Insulation and Weatherization

COMMON AIR LEAKS

- Air Leaking into the house
- Air Leaking out of the house

Source: U.S. EPA
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Introduction

One of the most significant issues confronting many of the homeowners we assist is high utility bills during the winter. So it is important that we look for ways that we can improve the weatherization of their home. We have identified below several areas that we have observed as significant problems at past homes that can easily be resolved with maximum benefit to the homeowner both in warmth and lower utility bills.

Seal openings to the attic and exterior.
Many of the houses we work on have had roof leaks that have caused collapse of plaster from ceilings. These openings allow heat to escape from the living space into the attic and need to be repaired. Many of these homes also have no exterior wall insulation, and when there is a hole in the exterior wall air again will escape from the living area. If there is also any damage to the exterior siding it will allow cold air to blow into the room. These openings need to be sealed.

Replace broken window panes.
Broken window panes are also common in many houses and need to be replaced. The glazing should be checked on all windows and re-glazed if necessary.

Weather-strip doors and windows.
All exterior doors should be inspected and sealed as effectively as possible. For houses that do not have air conditioning it is important to seal them in a manner that will allow some to be opened in the Spring and Summer. Be sure to seal around window air conditioners.

Seal Furnace Ductwork.
The duct work to and from the furnace is a significant problem in older homes. It is not uncommon to see sections completely disconnected. Most ductwork connections are not sealed. All interconnections should be sealed with water based duct sealing mastic or metal foil tape.

Replace the furnace filter
Clogged furnace filters are another common problem in many houses. This seriously affects air flow and thus furnace efficiency. In addition to replacing the filter, it is recommended that we leave a couple extra clean filters with instructions to the homeowner that the filters should be changed every couple months.

Insulate the attic. Many houses lack adequate insulation in the attic. Some aren’t insulated at all.
Weatherization of a home is intended to protect the home from the elements, reduce energy consumption and optimize energy efficiency. This will include: insulating and air sealing the thermal envelope, updating HVAC systems, sealing air ducts, reducing resource consumption and behavioral changes by the home occupants. The thermal envelope includes the exterior walls and ceilings that separate living space from the exterior or non-living spaces. We are attempting to reduce the amount of air exchange with the exterior and reduce the amount of heat lost or gained through exterior walls or ceilings.

**Air Sealing**

1. **Outlets and Switches on exterior walls.** The thermal image shows the air leakage around and through the outlet. To remedy this, we will seal the outlet/switch box to the drywall/framing using caulking, install insulation gaskets and install child safety plugs. This will seal out air leakage and provide a level of safety for the occupants. This process is also good for outlets and switches on interior walls of the top floor of the home. (Main floor in single story home and 2nd floor in 2 story home). This is good practice when air sealing the top plates of the walls in the attic space is not an option or is limited.
2. **Window and Door Trim.** Air leakage also occurs at the trim around doors and windows because expandable foam insulation typically would not have been installed around the door or window frame during construction unless the home was built in the last 10 to 15 years. The thermal image below shows the air infiltration at the trim around the window. To remedy this you can pull the interior trim and install expandable foam insulation or you can leave the trim in place and use clear paintable caulking to seal the trim to the wall and the window frame or sill on the interior of the home. (Be sure to not caulk any of the moving parts of the window)
At the exterior of the home we will seal the window frame and trim to the siding. Be careful to not seal the moveable parts of the window or any drains built into the storm windows or the window frame itself.

3. **Exterior Vents.** At the exterior of the home, there will be vent covers for dryer vents and bathroom exhaust fans. These covers should be clean and close properly to prevent air leakage out of or into the home.

4. **Single pane windows.** These type of windows will not be as energy efficient as modern double or triple pane windows but with maintenance, repair and the installation of storms windows, they can achieve roughly 70% of the efficiency of modern windows. Ideally old single pane wood windows would be replaced but this does not always make financial sense. In many cases, the windows can be repaired and re-glazed. Glazing compound is installed at the exterior of the window.
to seal and secure the panes of glass in place in the window sash. If re-glazing is too much labor, you can apply caulking to the interior or exterior of the window frame to perform a similar function as the glazing compound.

In lieu of re-glazing, clear or white paintable caulking can be applied on the interior or outside of the window sash. We are mainly concerned with keeping the panes of glass in place and reducing the air flow through the window.

5. **Caulking Rope.** The use of caulking rope can be used to seal the window sashes on a temporary basis to seal out air leakage when the window is not being used. The material can be removed and reused.
6. **Weather-stripping at doors and windows.** At exterior doors, the weather-stripping, sweep and thresholds should be evaluated and replaced as needed. At windows, weather stripping can be installed along the bottom of the sash to form a tighter seal and window insulation kits can be used to help seal out air leaks. Keeping all doors and windows completely closed and locked will form a tighter seal and keep air infiltration to a minimum.
7. **Rim joist and sill plate.** Sealing the rim joist and sill plate in the basement or crawlspace is the primary way to reduce air infiltration in these areas. Caulking can be used but expandable foam insulation makes more sense, is easier and will last longer.

![Image of rim joist and sill plate being sealed](image_url)

8. **HVAC ductwork in the basement/crawlspace and attic space.** Sealing the HVAC ductwork is an important way to ensure the conditioned air is not leaking into unconditioned areas. The easiest method for sealing ductwork is using metal tape to wrap and seal the joints in the ductwork. There are other ways of sealing the ducts such as applying duct mastic but the metal tape is the easiest and least messy method.
You also want to make sure the air ducts are properly insulated in unconditioned spaces or spaces that are not considered part of the living space (attic spaces and crawlspaces). The ducts will either have insulation wrap around the outside or it could be on the inside. To verify if the ducts are insulated on the inside you can tap on the ductwork. A hollow sound would indicate no insulation. A “dull” thud would suggest insulation was on the interior of the ducts. There are
multiple ways to insulate ductwork so check which materials will be appropriate.

9. **Fireplace Flue.** Fireplace dampers should be closed when not in use and an inflatable bladder can be purchased to seal the flue off and prevent air leakage up the chimney.
COMMON DUCT PROBLEMS AND SOLUTIONS

PROBLEMS:
A. Leaky, torn, and disconnected ducts
B. Poorly sealed registers and grills
C. Leaks at furnace and filter slot
D. Kinks in flexible ductwork restricting airflow

SOLUTIONS:
E. Properly sealed ducts
F. Registers and grills tightly sealed to ducts
G. Sealed furnace and filter slot
H. Well-insulated ducts in unfinished areas
I. Straightened flexible ducts with improved airflow
10. **Openings in the attic space.** In the attic space, we are looking for any openings in the ceilings, attic fans, wall top plates or bypasses that go through the ceiling. This would include plumbing, wiring, HVAC ductwork, chimneys and light fixtures. Use silicone caulking or expandable foam insulation to seal small openings. Use rigid foam insulation board or drywall cut to size to cover large openings or bypasses and seal the board or drywall to the studs or ceiling to form an air tight seal.
Light fixtures and gas burning appliance vent pipes need special consideration due to fire hazards. You can either not insulate near them or install approved covers or barriers.
Cut sheet metal to fit around furnace/water heater vent pipes and use high temperature sealant to make an air tight seal. Covers can be purchased or fabricated to cover whole house fans when not in use.
The attic access panels and doors should be weather-stripped and insulated.

**Insulation**

Insulation should surround the thermal envelope of the building. The thermal envelope is comprised of the elements of the building that separate the living space from the non-living space. The primary focus for insulation for our purposes will be in the attic space and basement/crawlspace at the rim joist on top of the foundation walls. Insulation inside the exterior walls is very important but is a project outside the scope of the typical “do-it yourself” type projects in many cases. In many older homes, blowing insulation into attics or wall cavities will not be safe or feasible without rewiring the house due to old wiring called knob and tube wiring. Be cautious.

**INSULATION INSTALLATION PRECAUTIONS**

- Wear clothing adequate to protect against skin contact and irritation. A long-sleeved shirt with collar and cuffs buttoned, gloves, hat, glasses, and disposable dust respirator are advisable in all do-it-yourself insulation projects. Also, read the label and follow all the manufacturer’s directions.
- Do not cover or hand-pack insulation around bare stove pipes, electrical fixtures, motors, or any heat-producing equipment such as recessed lighting fixtures. If you pack insulation around these heat-producing locations, the heat can build up, leading to fire. Electrical fire-safety codes prohibit the installation of thermal insulation within three inches of a recessed fixture enclosure, wiring compartment, or ballast, or above the fixture so that it will trap heat and prevent free circulation of air, unless the fixture is identified by label as suitable for insulation to be in direct contact with the fixture. THIS IS FOR FIRE SAFETY.
- Do not cover attic vents with insulation. Proper ventilation must be maintained to avoid overheating in summer and moisture build-up all year long.
1. **Exterior walls.** If knob and tube wiring is present in the homes exterior walls or in the attic space, insulation cannot be safely installed until the wiring has been removed or if it will not be in contact with or buried beneath the insulation.

(Knob and tube wiring in walls and attic space)
2. **Basement/crawlspace.** R-19 to R-30 fiberglass batt insulation will be cut to fit in between the floor joists on top of the foundation wall after the air sealing has been completed.

Crawlspace insulating can vary depending on whether you are including the crawlspace as part of the home or not. If you are including the crawlspace as part of the home then you would insulation the exterior walls of the crawlspace foundation, close off the ventilation and install a vapor barrier on the floor of the crawlspace to reduce moisture levels. If the crawlspace is excluded from the home, you would install insulation in between the floor joists, ensure proper ventilation and install a vapor barrier as optional but still a good idea.

3. **Attic Space Hazards:** Prior to installing insulation in the attic space, a thorough inspection by a qualified contractor must be done to identify any potential safety hazards that present an immediate hazard or those which may present a hazard when insulation is added. These include but are not limited to electrical hazards, asbestos containing materials, attic ventilation, animal infestations and animal waste. The electrical hazards may include junction boxes
missing covers, light fixtures, frayed or damaged wiring, electrical splices made outside of junction boxes and knob and tube wiring.

Asbestos containing materials will most likely be an insulation called vermiculite or a white paper material wrapped around ductwork. If this insulation material is found in an attic space, no work should be done in the attic space or to the ceilings in which it is installed. All work with this material should be done by professionals only.
The white paper wrapped on ductwork should not be disturbed except by a professional contractor. In many cases, encapsulation paint can be used to seal the tape and leave it safely in place. This can be found in attic spaces and basements/crawlspaces.
Animal infestations should addressed prior to insulating the attic space and may include pest removal, waste removal and repairs to the structure to prevent reentry of the animals.
Be cautious of vent pipe issues with gas or wood burning appliances. The vent pipe should be intact, should not be corroded and not disconnected. Further investigation is needed by an HVAC contractor if the piping is corroded or disconnected as this may lead to carbon monoxide issues or fire in the home.

4. **Attic Ventilation.** Special attention needs to be paid to attic ventilation to ensure adding insulation does not block soffit or gable vents and lead to moisture issues and heat build-up in the attic space. If the home is equipped with soffit vents, baffles must be installed to
keep prevent blockage of the vent covers. If gable vents are installed, you must ensure you do not blow insulation near the vents clogging them.
Winter Conditions

Functional Attic

- Seal attic floor penetrations / Exhaust moisture and heat from fans
- Even snow cover
- Cool air circulation
- Reduced energy costs & even temperature between floors
- R50 Insulation
- Air intake at soffits

Dysfunctional Attic

- Condensation on roof deck causes mildew and wood rot
- Ice dams / moisture permeates roof deck
- Minimal insulation
- Blocked soffits
- Condensation from roof deck causes interior water damage
- Hot air and moisture radiates into attic resulting in a cold upper floor and energy loss
5. **Radiant Barriers.** A radiant barrier can be added in the attic space to reflect radiation from the sun back outside. This will reduce the temperature of the attic space and reduce the temperature of the living space. These barrier comes in various forms and should be installed in accordance with the manufacture specifications. If you plan to reroof, you can also purchase roof deck that has a radiant barrier.
6. **Attic Space.** The easiest insulation to install in an attic space is blown in loose fill cellulose. It’s non-toxic and requires only safety goggles and a dust mask. The current recommended R-value of insulation in attic spaces is R-50. For cellulose insulation this would equate to approximately 15” of insulation. The equipment is typically provided during the purchase of the insulation and requires 2 people to operate.

Remember to be safe in the attic space, use eye protection, dust masks, proper lighting, protective clothing, wear gloves and be careful to always walk on the ceiling joists or trusses.
If you encounter fiberglass batt insulation installed in an attic space, you should consider removing the material and properly blowing in cellulose insulation. Fiberglass batt insulation is typically only installed in the exterior wall applications as a near perfect installation would be needed for it to be effective in the attic space.
HVAC Systems and Water Heater

1. **Updating old HVAC systems.** is a good way to improve energy efficiency but have high upfront costs with longer payoff periods. If this is a financially feasible option, this can generate significant savings. Properly servicing the HVAC systems yearly will ensure you maximize the life of the units and keep them operating at optimum efficiency.

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<tr>
<th>Low Efficiency</th>
<th>Mid Efficiency</th>
<th>Hi Efficiency</th>
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<tbody>
<tr>
<td>Old A/C</td>
<td>New A/C</td>
<td>Dirty A/C</td>
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Old A/C | New A/C | Dirty A/C
2. **Water Heater.** If your home is a long term investment and your current water heater is 10 years or older, it may make financial sense to have a tank-less water heater installed. The upfront costs are high, but in the long run you can save money by not having to heat and store water in a tank when you aren’t using it. For your current water heater, you can install an insulation blanket on the outside of the tank to reduce the heat loss of the how water being stored. You can also install insulation on the water lines to reduce heat loss and sweating.

![Before and After images of water heater insulation](image-url)
Tools and Materials Needed

1. Safety Goggles
2. Dust mask
3. Caulking gun
4. Utility knife
5. Tubes of caulking
6. Expandable foam insulation
7. Gloves
8. Fiberglass Batt insulation
9. Weather-stripping
10. Caulking rope
11. Outlet and Switch gaskets
12. Outlet child safety plugs
13. Flashlight
14. Aluminum Foil Tape
15. Window Insulation Kits
16. Rigid Insulation Board
17. Knee Pads
18. Wood Plank for attic work
19. Step Ladder
20. Water heater insulation blanket
21. Insulation for water lines
Reduce Energy Consumption

1. Install a programmable thermostat. This will allow you to turn down the thermostat while you are away from the home and have it heat/cool the home just before you return.
2. Turn the thermostat down in general. For every degree the thermostat is lowered, there is 2% savings in energy consumption.
3. Install low flow aerators at sink faucets
4. Install low flow showerheads.
5. Use shades at windows that face the sun. Close the shades in the summer and open them in the winter.
6. Switch light bulbs to CFL or LED bulbs
7. Unplug electronics when they are not in use
8. Use ceiling fans to circulate air and reduce usage of HVAC systems
9. Change the air filter for the furnace regularly
10. Install low flow toilets
11. Take showers vs. baths
12. Install an insulation blanket on the hot water tank.
13. Service the furnace and A/C yearly
14. Don’t over dry your clothes or even use a clothes line to dry them for free. Keep the lint trap on the dryer clean.
15. Wash clothes in cold water
16. When purchasing new appliances, make sure they are Energy Star appliances.
17. Check with the local utility providers to see if any tax credits or reduced priced energy audits are available for energy efficiency improvements.