



Fraser Basin Council

Best Practices for Air Sealing and Insulation Retrofits

MAY 11, 2018

PRESENTED BY RDH BUILDING SCIENCE

Overview

- What is Weatherization?
- Building Science Fundamentals
- Health & Safety Considerations
- How to Prioritize Retrofits
- Demonstrations
- Further Information



Air Leakage Demonstration

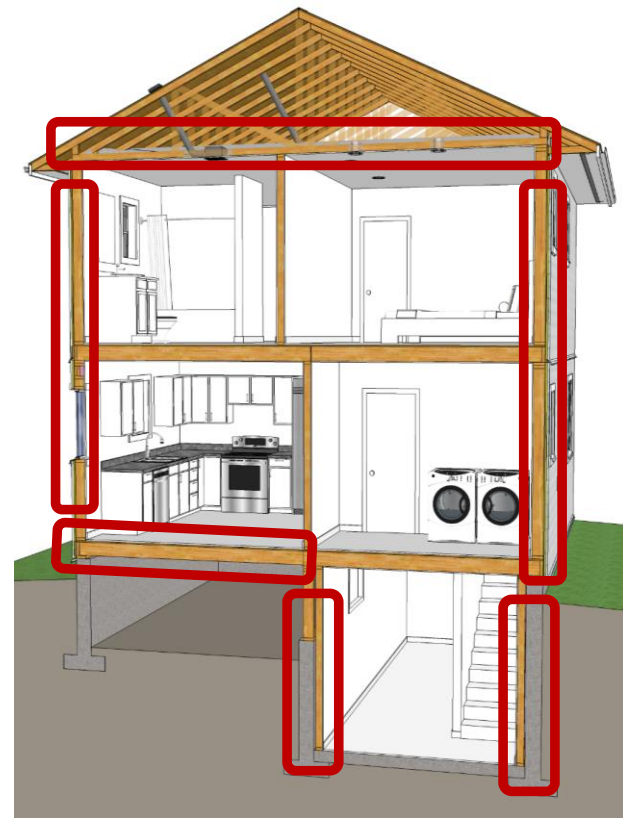
What is Weatherization?

- Identifying locations of heat loss in the building enclosure – air leakage and heat loss including missing/minimal insulation
- Performing air sealing work
- Installing new or topping up old insulation
- Other minor building enclosure repairs and improvements (ie window upgrades, residing etc.)
- Purpose to improve thermal comfort, reduce energy bills and improve building enclosure durability



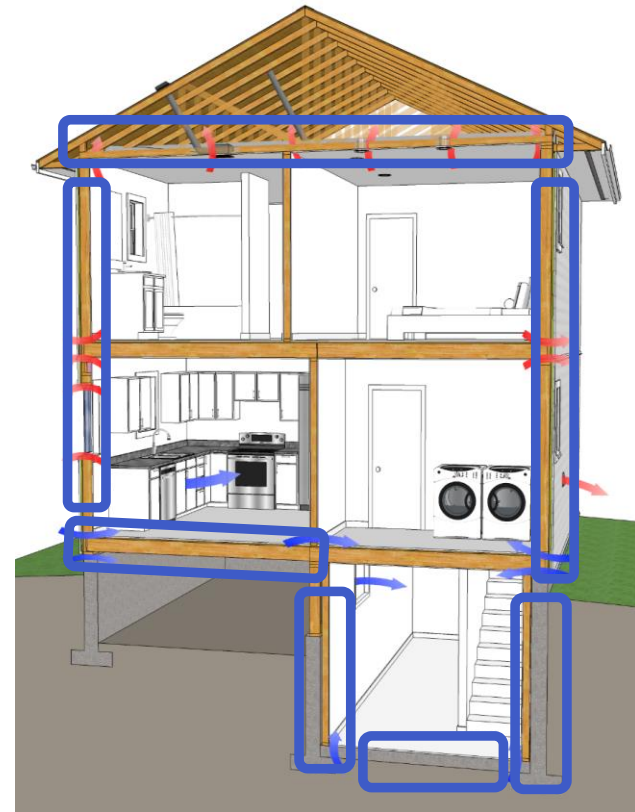
Potential Areas for Insulation Upgrades

- Attics – easy and very common
- Floors/Crawlspaces (vented to unvented conversions) – easy and somewhat common
- Compact Roofs/cathedral ceilings – harder to access
- Walls (cavity fill or exterior insulation during siding retrofits) – more intensive and costly
- Floor headers, bay windows and other locations of missing insulation – depends on access



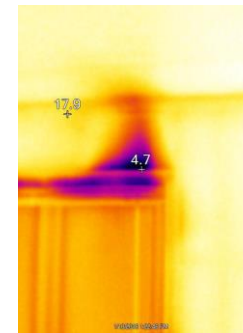
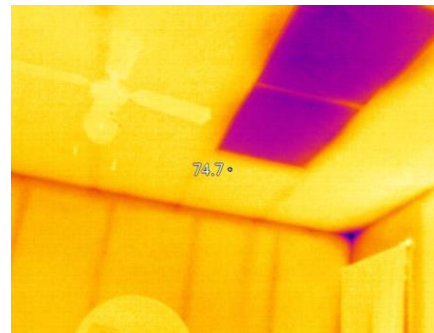
Potential Areas for Air Sealing Upgrades

- Attic/ceiling penetrations
- Exterior wall penetrations
- Floors over unconditioned space
- Below grade/basement walls and floors



Identifying Candidate Homes

- Visual Assessment
- Infrared Scans
- Blower door test
- Prioritizing poorly insulated and easy/cost effective to access locations first
- Identifying very air leaky homes and locating the big holes and sealing

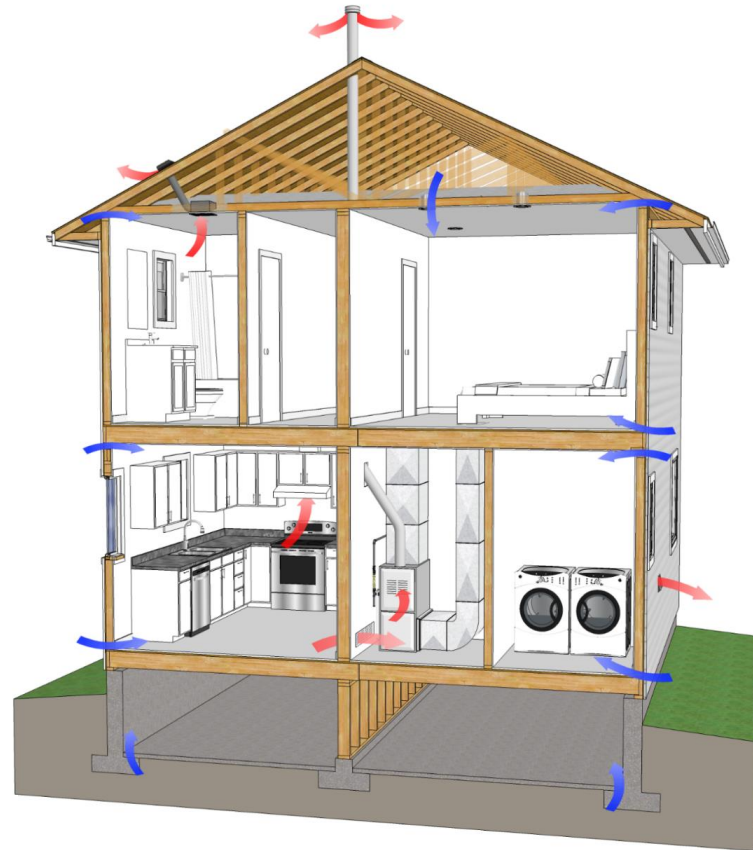


Building Science Fundamentals

- The House as a System
- The Building Enclosure
- Attic Air Sealing, Insulation, and Ventilation
- Crawlspace Air Sealing, Insulation, and Ventilation

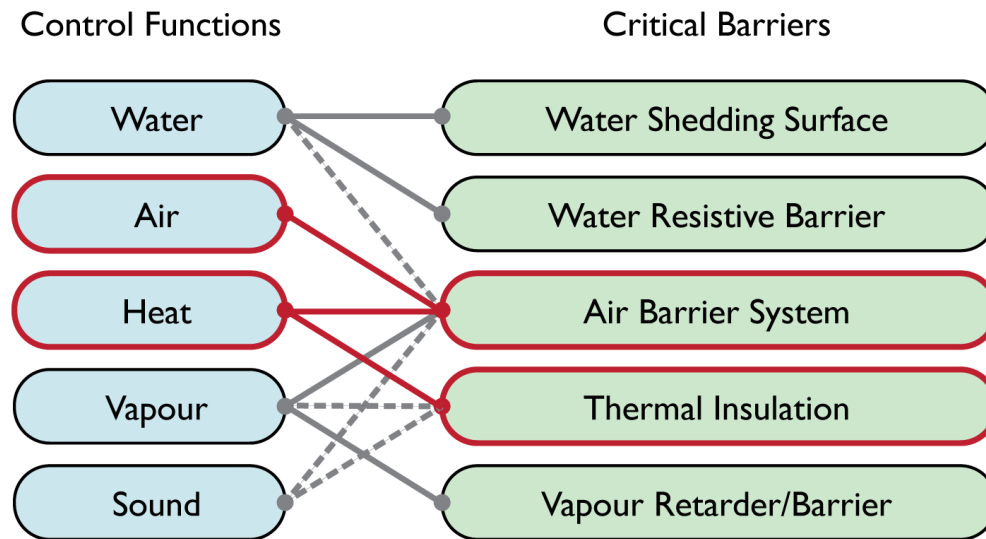
The House as a System

- House is made up of building enclosure, structure, mechanical and electrical equipment, etc.
- Energy upgrades do not occur in isolation and may affect several building components
- Airtightness improvements to building enclosure may reduce loading on space heating equipment and may increase moisture accumulation or problems.








The Building Enclosure

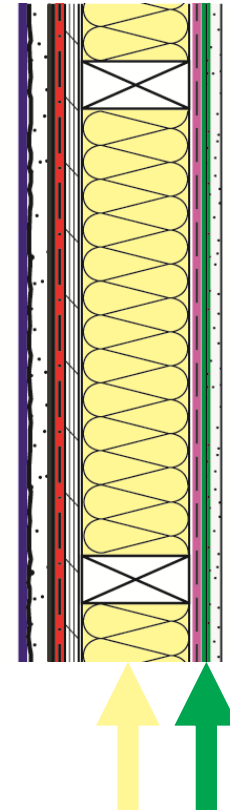
- Materials and components that separate the exterior from interior environment
- Increasing building airtightness and insulation levels can improve energy performance, occupant comfort, and building durability



The Building Enclosure

→ Layers of materials and components that control elements

-  Water Shedding Surface
-  Water Resistive Barrier
-  Air Barrier
-  Vapour Retarder
-  Thermal Insulation



The Building Enclosure

→ Air Barrier

- Resists airflow between interior and exterior spaces
- Heat loss occurs when interior conditioned air escapes or when exterior air infiltrates building



→ Thermal Insulation

- Materials with low thermal conductivity resist heat flow
- Higher R-value indicates greater resistance to heat flow



Insulation and R-values

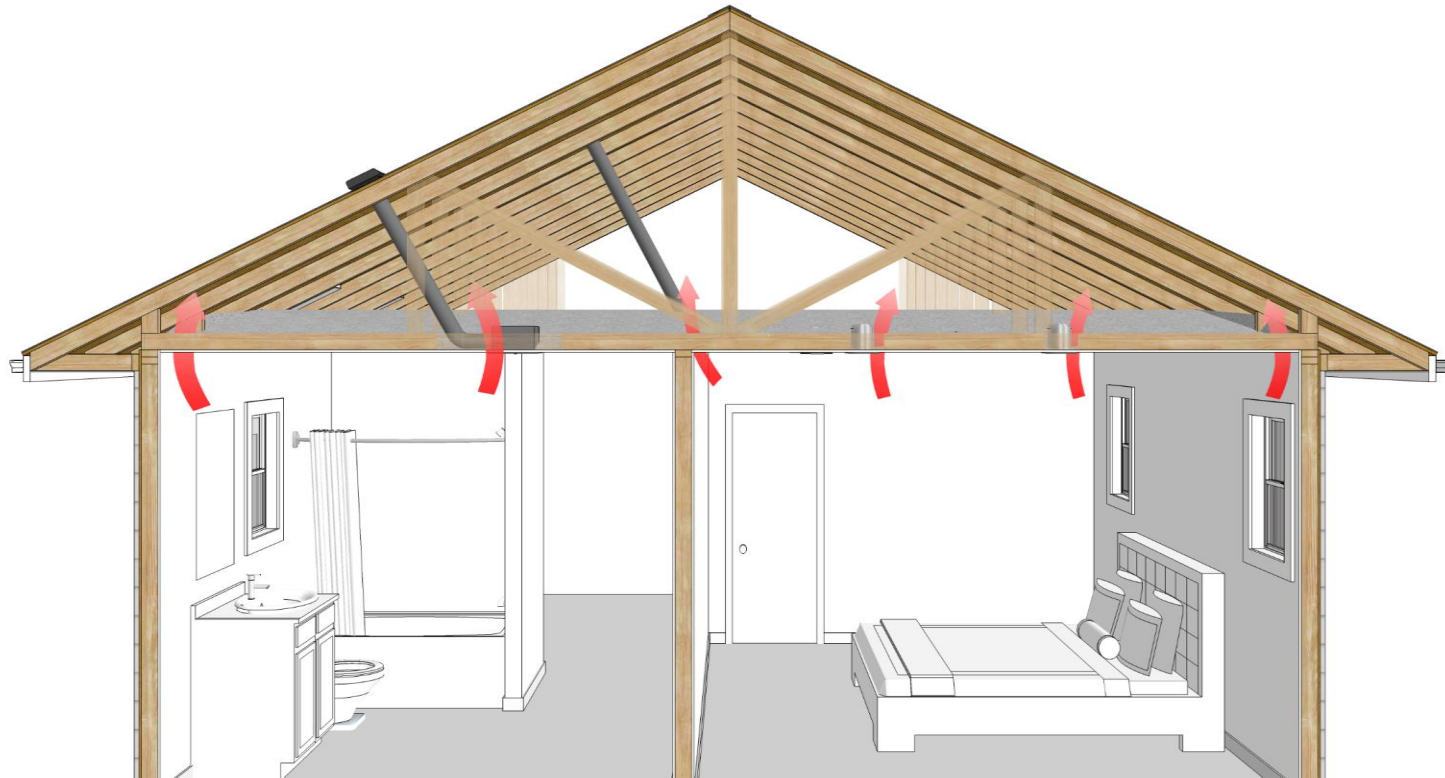
- Insulation is rated by a term called an R-value, which is its rating of thermal resistance. A higher value results in less heat flow.
- Most insulation has an R-value of between R-3 and R-6 per inch of thickness – though framing and other thermal bridges will reduce the assemblies overall performance
- Common insulation products include: fiberglass and mineral fibre, cellulose, wood fiber, and various foamed plastics
- Code minimums – R-15 to R-20 for above and below grade walls, R-30 to R-50 for roofs. Targets when retrofitting – code minimum or higher if possible



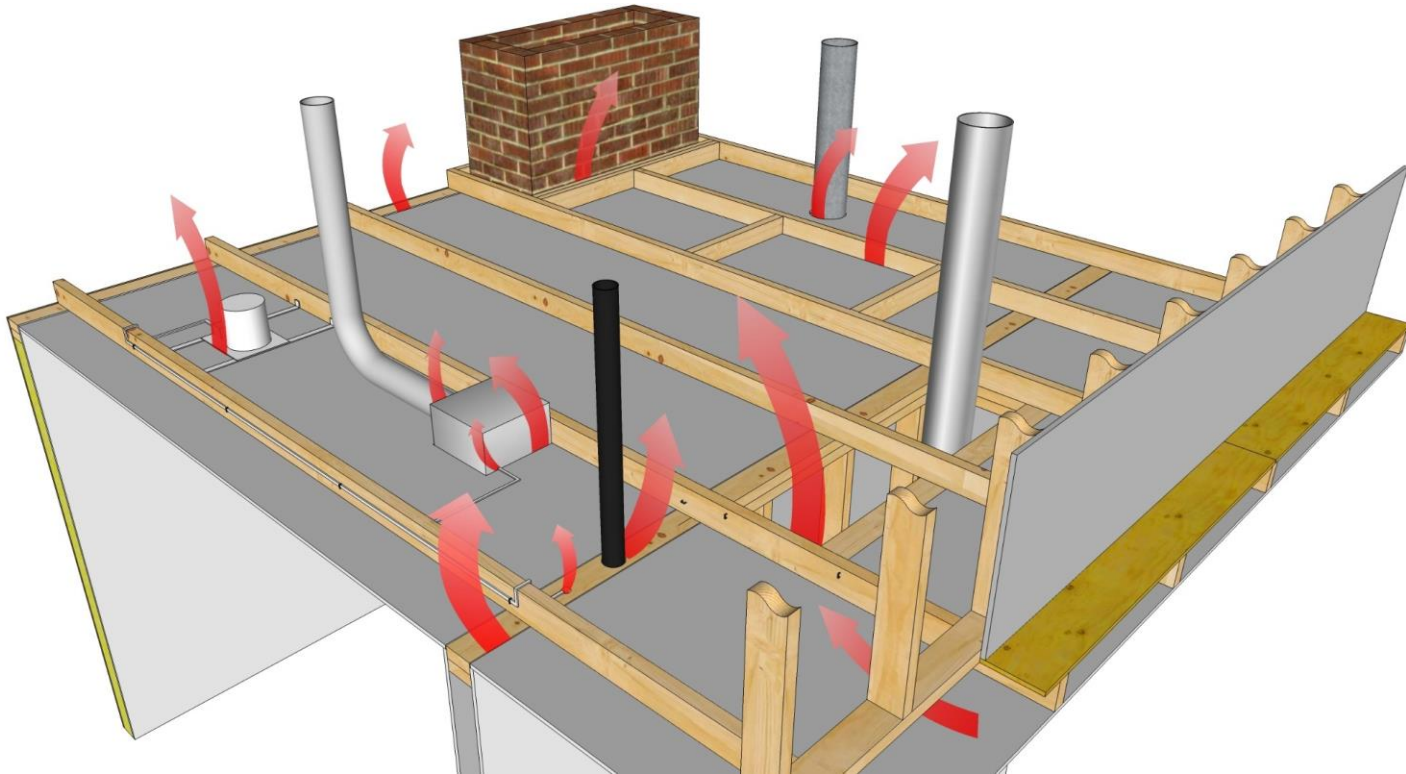
Attic Considerations



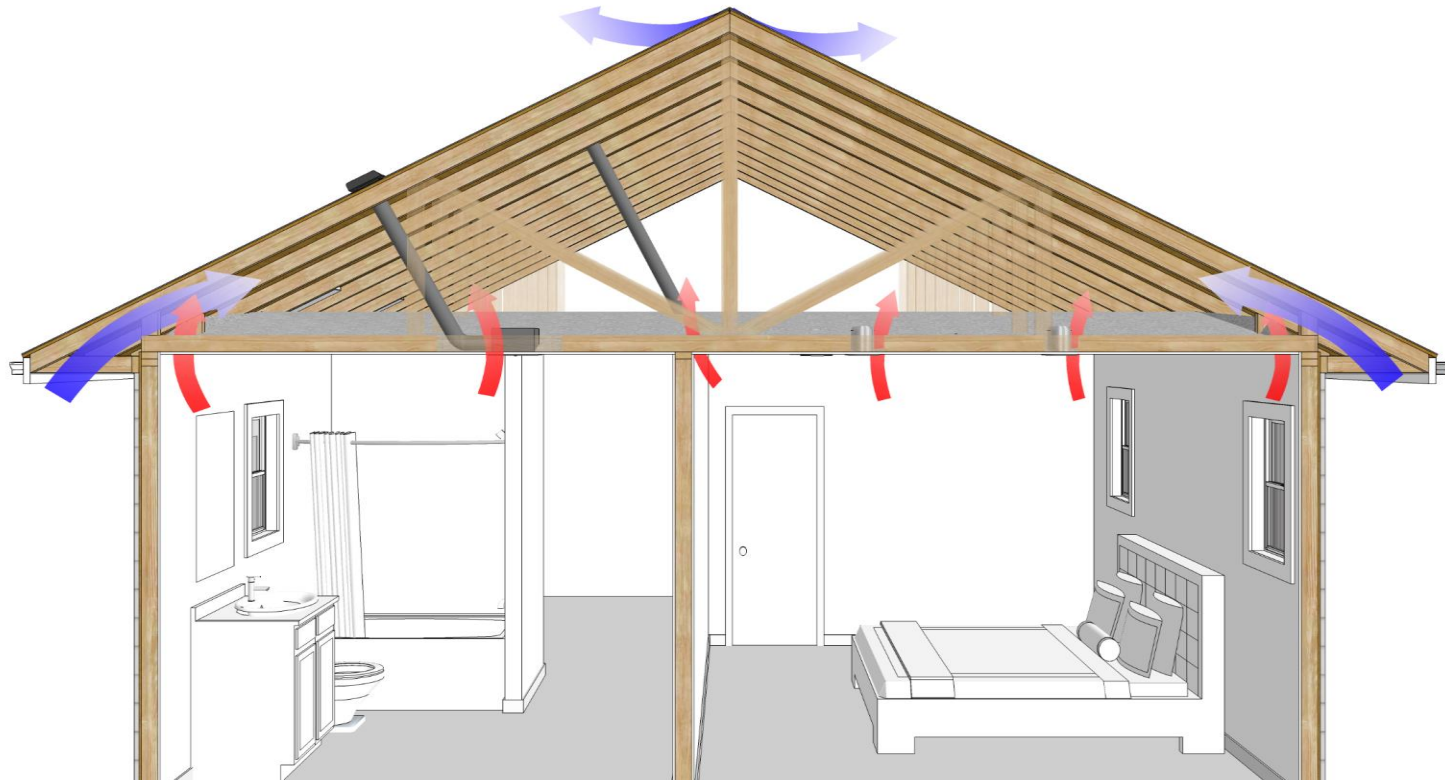
Attics- Air Leakage



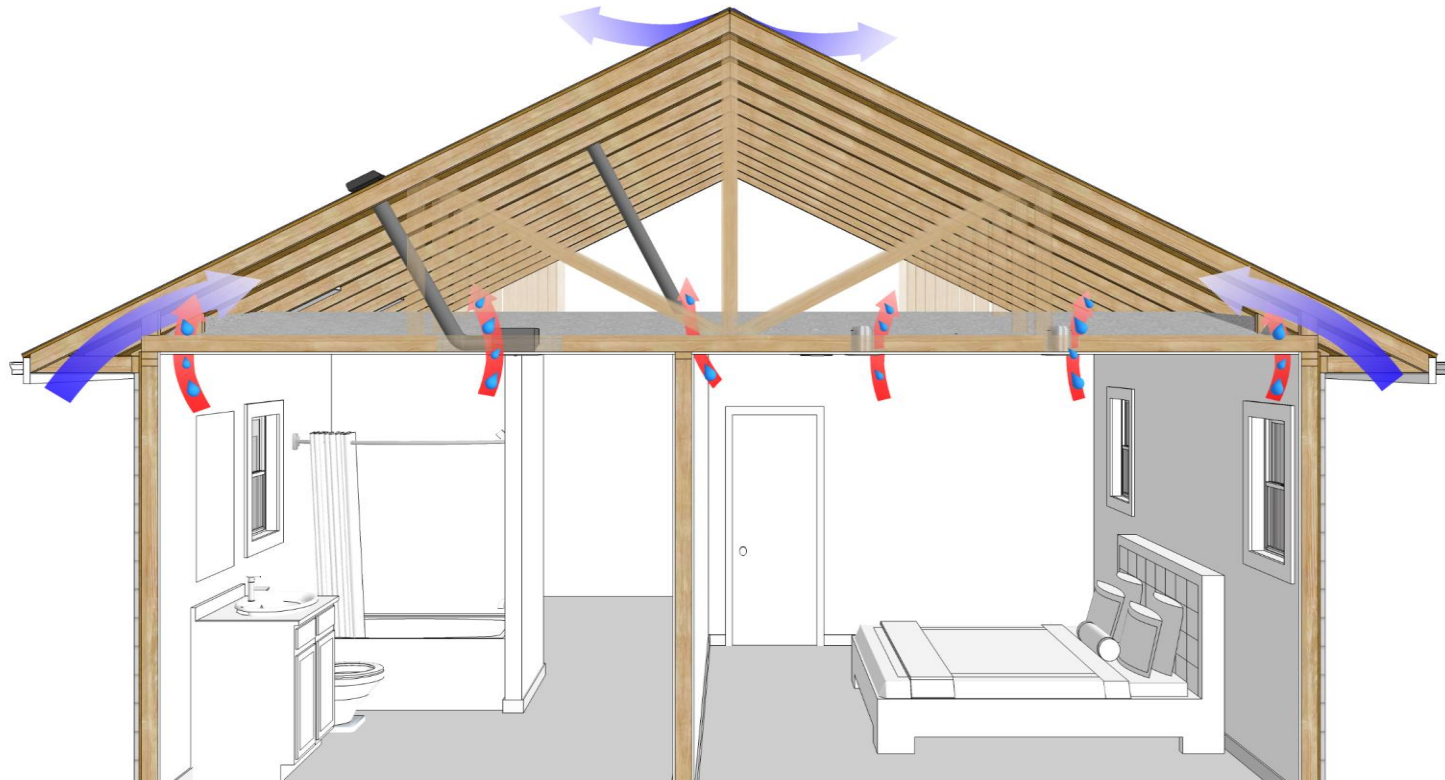
Attics – Many Sites of Air Leakage



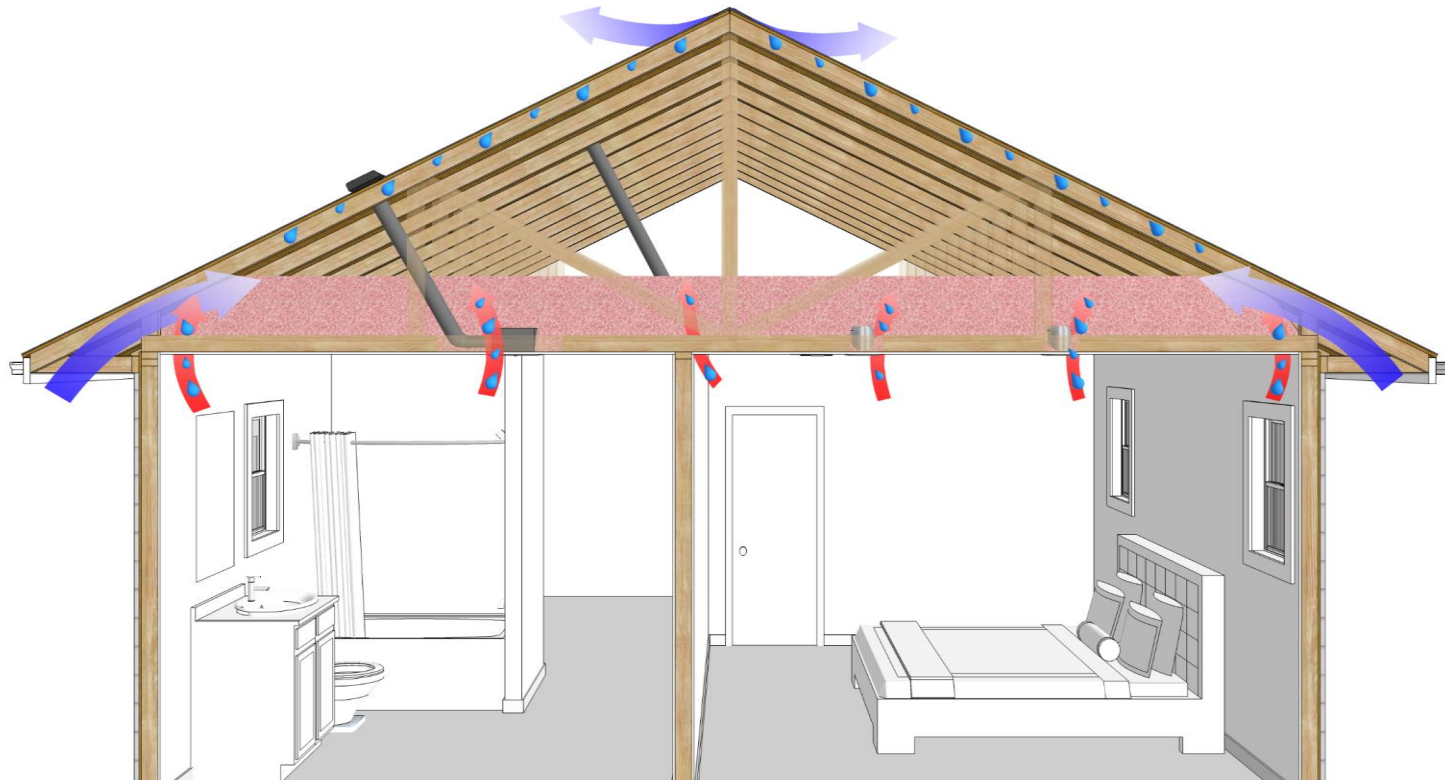
Attics - Ventilation



Attics – Moisture Sources



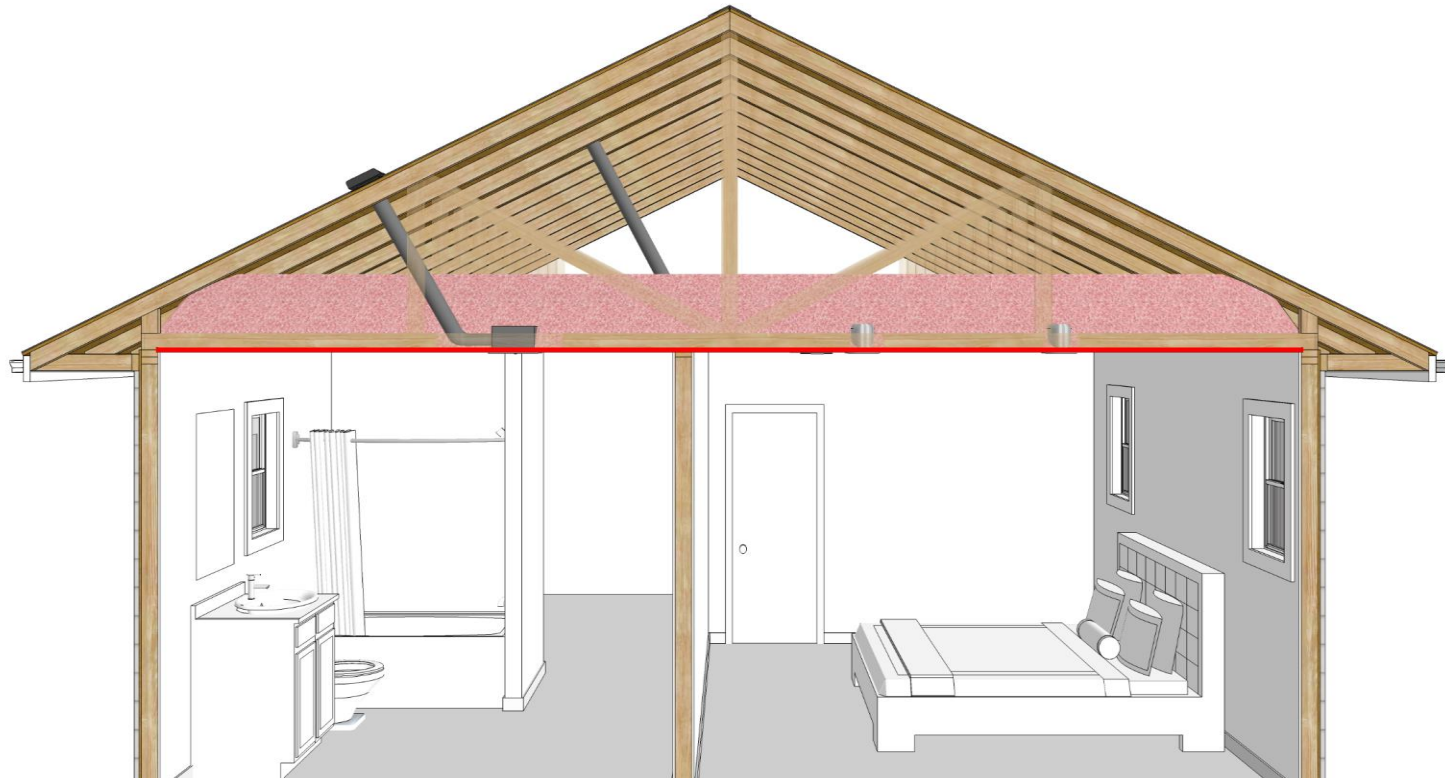
Attics – Insulation & Moisture Risks



Attics – Insulation & Moisture Risks



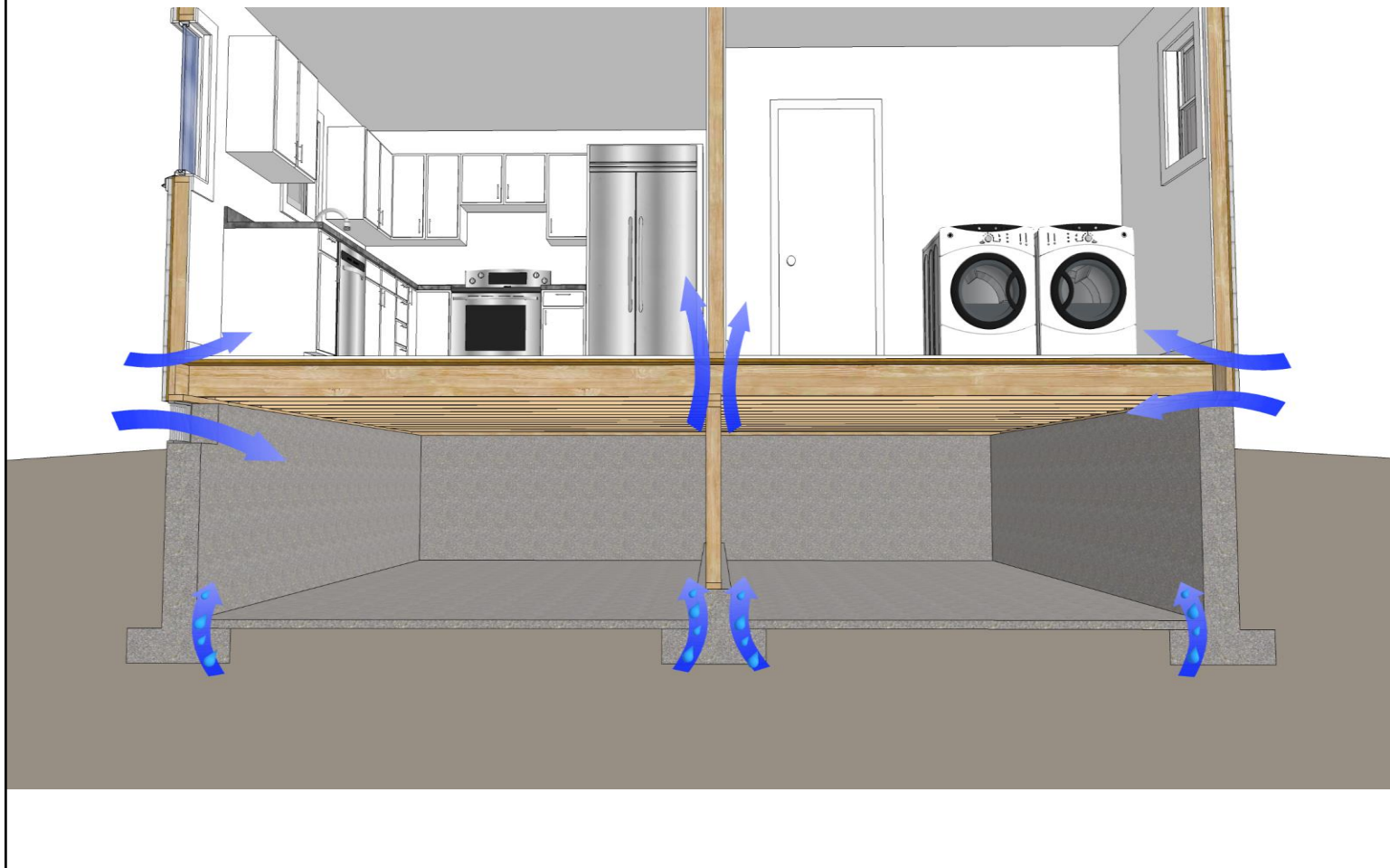
Attics – Air Sealing & Insulation



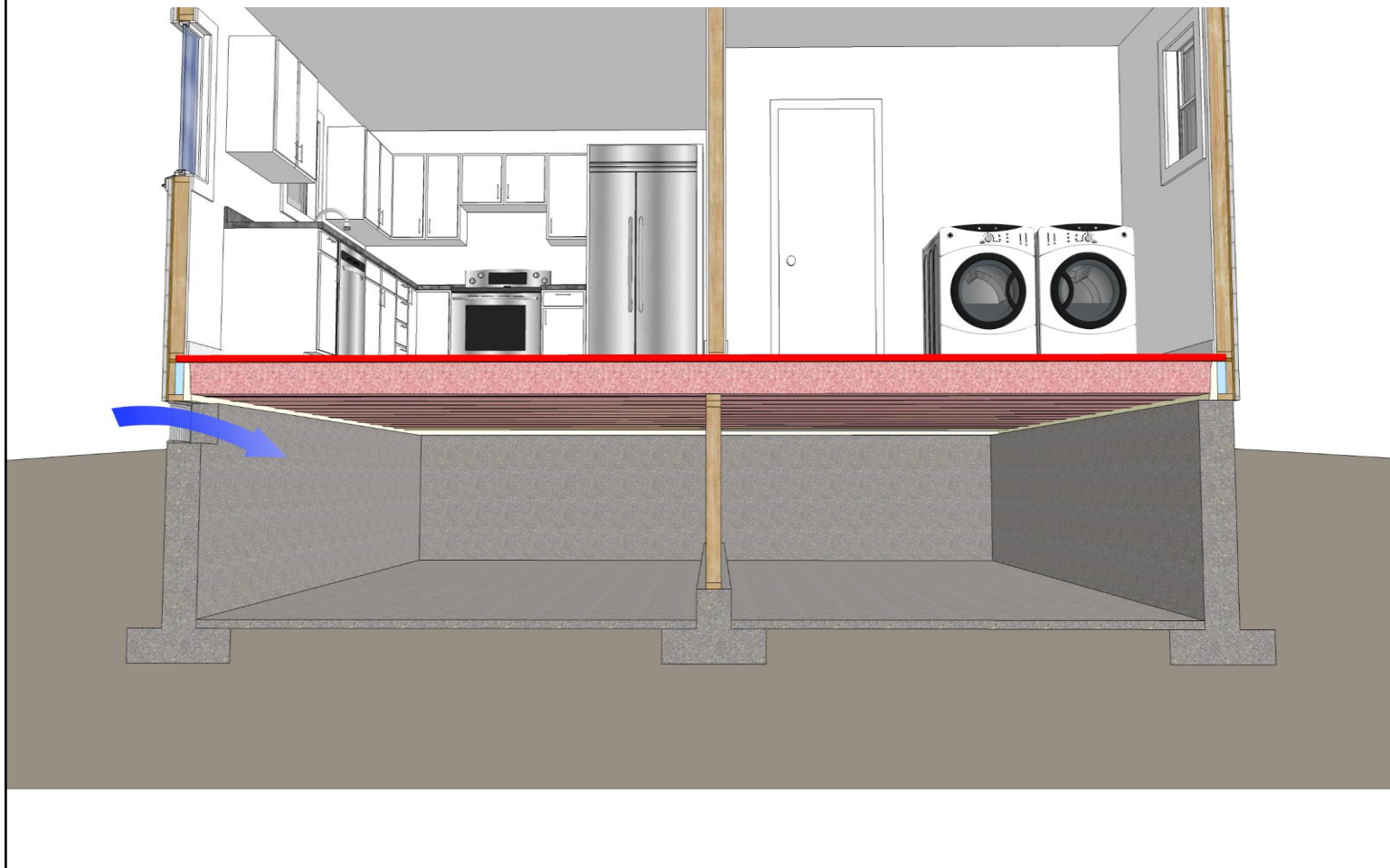
Crawl Space Considerations



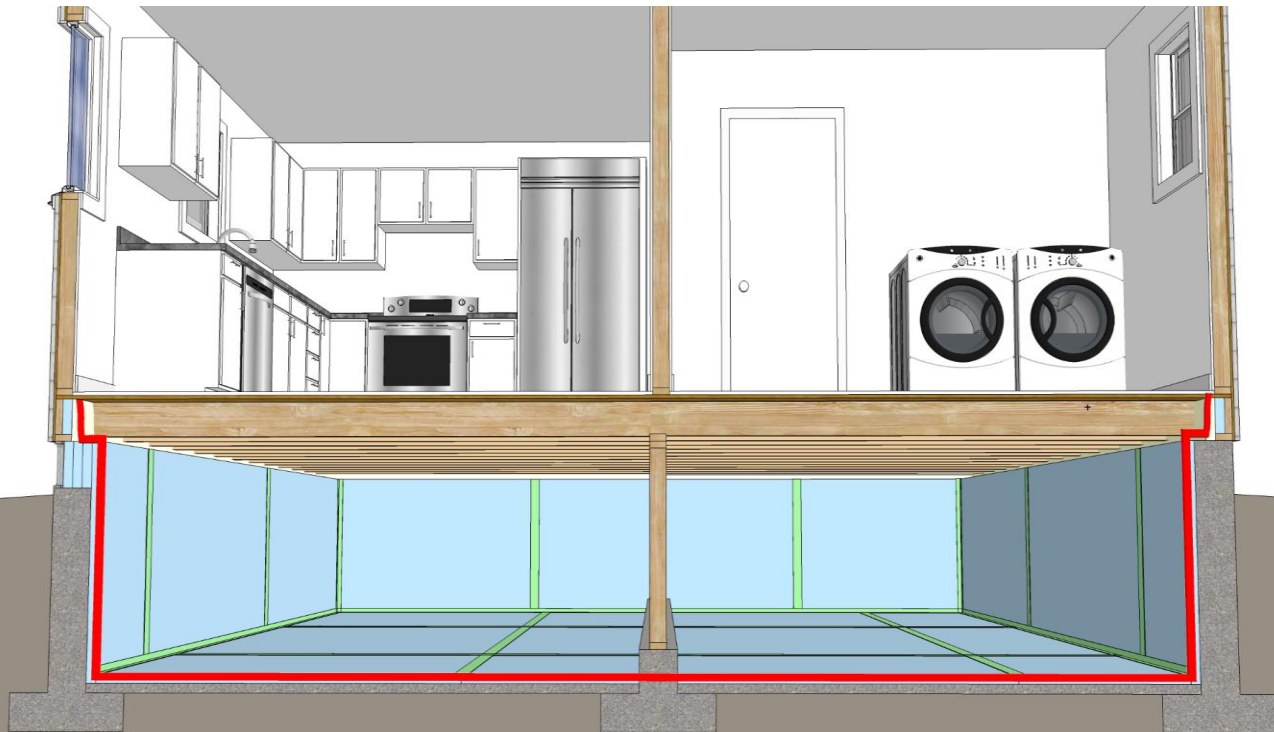
Crawl Spaces – Air Leakage & Ventilation



Crawl Spaces – Air Sealing & Insulation



Crawl Spaces – Conversion



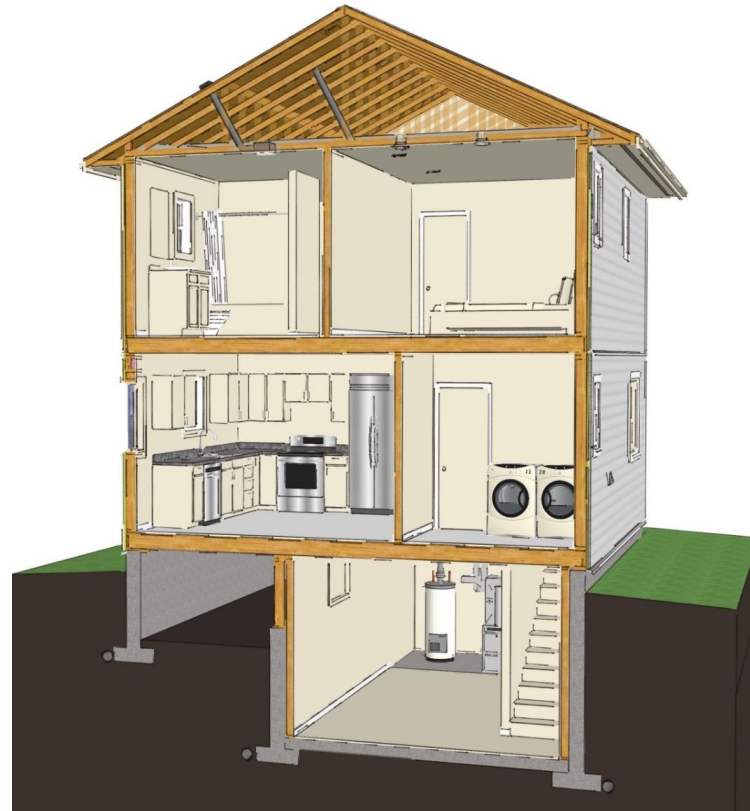
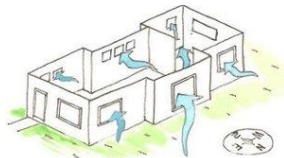


Health & Safety Considerations

Health & Safety Considerations

Ventilation

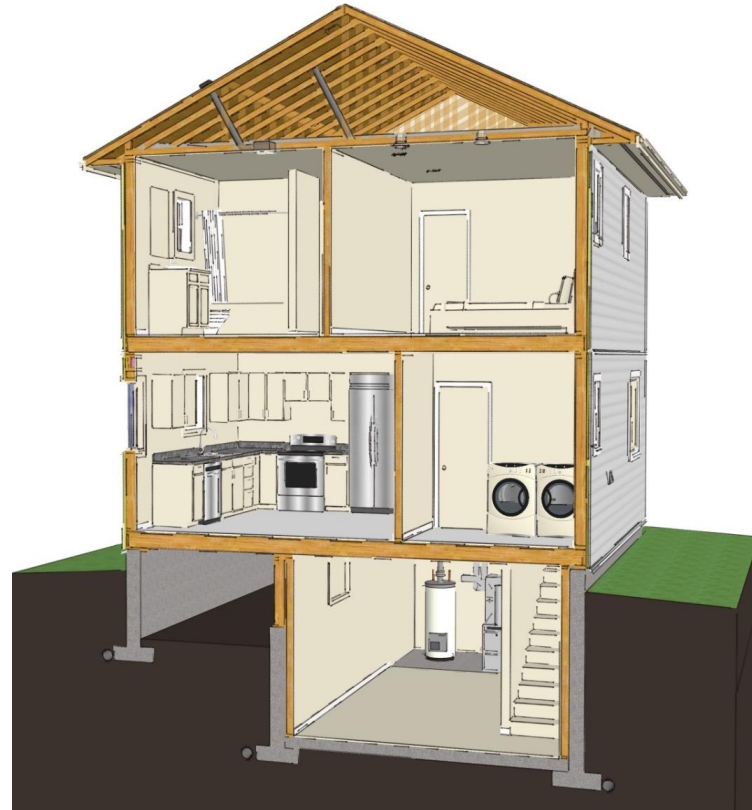
- Chemicals & VOCs
- Temporary ventilation fans
- Windows/doors open
- Full respirator equipment



Health & Safety Considerations

Homeowner Safety

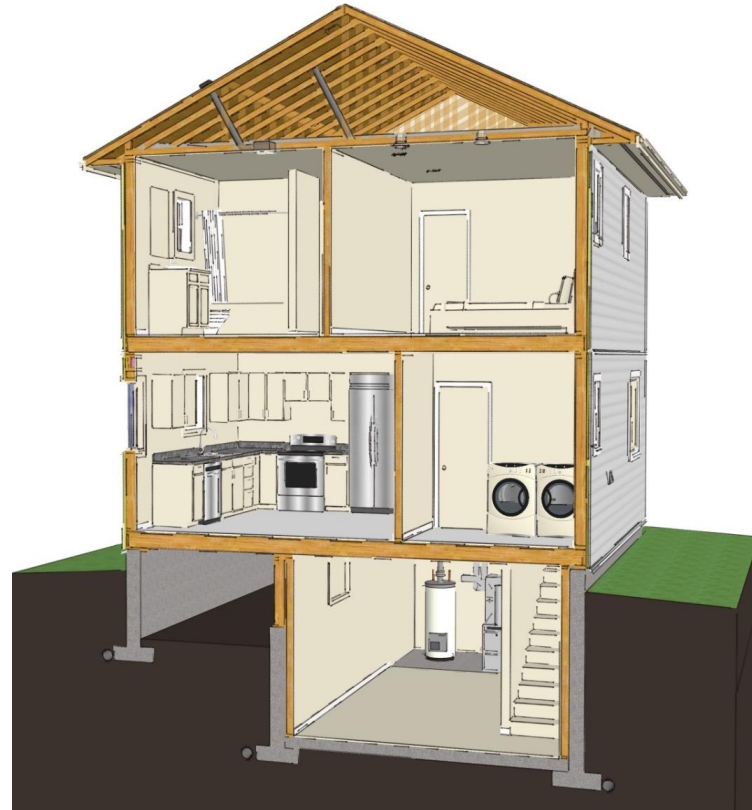
- Block off access to hazardous areas
- Lock-out equipment
- Beware of children
- Warn of dust
- Don't block exits



Health & Safety Considerations

Electrical Wiring

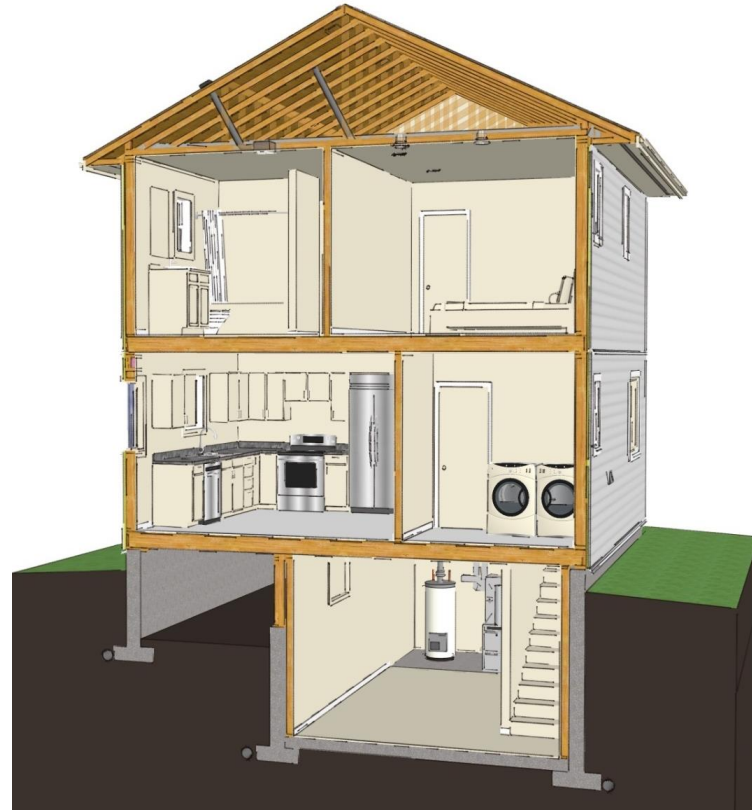
- No contact with bare wires
- Hire an electrician
- Disconnect ceiling radiant heating panels
- Knob and tube wiring = no-go



Health & Safety Considerations

Ladders

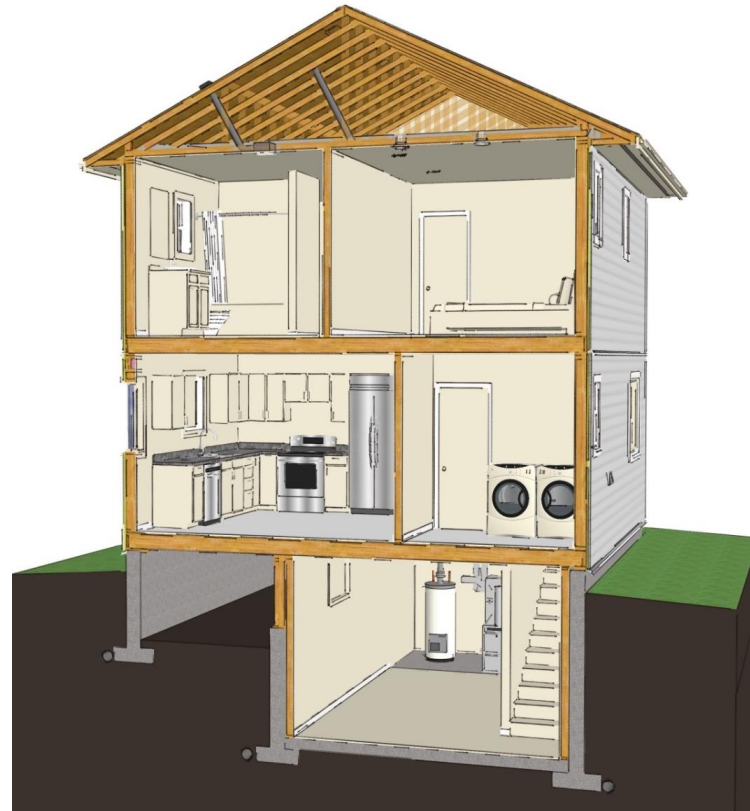
- Grade 2 or better
- Three points of contact
- Solid ground
- Face the ladder
- Use tie offs



Health & Safety Considerations

Structural Elements

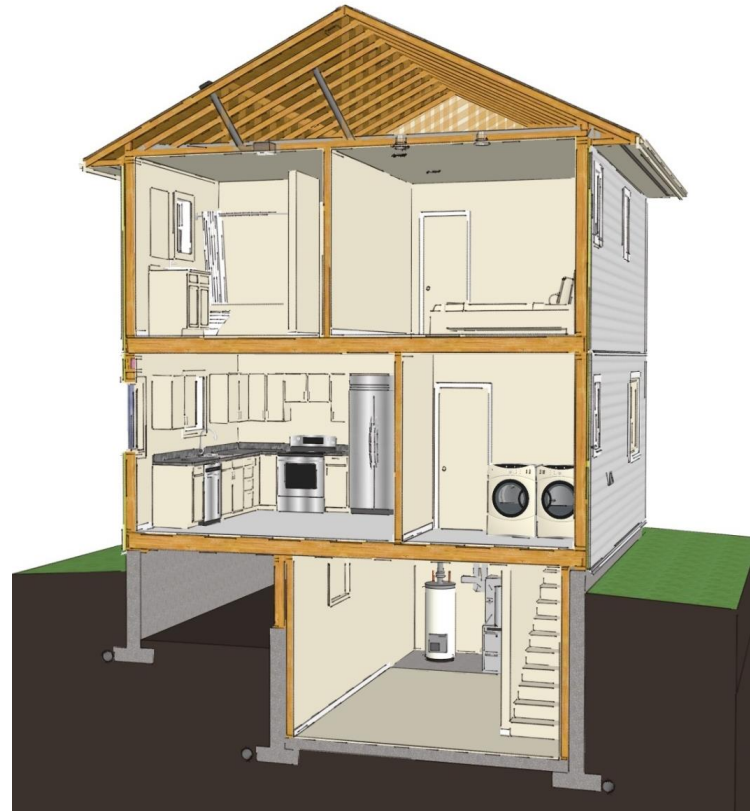
- No modifications to structural elements without structural engineer!



Health & Safety Considerations

Attic Fall Hazards

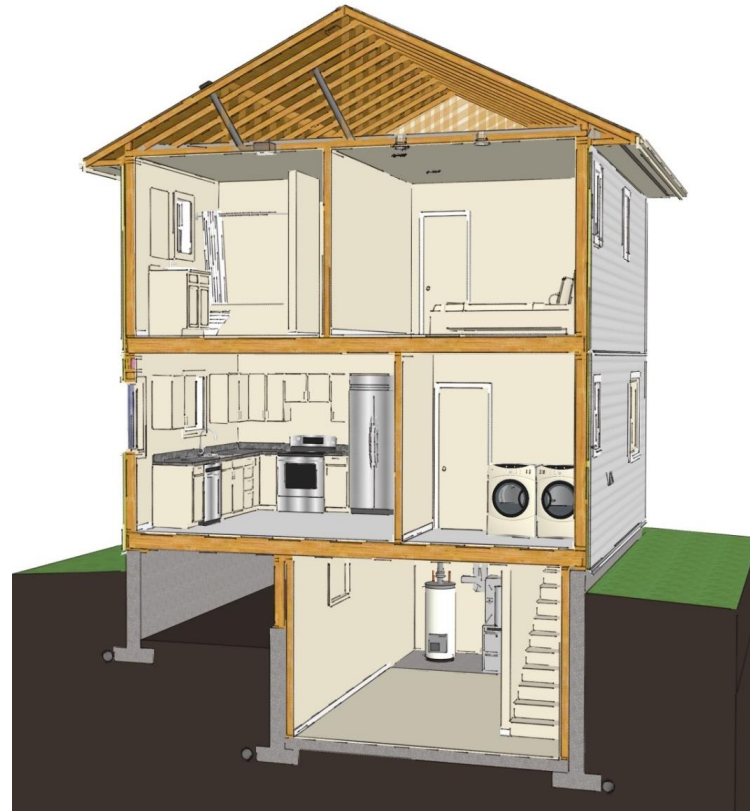
- Wires, nails, wood blocking
- No capacity on gypsum
- Use good lighting



Health & Safety Considerations

Fungal Growth

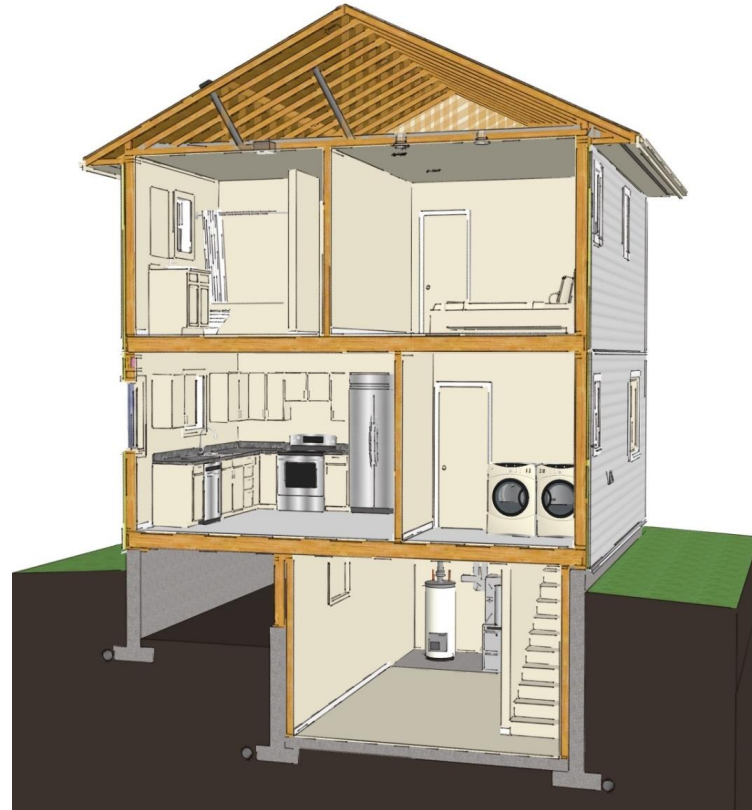
- Severe mould growth should be addressed before retrofits



Health & Safety Considerations

Asbestos

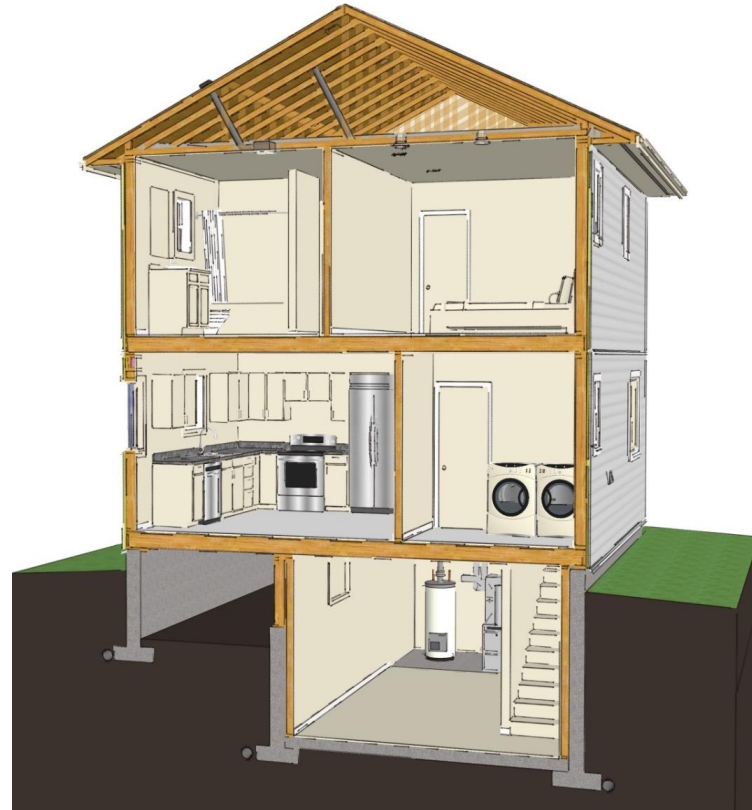
- Vermiculite insulation = no-go
- Old pipes, adhesives, GWB
- Complete environmental assessment if doing major work



Health & Safety Considerations

Spray Foam

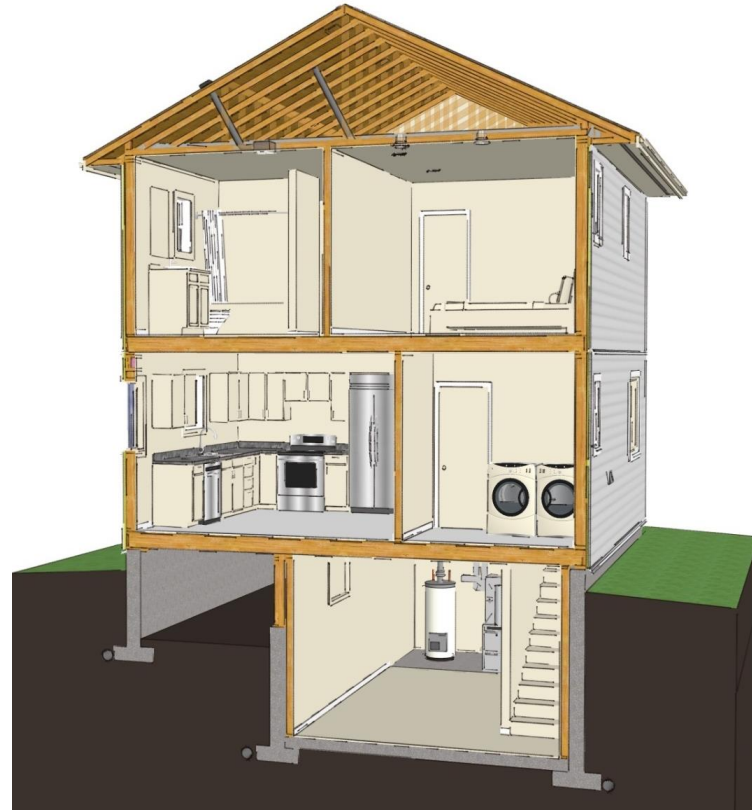
- Large amounts installed by trained contractor
- Use respirator
- May need to vacate home while installing/curing



Health & Safety Considerations

Solvents & VOCs

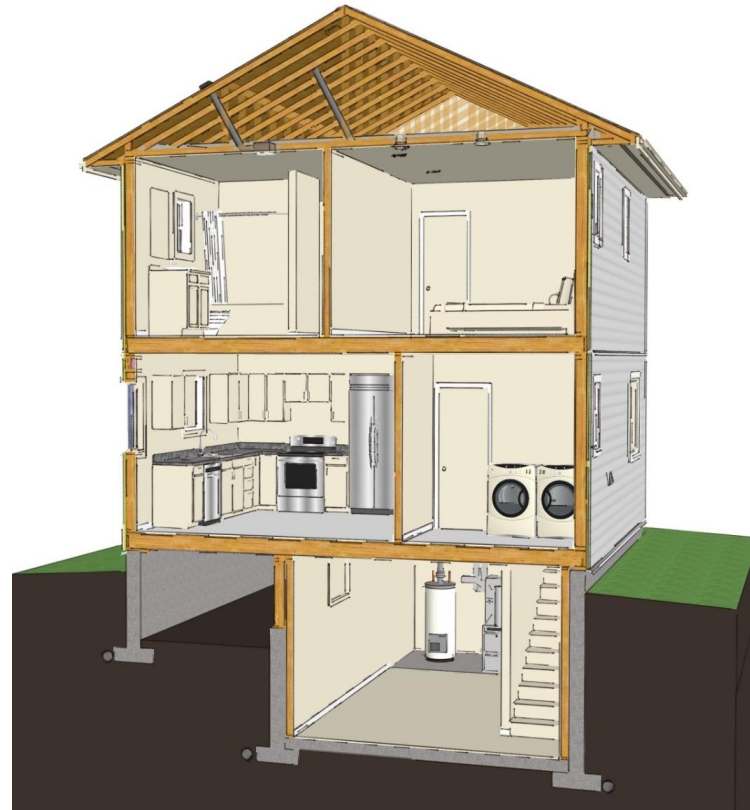
- Check SDS for all chemicals, sealants, insulations
- Use low-VOC products where possible



Health & Safety Considerations

Lead Paint

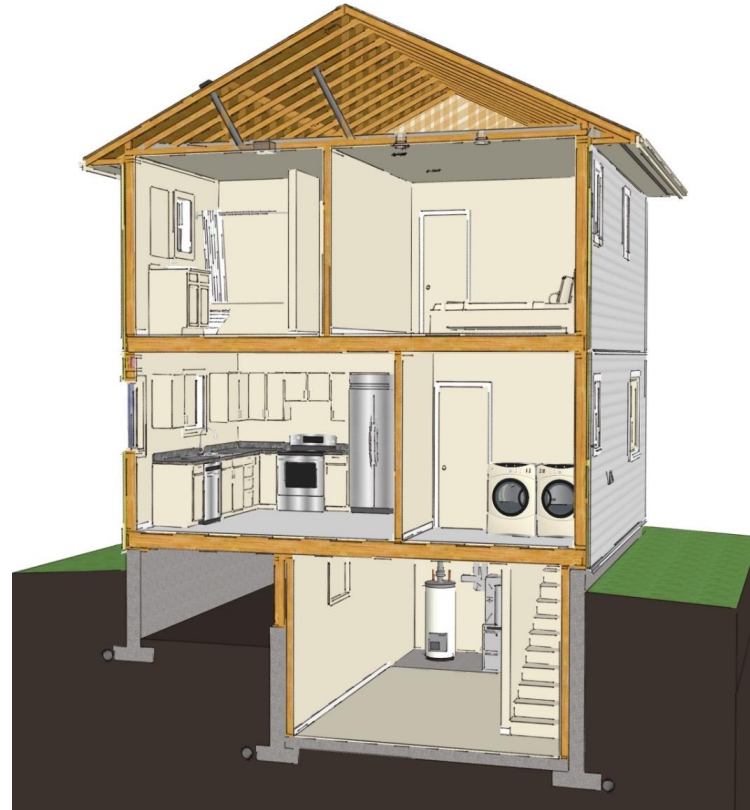
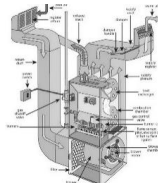
- Used until 1980s
- Not a hazard if left intact
- Requires special removal measures if damaged or being removed



Health & Safety Considerations

Gas Safety

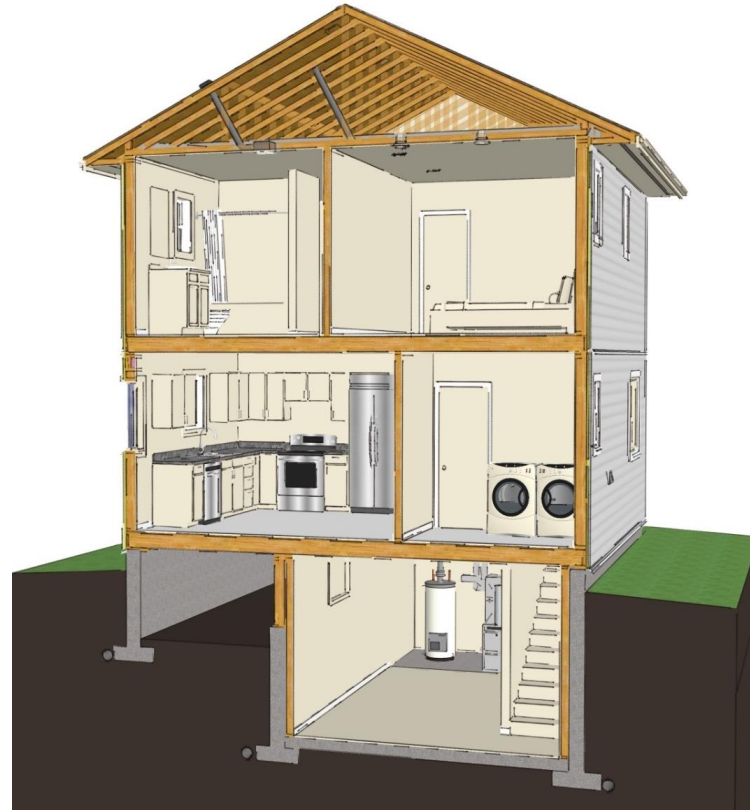
- Gas smell = no-go
- Use certified contractor for all gas work
- Combustion safety test may be required
- Consider carbon monoxide sensor



Health & Safety Considerations

Combustion Safety

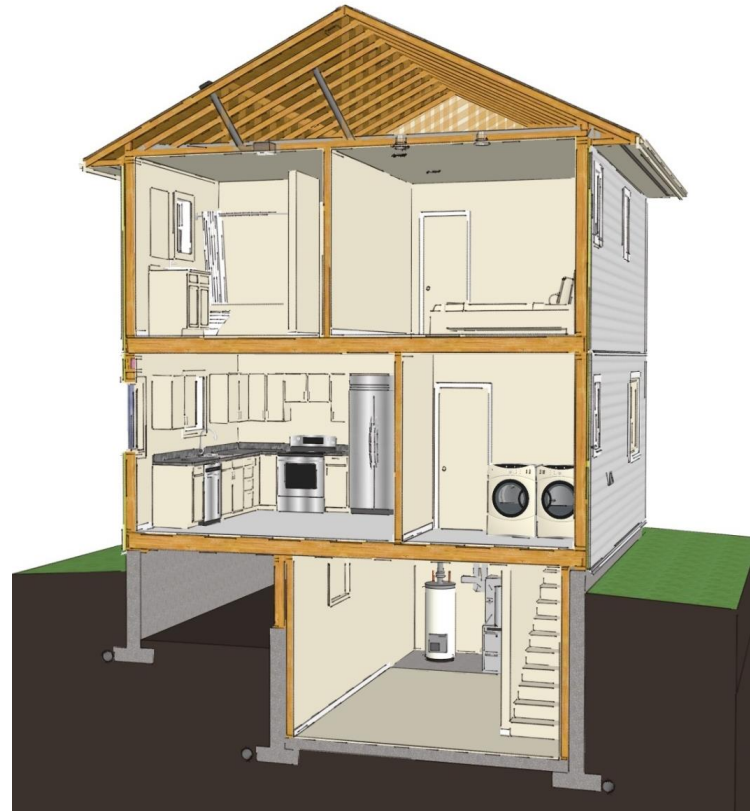
- Air sealing may affect combustion equipment access to air
- Direct vent or makeup air inlet may be required
- Removal of fireplaces may be warranted
- Depressurization test required if large scale air sealing retrofits completed – discuss with homeowner



Health & Safety Considerations

Radon Gas

- Check if the area is prone to radon exposure
- Can be tested easily
- Notify homeowner to address this before beginning retrofit
- Always complete sealing of basement or crawlspace before doing other work.
- Radonaware.ca





How to Prioritize Retrofits?

How to Prioritize Retrofits?

EXTERIOR RETROFIT

When high thermal performance is desired, and an interior retrofit is intrusive or impractical. This is also the most durable approach as exterior insulation results in less risk of moisture damage within the enclosure.

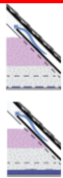
INTERIOR RETROFIT

When high thermal performance is desired, and where an exterior retrofit is impractical or not possible due to property setbacks.

INSULATION TOP UP

For small budgets, or where neither interior or exterior retrofits are possible.

Accessible Attic



Insulation top-up

Air seal from within the attic space



Flash and fill

A continuous air barrier is installed in the attic



Insulation top-up

Air seal from within the attic space



Flash and fill

A continuous air barrier is installed in the attic

Accessible Attic



Insulation top-up

Air seal from within the attic space

Vaulted/Flat Ceiling



Insulation added to the exterior

New air barrier installed on the exterior



Insulation added to the interior

New air barrier installed on the interior

Vaulted/Flat Ceiling



N/A

Seal air leakage points from the interior

Above Grade Walls



Insulation added to the exterior

New air barrier installed on the exterior



Insulation added to the interior

New air barrier installed on the interior

Above Grade Walls



N/A (unless there is no existing wall insulation.)

Seal air leakage from the interior

Exposed Floors



Insulation installed in empty joist cavities

Air seal from below



Insulation installed in empty joist cavities

Air seal from below

Exposed Floors



Insulation installed in empty joist cavities

Air seal from below

Below Grade Walls



In combination with foundation work insulation is added to the exterior of the wall
The concrete wall is the air barrier—ensure air barrier continuity between foundation wall and wood framing



Insulation is added to the interior

Tape and seal interior foam insulation board—this lowers the risk of condensation on the concrete wall

Below Grade Walls



N/A

Seal air leakage points from the interior

Crawlspaces



Convert the crawlspace to an unvented and insulated space

Air seal ceiling, walls and floor



Convert the crawlspace to an unvented and insulated space

Air seal ceiling, walls and floor

Crawlspace Ceilings



Insulation installed in empty joist cavities

Air seal from below during insulation work

Windows and Doors



Replace with high thermal performance windows and doors. See "additional resources" in the guide for guidance on replacement considerations and installation procedures



Replace with high thermal performance windows and doors. See "additional resources" in the guide for guidance on replacement considerations and installation procedures

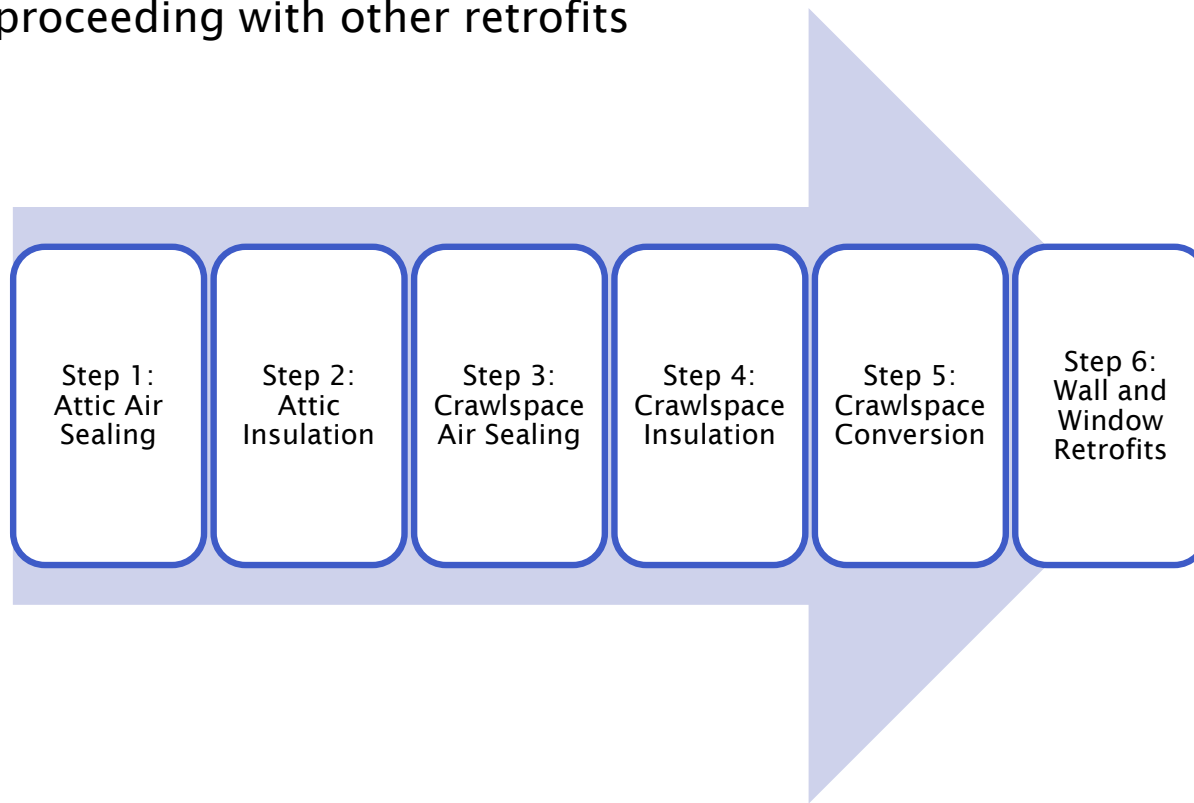
Windows and Doors



Retain windows and air seal as viable.

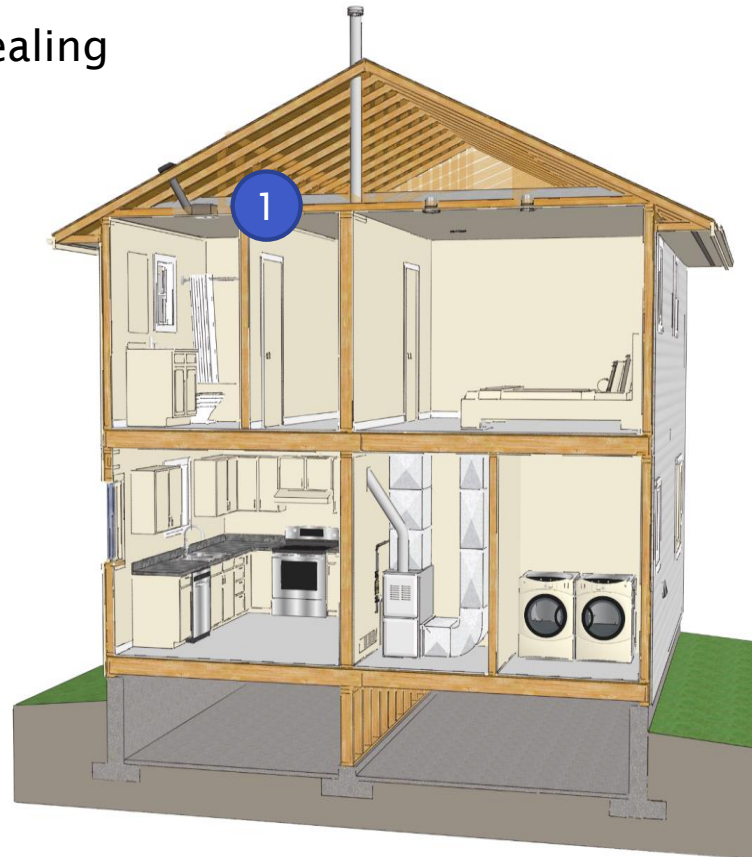
How to Prioritize Retrofits?

- Sequence of work affects durability and cost
- Always seal obvious holes in building enclosure before proceeding with other retrofits



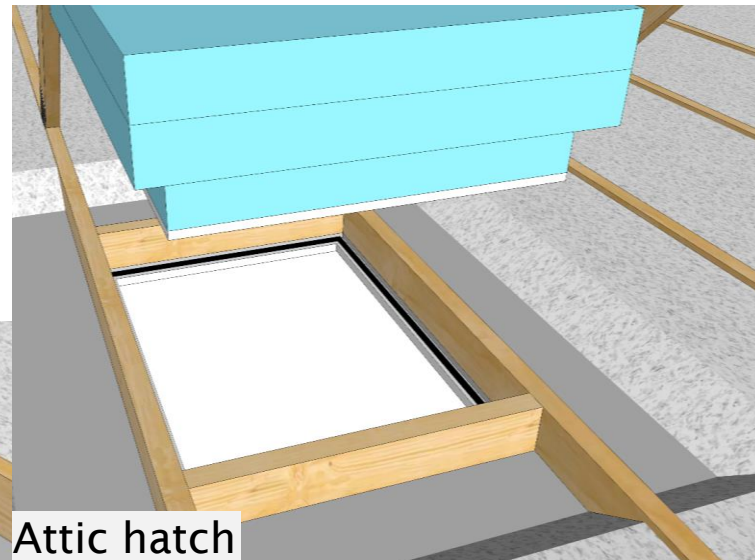
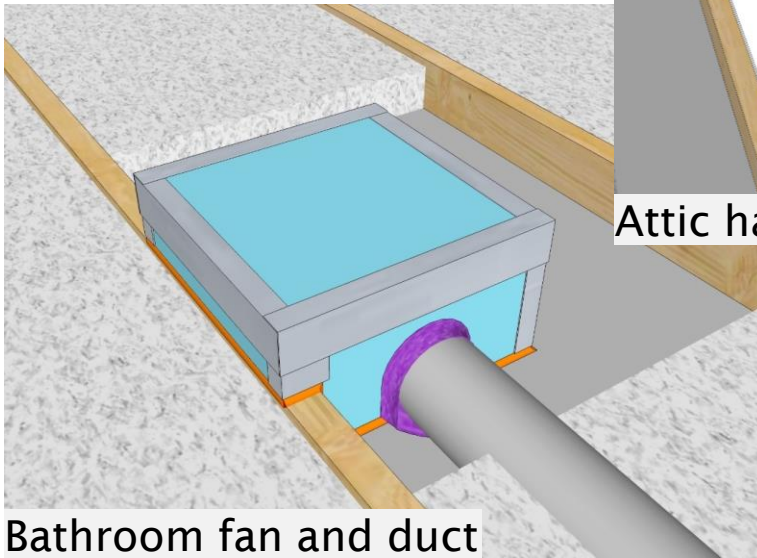
How to Prioritize Retrofits?

→ Attic air sealing



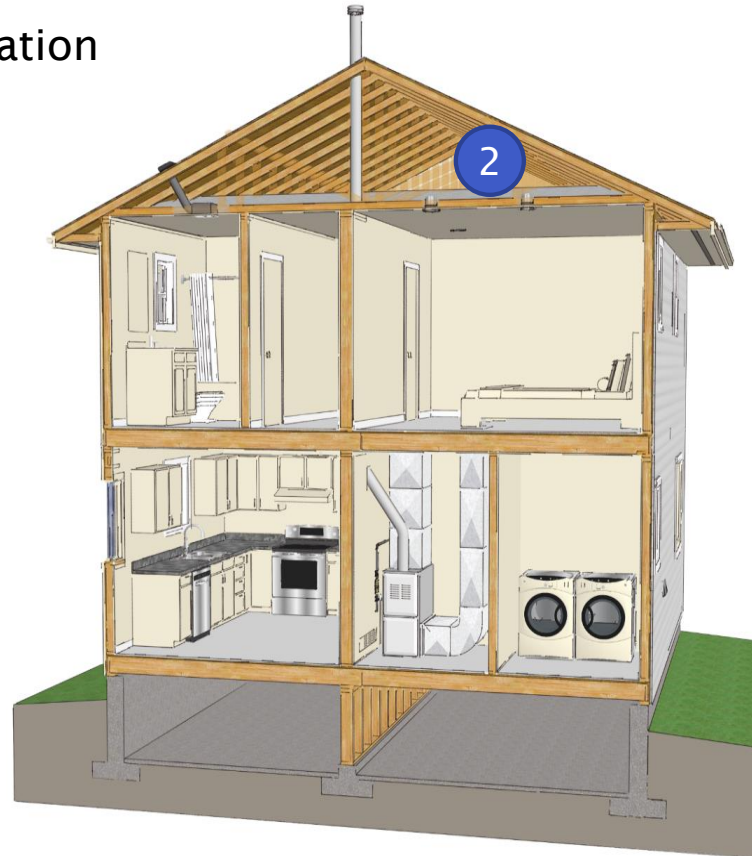
How to Prioritize Retrofits?

→ Attic air sealing

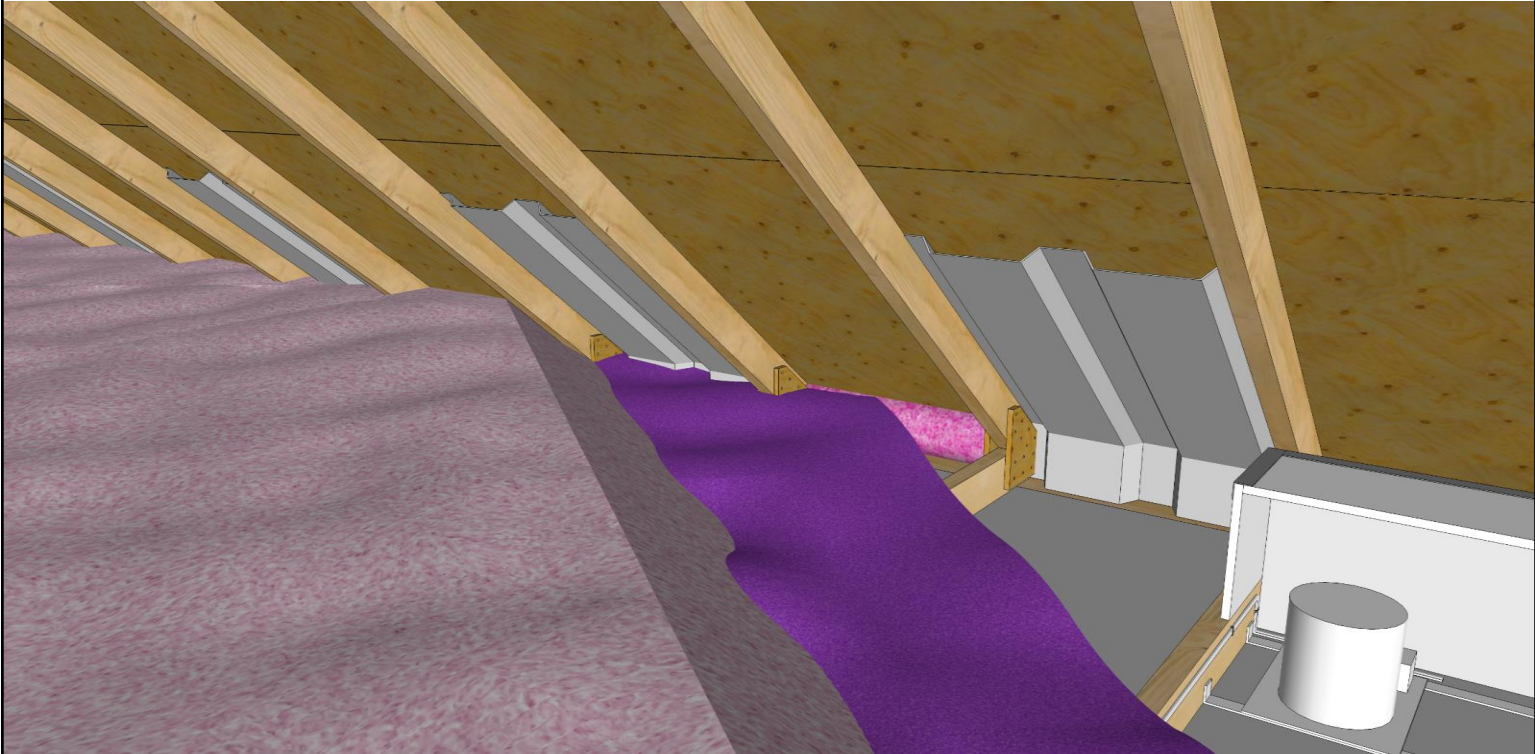


How to Prioritize Retrofits?

→ Attic insulation

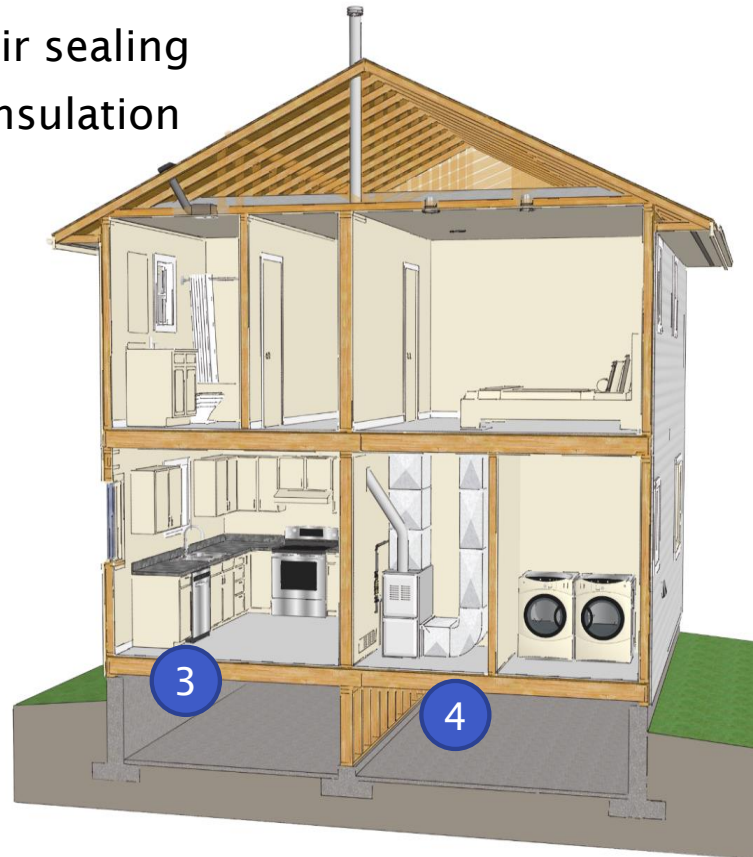


How to Prioritize Retrofits?



How to Prioritize Retrofits?

- Crawl space air sealing
- Crawl space insulation

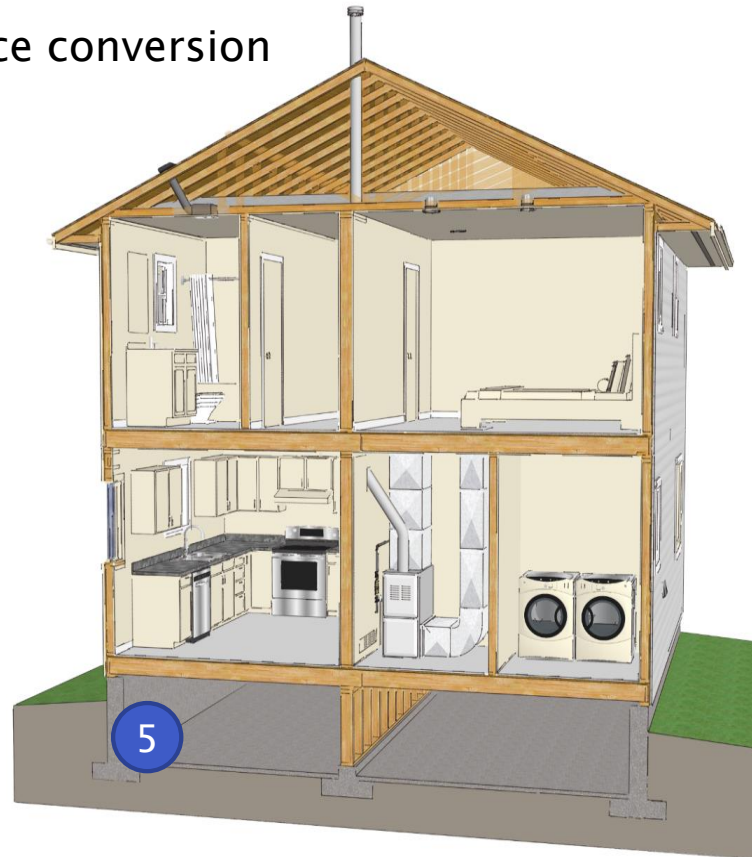


How to Prioritize Retrofits?

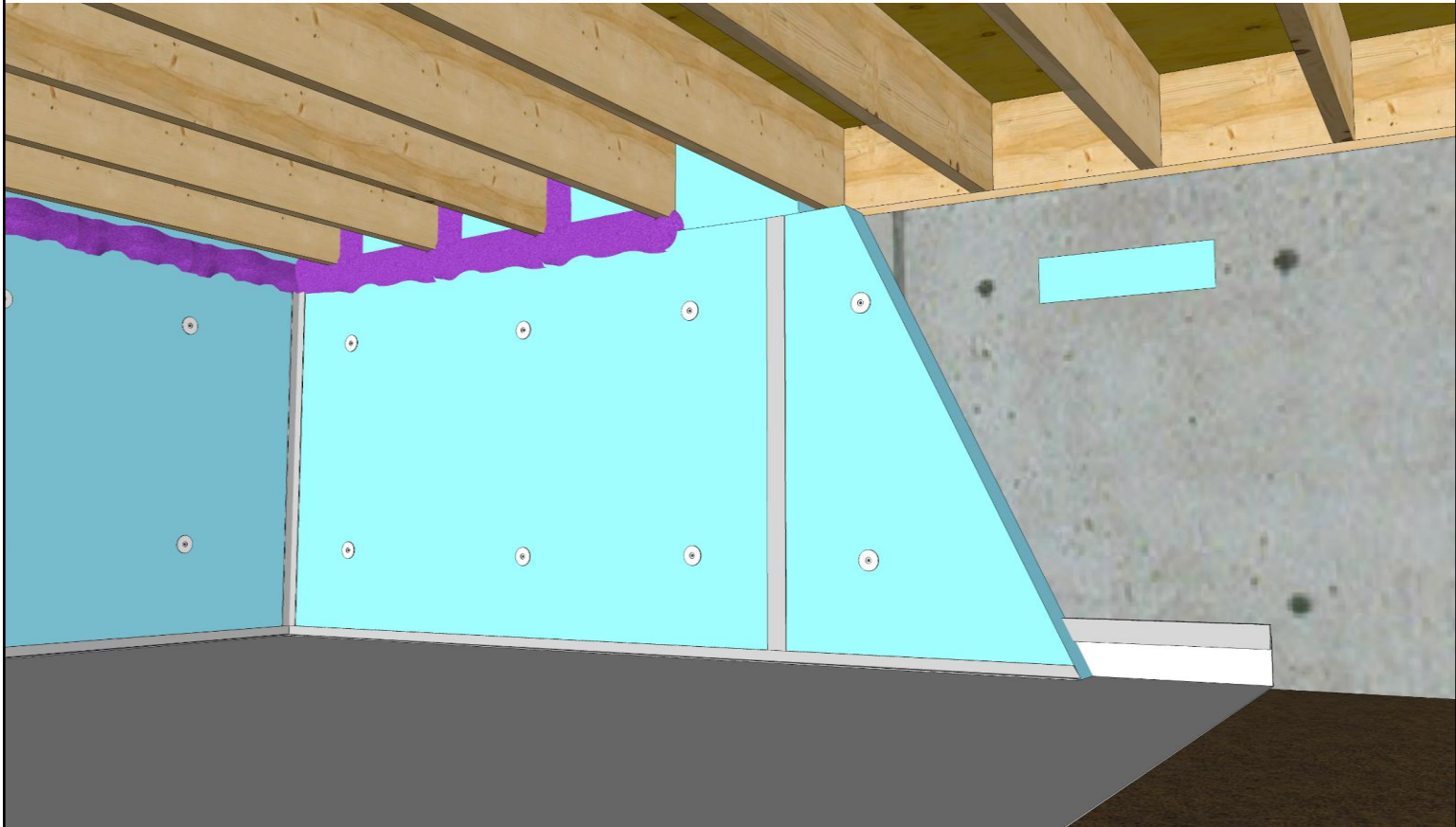


How to Prioritize Retrofits?

→ Crawl space conversion

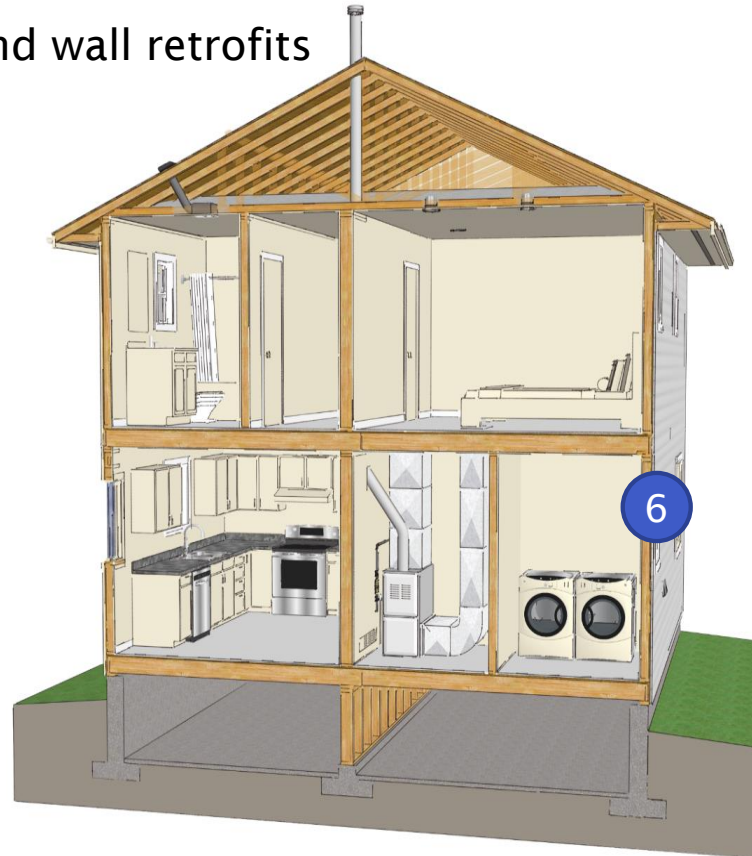


How to Prioritize Retrofits?

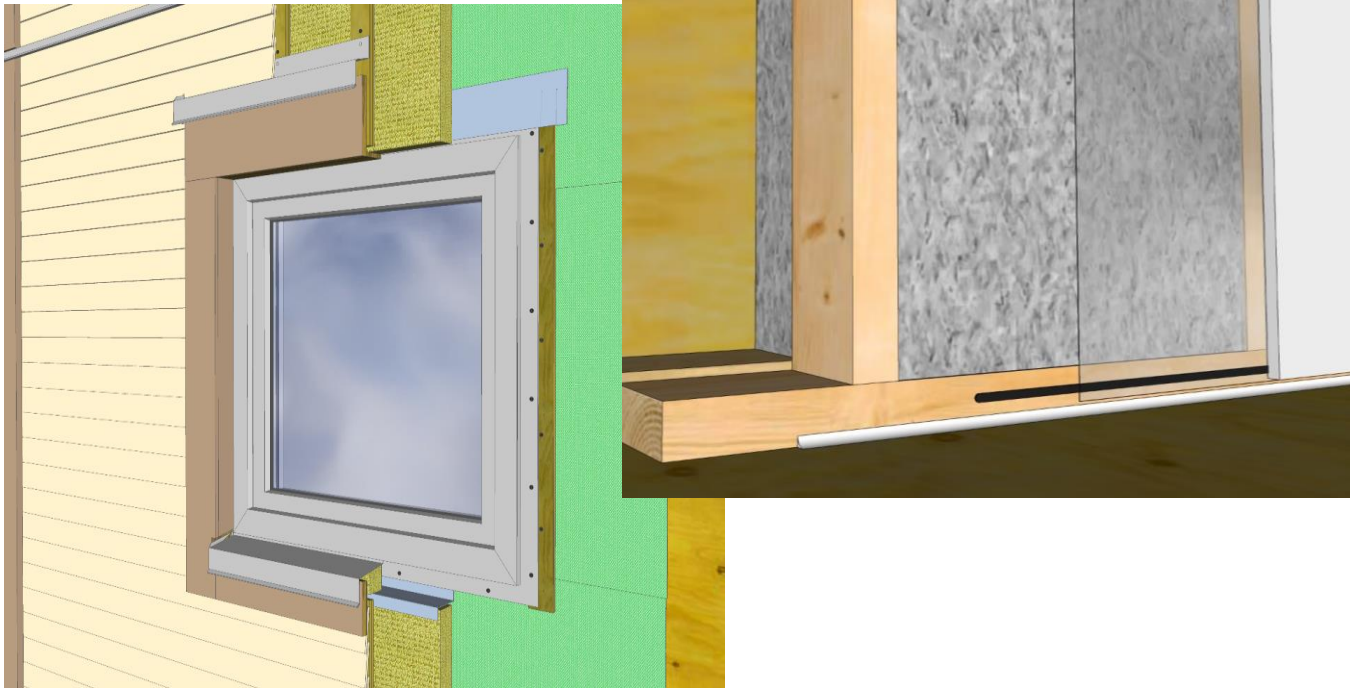


How to Prioritize Retrofits?

→ Window and wall retrofits



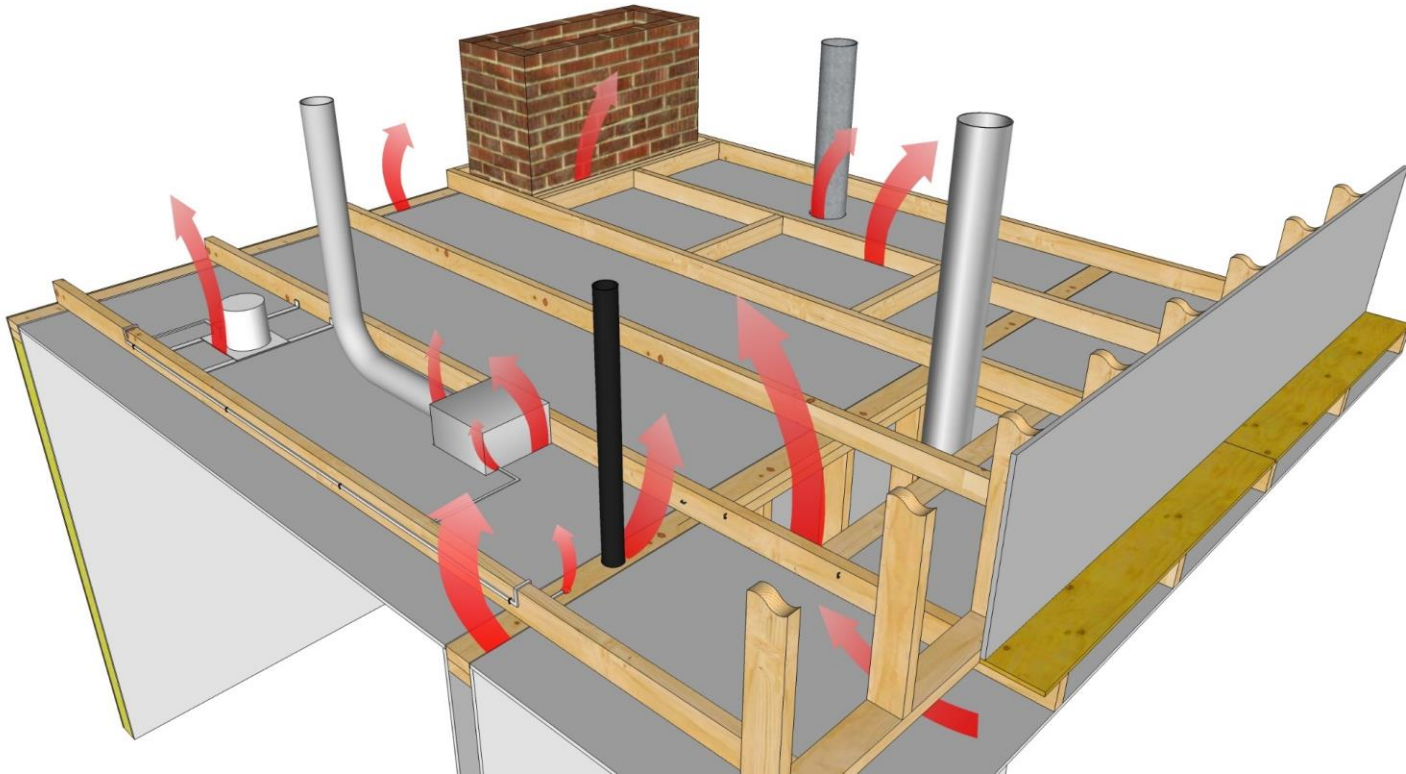
How to Prioritize Retrofits?



Demonstrations

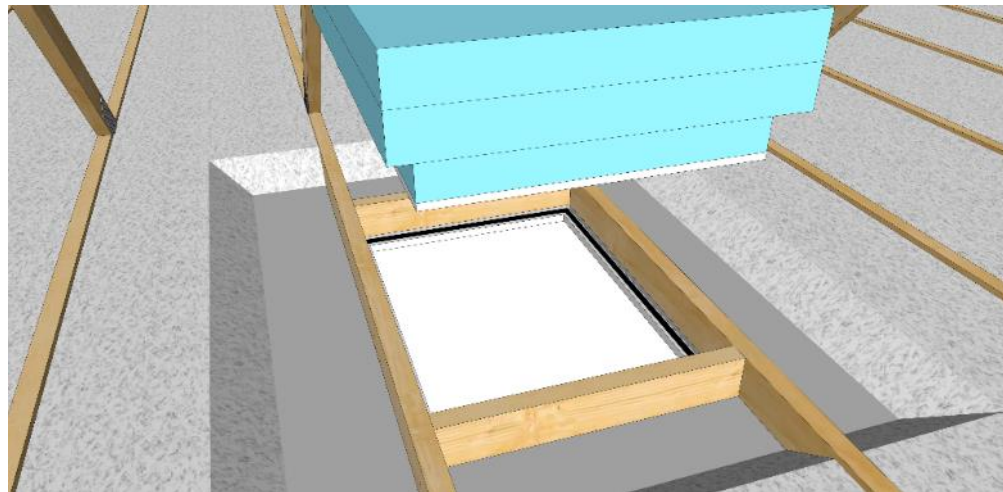
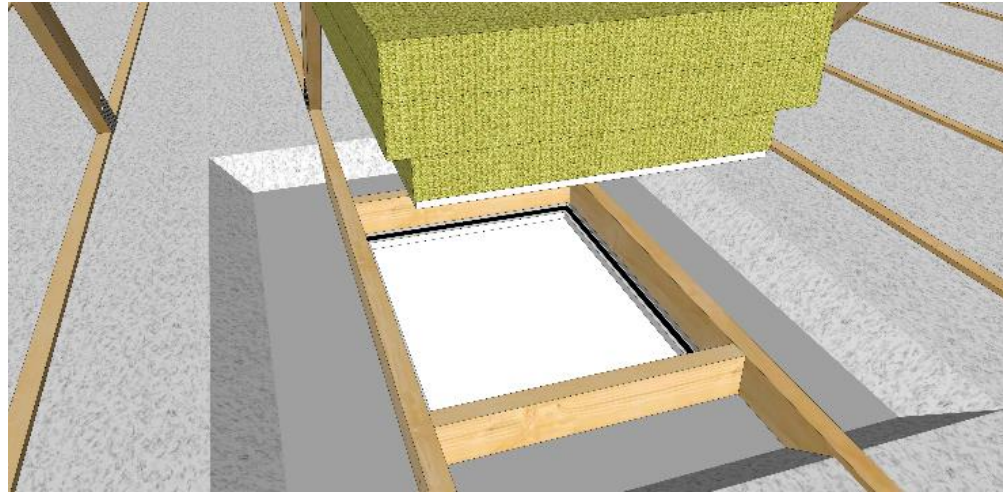
- Attic Air Sealing & Insulation
- Floor Air Sealing & Insulation
- Vented/Unvented Crawlspace Conversion

Attic Air Sealing



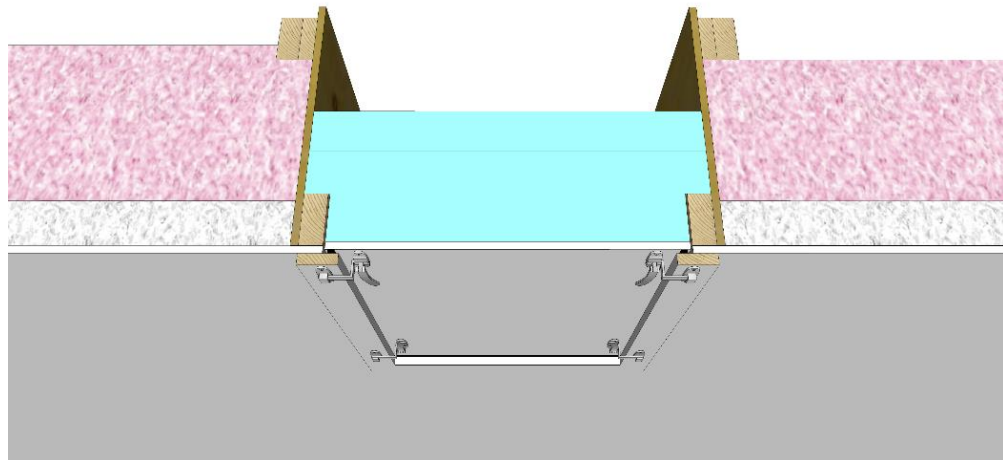
Attic Hatch

- Remove existing insulation around hatch
- New insulation on hatch



Attic Hatch

- Insulation guard
- Latches



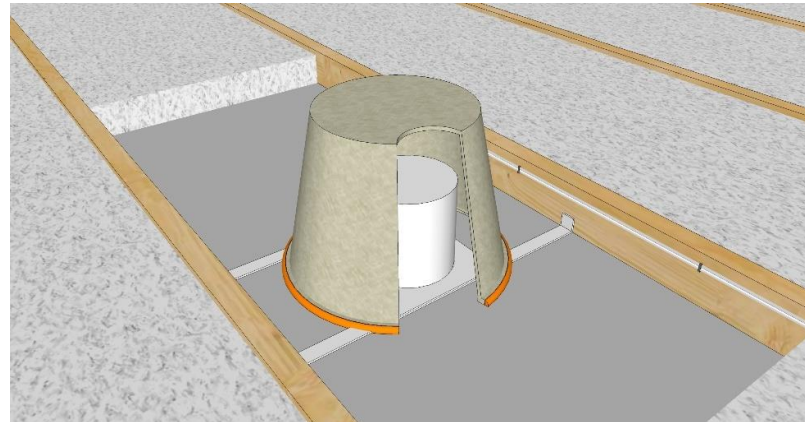
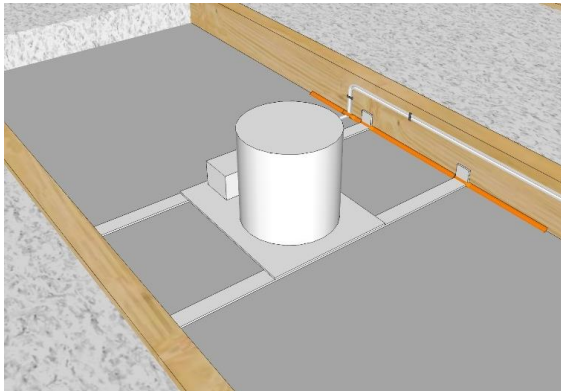
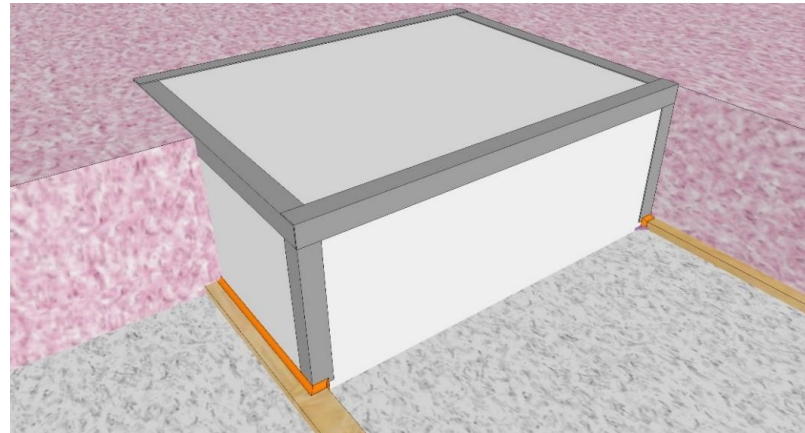
Common Deficiencies – Attic Hatch

→ Poorly Sealed and Uninsulated Attic Hatches



Pot-Lights (Non IC Units)

- Hand-made or manufactured airtight pot-light cover
- Sealed to ceiling
- New insulation over top



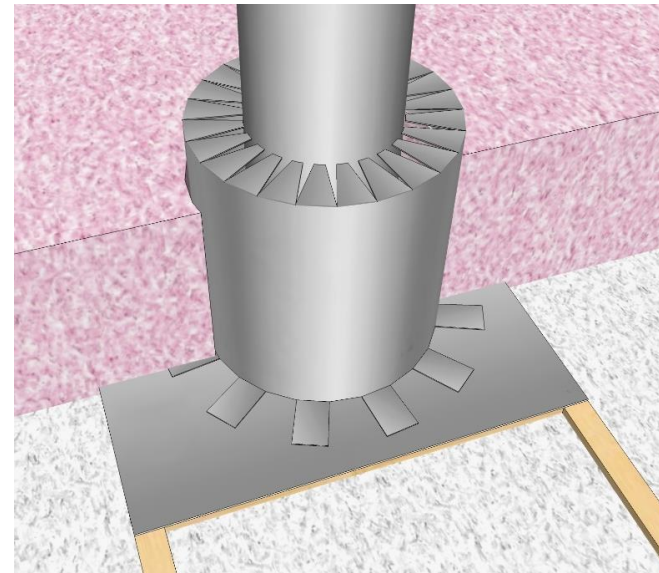
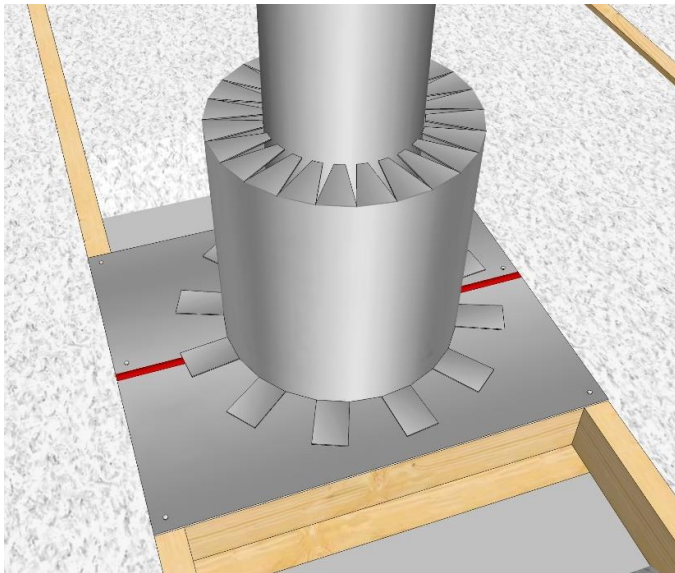
Common Deficiencies – Pot-Lights

- Blown-in attic insulation should never be installed over pot-lights
- Only pot-lights rated for insulation contact (IC) can be insulated above, otherwise must be protected
- Fire risk to wiring and fixture
- Issues with air-sealing
- Option to replace with new fixture if possible



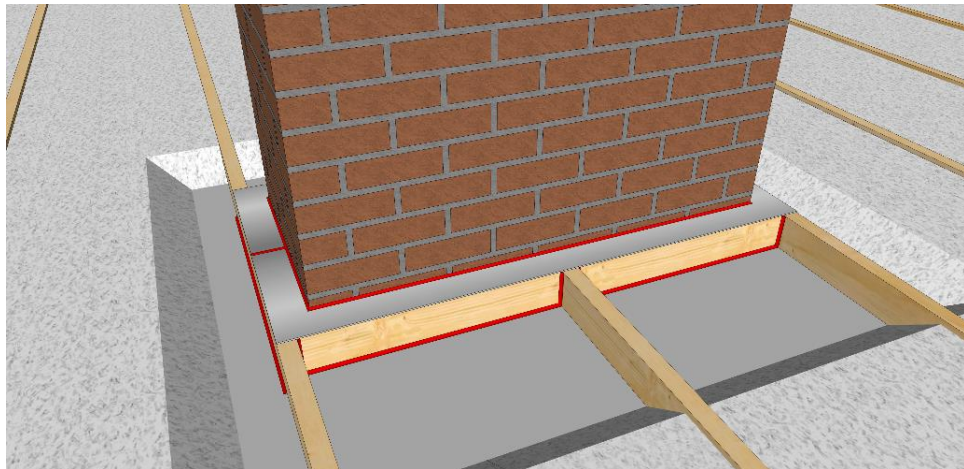
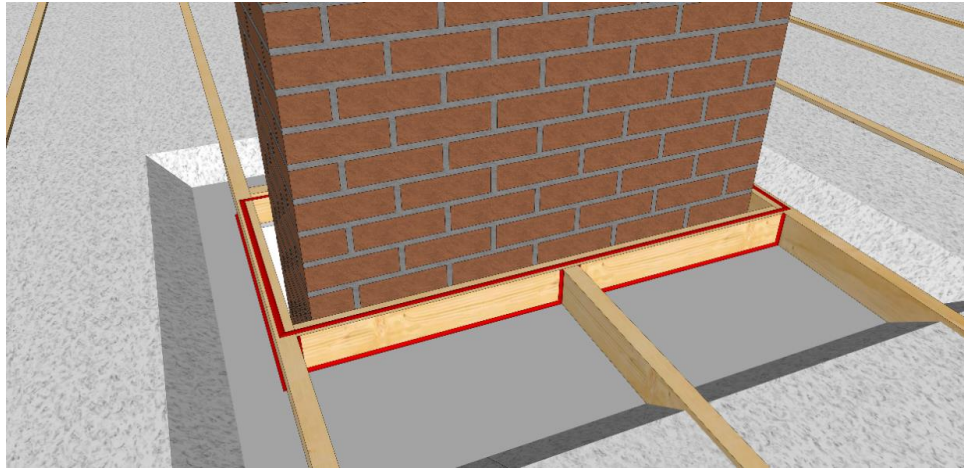
Combustion Exhaust Ductwork

→ Insulation guard around penetration



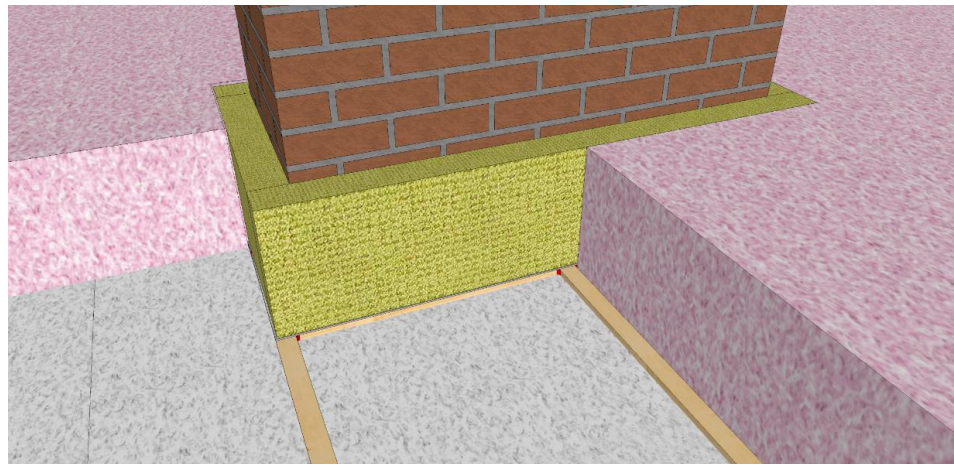
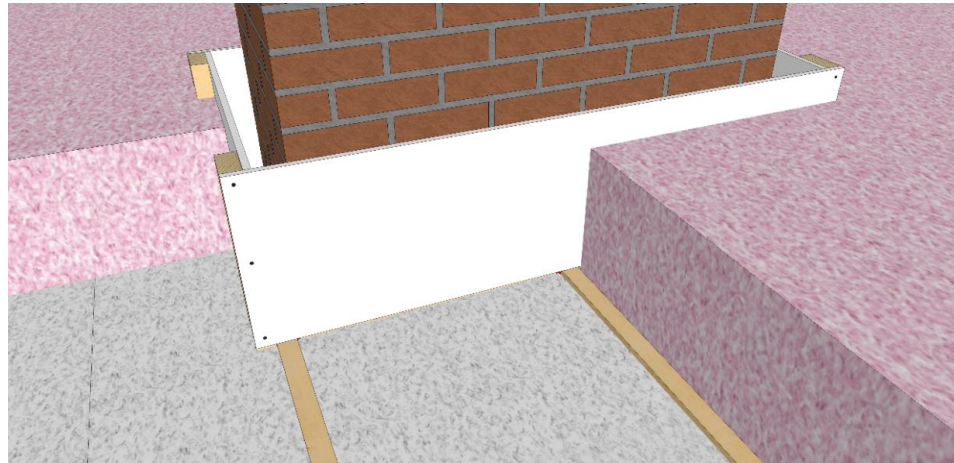
Chimneys

→ Non-combustible
air seal



Chimneys

→ Insulation guard or non-combustible insulation



Common Deficiencies – Chimneys and Ductwork

- Blown-in fiberglass or cellulose insulation should never be blown against chimneys or other hot exhaust ducts (furnace, fireplace, hot-water etc.)
- Insulation in contact with potentially hot surface must be non-combustible (i.e. mineral wool) or gap left between



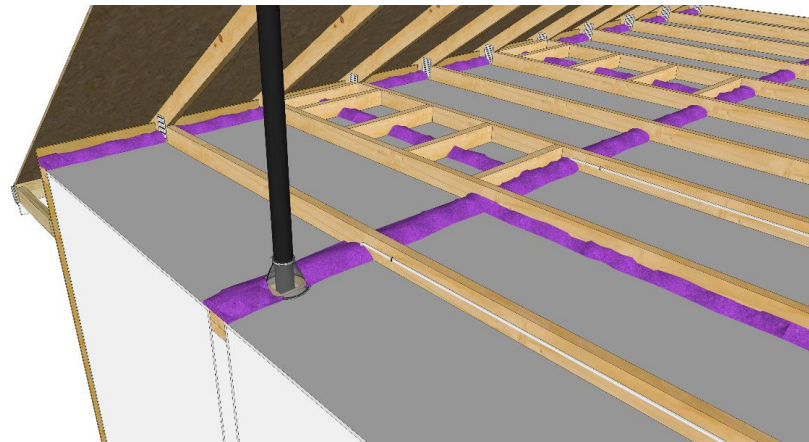
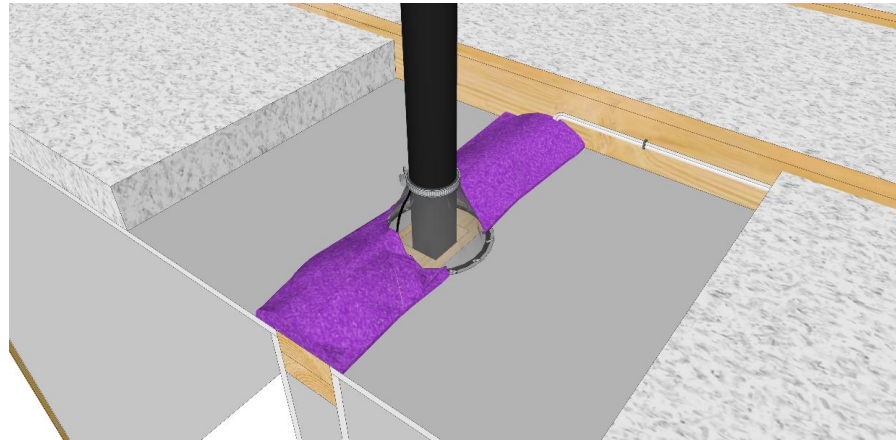
Common Deficiencies – Chimneys and Ductwork

→ Unsealed exhaust ductwork & direct exhausting fans into attic spaces



Attic Perimeter & Top Plates

- Spray foam
- Flexible tape/sealant

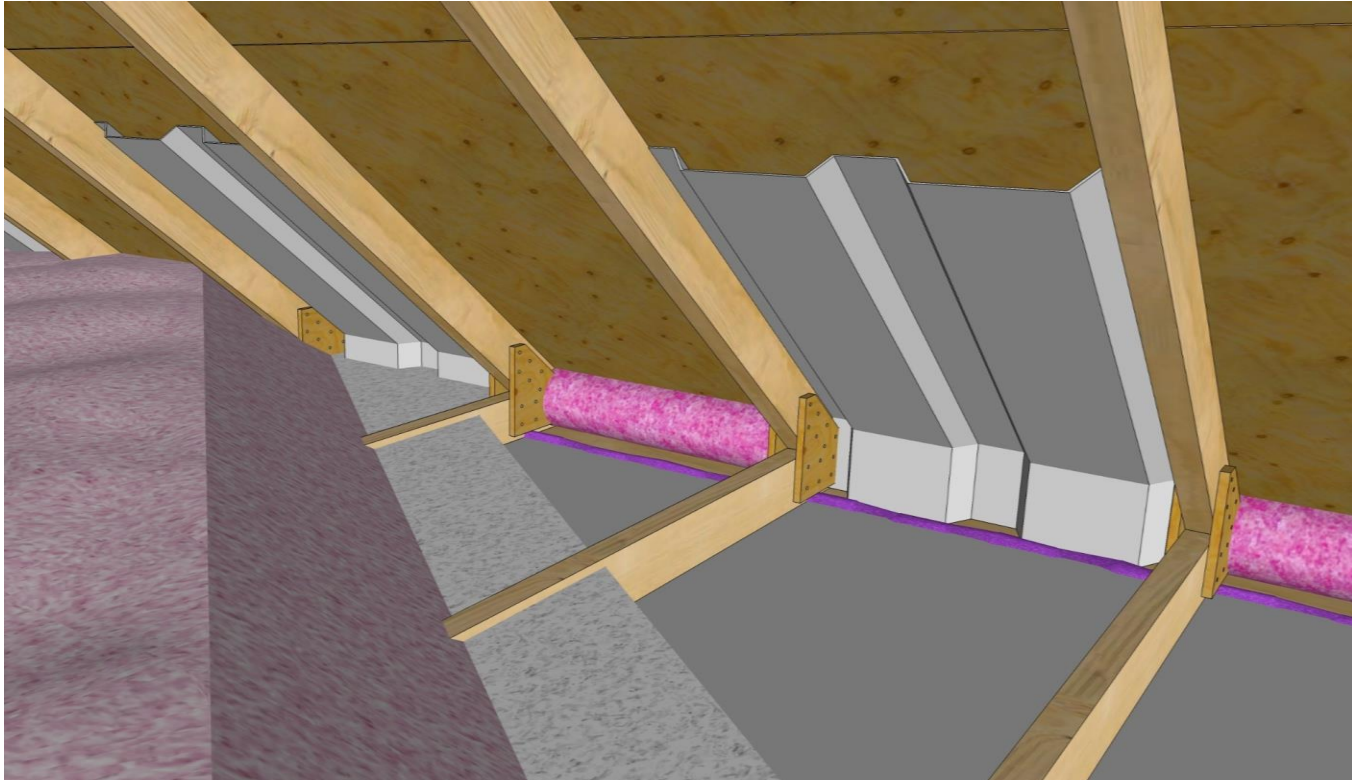


Common Deficiencies – Top Plates

→ Incomplete air sealing



Attic Insulation



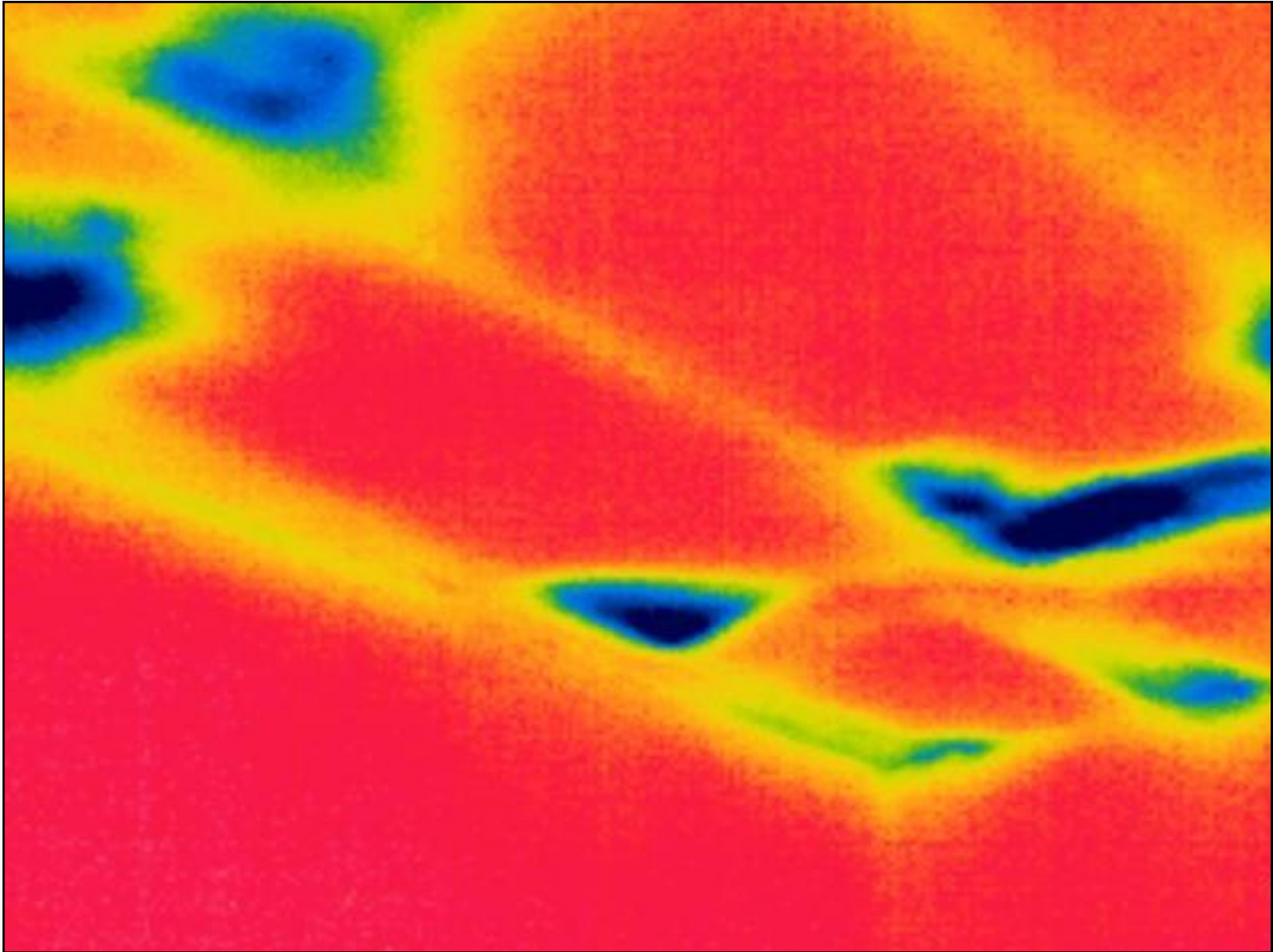
Common Deficiencies – Attic Insulation

→ Poor Coverage of Blown Insulation or Missing Insulation



→ “Insulation” Products (Reflective Foil)





Important Considerations for Attic Work

- Condensation and moisture-related problems can occur due to air leakage combined with the added or upgraded insulation.
- For all procedures, air sealing work must always be performed prior to insulating.



Important Considerations for Attic Work

→ Sealing and insulating attic duct runs is vital to avoid potential moisture issues in attic



Floor Air Sealing & Insulation



Crawlspace Questions



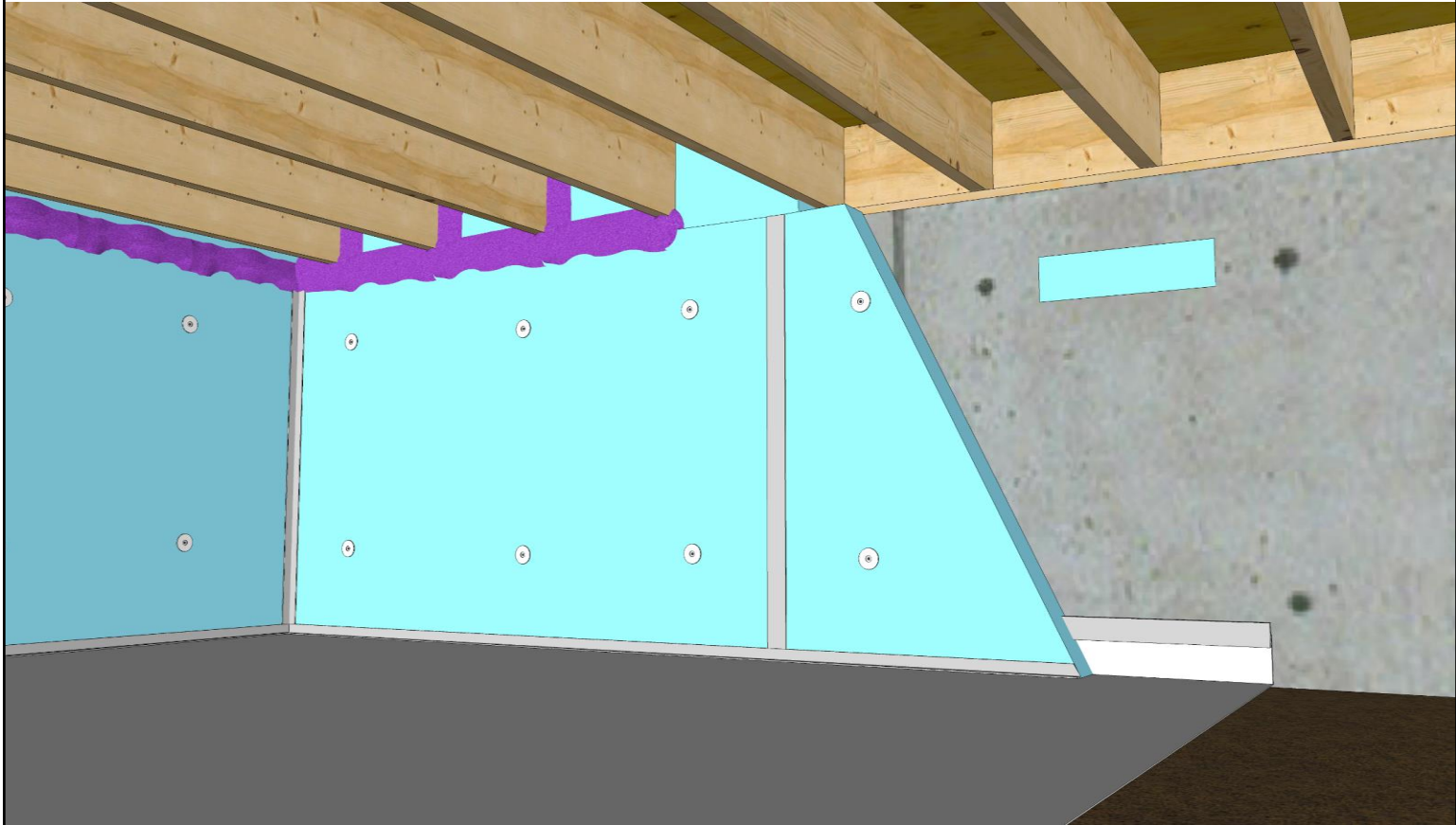
Crawlspace – Vented or Unvented?



Pipe Insulation



Converting Vented Crawlspace to Unvented

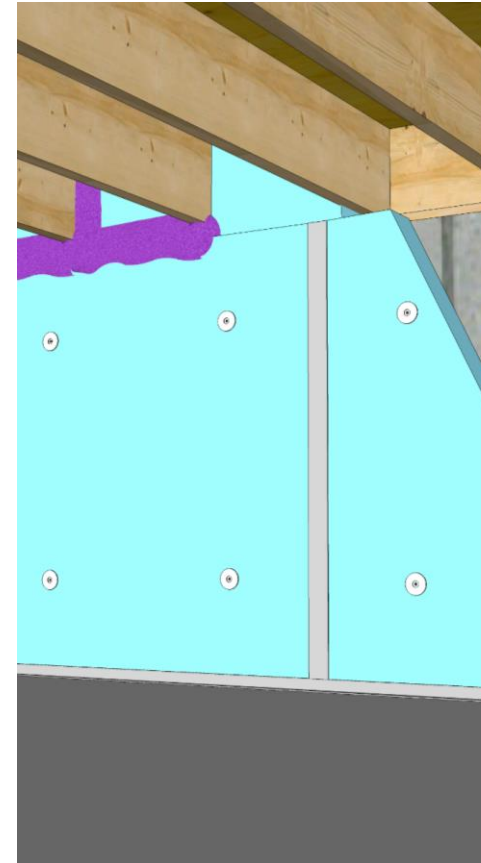


Crawlspace Insulation



Fire Considerations

- Where foamed plastics are exposed in the crawl space, the adjacent living areas are required to be protected from fire and smoke spread.
- The sub floor above the crawlspace and the enclosing wall function as the required protection of the living area from the adjacent concealed crawl space.
- Penetrations through the floor should be tightly fitted or sealed to close any gaps.
- Exposed foam in occupied basements must be covered with at least ½" GWB



Common Deficiencies – Exposed Foam

→ Unprotected/exposed spray foam within occupied space





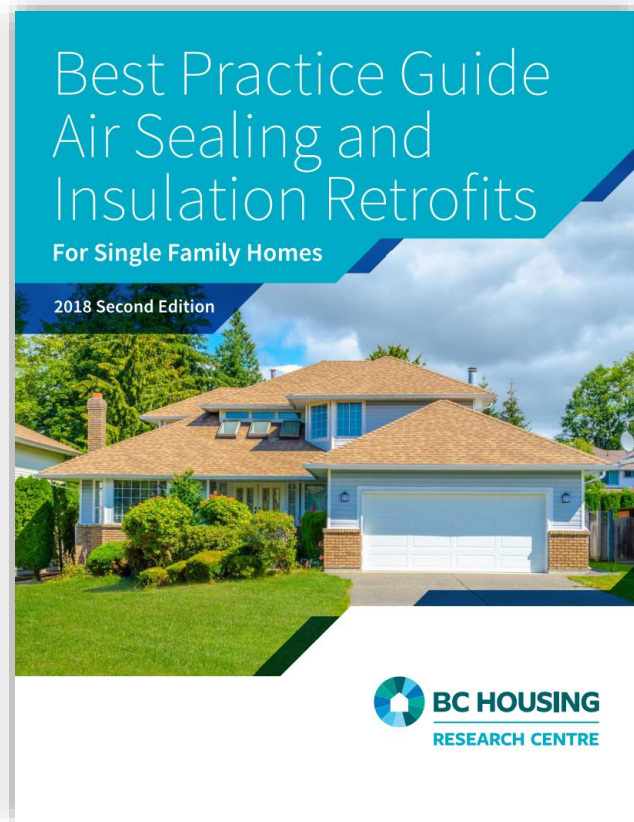
Air Leakage Re-Test



Further Information

- Best Practices for Air Sealing and Insulation Retrofits
- Additional Resources

Best Practices for Air Sealing and Insulation Retrofits



3.1.2: Attics and Roofs: Bathroom Fan and Duct

Air Sealing Procedure - Page 1 of 2

Bathroom exhaust fan housings and duct connections are common air leakage points through the ceiling plane into the attic. Air leakage occurs between the housing and the drywall (and polyethylene air barrier, if present) and through the fixture housing holes and electrical connections. Air leakage can also occur at the duct connection into the housing. It is important to seal this connection to stop warm moist air from venting into the attic.

This procedure is for exhaust fans mounted to the side of a joist. If the exhaust fan is mounted in the middle of the joist space, the procedure can be adjusted accordingly.

Note: See exhaust duct air sealing and insulation procedure 3.3.3 if exhaust ducts are not insulated or are discharging in the attic.



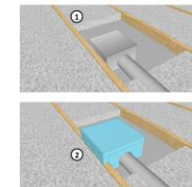
Bathroom exhaust fan venting into the attic. Conditions such as this should be remedied prior to or as part of air sealing and insulation work.

MATERIALS NEEDED

- 1.5" RPS foam insulation board (Alternately, gypsum drywall can be used)
- Polyurethane sealant
- Sheathing or foil tape
- Spray polyurethane sealant (Spray can or two-part froth pack)

RECOMMENDED TOOLS

- Utility knife
- Caulking gun



PROCEDURE

- Expose the ceiling gypsum board approximately 12" on both sides of the fan housing.

Note: If the bathroom fan is mounted to the side of a ceiling joist (as shown) it may be beneficial to temporarily move the housing out of the way in order to seal the joint to gypsum board joint. (See Recessed Pot/Can Lights).

- Create a five-sided box with extruded polystyrene to fit over the fan housing leaving a minimum 1/2" clearance around the housing. Scribe and cut access in the box for the exhaust duct outlet.



View inside wall at floor rim joint.

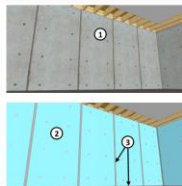
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Best Practices for Air Sealing and Insulation Retrofits

- Sheathing tape and sealant
- Wood framing and gypsum board

RECOMMENDED TOOLS

- Utility knife
- Roof attachment system or glue
- Tools for framing and drywall finishing



PROCEDURE

- Expose the basement foundation wall and floor joints. If required, remove existing finishes and cut back the ceiling finish at the edge to expose the rim joint.

- Install rigid foam insulation on the basement walls per manufacturer's instructions.

- Tape the joints of the insulation with sheathing tape and seal the bottom edge of the insulation to the basement floor slab.

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Best Practices for Air Sealing and Insulation Retrofits

Additional Resources

- Best Practices for Window and Door Replacement in Wood-Frame Buildings, 2013. BC Housing.
Available online: www.bchousing.org
- Managing Environmental Risks During a Renovation Project
Builder Insight Bulletin, 2014. BC Housing.
Available online: www.bchousing.org
- WorkSafeBC OHS Guidelines - Part 4 Indoor Air Quality.
Available online: www.worksafebc.com
- Asbestos Hazards When Renovating Older Homes. WorkSafeBC
Publication. Available online: www.worksafebc.com
- Lead-Containing Paints and Coatings—Preventing Exposure in
the Construction Industry. WorkSafeBC Publication.
Available online: www.worksafebc.com
- Radonaware.ca

Questions?

FOR FURTHER INFORMATION PLEASE VISIT

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- www.buildingsciencelabs.com

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