic. However, its historic presence implies a greater level of commitment to the building. Therefore, while air sealing could reduce some of the heating costs cost effectively, a more comprehensive retrofit is recommended.

With the envelope defined at the ceiling, there is an ambiguous area at the stairwell which is not defined. Rigid foam board and plywood with a caulking gun and thoughtfulness connecting the 'plane dots' is recommended.

1.Best if fg batt in ceiling is also removed before installing the same 2" rigid foam board d on the ceiling strapping – strap again and apply drywall. Foam seal all perimeter connections.

2.Create a removable foam panel for side door and gasket into place.

3.Install interior thermopane storm windows on

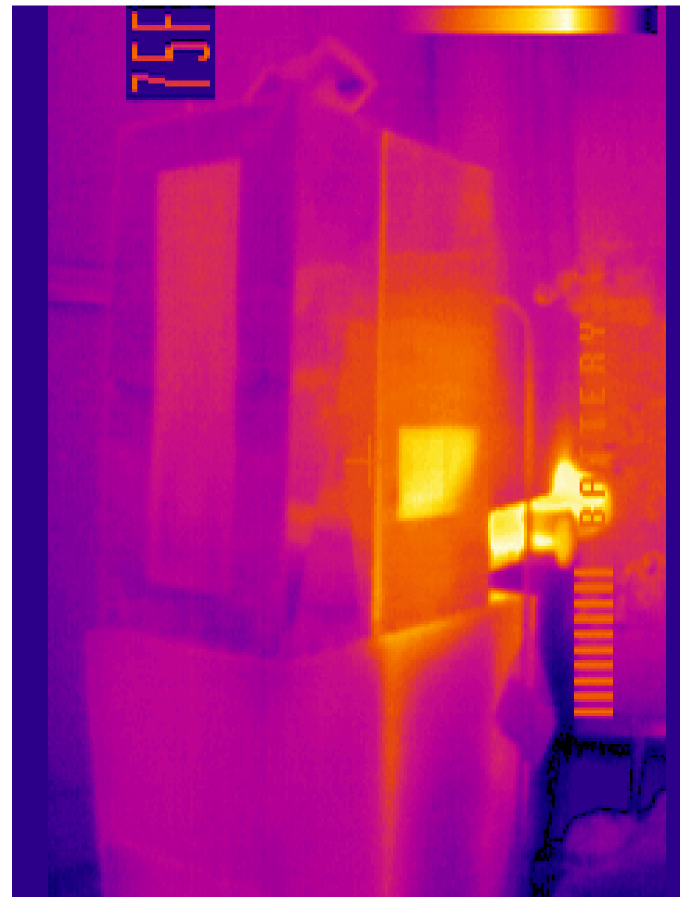
4.Windows.

5.Gasket garage door.

6.Install programmable thermostat and set to 40 degrees. The furnace will come on very little if at all, all winter.

For a deeper energy upgrade, it is recommended that the clapboards be removed and 3-4" foam board be applied to the exterior; jamb extensions foam in and other trim detailing occur for a tight wall assembly. Interior cavities could also be dense packed cellulose, but it would matter less. Clapboards should be back vented or installed on strapping and drainage/drying plane, or over rain screen or similar product. This assembly allows for building tightness; drying to the interior; exterior drying; and minimal heat transfer…all the important aspects of an effective and durable envelope assembly.

While this furnace is not efficient, it does serve the purpose until the new loads can be calculated, at which time a cleaner and more efficient solution can be found. Using about 150 gallons does limit the cost/benefit approach to energy upgrades.



For professional insulation and air sealing, I recommend calling Don LaTourette and Andy Duncan of Building Energy Technologies in Concord. 724-7849.

Please contact me at the number or email below with any further questions or concerns. Thank you.

BUILDING STRATEGIES FOR AN AFFORDABLE FUTURE

S.E.E.D.S.

SUSTAINABLE ENERGY EDUCATION DEMONSTRATION SERVICES

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