Chapter 12. Air Sealing and Insulation

Tools needed by volunteers:

Nail apron
Tape measure
Utility knife
Pencil

Tools and equipment needed:

Generator
Extension cords
Lighting
Hammer tacker stapler
Caulk gun
Hand stapler
Framing square
Stainless steel straightedge
Step ladders
Push brooms
Black felt tipped pen
Red marking crayon
Red utility knife blade disposal tube

Materials needed:

24" R-19 insulation
Red poly tape
Weathermate™ Straight Flashing tape
Weathermate™ Construction Tape
Painter's tape
Caulk
Poly vapor barrier
Staples
Spray foam
1" Foamboard
Soffit nails
1¼" Sheetrock screws
Shims:

- Wood shim
- Felt paper
- Shingle
- ⅛" and ¼" spacer

OSB scrap
Garbage bag

Personal Protection Equipment:

Safety glasses (required)
Work gloves (recommended)
Dust mask (recommended)
Hearing protection (recommended)

Safety First! Review the Safety Checklist before performing tasks in this chapter.

12.1. BUILDING SCIENCE FACTS

1. All of the affiliate's homes are Focus on Energy New Homes Program and Energy V3 certified. The average air leakage of homes built in 2011 was 53% better than certification requirements. This was achieved by focusing on the details of energy conservation at every step of the building process, from framing to installing appliances. These efforts provide a great end product that benefits not only the families but the environment as well.

2. The primary leakage concern is the building envelope, which is any surface between conditioned and unconditioned air. The building envelope should be a closed system, which means that all air/moisture flowing in or out of the building is "intentional" and controlled. Capping the "lid" (ceiling to the attic) is the most critical because it is the highest pressure point of the building envelope. For the walls, creating a completely sealed, 6-sided box for each wall cavity ensures that no air/moisture can be transported through the wall cavity. Maximum insulation efficiency (R-value) is ONLY achieved within "dead" air space. ANY airflow through the fiberglass batt insulation can reduce the R- value by 50% or more.

3. The average home experiences a 30% heat loss as a result of warm air leaking out of the house. Therefore, it is important to control both air and moisture movement by being VERY intentional about sealing every penetration and hole in the building envelope as well as from one level to the next. The most common leakage areas are doors and windows, foundation cracks, sump pits, sill/rim board areas, floor to wall seams, floor to ceiling seams, interior penetrations (i.e. one level to another) and exterior penetration (i.e. inside to outside).

4. It is critical to keep moisture where it can be seen (not hidden in walls or attics) by using appropriate air/moisture barriers/retarders. All building materials (e. g. OSB, sheetrock, plaster, fiberglass insulation, rigid or spray foam, poly/plastic, paint etc.) qualify as air and/or moisture barriers or retarders with varying permeability ratings (the rate at which moisture can pass through). Following is an example of how a moisture barrier/retarder can easily be compromised:

   EXAMPLE: A 4'x8' area of ½" sheetrock has a permeability rating of 90 (6 mil poly is rated at 0.06). At 70°F and 40% RH, ⅓ quart of water will diffuse through this sheet over a given amount of time. By simply adding a 1" square hole, moisture diffusion increases to 30 quarts of water over the same amount of time (i.e., several gaps around electrical boxes could easily add up to this 1" square).

12.2. PREPARATION

1. Mark all stud center locations on the floor with a red crayon prior to installing poly vapor barrier.

2. Mark the location of all HVAC ducts, basement ceiling duct dampers, and plumbing pipes that will protrude through the sheetrock using a red marking crayon. Draw a 6"-8" rectangle directly beneath ceiling heat vents, and in front of cold air return ducts and mark an "X" across corners. Draw a red circle for each pipe on the floor directly in front of the pipe or directly beneath the damper for HVAC damper controls.

3. Verify that all wall and ceiling electrical boxes are identified by a spray painted pattern, about equal to the width of the box on the floor. If there are any electrical boxes that are not marked, use a red marking crayon and draw a rectangle the approximate size of the box on the floor, directly beneath or in front of the box.

4. Verify that the wall studs behind the countertop are all in the same plane to ensure the countertop will fit flush to the wall. Use the edge of a stainless steel straightedge to check the inside edge of the wall studs about 41" above the floor and shim any gaps until all studs are in line at that level. If the gap is ¼" or more, taper off each shim to a zero thickness upward about 20" and downward about 10" from the 41" height. Attach shim(s) with soffit nails.

   NOTE: Materials to use for shimming: shingles, wood shims, wood spacers (⅛" or ¼" thick), or felt paper.

5. Verify that all blocking has been installed per Section 10.5.5. Complete blocking as required.

6. Remove the temporary 2x4 plenum support block positioned across the range plenum in Section 10.2.3.

7. Clean debris from all wall cavities prior to caulking holes and installing insulation.

12.3. AIR SEALING

12.3.1. Main Level

1. Caulk all holes in all of the wall and ceiling electrical boxes.

2. Caulk or spray foam all holes in both interior and exterior wall studs. This is recommended to help insulate and to create a fire block.

3. Fill all holes, including unused holes, in the top and bottom plates on interior and exterior walls.

4. Caulk or spray foam all holes (being used or not) or gaps in the foamboard or OSB that are visible from inside the house. Also, seal around the range plenum duct exit to the exterior with spray foam.

5. Fill the gap between the exterior door jambs and the door framing (rough opening) with spray foam (or caulk if gap is less than ¼"). Fill cavity until FULLY EXPANDED foam reaches the inside edge of the framing. Fill in multiple passes

(waiting 15-20 minutes between each pass) to allow foam to fully expand before applying the next layer. Trim any excess foam ONLY AFTER it has dried thoroughly.

6. Partially fill the gap between the windows and the window framing (rough opening) with spray foam (or caulk if the gap is less than ¼"). Fill the cavity until neither the window flange nor the exterior sheathing (blue foam board or OSB) is visible. DO NOT FILL THE ENTIRE DEPTH to the inside of the window frame. Trim any excess foam ONLY AFTER it has dried thoroughly. If more than one pass is required, wait 15-20 minutes between passes to allow foam to fully expand before applying the next layer.

   NOTE: It is best to have only one experienced volunteer do both the door and window spray foaming.

7. Apply a bead of caulk along the floor and inside edge of each exterior door threshold and both door jambs.

8. Install foamboard instead of fiberglass around all PVC pipes, insulating from the baseplate to just beyond the height of the pipe, and the complete width of the stud bay. Fill the entire stud bay for pipes running floor to ceiling. Install up to three layers of 1" foamboard behind each pipe, then fill in around the sides of each pipe with additional layers. Stagger seams between foam layers. Do not extend foam beyond the interior face of the studs or force foam behind the pipe (i.e., do not bend the pipe). Tape all seams in the final foamboard layer with Weathermate™ Construction tape and spray foam or caulk the perimeter gap between the foamboard and the studs.

12.3.2. Basement Level

1. Caulk all holes in all of the wall and ceiling electrical boxes.

2. Fill all holes in the top plates on interior and exterior walls to create a fire block.

3. Caulk or spray foam all holes in both interior and exterior wall studs.

4. Caulk or foam all sillbox penetrations such as dryer vent, plumbing pipe, gas line, etc.

5. Caulk or foam any holes in the decking such as water lines, drains, vent stack etc.

6. If the plumber has run drain pipes for the tub, cover the hole in the floor for the bathtub plumbing with scrap OSB, fasten with several 1¼" drywall screws, and seal tight with caulk or spray foam.

REQUIREMENT: This is a Building Code and a Focus on Energy New Homes program requirement.

7. If there is a 6" bath fan vent duct (for a future bathroom) exiting through the sill box, use spray foam to seal the vent perimeter around the sillbox foamboard. Push a garbage bag into the duct from the inside (see Figure 12-1). Completely fill the duct and the sill box around the vent with fiberglass insulation (see Figure 12-2).

Figure 12-1. Plastic Bag Inserted Into Future Fan Vent Duct.

Figure 12-2. Insulation Filled Around Future Fan Vent Duct.

12.3.3. HVAC

1. Vacuum debris from the sub-flooring around all in-floor heating ducts as well as the inside area around the top of the duct. Also, vacuum inside the cold air return boots, particularly the joint between the duct and the boot. This will create a clean surface for Weathermate™ Straight Flashing tape application.

2. Secure every in-floor heating duct to the OSB sub-floor by nailing it with two soffit nails (see Figure 12-3). Prior to nailing, adjust the duct up or down as needed so the top edge is flush with the top of the sub-flooring.

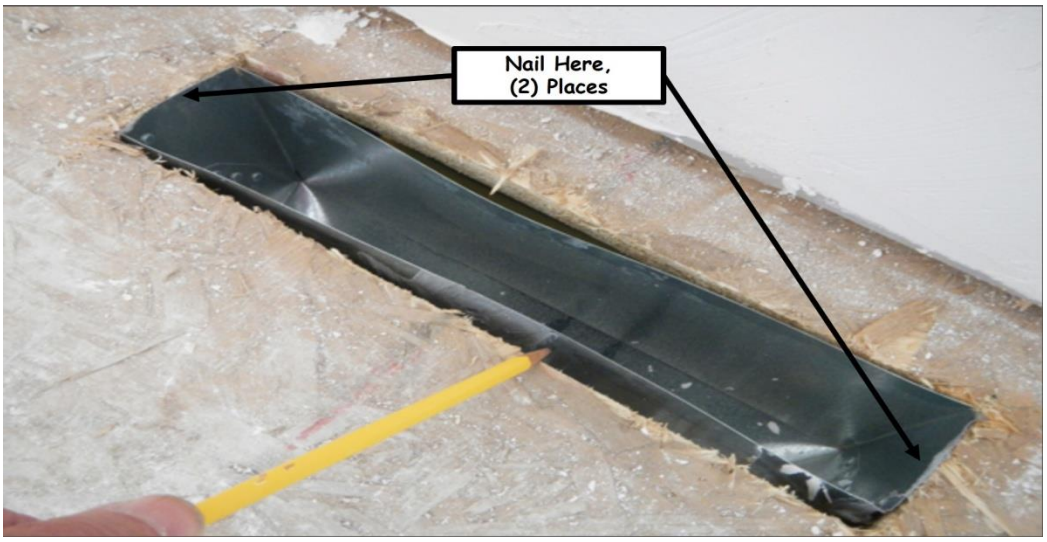

Figure 12-3. Securing In-Floor Heating Ducts

3. Seal gaps between in-floor heating ducts and OSB sub-flooring with a single piece of Weathermate™ Straight Flashing tape. Cut the tape 3" longer than the duct width. Remove the peel strip, center over the duct and apply to the OSB. Make a cut down the center of the tape (long direction), stopping 1" short of each duct side. Make four short diagonal cuts out from each corner to each end of the center cut, (e.g. cut looks like this [>--------<]. Fold the cut ends down and seal to the duct. See Figure 12-4.

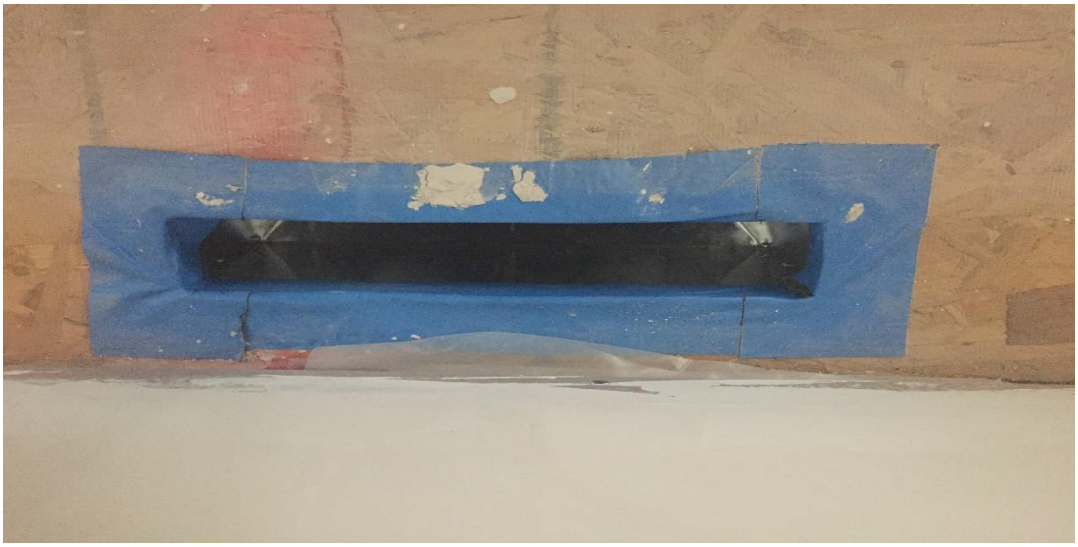

Figure 12-4. Sealing In-Floor Heating Ducts

4. Seal the joints between the cold air return ducts and the cold air return boots with Weathermate™ Straight Flashing tape. Cut into 3" wide pieces, 4"-6" long and apply to the joint in shingle fashion. See Figure 12-5.

Figure 12-5. Sealing Cold Air Return Joints

12.4. INSTALLING INSULATION IN WALL CAVITIES

1. Batt type insulation performs best when installed properly. Failure to seal all air leaks can cause the insulation to lose up to half of its insulation R-value.

2. Failure to fluff the insulation in the wall cavity, or compressing it as little as an inch can cause the insulation value to go from an R-19 to an R-10.

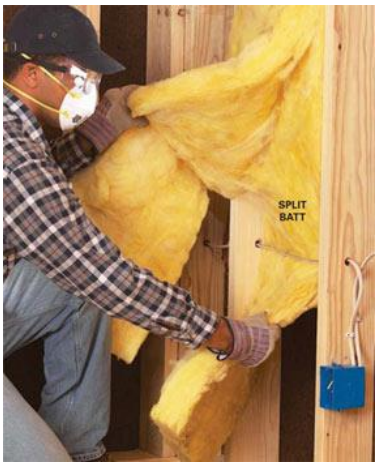

Figure 12-6. Insulating Around Electrical Wires.

3. Insulate all outside walls with (R-19) batt insulation. Install loosely, never pack it in.

4. Split the batt in half to fit it around electrical wires. See Figure 12-6.

5. For stud bays containing 2x4 or 2x6 blocking, cut insulation to fit around the blocking to eliminate densifying the batt. Cut only as deep as the approximate thickness of the blocking and peel away the excess insulation.

6. For those areas where the batt needs to be "cut to size", cut the batt ¾" larger than the size of the area.

   EXAMPLE: If there is an area that measures 18" x 30", the batt should be cut to 18¾" x 30¾".

7. Use foamboard to fill any wall cavity less than 3" wide. It is very hard to fill such a small space effectively with the batt insulation. If the cut edges of individual layers are facing the room, seal off the spaces between the layers with Weathermate™ Construction tape. If the cut layers are facing the studs, tape, caulk or spray foam the perimeter gap between foamboard and studs. Tape any foamboard joints on the interior layer with Weathermate™ Construction tape.

8. Cut out around electrical boxes, as tightly to the box as possible (see Figure 12-7).

   EXAMPLE: If the box measures 4" for the height, 3" for the width and 3" for the depth, cut out the insulation only to that size. Be sure to install insulation behind the box.

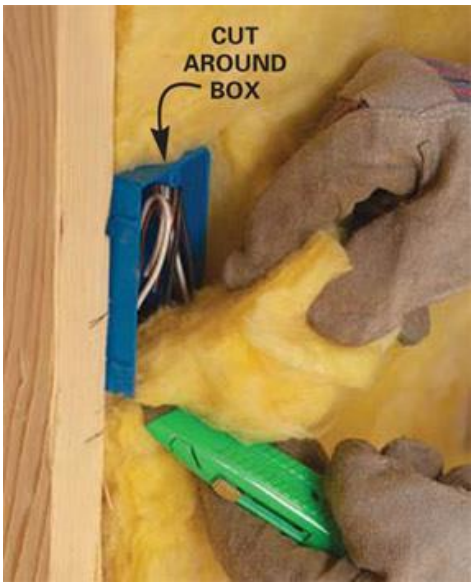

Figure 12-7. Insulating Around Electrical Box.

9. Do not insulate any ceiling areas.

10. **Do not cover thermostat and doorbell chime wires with insulation.** Feed them through the insulation, at the height they are attached to the studs, so they are visible for the crews installing vapor barrier and sheetrock.

    NOTE: The chime wire is typically located above the thermostat wire.

11. If the bathroom vanity light is not running through an electrical box, feed the wire through the insulation (so it visible at the height it is attached to the stud) and leave it hanging in the stud bay. The electricians will drill a hole later and fish out vanity wire through the wall rock.

12. Take time to ensure insulation is fluffed/pulled out so it is flush to the interior face of the wall studs. Make sure insulation fills the entire space from top plate to bottom plate and from stud to stud. The sharp end of a pencil inserted into the edges of the insulation works well to fluff the batts.

12.5. INSTALLING POLY VAPOR BARRIER

12.5.1. General Poly Installation Rules

1. Minimize the number of staples (more is not better) to reduce the number of holes in the poly. An adequate stapling interval is 2'.

2. Tape or seal any holes or punctures with red poly tape.

3. All poly overlaps must cover two studs (including corner stud) or trusses.

4. BEFORE STAPLING CORNERS, be sure to "tuck" poly COMPLETELY into the corners and tight to the ceiling blocking. Use a hand stapler to push the poly into the corners before stapling. A folded poly corner not cleanly conforming to the shape of the corner framing and may result in a tear that will compromise the barrier or could break off a corner of the sheetrock upon installation.

5. For poly installation, consider these orientation definitions:

    a. LENGTH of a room runs parallel to the trusses.

    b. WIDTH of a room runs perpendicular to the trusses.

6. Use nominal 12' wide poly for ceiling areas; 8' wide poly for walls.

7. Install all ceiling poly before installing wall poly.

12.5.2. Installing Ceiling Poly Vapor Barrier

1. Installation typically begins in a bedroom, kitchen or living room. Bathrooms, closets and hallway areas are generally completed last, often utilizing scrap pieces of poly.

2. Create a reference chalk line on the bottom of the trusses. Determine the length of the ceiling area to be covered with poly (see "LENGTH of a room" definition in Section 12.5.1.5 above). Divide this length in half and make a midpoint mark on the bottom of both end trusses in the room. Snap a chalk line between the marks.

3. Measure the length and width of each room to determine the best utilization of the poly. In general

   a. If the room length is > 10', cut the poly 2' longer than the room length. Fold the cut length of poly in half. Use a felt marking pen to draw a straight, continuous line along the fold. Unfold the layers underneath this line and draw the line on all folded layers. This poly line will be used to align the poly to the reference chalk line created in Step 2 above.

   b. If the room length is < 10', cut the poly 2' longer than the room width. Use the factory crease line down the middle of the 12' wide sheet to align the poly to the reference chalk line created in Step 2 above.

4. Begin installation at room center, at a wall that is parallel to the trusses. Unfold the poly sheet, and at the poly reference line, or the center crease line, grab the poly in a cape-like (or tent-like) fashion, behind the shoulders, and walk it up a step ladder to the ceiling. Extend the poly forward so it hangs down the top of the wall about 12" and align the poly reference/crease line to the reference chalk line. Starting at one end, staple at room center for two or three trusses to hold up the center of the poly and work toward the opposite end. Ensure that there is about 12" of poly at each end extending down the wall. Place several staples to the right and left of center before moving to the next truss. Continue to the adjacent trusses, aligning and stapling the center first, then moving outward from the center to the walls. Staple at a spacing distance of about every 2'

   NOTE: Aligning a poly reference line to the reference chalk line before stapling to the left or right helps keep the poly straight and square to the room. Soliciting help from two to four co-workers to hold up the poly with the brush end of a push broom will help keep the poly reasonably tight and aid in the stapling.

5. If the poly WIDTH is insufficient to cover the entire ceiling area of a room, cut an additional piece and overlap the seam a minimum of two trusses. Make sure to include this overlap and the 12" extension down the wall in the measurement prior to cutting. Center the overlap end of the new poly piece on the bottom chord of the truss and tape the seam along the truss chord to ensure a good seal.

NOTE: All ceiling poly seams must be parallel to the trusses, with the exception of outside corners, support posts, entry areas into bedrooms, etc.

6. Tape all ceiling seams with red poly tape.

NOTE: When taping the poly at the point where two intersecting walls and the ceiling meet, make sure the poly and tape is tucked tightly into the corner so as to not interfere with the installation of the sheet rock.

7. Cut the poly over the bath fan by slicing through the poly along the outer edge of the fan flange. Attach the poly to the fan flange using red poly tape.

8. Cut an X opening for the scuttle hole, wrap poly around rough opening and staple. Trim any excess.

9. At each electrical box, cut an X slightly smaller than the inside of the box (staying ¼"–½" away from the corner) and push the poly out and around the outside of the box for a snug fit. TAPE WITH RED POLY TAPE ONLY IF THE FIT IS NOT TIGHT.

12.5.3. Installing Wall Poly Vapor Barrier

1. Before installing wall poly, verify that the centers of all stud locations have been marked on the floor with a RED CRAYON. Mark any missing stud center references.

2. Install the wall poly on all exterior walls. Staple at every stud, plate and window/door rough opening, spacing staples about 2' apart. When wrapping around corners, extend the poly to cover the first stud on the intersecting wall. Use care in wrapping in and around corners so the poly does not bunch up or "stretch" across the corner. Tuck poly tightly into the corner before stapling and keep staples 1" away from the corner to avoid tearing or puncturing poly. Overlap seams a minimum of two studs (including corner stud).

3. To facilitate hanging poly and provide quality corners, begin stapling to the top plate. Beginning in a corner of an exterior wall, **verify a sufficient free length exists to wrap the corner to the first stud on the adjacent intersecting wall,** and align the factory cut edge of poly along the top edge of the wall top plate. Staple along the top plate for about four studs, then continue stapling down these studs to the bottom plate. When this initial section is stapled, secure the corner, and then secure the short free end to the adjacent wall stud and continue toward the opposite end.

4. To install poly around closets without a flush sliding door, wrap the poly around the front closet wall and staple to the Jack or King stud supporting the header. Use a separate piece to wrap the exterior wall corners inside the closet.

5. To install poly around closets with a flush sliding door, cut and install a preliminary piece around the closet top/upper plates and the T-header first before wrapping the rest of the wall. This helps ensure a good seal around a difficult sealing situation.

   a. Cut a scrap piece of poly wide enough to span the two studs supporting the header and long enough to cover the face of the top plate and the 2x4 horizontal blocking under the header.

   b. Hold the poly sheet up under the upper plate. Center the poly between the two supporting studs. Use a utility knife to make two vertical 3" long cuts, about 3½" apart, to fit around the top/upper plates. Staple the poly to the top plate.

   c. With the poly hanging straight down, make a 1½" slit along the top of the T-header. From the center of this cut, slit the poly straight down to the bottom so it hangs loosely around the header. Make several more cuts on both sides of the header to improve the fit around the header profile. Staple the poly to the studs and the 2x4 blocking. Seal all gaps around the framing with red poly tape.

   d. Wrap the entire wall per Steps 2 and 3 above. Upon reaching the closet, cut a U shape in the poly to fit around the header and top/upper plates, then continue into the closet and wrap the corner. Seal around the U shape cut with red poly tape.

6. After the poly has been installed, remove the poly covering the windows. At each corner, make a 2" long 45° cut toward the interior of the window, then finish by cutting straight down and straight across to cut out a rectangular piece of poly. Place these rectangles in the bath tub for use under paint trays on painting days. Wrap the poly remaining around the windows into the rough openings and staple to the frame.

7. At each exterior door, cut poly along the outside edge of the door jamb. Tape poly to the top of the door with painter's tape, making sure to cover the hinges. This will help protect the door surfaces from plaster and paint.

8. When installing poly over loose wires (e.g., bathroom vanity light, thermostat, etc.), push the wire through the poly at its stud attachment height and leave it hanging outside the poly. Seal the hole with red poly tape if poly is not tight to the wire.

9. At each electrical box, cut an X slightly smaller than the inside of the box (staying ¼"–½" away from the corner) and push the poly out and around the outside of the box for a snug fit. TAPE WITH RED POLY TAPE ONLY IF THE FIT IS NOT TIGHT.

10. Install any unusable scrap pieces of poly on any interior wall (except bathroom walls) to minimize waste and reduce contributions to the landfill.

11. Tape all seams that have less than a two stud overlap with red poly tape.