

THE ATTIC AIR SEAL MANUAL

By: Casey Ray

Head Light



Attic Suit



High Particulate Respirator P100



Safety Gloves



No Rock Knee Pads



Two Way Radios

Comfortable Safety Shoes



Coming to Your Attic!



People

Planet

Profit

Introduction

Eventually, your house will need attic air sealing. Reading this manual will prepare you for what to expect whether you do the work or someone else does.

Air sealing the attic right the first time will prevent many troubles down the road. This manual will inform you about what exactly to air seal, what products are used and much more.

Air sealing the attic is only one part of making a home or building energy efficient. Overall, a home should be as tight as possible and introduce fresh, filtered air into the home at a controlled speed to maximize energy efficiency and the health of the occupants.

Americans must set the standard in energy efficiency.

Letter From the Author



Casey Owen Ray
Licensed Residential Builder
LEED®AP
BPI Building Analyst
(cell) 989-980-2327
caseyowenray@gmail.com
www.core09.com

Utility Slashers, LLC
925 Wisconsin Avenue
Lansing, MI 48915
(cell) 517-303-9963
UtilitySlashers@gmail.com



Air sealing in the attic is very often a stressful activity. It is time-intensive, labor-intensive, and workers are exposed to tight and enclosed spaces, toxic chemicals and materials, pests, and many hazardous work areas. The procedures for air sealing in an attic described in this manual are designed to reduce the stressfulness of the task, while at the same time improving quality.

Clearing the attic areas of insulation is the most important task to ensure the quality of an air seal. A cleared area reduces the stress of air sealing by creating a safer and more organized place to work, and at the same time increases time efficiency. For example, if a tool is dropped, it is not lost in the sea of insulation; if a worker needs to get into a tight spot, he/she has easier access and is no longer rolling in insulation. Not only does clearing insulation create a healthier environment, but a clear, clean attic can make air sealing efforts last longer, and this increases payback.

In order to be efficient, workers need to know what to air seal, be able to see it, have the proper materials for the task, and have the safety equipment to protect their body. Attic suits provide the best protection when clearing insulation, but are stressful to wear all day. Proper respirators protect workers from lead, dust, feces, fiberglass, mold and many other unknowns; however, it decrease communication between workers. In order to reduce as much stress as possible, the goal is to move insulation as quickly as possible while maintaining worker safety.

Many people are allergic to contact with insulation, and having irritated skin, sore lungs or having to wear an attic suit all day are the kinds of things that make workers sacrifice the quality of their work. Workers who are under stress are generally less productive, have higher absenteeism rates, and are less satisfied with their careers. People that are able to perform quality work while maintaining a healthy body are more loyal and committed to the company, and are more likely to find ways to improve the company and increase efficiency. This benefits both the employees and the company. Having energy at the end of the day and being enriched by the comfort they deliver to customers creates an attitude of acceptance to new ideas, feedback and communication.

Some attics are very complex. Being able to communicate to the work force is essential to learning about new methods and materials to increase innovation, reputability, and skills. Air sealing an attic is a task that should only be done once and done professionally.

An air sealed attic will contribute to the comfort of the occupants and lower the utility bills.

Copyright 2011 Casey Owen Ray

All rights reserved. No part of this manual may be used or reproduced in any manner whatsoever without the written permission of the Publisher. Printed in United States of America. For information address Casey Ray, 925 Wisconsin Avenue, Lansing, MI, 48915 or call 989-980-2327. Thank You.

Manual Written and Designed by Casey Owen Ray

Attic Air Seal Contents



1 Remove Insulation

2 Basic Air Sealing

3 Advanced Air Sealing

4 Spray Foam Cans

5 Foam Board



6 Spray Foam Tanks

7 8 Leaf Blower Guide

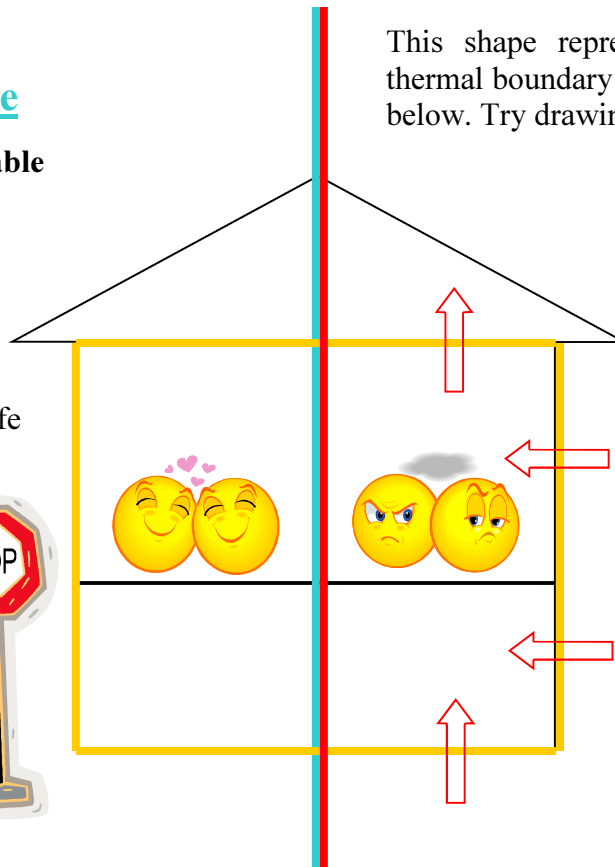
9 10 Money

11 Ventilation

Air Sealing is sealing all the holes that penetrate the thermal boundary. These holes leak air and at greater pressure in the attic. This pressure increases as outdoor temperatures become more extreme and it increases with taller buildings. **Air Sealing is always done before adding insulation.**

Air Sealed Side

- **More Comfortable**
- Healthier
- Saves Money
- *Reduces Pest*
- *Reduces Dust*
- *Reduces Mold*
- Increase HVAC equipment life

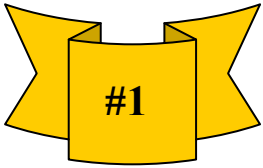


This shape represents a two-dimensional thermal boundary for this specific house below. Try drawing one for your home!

Not Sealed Side

- **More Drafty**
- Cold Spots
- Uncomfortable
- **Higher Utility Bills**
- *More Pests*
- *More Dust*

1st Step: Remove Insulation Before Air Sealing



Removing insulation will allow more time for advanced air sealing, decrease worker dissatisfaction, increase production, and drastically improve the quality of the seal. Having one side or all of the attic cleared at a time also makes visual inspection for quality a simple task. Pictures can be logged and shown to home owners so they know what they paid for.

Having a truck mounted insulation remover/blower is of course the best way to handle materials in the attic. Newer companies may not be able to purchase this machine at the start; however, purchase of such a machine, can increase production and pay for itself.



Truck Mount Insulation Removal

- Advantages
- **The Fastest**
 - Greatest Holding Capacity
 - Free Advertising
 - Quality Air Seal
 - Durability

- Disadvantages
- **Higher Investment**
 - Weather
 - Long Hose May Clog
 - Maintenance



Vacuum Insulation Removal

- Advantages
- **Very Fast**
 - Great Holding Capacity
 - Free Advertising
 - Quality Air Seal
 - Durability
 - Cellulose processing capacity of 6042 lbs./hr.
 - Fiberglass processing capacity of 4199 lbs./hr.

- Disadvantages
- Weather
 - Long Hose May Clog
 - Maintenance



Leaf Mulcher & Blower

- Advantages
- Fits Inside Attic
 - Quality Air Seal
 - Sew t-shirts together to make large homemade bags
 - *Mulches Some Debris*
 - **Lowest Investment**

- Disadvantages
- **Very** Dusty without Bags
 - *Equipment Life?*
 - Electrical Cords in Attic
 - *Maintenance?*
 - High levels of insulation need to be raked first.
 - **Slowest**

Management Tip

- Having all machines makes “insulation removal” adaptable to different environments.
- Every Project is Different!

2nd Step: Air Seal Attic (Basics)

Removing insulation before air sealing will dramatically help to find all these places to seal. Quality air seals are accomplished when trouble spots are easier to find and access.

Basic air sealing includes sealing: 90% of interior top plates, light boxes, can lights, wire holes, gable end top plates, plumbing stacks, weather stripping attic access, exhaust fans, knee walls, and the chimney.

1. Plumbing Stacks



2. Wire Holes



3. Light Boxes



4. Chimney



5. Interior Top Plates



6. Exhaust Fans



7. Knee Walls



8. Gable End Top Plates



1. **Plumbing Stacks** can be a big thermal bypass into the attic.
2. **Wire Holes** are easily seen when insulation is removed.
3. **Light Boxes**: Seal around electrical boxes. Injecting boxes with foam should not be done.
4. **Chimney**: Builders are required to frame a 1” to 2” gap around the chimney. Sealing this hot spot is a must. Material depends on use of chimney.
5. **Interior Top Plates**: Interior walls typically have no insulation. These little holes into the attic can add up to very large holes when looked at as a whole.
6. **Exhaust Fans** with no lights can easily be sprayed to seal. Sealing bath fans will also increase the performance of the fan. Make a sealed box when a bath fan includes a light. Keep foam board 3” away from fixture on all five sides.
7. **Knee Walls**: 1” foam board cuts & breaks easily. Using 2-way radios to communicate size of pieces, will decrease time on the job.
8. **Gable End Top Plates** are easily accessible.

Safety Check

Never depressurize a house or remove insulation when **vermiculite** is present. Assume it contains asbestos. An asbestos abatement crew will need to properly remove the vermiculite.



Vermiculite

2nd Step: Air Seal Attic (Advanced)

Advanced air sealing includes sealing: thermal boundaries, hard to reach interior top plates, exterior top plates, kitchen & bathroom soffits, sky lights, exterior soffits, stairway lids, can lights, installing insulation blockers that run continuous from exterior top plate to baffle, and the unknown.

The advanced air sealing tasks and knee walls are best done with spray foam tanks after all foam blockers are in place. Work your way out of the attic to the access so foam does not get all over your body.

1. Kitchen & Bathroom Soffits



2. Exterior Top Plates



3. Can Lights



4. Sky Lights



5. Exterior Soffits



1. **Kitchen and Bathroom Soffits** must be capped off from the attic. This will fix cold spots and prevent further heat sinks at those places. Knee walls and sky lights create a man-made draft when not properly sealed.
2. **Exterior Top Plates** can be sealed safely and quickly with quick setting spray foam (tanks).
3. **Can Lights:** Pre-made boxes can speed up time in the attic. Temporary nails are useful to solidify the box until sealed tightly. Keep combustible materials 3" away from can light per code. Impossible to reach can lights may be taped with reflective tape from conditioned space, only if incandescent bulb is replaced with a compact fluorescent light bulb.
4. **Sky Lights:** Fiberglass insulation works by trapping air within pockets of material. Foam board was needed here to seal the sixth side that was missing to the 6-sided box. Completing the box is necessary with sky lights, knee walls, and much more.
5. **Exterior Soffit** seals between floors requires investigation. Remove a sample spot to check or use a second pressure gauge during blower door to test if floor joist cavities are truly connected to the outside.
6. **Thermal Boundary:** Defining the thermal boundary is extremely important. These blockers were placed between floor joists in a knee wall and sealed. The heat from the 1st floor now can pass to second floor without spilling into the attic.
7. **Blockers** are needed in low slope roofs to maximize insulation at the exterior top plate and can negate wind washing by separating the insulation from the roof ventilation strategy.
8. **The Unknown** includes holes from old solar panel systems, missing lids over stairways, drop ceiling mysteries, changes in ceiling heights to hundreds of other possibilities. The best way to discover the unknown is to remove the insulation.

6. Thermal Boundaries



7. Blockers



Choosing Materials

Air Sealing is best using a combination of methods:

- Spray Foam Cans
- Foam Board
- Spray Foam Tanks

All the materials used in air sealing work longer when applied to a clean surface. Some payback formulas include the life of the product in the calculation. Spray foam applied to a dirty surface decreases the life of the air seal and in turn decreases the payback of the investment. When done right, air sealing can last over 30 years to a lifetime.

Choosing Materials: Spray Foam Cans



Expansion foams need appropriate weather conditions to cure properly. Spray Foam Cans have a slower cure time, meaning the area being sealed needs to maintain that optimal curing temperature longer. Spray Foam Cans are less expensive and suggested for beginners.

- Advantages**
- Cheap
 - Easily Obtainable
 - Flexible Nozzle to reach trouble spots

- Disadvantages**
- Messy
 - Slow Cure Time
 - One Nozzle per Can
 - Decreases Production

Small Closet



Notice how the installer sealed the interior and exterior top plates. Extra foam extends from top plates to ensure a good seal due to the age of the attic and condition of the lath boards.



Light Box

Management Tip

- The best way to ensure a quality seal is to have a clear and clean surface before sealing.

Choosing Materials: Foam Board

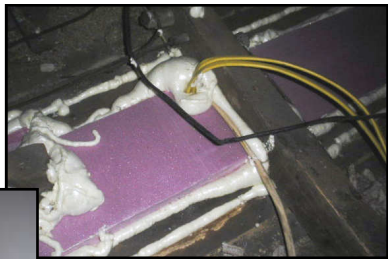
Foam board makes for great fillers for large holes. Less spray foam is used with foam board since only the perimeter is being sealed versus the entire surface area. Foam board is ideal for defining thermal boundaries, sealing knee walls, skylights, kitchen & bath soffits, exterior soffits, stairway lids, can lights, etc.

Ring shank nails work very well to fasten foam board to studs. Properly sized nails will ensure a good bite into the framing members. All foam board requires spray foam to finish the seal.

- Advantages**
- Fairly Cheap
 - Easily Obtainable
 - Increases Production
 - 1" is Easy to Break/Cut
 - Perfect for Knee Walls

- Disadvantages**
- Bulky to Transport
 - Doesn't Sit Well on Uneven Surfaces

Interior Top Plates



Knee Wall



These pictures shows how Foam Board is versatile and can be used to solve many types of Thermal Boundary penetrations. The picture to the left shows extra detail to seal off the Knee Wall from the attic by including the perpendicular wall. The large piece cut for the kitchen soffit below, was done as a whole and then cut into strips to fit onto braces.

Thermal Boundary



Kitchen Soffit



Management Tip

- Two way radios are an excellent way to communicate when using foam board. One worker is in a cutting area below and the other is in the attic with a tape measure and tools.

Choosing Materials: Spray Foam Tanks

Quick curing, expansion foam tanks are hands down, the best way to air seal. Spray Foam Tanks seal better, last longer, and sprays quickly and is easy to use. Tanks are also more forgiving than spray foam cans when some dirt or dust is present. On the other hand, tanks are expensive and should be used by someone who knows where to seal.

The P100 masks are mandatory when using rapidly expanding foam tanks. Each mask is properly fitted for the specific individual and should not be shared. An improper seal will allow toxic fumes to enter the mask and can easily cause someone to pass out and get injured. Whenever possible, use outdoor ventilation during the spray process.

Advantages

- **Increases Production**
- **Fastest Cure Time**
- **Best Seal**
- **Enables Using a Blower Door during installations**
- **Increases Payback (Life of Material)**

Disadvantages

- ***Dangerous Fumes* (Wear P100 Respirators)**
- **Check with local landfills about Disposal**

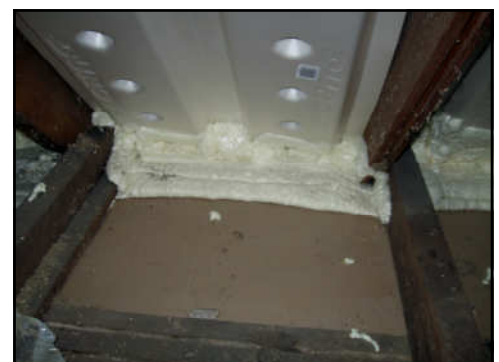


Interior void capped with foam board and sealed completely in.

Tanks



This attic was an extreme case that needed total coverage over a drop ceiling that had no plaster left on the lath boards. The attic was directly communicating with the bedroom below; no interior air seal (drywall) was ever installed before the drop ceiling was installed. This would be a huge hole in the thermal boundary.



Maximizing insulation at exterior top plate and a seal in one!

Leaf Blower Guide for Removing Insulation

Start off an attic air seal with an *insulation removal team* and an *air seal team*. The removal team is dressed in full safety gear (see cover). While the removal team is suiting up, the air seal team is laying floor protection to attic access, running power cords and clip-on lights. Removal team members must be familiar with walking in attics, comfortable with decreased vision during clearing, trained, and of course, be fast.

Critical: Before everything gets dusty, move the bulk of loose insulation with a large plastic rake. The leaf blower/mulcher can not handle large amounts of insulation. Anyone who has blown leaves across a yard knows that when the pile gets to be a certain size, it becomes unmanageable. It simply can not be moved. A large rubber or plastic rake is best even in extremely small attic accesses (18" x 12").

Before Removal



After Removal



Safety Check

Knob and Tube wiring needs to be replaced. Total insulation removal is necessary by either the insulation removal vacuum or the truck mount insulation remover.

One leaf blower is set to suck or mulch insulation and has a flexible duct or leaf bag attached to the outtake. The other leaf blower is set to blow. Use the two leaf blowers to move the loose blown insulation to the other side of the attic. Having multiple leaf bags and forming a chain gang to dump insulation is ideal, but slower. The advantage is minimal dust and higher visibility.

When blowing insulation, take care not to intentionally plug baffles for ventilation. Masking tape can easily be placed over the top of the baffle. In most cases, attics have half or no baffles installed for ventilation and installing new ones in every bay should be included in the attic air seal. Baffles that are poorly installed, should be fixed.

Use the leaf mulcher, to clear what the rake and leaf blower could not feasibly reach. The clip on bag that comes with your leaf blower is great for this task. If possible, purchase extra bags from the manufacturer that fit your specific leaf blower/mulcher. Simply, vacuum up the rest of the insulation. Smaller shop vacuums can clear the rest. Being able to have a fresh bag to clip on when the other is full is key. The efficiency of the *insulation removal team* is dramatically increased with two participating members.

If you are unfortunate to encounter fiberglass batting underneath the loose blown insulation, roll the batting to the other side for your final step. Sometimes, the insulation batting is so old that it crumbles and throwing away insulation might be worth considering.



After clearing the attic, the air sealing team enters and begins spraying.



Vacuum before laying rolled insulation back.

The *insulation removal team* at this time exits the attic and has an opportunity to un-mask, un-suit, and refresh at the cleaning station. The *air seal team* immediately enters the attic and begins sealing. The dust should be settled enough to use dust masks. The places to seal are easily seen and any tools accidentally dropped are easily spotted and not lost in the insulation.

After the air sealing team is finished with half of the work area, the insulation removal team re-enters for Phase Two of the clearing.

Phase Two: Removing Insulation



Phase Two: Air Sealing



Leaf Blower



Flexible Rake

List of Materials

- leaf blower/ mulcher (2)
- 4" to 6" flexible ductwork
- leaf bags
- safety gear (see cover)
- flexible rake
- clip-on lights
- electrical cords
- 4'-8" planks
- garbage cans
- carpet saver
- plastic
- tape
- duct tape
- shop vacuum
- -

When the air sealing is finished, the loose insulation is dumped over until an R-60 spread of insulation is achieved. We now have our mark for depth of insulation set and half or some portion of the attic does not need to be insulated to R-60. That portion is done.

Looking at the pile of insulation



Looking at the cleared attic



New Attic Access

Making time for the little things on projects is something that people notice. The techniques used in this manual will leave someone at the work site able to perform these little touches such as the new attic access below. Also, rotating the removal team with the air sealing team throughout the week will greatly increase worker satisfaction.



After



Management Tip

Don't forget to insulate access to a minimum of R-30 & weather strip the access well.

Note: A smaller shop vacuum is great to clean out your respirator, while in the attic.



Profit

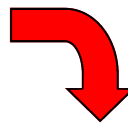


Planet

People

You will make the decision to change your home to a more efficient and healthy environment based on many different reasons. Your comfort at home can have an impact on stress levels and health for your body. Making your building more efficient saves precious resources, reduces your utility bill costs, and has direct and indirect effects on the environment. Most older homes have a great potential for savings, and every home has the potential for a healthier and more comfortable environment. **What will you make your decision based on?**

Customer Feedback Letter *After Air Sealing Improvements*



To: Utility Slashers,

I am writing to let you know what a change I have noticed in my home and heating comfort since you started working with me. Your energy audit was so much more than telling me how to insulate my home. What you told me about my leaky home after the blower door test actually made sense to me. The soffit revision, duct and air sealing you did made more of a difference than all my other efforts including blown in insulation, injection foam insulation and new windows. The visual infrared camera helped me see the hot spots in my home and the energy monitor was really helpful as it told me how much energy both my small and large appliances used. Since completion, I have also seen a difference in both my electrical and heating bills. Thank you for your honest appraisal and home energy improvements.

Sincerely,

Paula Galloway





Air Sealing Budget Glance



This example shows a typical one-story home with normal exposure to the wind. It has 1,200 SF of living space in the first story and the basement. The **BAS or Building Airflow Standard** for this home is 2072 CFM 50. (CFM 50 = cubic feet per minute read at 50 pascals of pressure)

The blower door initially read **4072 CFM** 50. One can see that a reduction in the blower door number will realize more savings.

4072 CFM

Very Leaky

3072 CFM

Leaky

2072 CFM

BAS

1772 CFM

Tight

1000 CFM

Very Tight

POTENTIAL SAVINGS

\$697

\$1395

\$1604

\$2142

At about 300 CFM under the **BAS** the home is getting pretty tight. As the building starts to perform near the very tight level, a HRV (Heat Recovery Ventilator) or Earth Tubes are necessary to provide adequate fresh air for the occupants. Fresh filtered air is always better than air that leaked into your house to get to your lungs.

Below you can see the difference height of the building makes on Air Sealing efforts.

Air Leakage in 500 CFM Increments

	500 CFM	1000 CFM	1500 CFM	2000 CFM	2500 CFM	3000 CFM	3500 CFM	4000 CFM
1 story	\$349	\$698	\$1,047	\$1,396	\$1,745	\$2,094	\$2,443	\$2,792
1.5 story	\$387	\$774	\$1,161	\$1,548	\$1,935	\$2,322	\$2,709	\$3,096
2 story	\$439	\$878	\$1,317	\$1,756	\$2,195	\$2,634	\$3,073	\$3,512
3 story	\$495	\$990	\$1,485	\$1,980	\$2,475	\$2,970	\$3,465	\$3,960

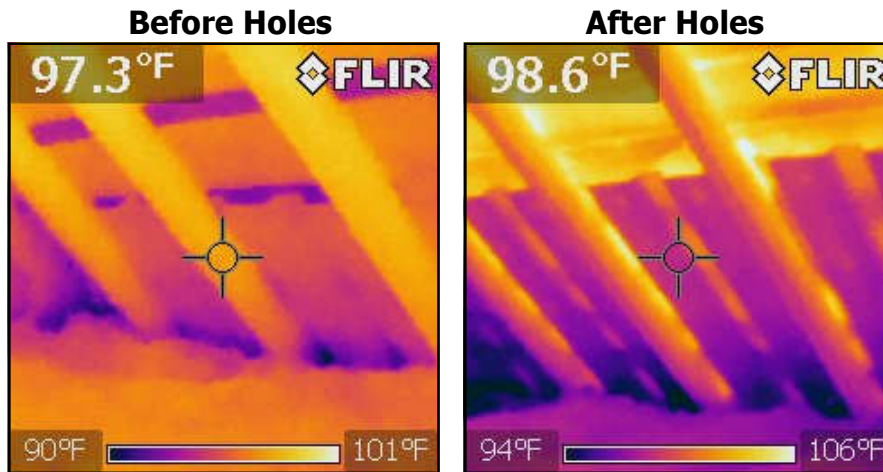
The air sealing budget numbers are based on a home that has 16,000 cubic feet of volume, 8'-0" ceilings, 7000 heating degree days (Lansing, MI), \$1.18 per therm gas price, and a ten year payback.

Key Notes

- **Each house has a different BAS; A separate calculation and energy audit must be done.**
- Climate zone, height of building, cubic volume, fuel type, fuel price and leakiness can affect payback/air sealing budget.
- Location affects heating degree days and utility costs can be very different depending on fuel type.
- Rising utility costs will make the 10 year payback realize sooner if the entire budget is used.

Ventilation

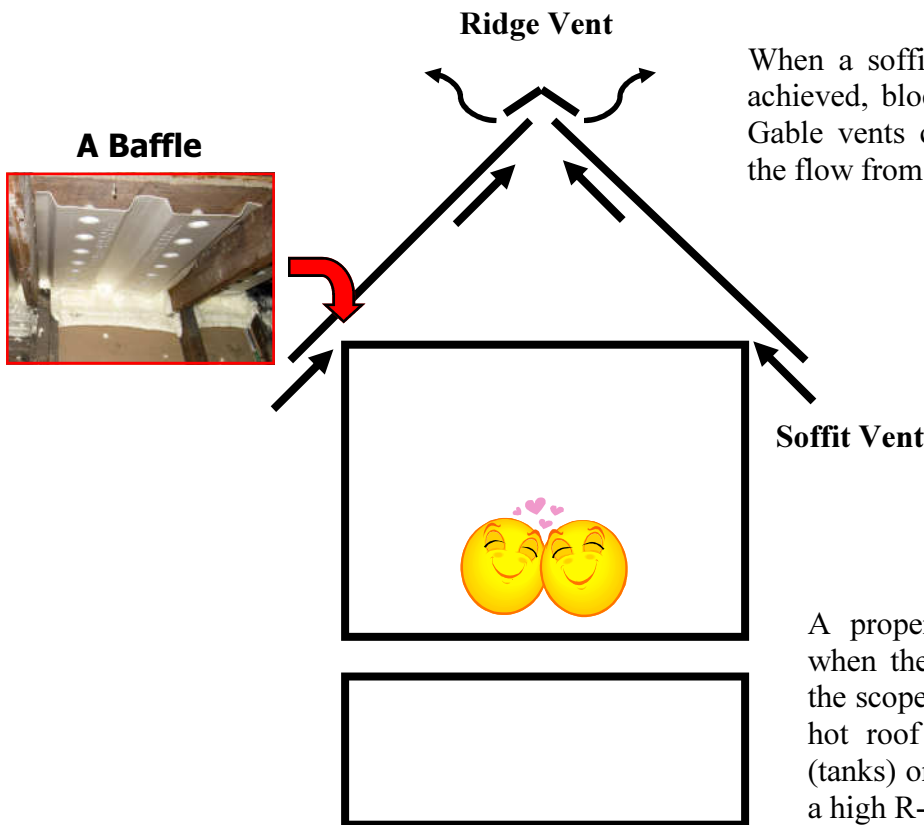
Not changing the ventilation strategy when air sealing is a safe approach, but a soffit vent to ridge vent ventilation strategy is best. **Baffles must be installed when air sealing**. Baffles separate insulation and air sealed top plates from vented soffit. Insulation should never be blown into the soffits. Baffles make great blockers to prevent this.



Installing Soffit Vents



Both pictures were taken with baffles already installed. The right picture is after holes were cut into soffit for ventilation and was taken later in the day. It is clear **cool air** is coming in now.



When a soffit to ridge vent strategy can be achieved, block off any existing gable vents. Gable vents create turbulence that interrupts the flow from soffit to ridge vent.

A properly installed hot roof can work when the right materials are called for in the scope of work. The right materials for a hot roof (un-vented roof) is spray foam (tanks) or high density foam board that has a high R-value.

Management Tip

- A properly vented and air sealed attic can reduce icicles, prolong roof shingle life, reduce cooling costs, and increase air conditioning equipment life.

References

Residential Energy, by John Krigger & Chris Dorsi (2009)

Industrial/Organizational Psychology, Association for Advanced Training in the Behavioral Sciences, (2009)

Pictures and quality work from Utility Slashers - utilityslashers@gmail.com

Truck mount insulation removal pictures from www.californiapowervac.com

Vacuum insulation removal pictures from www.meyerinsulation.com. Suggested model is the Versa-Vac with a 18 HP Kohler V-Twin OHV gas engine, a cellulose processing capacity of 6042 lbs./hr., and a fiberglass processing capacity of 4199 lbs./hr.

Human psychology assistance from Dr. Jessica Charron, Licensed Psychologist - jessica.charron@clintoncountymedicalcenter.com

Photography assistance from John M. Galloway - www.johngalloway.com

Marketing and business assistance from Tera Lynn Galloway - tera.galloway@gmail.com

Air Sealing performed by Jeremy Young and Eric Austin

Writing assistance from Paula Galloway, Occupational Therapist - www.strideglide.com

Web site assistance from Stephen Couchman - www.livedevelop.com

Special thanks to AmeriCorps, Habitat for Humanity, Dr. Energy Saver, and Utility Slashers for all the hands on experiences.



Casey Owen Ray
Licensed Residential Builder
LEED®AP
BPI Building Analyst
(cell) 989-980-2327
caseyowenray@gmail.com
www.core09.com

Utility Slashers, LLC
925 Wisconsin Avenue
Lansing, MI 48915
(cell) 517-303-9963
UtilitySlashers@gmail.com

