Some notes regarding Mann House and Library insulation

The external thermal images were taken before sunrise, so the matching visual images are unusable (very dark). For orientation, here are some visual images taken during daylight on other days:

Left side, main entrance

Front side

Front-right side diagonal

Right side, Library entrance

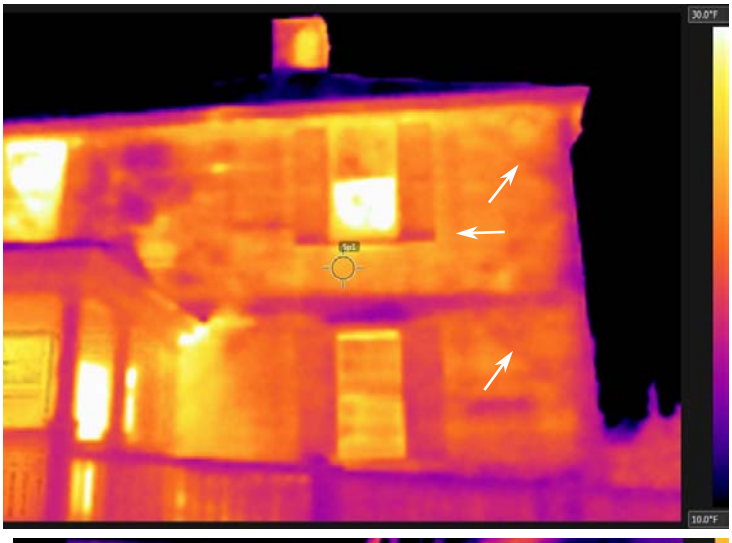
Right-rear diagonal

Rear side

External thermal images were captured March 26, 2018, between 5:44 to 6:09 AM (sunrise at 6:40 AM). Outside temperature was approximately 15°F under clear sky and low wind speeds. Inside thermostat set for 60°F; actual inside temperatures were not measured.

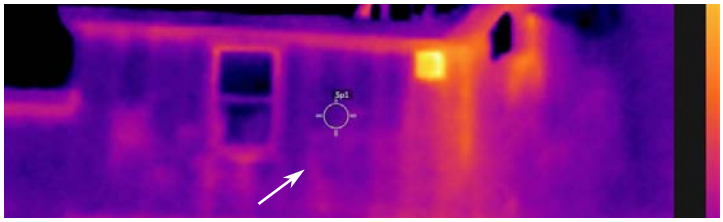
The inside (warm) and outside (cold) wall surfaces are connected either by cavities or by wood studs. Heat loss through the walls warms the outer surface - so the outside surfaces of poorly insulated areas will be warmer than those over better insulated areas.

Starting at the left (main entrance) side we see that the areas over studs and diagonal braces (see white arrow) are cooler (darker) than the areas over cavities. This shows that the cavity insulation is poorer than solid wood - a clear indication of missing insulation in the cavities. *Note: the shutters must be ignored because they are decorative pieces attached to the outer wall but not part of it.*



Compare that with the back side of the upper library's wall (lower image) where the studs are clearly warmer while the sections between are clearly colder - indicating well insulated wall cavities.

Thus it appears that neither the first nor second floor walls of the main building contain insulation, at least on this side.



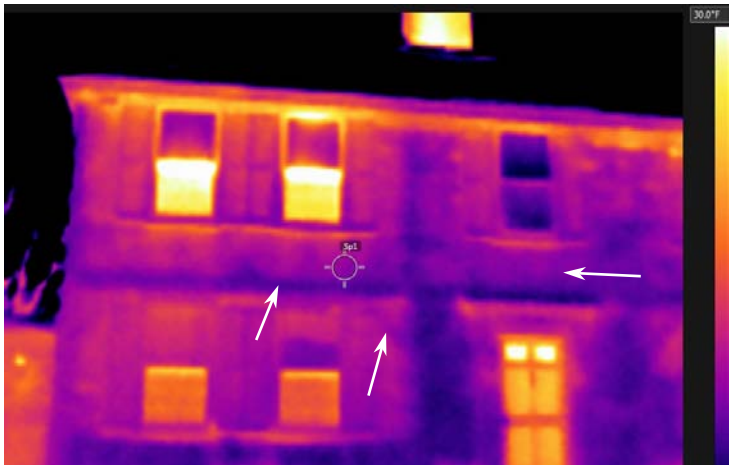
Library rear wall

The front side of the main building is harder to interpret - much of the area is covered by shutters making it difficult to see a pattern of studs.

Also, the front door leads into a much cooler unused area, so the cooler walls around it are to not unexpected.

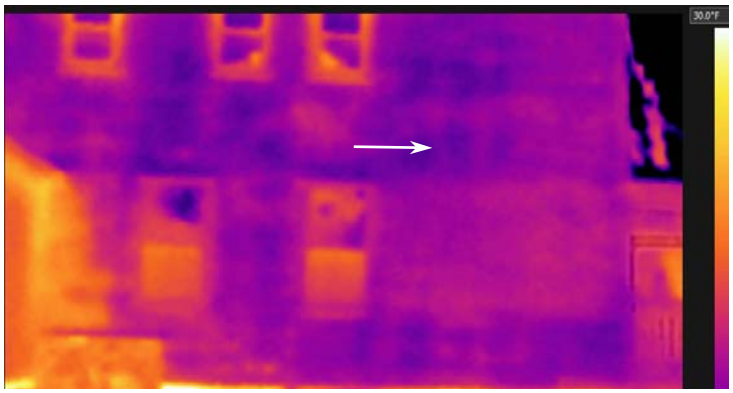
Nonetheless, a pattern can be seen of cooler outer walls where the wall top-plates and the diagonal braces (to the left of the door, above and below the 2nd floor) - see white arrows - provide better insulation than the cavities.

Again this indicates a lack of cavity insulation in the main building's front.



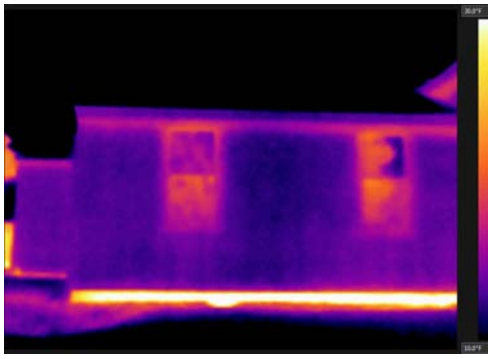
However, at the rear of the main building the pattern is reversed - now we see warmer (less well insulated) areas over the studs and cooler (better insulated) areas over the cavities, suggesting that insulation may have been blown into those cavities!

I did not get a sufficiently detailed exterior image of the main building's wall on the right (library) side to judge whether its cavities were insulated or not.

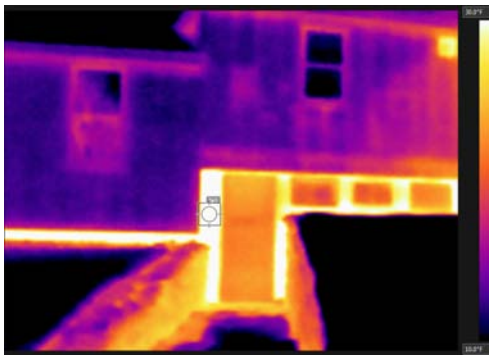


In contrast, the Library parts of the building all seem well insulated: warm over the studs and cold over the cavities,

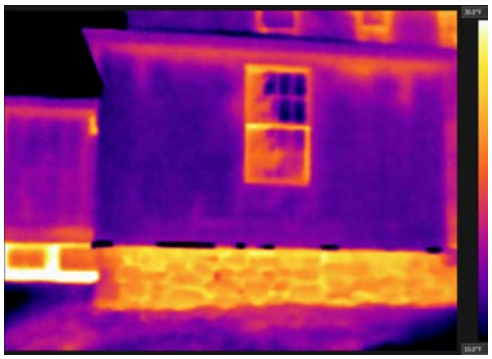
Library, rear left



Library, rear center

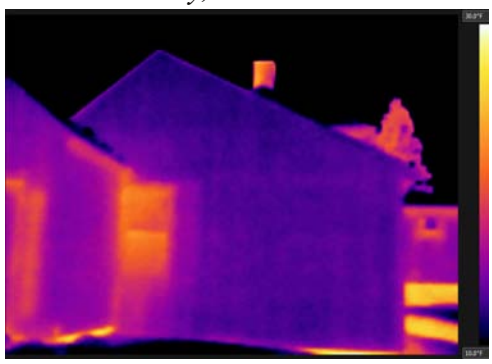


Library, rear right (children's room)

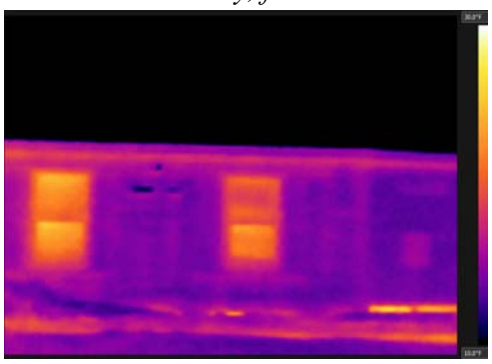


indicating insulated wall cavities.

Library, entrance end



Library, front



One item to note: the masonry areas, whether concrete or stone, are much warmer, indicating substantial heat losses - not surprising as both materials conduct heat well. While a properly insulated wood frame construction, even one built to 1950s specifications, would have a wall insulation value of at least R7 to R11, an 8" thick concrete wall provides only R1 - around 1/7 to 1/11 as effective as the wood frame wall!

In the image of "*Library, rear center*" above, the masonry hotspot next to the door measures 33°F, while the center of the door is at 21°F and the wood frame construction walls above range between 12°F to 14°F (with smaller areas up to 17°F). Hot exterior walls can only stay hot by letting a lot of heat flow outwards...

Indoor images:

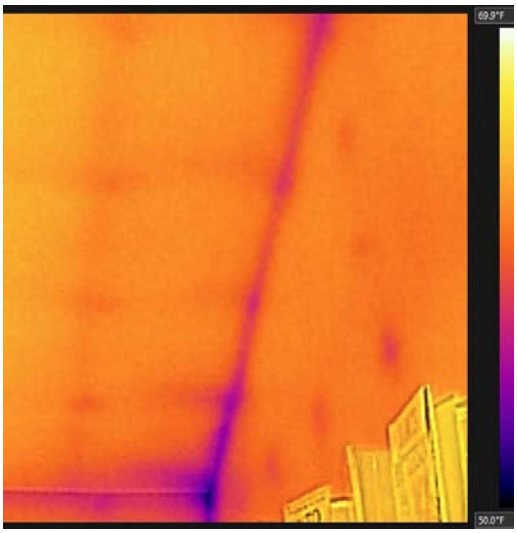
The indoor images were captured March 20, 2018, between 8:55 AM and 9:30 AM. Outdoor temperatures were in the mid-20's with low wind. Indoors the thermostat was set at 65°F though actual temperatures were not checked.

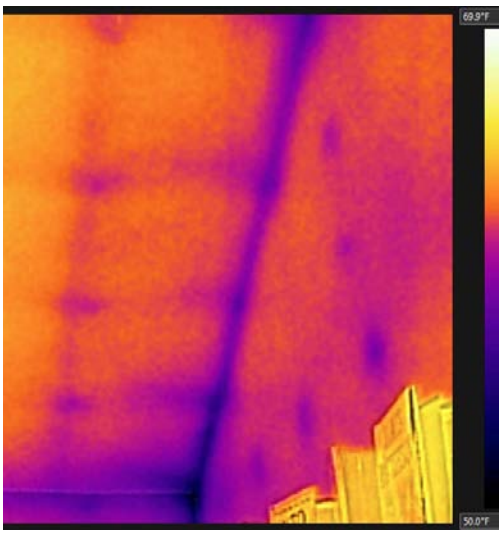
Insulation indicators in indoor thermal images are reversed in comparison to external images.

Indoors, relatively warmer readings mean less heat being lost due to better insulation in the walls; cooler readings indicate greater heat loss due to poorer wall insulation. ***Warm=more*** insulation, ***cold=less*** insulation.

A note about the color scales used:

Linear scale *Equalized scale*





Linear scale, shown in the left image, always spreads the colors the same way from the coldest (dark blue) through purple, red, orange, yellow to white for the warmest.

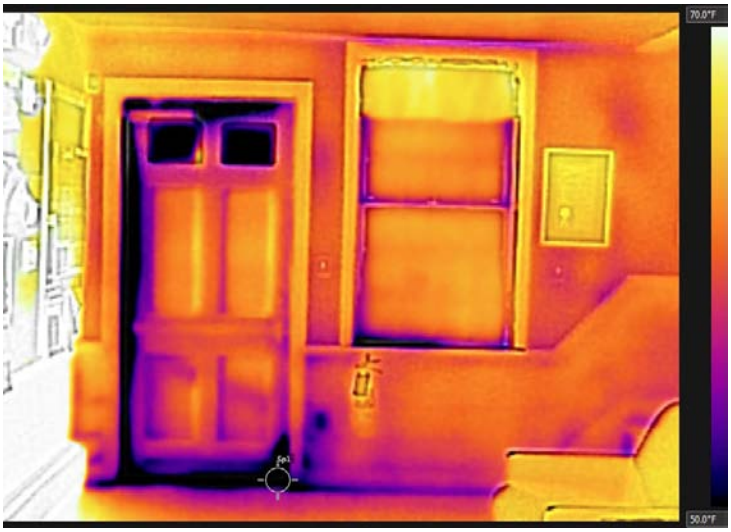
If all the images use the same temperature range, say 50°F to 70°F, this will mean that a particular color will indicate the same temperature in each image. This is the most useful scale for comparing images.

Equalized scale, shown on the right, changes the color scale to use each color an equal number of times. Notice how the blue section of the color scale has been stretched to cover a wider range of lower temperatures at the expense of a compressed orange-yellow-white range. Equalized scale has the advantage of providing more "contrast" which makes it easier to see differences ***within*** an image. On the other hand it is no longer possible to compare ***between*** images because their color scales will be different..

Almost all images presented in this report use the same 50°F to 70°F range and Linear scale, thus can be compared.

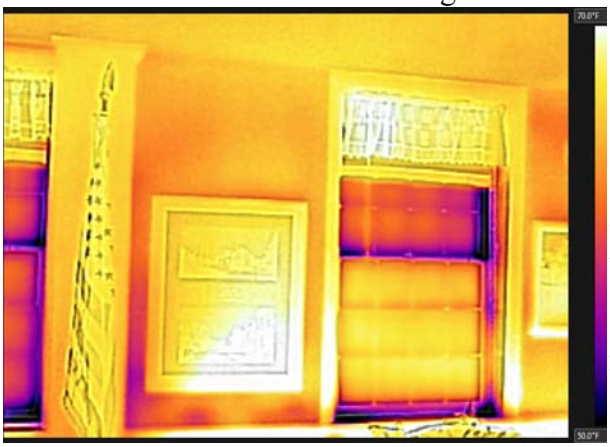
Equalized scale will be used only in cases where showing subtle differences is important.

Main entrance to Mann House, meeting room:



This shows a common problem in both the Mann House and the Town Hall - defective weatherstripping. The temperature at the door's lower right corner is 36°F due to cold outside air leaking in. Not only does this cold air cool down the room, but it also allows an equal volume of heated air to leave the building elsewhere.

This wall and the stairwell to its right are somewhat cooler



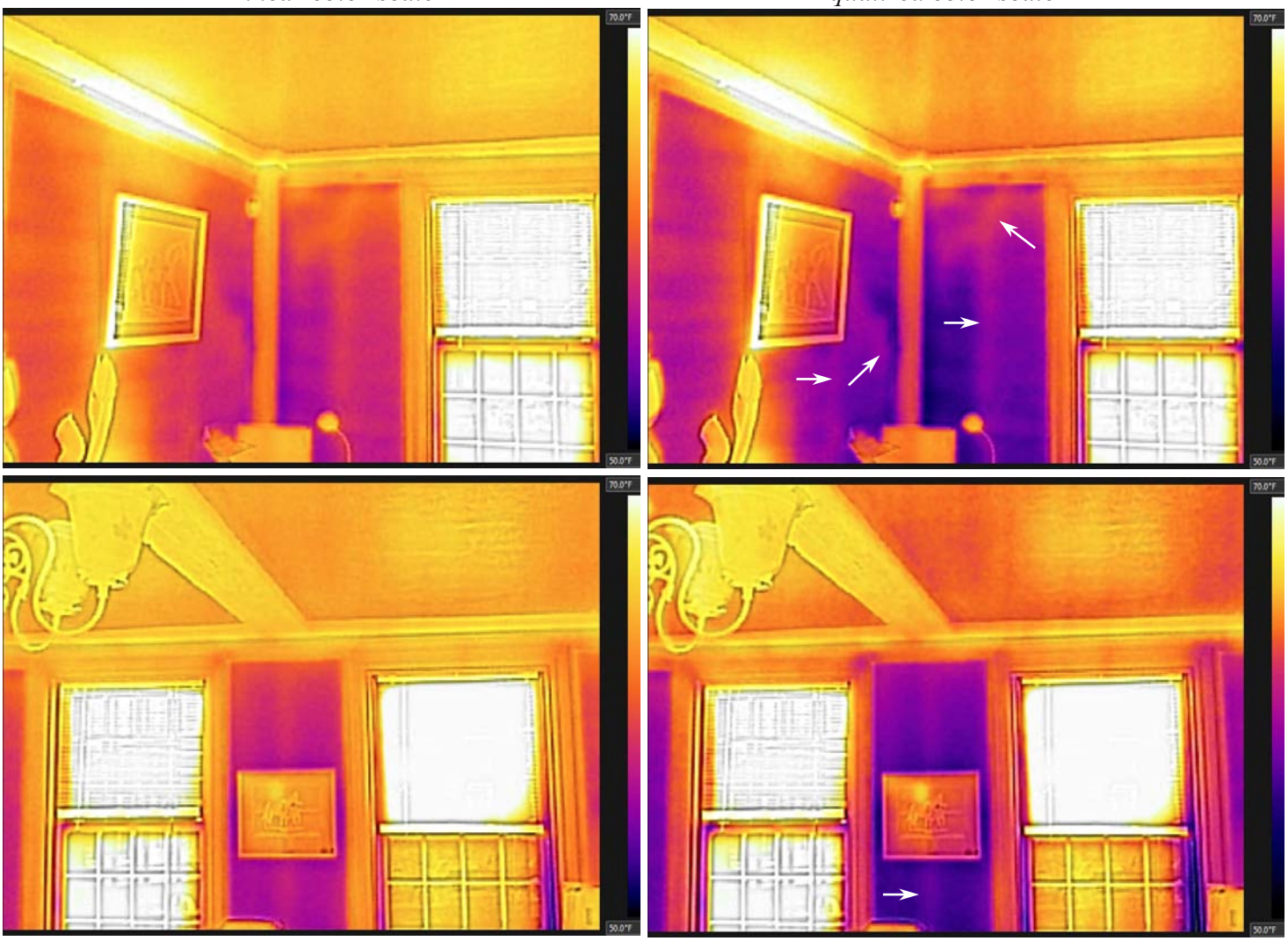
than the other outside wall (image at left) - which is well heated by baseboard heaters.

I could not see clear indications of the wall insulation status in this room.

Selectmen's office:

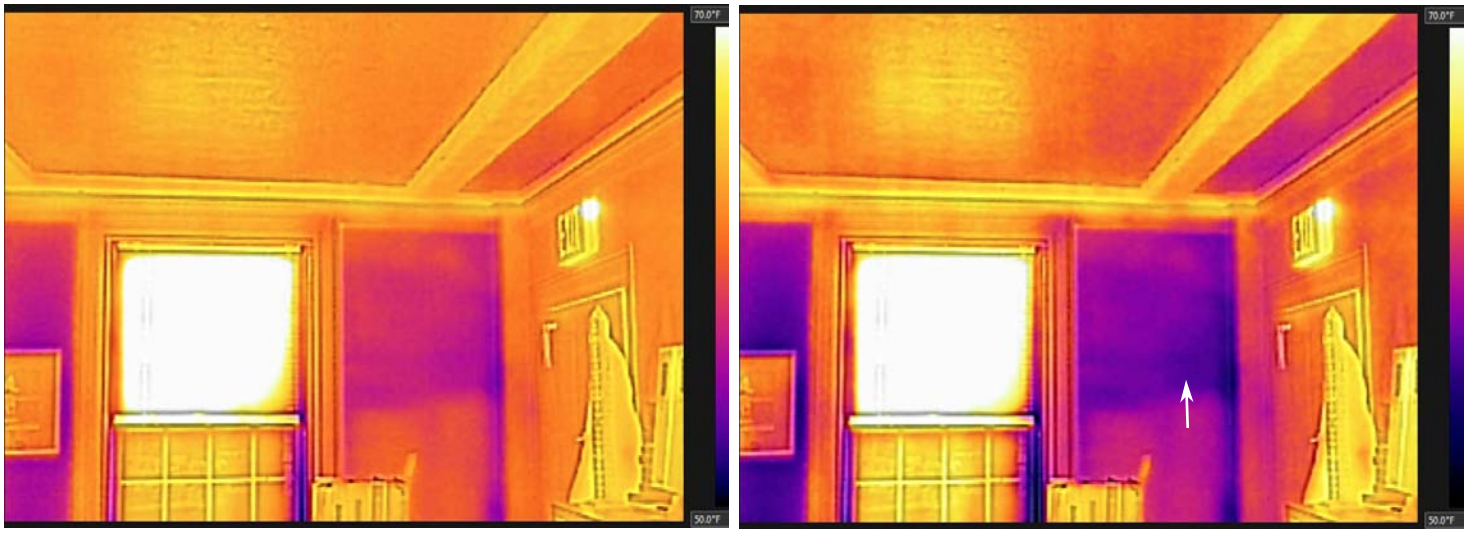
There is evidence of poor cavity insulation - see white arrows pointing to warmer studs/braces than cavities

Linear color scale *Equalized color scale*



The next images show what would often be interpreted as loose insulation which has settled down leaving a void

Linear color scale *Equalized color scale*

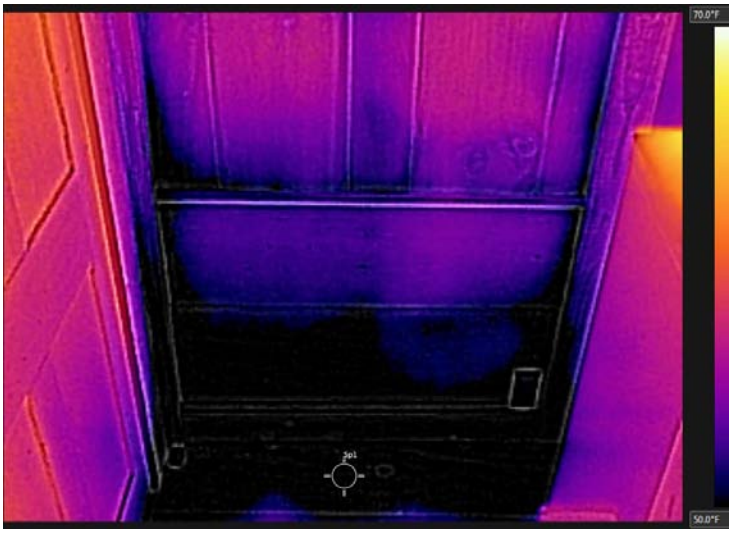


Though it isn't clear what it indicates in this context

Connecting corridor, front door, stairway:

This is an unheated (or less heated) corridor leading from the Selectmen's Office past the (unused) front door to the Town Clerk's office. A stairway leads up to the second floor.

As usual a somewhat leaky door, though the temperature at the bottom is 47°F. Wall temperatures in this area are in the mid-50's. The wall cavities appear to be insulated - note the cold stud/brace next to warmer cavities.



The cavity insulation and lower inside temperatures are consistent with the outside image on page 2 which shows lower heat loss (lower temperature) in this area.

A the top of the stairs the wall temperatures are around 52°F, with the cold spot in the upper right at 48°F.

Linear scale

Equalized scale + lower temp 47.4°F

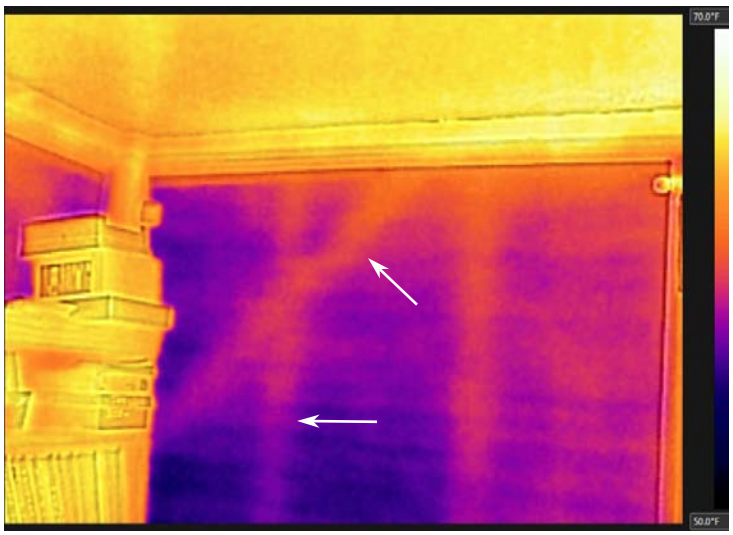
Door to the right leads into the room used for Conservation Commission, Building Inspector and other files.

Except for the suggestive triangular region in the upper right corner, there isn't visible evidence of stud versus cavity differences.

<== Left side of landing at top of stairs. Door to the left leads into the Historical Society room.

Town Clerk and Tax Collector's office:

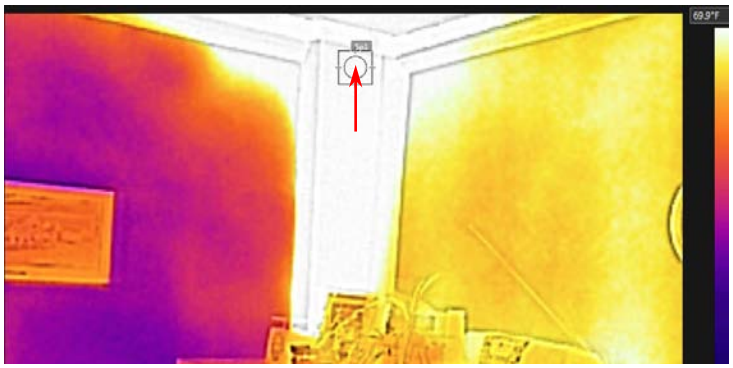
Both outer walls are clearly not insulated as shown by the hot stud / cold cavity pattern. All 3 images shown use Equalized color scale to highlight the stud/brace to cavity contrast.



The surface temperature of the outer walls ranges between 58°F to 61°F over most of the area.

The inner walls, and the ceiling are around 68°F.

The white vertical column shown at the right is a pipe chase covering a pipe (or pipes) carrying hot water from the heating system to the upper floor. Temperature at the chase top is 80°F (see red arrow).



Second floor: general observations

Windows on this floor all all single pane, usually plus an external storm window. In several cases the windows have cracked or broken panes so that the storm window is all that prevents massive outflow of heated air.

Some of the windows do not have latches, and one was found to have slid partially open. Weatherstripping is often in poor condition.

Since heated air rises, much heat is lost from the poor sealing on this floor. At a minimum all windows should have latches, broken or cracked panes should be replaced and inspection done to ensure that all storm windows are in position. Replacing single pane with modern double-pane insulating windows would help greatly.

Second floor: Library overflow room:

The first room at the head of the stairs from the main meeting room is the "Library overflow" room. Note the clear evidence of insulated cavities - cool (62°F) studs/ braces between warmer (66°F) cavities.

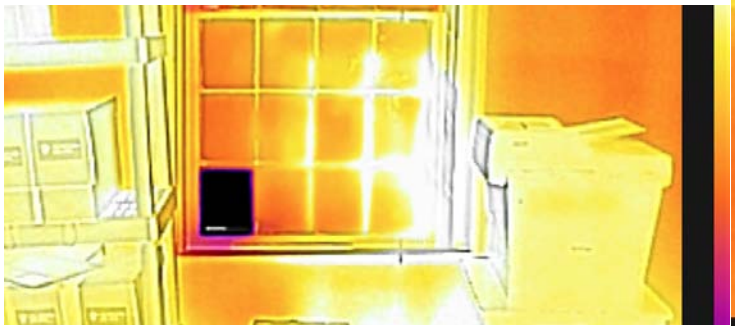
The door to this room seems to generally be left open and is unlocked.

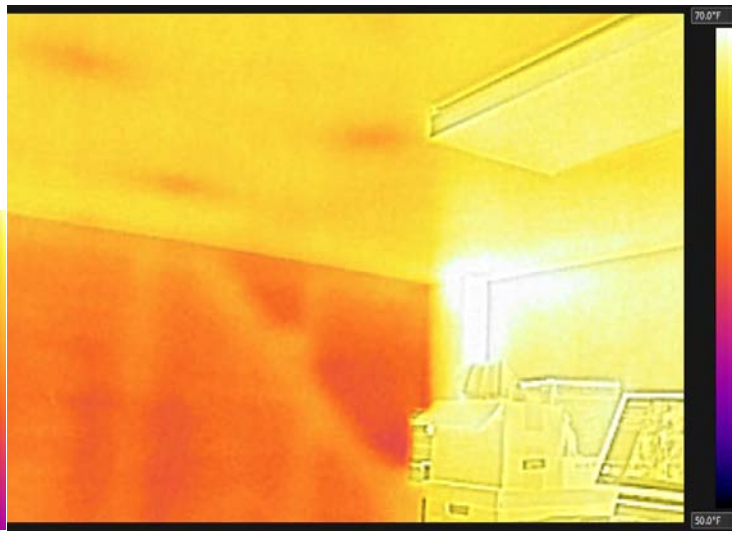
Second floor: File storage room:

This room is used for storage of files from the Conservation Commission, Building Inspector and others. The door is generally kept locked. The room is accessible from both stairways (one from the main meeting room and the other from the stairway from the front door / Selectmen's Office / Town Clerk & Tax Collector Office).

Note the evidence of **un**insulated cavities - warmer (62-63°F) studs/braces with cooler (60-61°F) cavities.

Interior walls, the ceilings, and objects inside are around 66-68°F. Note the missing window pane!





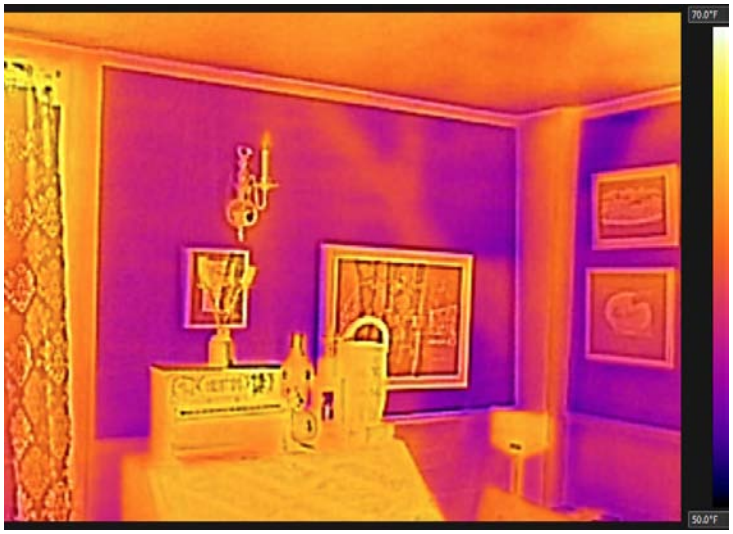
Second floor: Historical Society room:

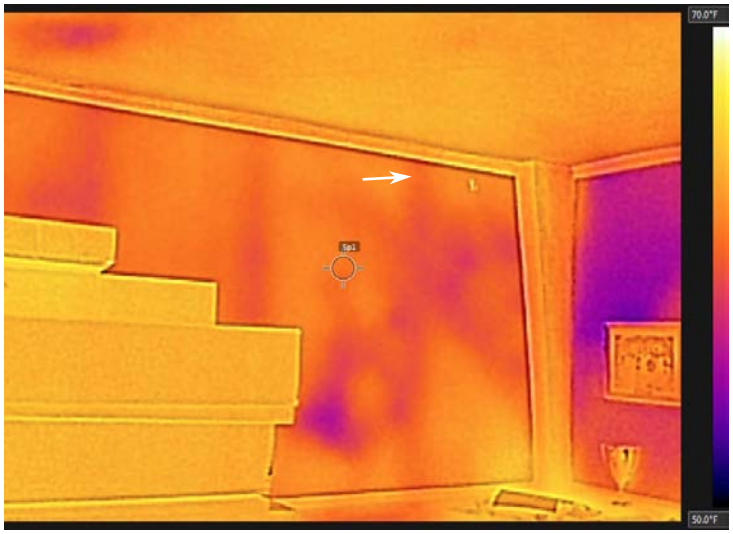
A door from the front stairway is secured by a chain and cannot be opened more than a few inches. Access is via the normally locked door from the stairway from the main meeting room.

Wall insulation varies. In the image to the right the cavities are clearly not insulated.

However, the second image shows insulated cavities in the wall at the left, and uninsulated ones around the corner in the walls to the right.

Wall temperatures vary from 55-62°F (purples to dark oranges). Free-standing objects are generally around 64°F, indicating the air temperature. There are a few cold spots below 50°F.



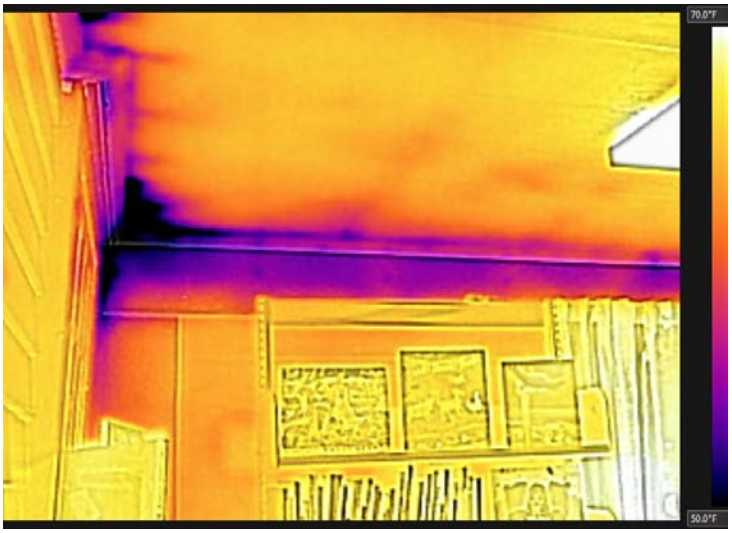


Library building:

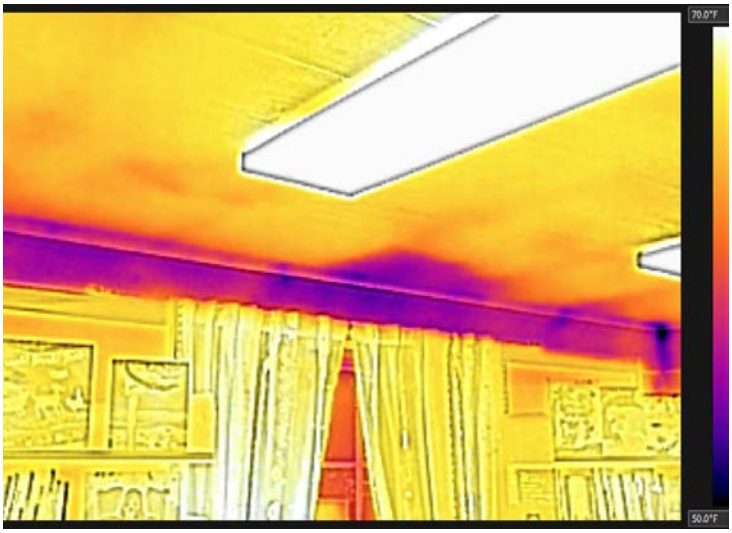
As discussed on page 2, the exterior images indicate that all the Library building walls are insulated.

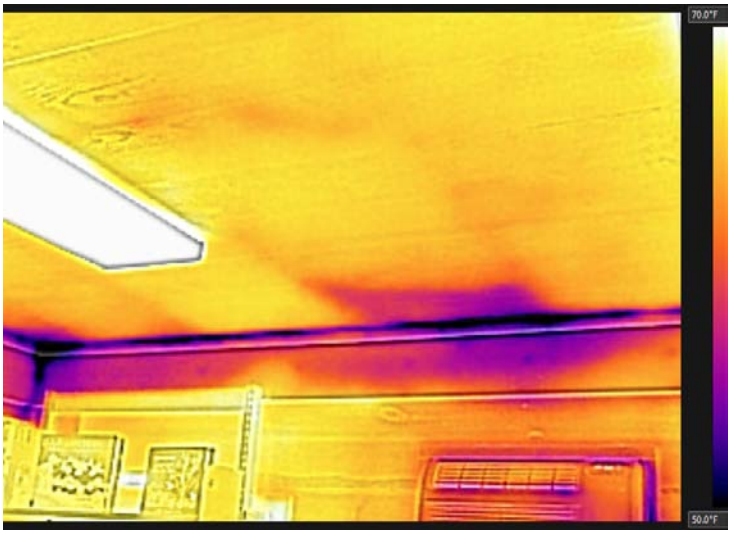
Library : children's room:

There appears to be a substantial heat leak in in upper left corner, which is around 38°F compared to the walls and ceiling which are at 64°F. Perhaps cold air inflow?

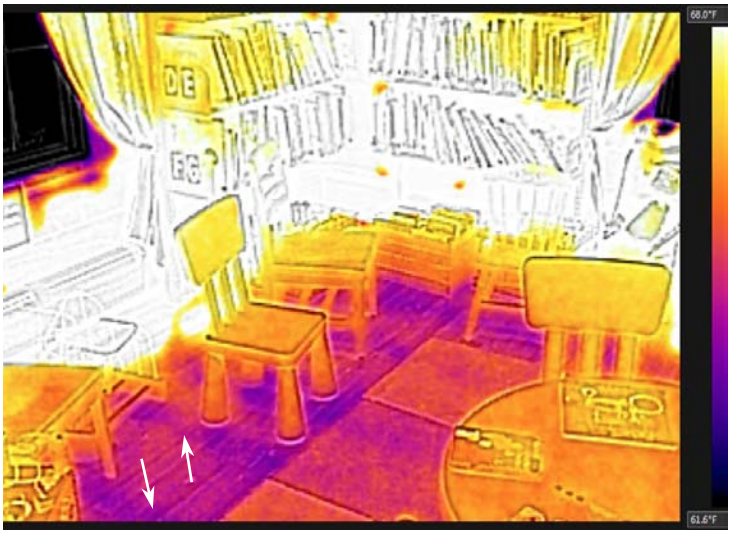


There consistently are similar, although not as extreme, heat losses along the joints between the wall and the ceiling all around the external walls. Temperatures in these black-colored areas are as low as 45°F while the walls and ceilings are ~ 64°F. See images below.





The equalized image to the right shows a narrow 9°F range to maximize the "contrast". The pattern of cooler joists and warmer areas between indicates that the floor is properly insulated.

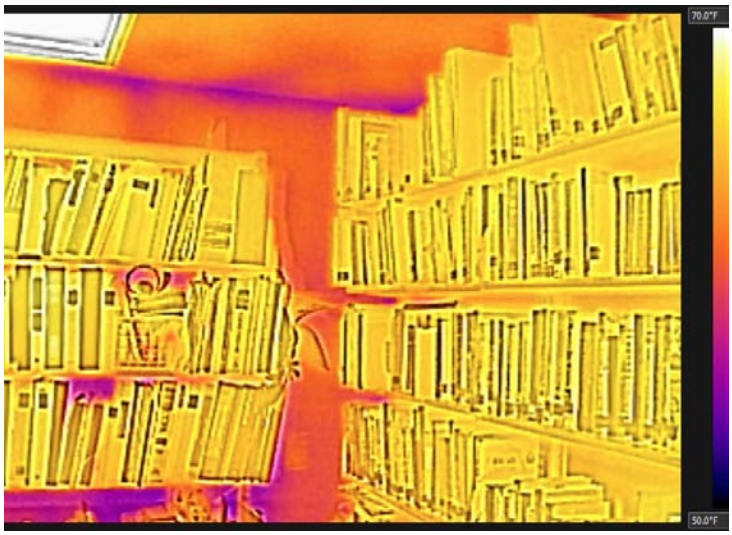


Library: upper floor:

Too much of the walls is covered with bookshelves to see a stud/cavity pattern, but there is no indication of any lack of insulation.

Wall temperatures are around 60°F, the ceiling around 62°F, the floor and standing objects around 66°F, suggesting an air temperature of 66°F.

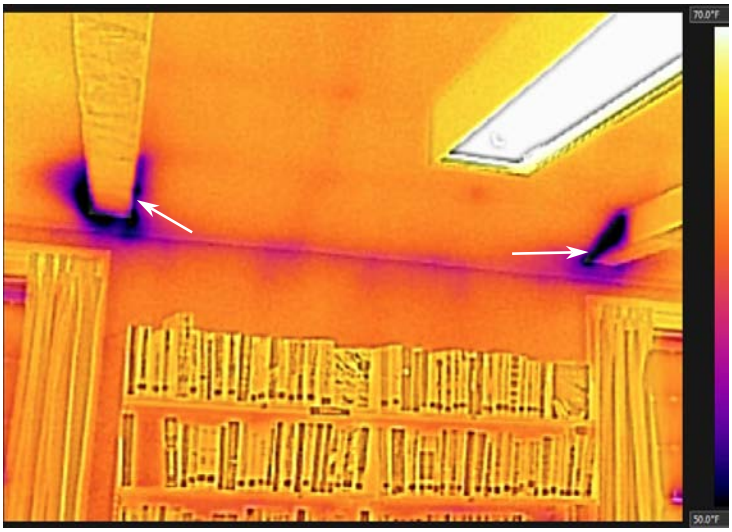
Walls behind rows of books will run cooler because of reduced access by warm room air. This can be seen in the purple areas just above the rows of books.

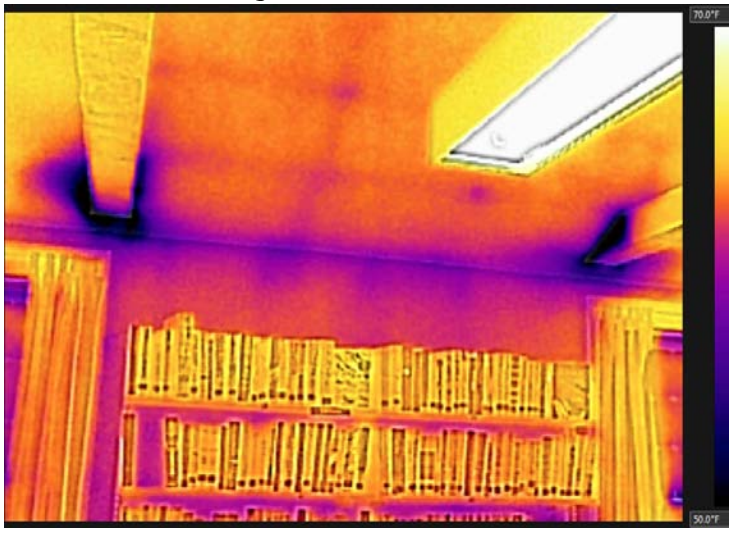


Library: lower floor:

Heat leaks are found where each tie beam pass through the ceiling. The temperatures in these areas can be as low as 39°F, though more commonly around 45°F. This might be caused by inflow of cold air?

Linear scale *Equalized scale*

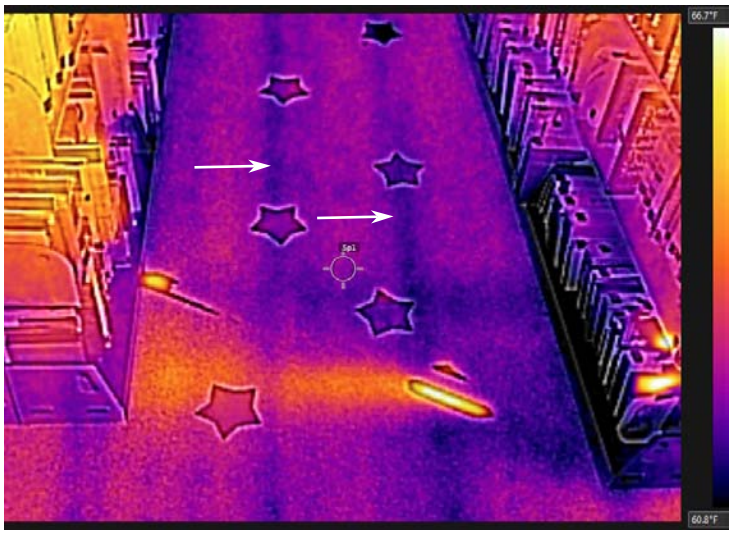




The cooler stud and warmer cavity pattern that indicates cavity insulation can be seen above the top book row.

Wall temperatures are around 62°F, ceilings 63-65°F, floors 60-62°F, standing objects ~ 64°F (air temp)

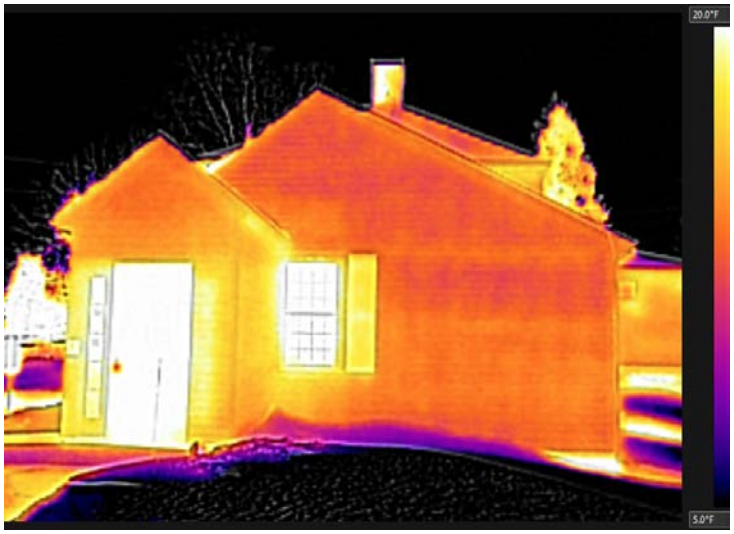
The cool joist and warm cavities shown in the Equalized image with a narrow 5°F range shows that the floor is insulated.

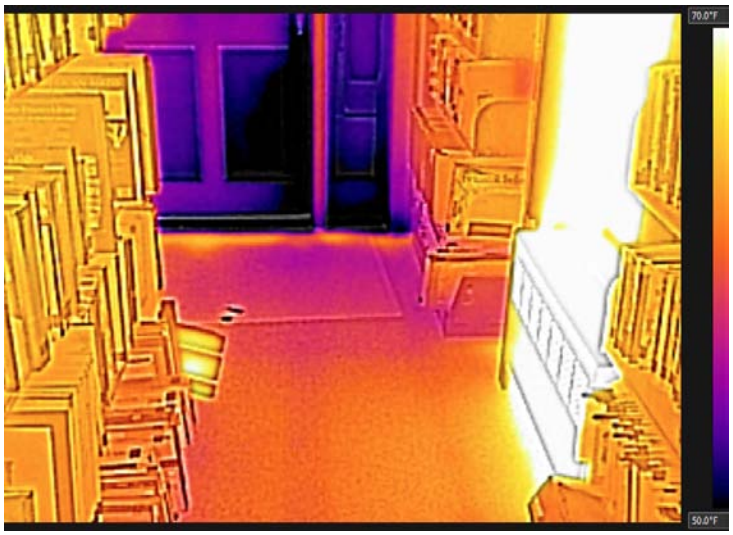


Library : Miscellaneous items:

The exit door is rather cold, 45°F at its lower edge and 55°F at its middle panel. This seems surprising as it is opening into an enclosed passageway to the exterior door.

An exterior image (before sunrise), suggests quite a bit of heat loss from this exterior passageway and door.

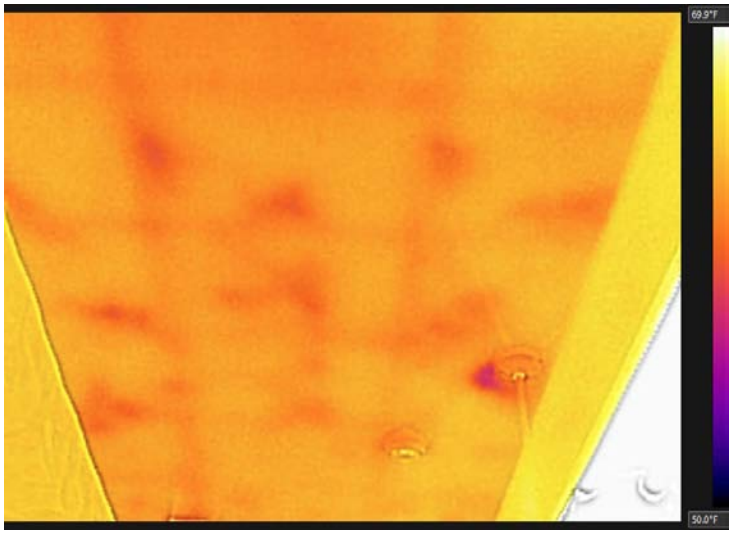




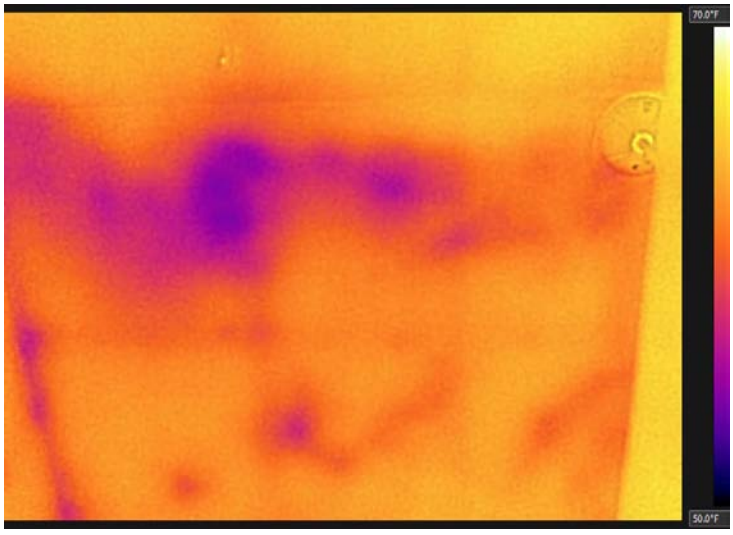
I did not observe whether the passageway itself is heated, but I assume it is not. I would have thought that two doors separated by a wide airspace would provide better insulation than is indicated by the low temperature of the inner door.

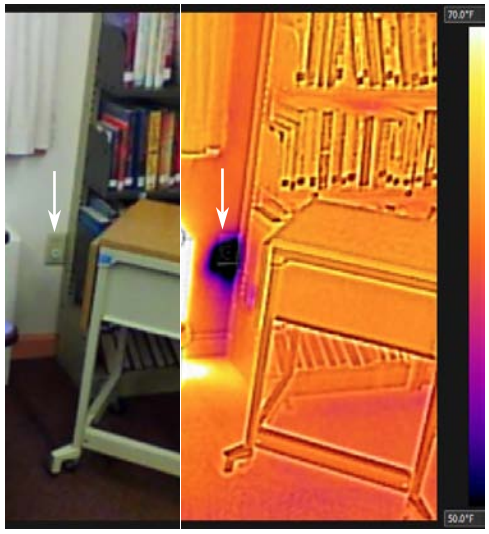
A curious "mottling" can be seen in several places in the ceiling of the lower library room. This reflects a difference of near 4°F between the spots and the rest of the ceiling (and 8°F difference in the lower image). One can also see the support grid.

Such mottling often results from thin spots in loose insulation, or moisture from roof leaks or condensation.



Cause is not obvious, but might be worthing thinking about...





Finally, an example of an uninsulated outlet (one of several wall outlets and switches throughout the building). The nearby wall temperature is over 60°F while the outlet face is 43°F, low enough to condense moisture from the air and create conditions for corrosion of the electrical fixtures inside. Modern construction standards provide for boxing in and insulating in-wall electrical boxes to prevent such problems.