



WAP Pressure Diagnostics Procedure



WAP PRESSURE DIAGNOSTIC PROCEDURE

This document is meant to describe an overall procedure that will allow a WAP Energy Assessor to conduct a thorough blower door / manometer guided diagnostic assessment of a single family site built or manufactured home in the Weatherization Assistance Program. This procedure is in no way a substitute for formal building science training. This is a guide is designed to complement individuals that have been properly trained by professional building science instructors.

This guide is illustrated using the 'DG-700' Digital manometer produced by the Energy Conservatory, and is meant to be used in conjunction with the SWBSTC Digital Manometer handouts provided by the SouthWest Building Science Training Center. Data collected in this procedure will be the same with this model manometer as it will with the Retrotec or Infiltec versions.

There are a lot of elements that go into a proper home energy audit. This guide only encompasses the pressure diagnostics section, and does not imply a complete assessment in any way. Your WAP program allows you to perform work on a home based on "Priority Lists" or a "Site Specific Audit" which will include modeling the home in your states approved energy modeling software. It is always recommended that you follow the priority lists if possible. The following procedure should be conducted in all WAP homes regardless of priority lists or site specific decisions.



WAP PRESSURE DIAGNOSTIC PROCEDURE

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WAP PRESSURE DIAGNOSTIC PROCEDURE

Introduction

There are two main data collection procedures when conducting pressure diagnostics on a home. First there are the tests that measure only the pressures created in the home with the equipment in the home. In other words, the actual blower door does not necessarily need to be set up. You will only need a few hoses and your manometer. For the purposes of this guide, it will be assumed that the blower door *is* set up in the front door of the home, but the fan cover is on. The second procedure is when you have the blower door fan running, create a 50 Pascal pressure difference and measure against that known pressure. At no point should your blower door fan and ANY other exhaust fan or air handler fan be running at the same time.

This guide should be used in conjunction with the DG-700 Digital Manometer color handout produced by the SouthWest Building Science Training Center.



STEP 1 - SETTING BASELINE & SETTING HOUSE INTO BASELINE MODE

Baseline Mode is having all exterior doors and windows closed, and all interior doors open. All exhaust fans and air handlers turned off. Your goal is to separate the indoors from the outdoors. During an initial assessment, you are simply collecting data. You should not fix anything to set up for pressure testing. If there is a manual or mechanical damper connected to an evaporative cooler, or to the duct work that separates an evaporative cooler from an air conditioning (AC) system you should close it. If no damper is present, then that is how that house has been operating and your data should reflect that. In the case of a doggy door, you should fasten it closed with some painters tape. It is important to maintain your "Adjusted Baseline" throughout all of the testing until you have completed the "CAZ" test. If you accidentally lose the "ADJ" under the "A" channel window, you must re-baseline your gauge before conducting a CAZ test.

Once the home is set up, follow the directions on *fig. 1. Setting Baseline*

- You should have a hose to the outside on your channel A 'Ref' port.
- All other pressure ports should be open.
- You will be monitoring numbers in the A channel window.
- Press "Baseline"
- Press "Start"



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Baseline

- Wait for the number in the A channel window to settle and lock on a number (30 seconds)
- Press “Enter”

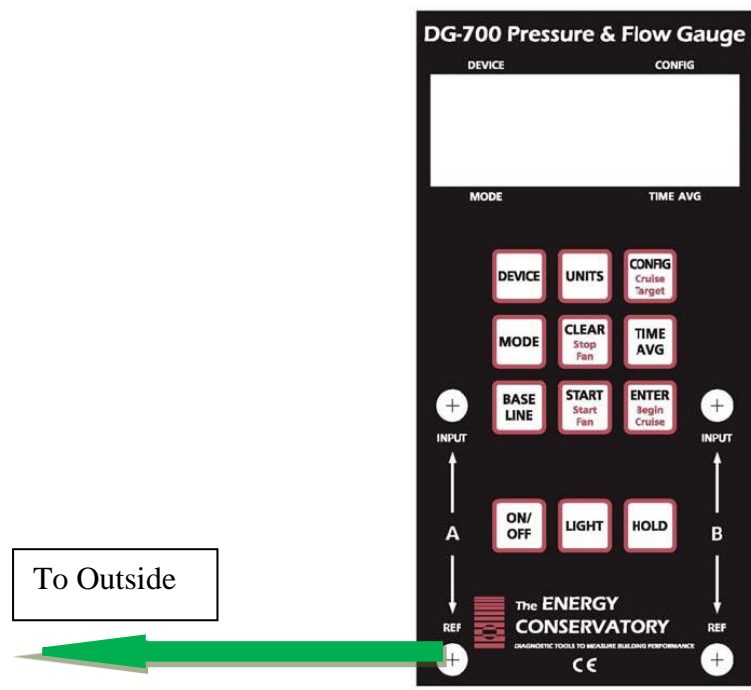


FIG. 1

NOTE: Baseline is not intended to compensate for wind in any way. It is simply looking at the natural pressure between the inside of the home *With Reference To* the outside. You should not attempt to do a Baseline on a windy day.



WAP PRESSURE DIAGNOSTIC PROCEDURE

Dominant Duct Leakage

STEP 2 - DOMINANT DUCT LEAKAGE

Your next test will be to determine the “Dominant Duct Leakage”. Refer to Fig 2

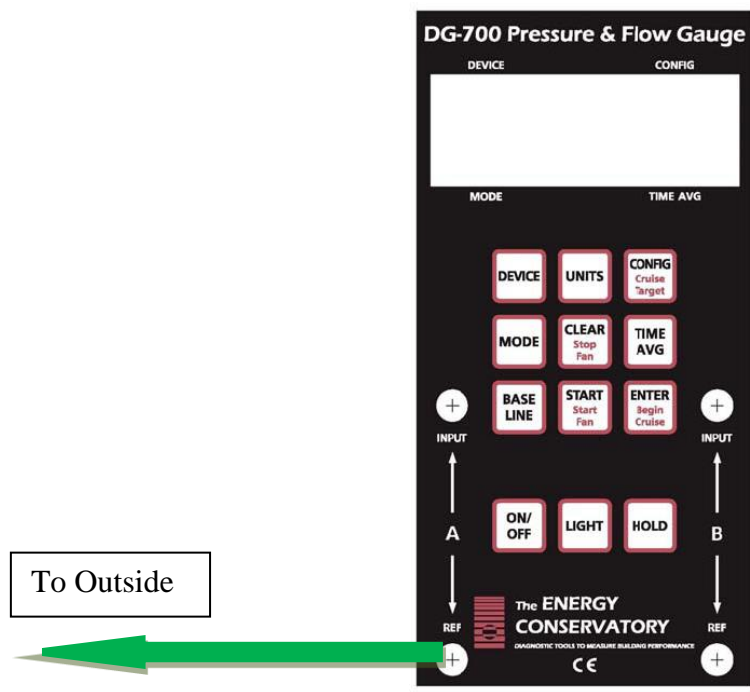


FIG. 2

You should notice that nothing is changing with how the manometer is set up, and nothing is changing with how the house is set up. You will be pressing no buttons on your manometer.

- Turn on air handler. If you have multiple Air Handlers, turn on “1” record number, then turn on “2” and record combination number, then shut down “1” to record the impact only the “2” air handler creates on the home etc.



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Dominant Duct Leakage

- Make sure air handler is running at full speed.

NOTE: Some high efficiency heating and cooling equipment may have multi-speed fans. These need to be running at full capacity. This can usually be accomplished by setting the Thermostat to the lowest possible temperature setting for AC and waiting for 8 minutes, or the highest temperature possible for heating systems.

You are still monitoring the “A” Channel numbers. As the air handler winds up to full speed, you will usually see a pressure appear on your manometer. While you do need to keep the number in mind for other tests coming up, for the purposes of the “Dominant Duct Leakage” test, the *positive or negative* is the more important piece of information.

A positive pressure implies that you have more leakage on the RETURN side of the duct system than the supply side.

A negative pressure implies that you have more leakage on the SUPPLY side of the duct system than the return.

NOTE: This test does not show either side as being leak free. Just that one side may be leaking **MORE** than the other. If you see no pressure changes at all, there could be several things to consider.

1. You may have left a window or door open to the outside. Double check this first. And if so, close it and start over from “Setting Baseline”



WAP PRESSURE DIAGNOSTIC PROCEDURE

Dominant Duct Leakage

2. You may have left the cover off of your blower door fan. If this is the case, cover the fan and start over with "Setting Baseline"
3. Your duct system may be leaking EQUALLY on both the return and supply sides, and that will be determined later in this procedure.
4. Your house may have excessive shell leakage and that will be determined later in this procedure.

Record your "Dominant Duct Leakage" number and specify if it was a negative or positive number. Record this data for each AHU (Air Handler Unit) working alone and in combination with other AHU's operating.

Example: **Dominant Duct:**

$$1 = -0.3$$

$$1 + 2 = -1.3$$

$$2 = -1.0$$

Note that both Air handlers must be running for the next test "Room Pressure's" and these numbers will have an impact on your CAZ procedure.



STEP 3 - ROOM PRESSURE TESTING

This test is designed to see what happens to the pressure balances in the home when interior doors are closed. Refer to Fig 3.

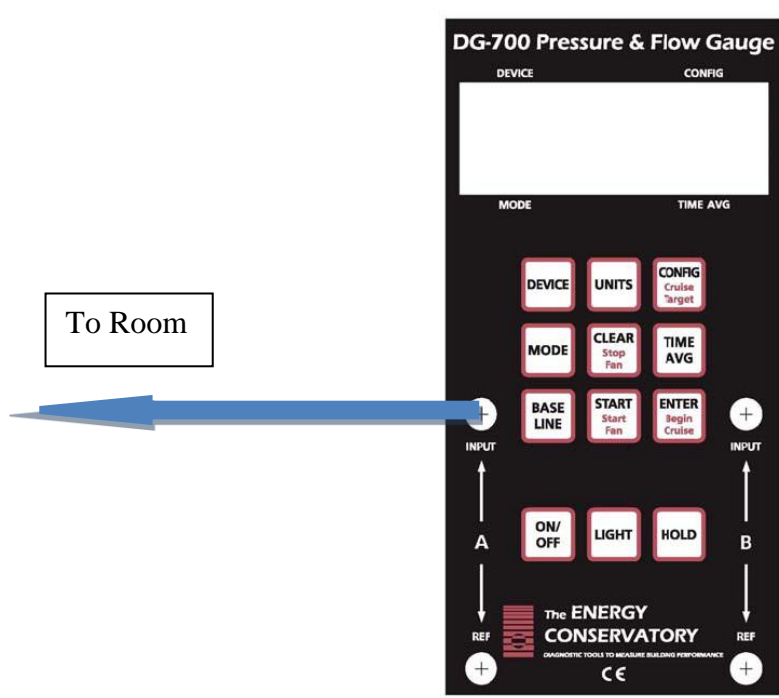


FIG. 3

You will be testing various ROOMs with reference to INSIDE.

For a room to qualify for a room pressure test, it must have a supply register, and / or a return register and / or an exhaust or supply fan and a door. This includes bathrooms and laundry rooms.



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Room Pressures

The procedure for this test is to perform all room pressure testing clockwise from the blower door. If your door is set up in the front doorway, you would look at it and walk to your right hand side and test the first qualified room you come too.

- Place 'INPUT' pressure hose a few feet into room.
- Close door. Record pressure number and if it is positive or negative.

The Arizona WAP dictates that no room should exceed +/- 3 Pascal's of pressure. If your room DOES exceed 3Pa, the next step is to determine what it will take to alleviate the pressure. You can do this by cracking the door open slowly until the pressure drops to within limits, then calculating the net free square inches you opened the door by multiplying the height of the door in inches by how many inches you cracked it open.

EXAMPLE: If my manometer reads 9.6 Pascal's and I cracked the door two and a half inches to get the pressure down under 3Pa. I would measure the Height of my door, in this example, 80 inches and multiply that number by 2.5. That would let me know that this particular room needs approximately 200 Square Inches of "Passive Return"

Conversely, if you are testing rooms with a supply register but no return system, and do not see a pressure exceeding 3Pascal's, that should be considered a flag for further investigation. For example: A low room pressure could indicate a crushed or disconnected duct, or maybe excessive shell leakage in that room. Once done with the actual room pressure, you may collect one more piece of information while at each



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Room Pressures

room that is used for the next test. Once you have collected the room pressure and the amount of area needed to relieve that pressure, look around that room for any type of exhaust fan.

NOTE: A clothes dryer is an exhaust fan.

If you see an exhaust fan, turn it on, close the door and note the new pressure. If the room goes into a negative pressure, this is VERY IMPORTANT information for the CAZ test and should be noted. A good example of note keeping for this particular test would look like this.

9.5 / 200 / -1.2

↑
This first number is the initial positive pressure recorded.

↑
This second number is the height of the door X the amount you opened the door in inches.

↑
The third number shows that there was an exhaust fan that created a negative pressure.



STEP 4 - "CAZ TEST"

NOTE: The CAZ test, as far as health and safety goes, is the single most important test an energy assessor performs. You **MUST** have a baseline on your manometer prior to performing this test. If you have no formal training in this area, **STOP**. You are not qualified to perform this test alone.

Refer to Fig. 4 – "CAZ Test" for manometer set up.

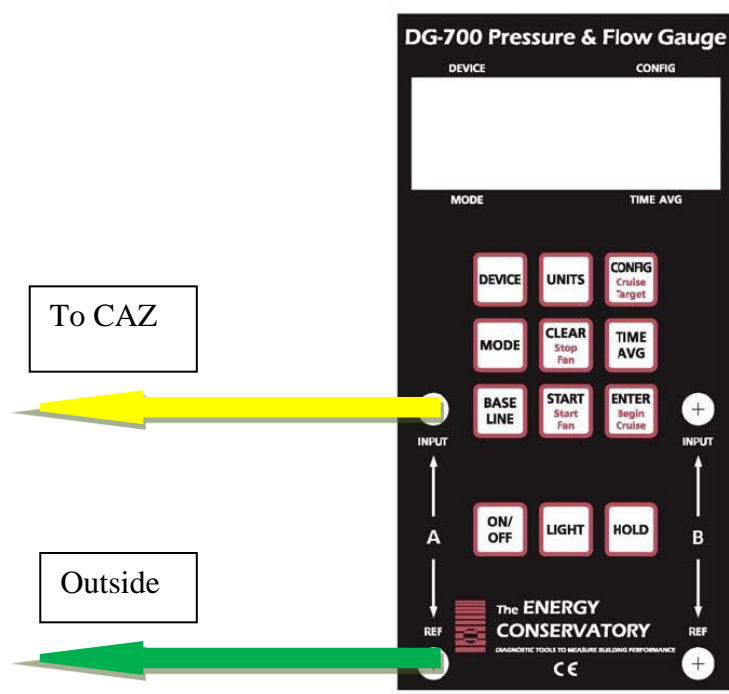


FIG. 4



WAP PRESSURE DIAGNOSTIC PROCEDURE

CAZ

The first step in a proper CAZ test is to set the actual CAZ into "Worst Case Scenario".

In MOST cases this is easily accomplished with 3 simple steps involving information you have already collected to this point. If your Dominant duct leakage from step one is a NEGATIVE number follow these next three steps:

1. Turn on all exhaust fans. This includes the range hood, bath fans and the dryer. Your air handler should still be running if you have followed every step to this point.
2. Close all interior doors that have a positive pressure, and open all interior doors that have a negative pressure behind them, any doors that appear to have no pressure behind them at all should be closed. *(It is very possible to have a bathroom with an operating exhaust fan where the door will still be closed because there is more supply air than is being exhausted by the fan. This was determined by your Room Pressure Tests)*
3. Run 'Input' hose to each individual CAZ WRT outside and record the number.

NOTE: If there is a door between the main body of the home and the CAZ, e.g.: Water heater in a closet. Test your CAZ with that door open, then check again with the door closed and record the GREATER negative number. For example, a reading of -3.9 is GREATER than -3.1 and therefore your CAZ TEST Number for that particular CAZ is -3.9.

IF your Dominant Duct Leakage Number from step 2 was a POSITIVE number, you should follow steps 1 through 3 above, but test each CAZ with air handler ON then



again with air handler OFF to see which has the greater negative depressurization.

NOTE you may have scenarios where multiple AHU's will have an impact on what creates "worst case scenario".

No home in the WAP program should have a CAZ zone with a pressure less than -

3.0Pa

The CAZ test should only be performed under the supervision of a trained professional.



STEP 5 - COMBUSTION SAFETY

Once your home is in “worst case scenario” that is when you will perform all “Combustion Safety Tests. These tests should only be performed by someone that has been professionally trained or Certified.

It is recommended that you use and follow the combustion safety process highlighted in the “Combustion Safety App” included in this field guide package.

SWS # 2.0201.1

Emergency problems (e.g., gas leak, ambient CO levels that exceed 35 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested

FUEL LEAK DETECTION:

- An electronic gas leak detector should be base lined outside in a clean air sample area before being brought into a CAZ area.
- Test all gas, oil or propane fuel lines at all connections and the entire lengths of any flexible piping for leaks. Any positive leak indications from an electronic detector should be verified with soap and water solution.
- Scope of work will specify any repairs needed to correct fuel leaks of any kind.



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Combustion Safety

COMBUSTION AIR REQUIREMENTS:

- Combustion air will meet *IRC 2012 Section G2407.5* guidelines
- Volume of air indoors to supply a device will be no less than 50 Cubic Feet per 1000BTU's of input for all devices in the space. Air volume must be always accessible, and measured shell leakage of the building cannot be below 0.4 ACH.
- If outside air is to be brought into the CAZ, at a minimum you will supply two separate inlets. One that terminates within 12 inches from the ceiling, and another that terminates within 12 inches of the floor. If inlets are horizontal (through a wall) 1 Square inch, Net Free area will be provided for every 2000 BTU/hr input of all equipment in the CAZ, OR combustion air can be brought in vertically (From vented attic space) providing a minimum of 1 Square inch, net free area per 4000 BTU/hr of combined input for all atmospheric vented appliances.

FLUE PIPE / EQUIPMENT INSPECTION:

- All flue pipes will be visually inspected to verify they are the right size.
- Slope a minimum of $\frac{1}{4}$ " rise per foot of run.
- Are free from blockage or excessive damage, leaks, disconnects, or other safety hazards.



SPILLAGE TESTING:

- In worst case depressurization mode, all non-mechanically assisted drafting devices must be tested for spillage at the diverter. If a device continues to spill flue gasses after 2 minutes, it must be tested again at natural conditions to determine if the failure is pressure induced or an issue with the device itself. Any failure of spillage testing requires specifications on how to mitigate the issue under any operating conditions.

UNDILUTED CARBON MONOXIDE TESTING:

- Carbon Monoxide production levels must be measured in all combustion appliances. In atmospheric, natural drafts appliances, this will be performed at the exhaust ports before the gases can mix with dilution air. In Mechanically Assisted or Sealed Combustion appliances this test is performed at the outdoor termination of the flue pipe.
- No appliance can exceed 200ppm undiluted, or 400ppm 'Air Free' at steady state efficiency.
- If CO levels exceed these limits in worst case conditions, they should be re-tested at natural conditions to determine if the failure is due to CAZ pressures or the device itself and appropriate actions to mitigate the problem should be added to the scope of work.



WAP PRESSURE DIAGNOSTIC PROCEDURE

Static Pressure Test

STEP 6 - EXTERNAL STATIC PRESSURE TEST

Refer to Fig. 6 for manometer set up.

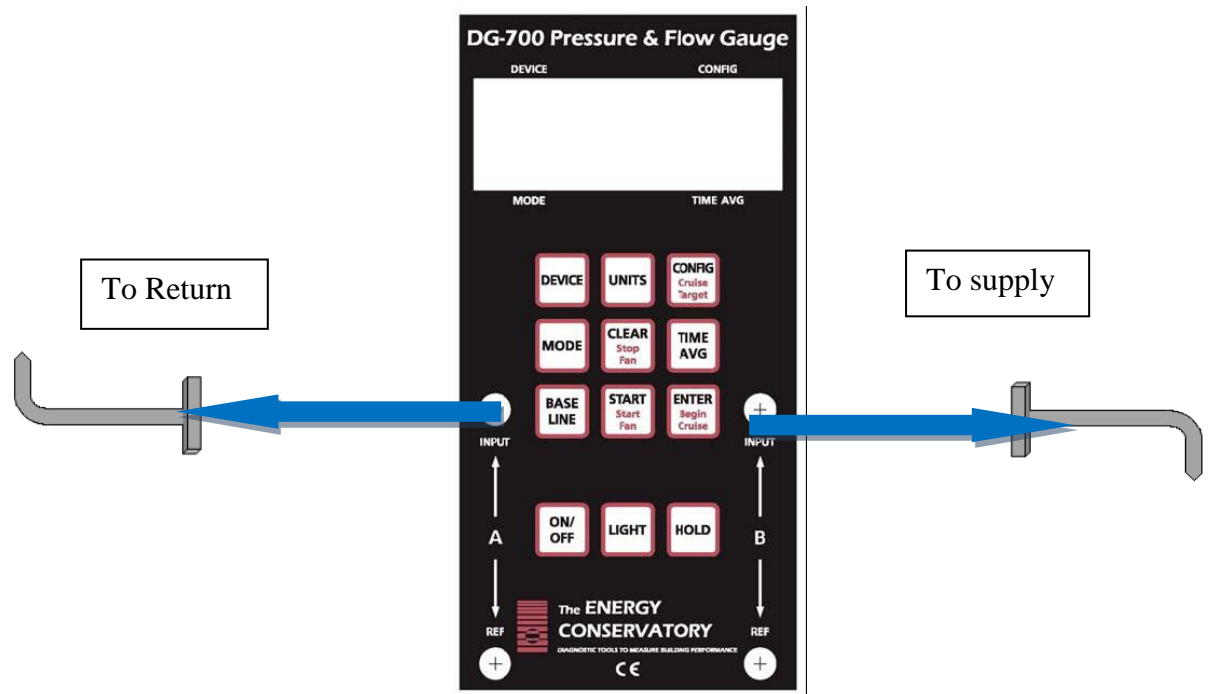


FIG. 6

The static test is meant to measure the static pressures created in the Air Handler itself when operating normally. There actually needs to be two tests performed. One with the air filter in place, and one with it removed and equipment operating without an air filter. In both cases, all interior doors of the home should be opened back up, and all the fans that were turned on for “Worst Case Scenario” should now be turned back off. Any supply registers that have been closed or covered should be opened up.



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Static Pressure Test

These tests are performed by drilling two 5/16" holes into both the supply and return plenums as close as you can get to the air handler without drilling into an Air Conditioning coil. Insert a draft probe into each hole insuring that both probes are pointing *into* the air-stream. In other words, your probe in the supply plenum would be pointing TOWARDS the air handler, while the probe in the return plenum would be pointed AWAY from the air handler. To switch the units of measurement on a DG-700 simply press the "Units" button once. You will record a number that looks similar to this: .5000 Repeat this test with the air filter removed and record that number as well. Most heating and cooling air handler equipment has a manufacturer's tag with the model number and serial number on it. Usually on that same tag you will also find the "Max External Static Pres. xxxx iwc"

Because you are testing pressures separately on both channels of your manometer you can simply add the two numbers together ignoring the "-" (Negative) sign. For example

$$\text{Supply} = 0.350 \text{ iwc}$$

$$\text{Return} = -0.410 \text{ iwc}$$

$$\text{Total TESP} = 0.760$$



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Static Pressure Test

Compare your number to the number on the tag. This will tell you if the duct system is operating at excessively high static pressures due to an undersized return system among other things. You will notice that the number increases with an air filter and even more with dirty filters. Both the supply and the return sides should be about Half of the max pressure recommended by the manufacturer.

Alternatively, you can look up the “Blower Performance Chart” provided by the manufacturer of the air handler unit. This chart estimates the volume of air the unit is moving based on the Total External Static Pressure. ACCA standards recommend an air flow in air conditioning units to be between 350-450 CFM per ton of air conditioning capacity. It is recommended in hot dry climates that you get to the higher end of that range for optimum efficiency.



WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

STEP 7 - INITIAL BLOWER DOOR

First step in preparing for an initial blower door test is to set the house back into BASELINE mode. Note that you should still have a baseline on your gauge before conducting this test. All exterior doors and windows should still be closed, and all interior doors should now be open, and exhaust fans OFF, from the static pressure testing. Your air handler can now be turned off. You should set all atmospheric combustion appliances in the home to OFF or PILOT and place your car keys on the water tank so that you cannot drive away without returning all equipment to operation positions.

As an energy assessor, you must now make a decision as to whether you want to “pressurize” or “de-pressurize” for your testing. Here are some considerations.

If any of the following conditions exist, you CANNOT depressurize:

- You find mold anywhere in the home
- You find Vermiculite insulation in the attic
- You suspect any friable asbestos is present in the home
- There is a fire burning in a fireplace within the home
- You suspect there may be lead dust from lead based paint in the home

WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

You may NOT want to depressurize if there are any ashes in a fireplace within the home, however wet newspaper carefully laid out will usually hold the ashes down on a



depressurization test. When looked at carefully, there are really only two benefits to De-pressurization testing.

1. The blower door is designed to give you access to the rings in the fan only when set up in De-pressurization mode.
2. You can feel infiltration on your skin when the door is operating at 50pa.

When you consider the dollar value of infiltration repair in some climate Zones in Arizona, being able feel infiltration is not really much of a benefit, but the potential to pull Mold spores, Lead dust, or Asbestos into the family's living space is quite a downside. If you do choose to Pressurize with the blower door, check for 'Up-Ducts', and temporarily hold all exhaust fan dampers closed with tape. Make sure that the manual gates that can be closed are in fact closed, and the spring or barometric controlled dampers are temporarily held closed.

NOTE: In order to 'Pressurize' for blower door testing, you MUST turn the entire fan around. You CANNOT flip the flow reversing switch that is on some fans, this will give very in-accurate numbers.



WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

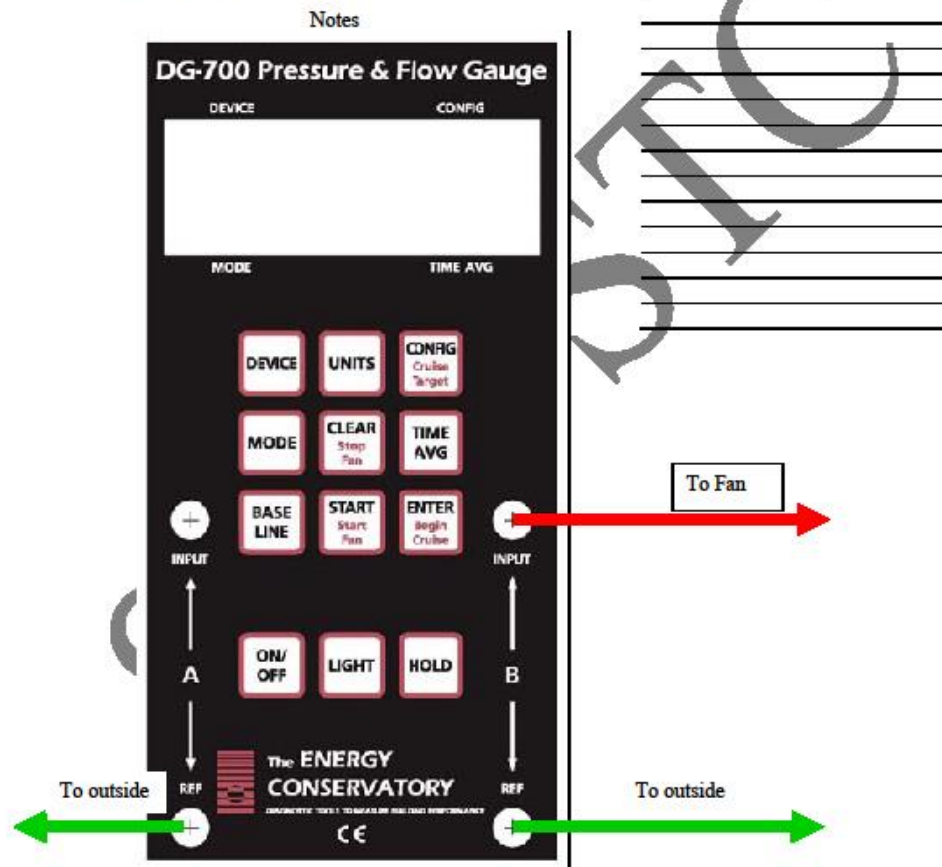
To “Pressurize” see fig 7

To “De-Pressurize” see fig 8 for manometer set up.

Initial Blower Door Test (Pressurize) *Turn Fan Around to Blow Air Into Building*

Channel A: Input open to house, reference to outside and establish 50 Pascals difference.

Channel B: Input to fan tap, reference to OUTSIDE, record fan pressure in Pascals and whole house CFM 50.



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FIG 7



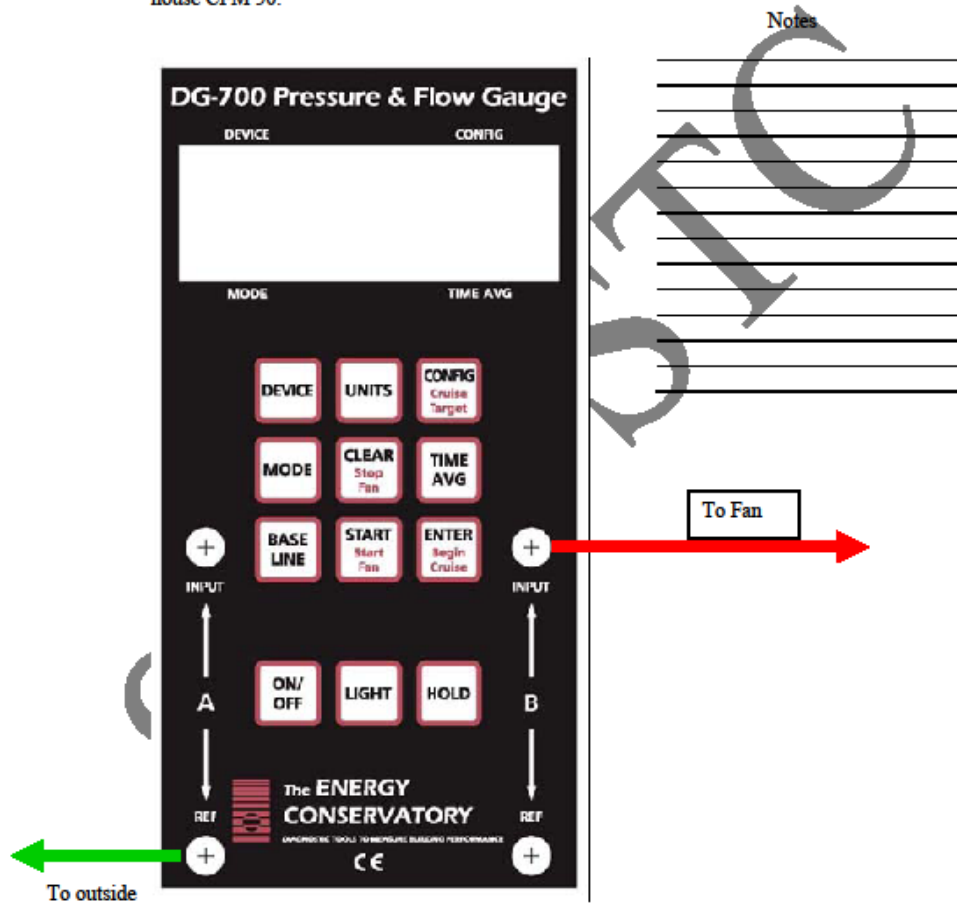
WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

Initial Blower Door Test (Depressurize)

Channel A: Input open to house, reference to outside and establish 50 Pascals difference.

Channel B: Input to fan tap, reference to inside, record fan pressure in Pascals and whole house CFM 50.



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FIG 8



WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

Once you are all set up, choose which ring you feel will be appropriate for the home you are testing. There are a couple rules of thumb that many people like to use. The reality is that it is in fact just a guess at this point. My experience has been that starting with the 'A' ring is a good guess. To start you should turn your rheostat clockwise increasing the fan speed until you achieve 50Pa on your 'A' channel. This is the HOUSE With Reference To Outside. From this point forward, all testing will be performed with the house at this 50Pa pressure differential with reference to the outside.

At this point a couple of things must happen. First you should verify that you have a minimum of 25Pa on your 'B' channel. If you do, you can skip ahead to the next step. If however you're 'B' channel is less than 25Pa, you will have to add another flow ring to your fan to increase the pressure inside the fan housing in order to produce an accurate CFM Flow number. Once you have 50Pa on your 'A' channel and a minimum of 25Pa on your 'B' Channel you will need to push the "MODE" button. This will switch the 'B' channel window from 'Pa' to 'CFM'. You should also notice that at the top left hand side of that same window you will see "OPEN". This is referring to your fan configuration. If you have an open fan, then the number you see above 'CFM' in the 'B' channel window is your CFM50 number. If you had to use a flow ring to get to this point you will have to tell the gauge which ring is in the fan. Press the "CONFIG" button and you will see the word "OPEN" scroll through the options available to the DG-700. You would press the button once for "A" ring, twice for "B" ring and so on. If you accidentally skip past your ring, just keep pressing "CONFIG" and you will see it



WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

scroll back to its original setting. The number you need here is pretty simple. It is a "CFM@50Pa" number.

If you are unable to achieve 50 Pascal's due to a very leaky home, you can push the "Mode" button again for a calculated flow at an estimated 50 Pascal's.

This is the whole house leakage number and is very important in weatherization for a few reasons. If you look carefully at the two windows in your manometer, you will see how this number is formed.

AIR SEALING BUDGET PROCEDURE

Let's say for example that the test reads:

2000CFM50

The "2000" is the number in the 'B' channel, and directly below that you will notice "CFM". In the 'A' channel, you should always see "50" and below that number "Pa". So when you break it down, you have **2000** Cubic Feet per **M**inute moving through the fan at **50** Pascal's of pressure.

The Weatherization Assistance Program has established within its priority lists, dollar amounts that can be spent when dealing with infiltration you find with your 'CFM50' number. The following procedure explains what to do with your 'CFM50' number to determine how much money can be spent to seal these holes. Let's use the previously



WAP PRESSURE DIAGNOSTIC PROCEDURE

Initial Blower Door

mentioned number of 2000CFM50 as an example. You can calculate how much to seal, and how much you can spend to accomplish that goal.

2000CFM50...Blower door reading
1100CFM50...Where I want to be.

900CFM50...Infiltration sealing
~~900~~.....Square inches to
seal

~~900~~ x \$35.00 .Budget

I have \$315.00 max. To seal 900CFM50

Can you seal 90 square inches of holes in the shell of this building for less than \$315 dollars? That includes the time and materials to find *and* seal these penetrations. An effective tip is if you see a hole that you think is actually shell leakage, tape it off with Duct Mask and re test your home. If the infiltration drops 100CFM50 for example, ask yourself: Can I seal that hole for \$35?

Remember: this dollar amount varies greatly depending on climate zone AND building type. Consult your priority list for building type and climate zone to determine your specific dollar amounts.



WAP PRESSURE DIAGNOSTIC PROCEDURE

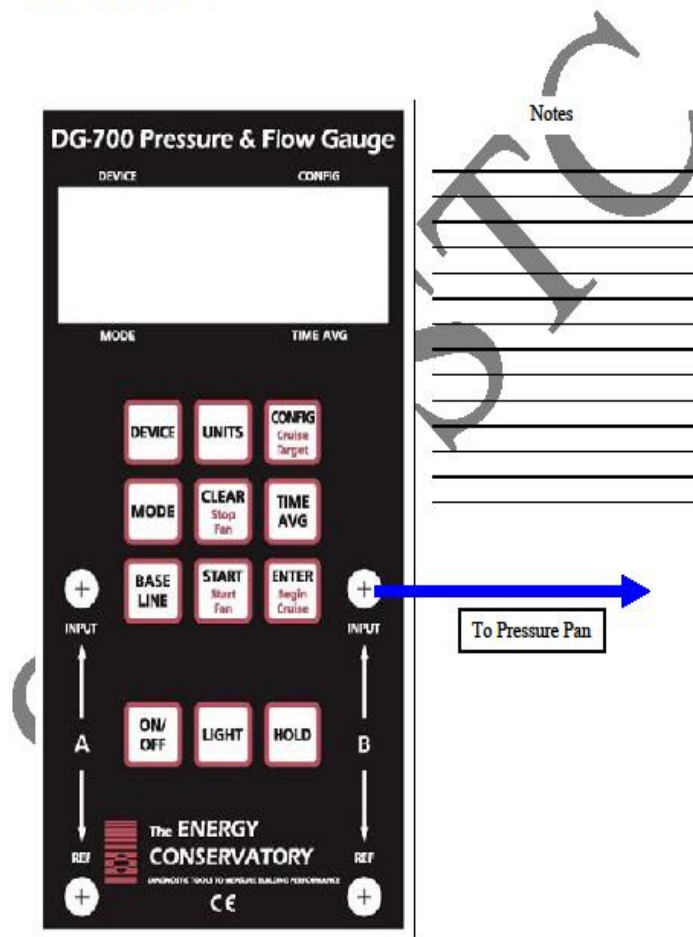
Pressure Pan Testing

STEP 8 - PRESSURE PANS TESTING

SEE FIG 9

Pressure Pan With Blower Door at 50 Pascals

Channel B: Measure leakage at each supply and return register in Pascals with hose input WRT inside of house



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FIG 9



WAP PRESSURE DIAGNOSTIC PROCEDURE

Pressure Pan Testing

In this test you are looking for the answers to two main questions.

1. Is the duct system leaking?
2. Where is the location of the majority of the leaks?

This test will NOT tell you how much leakage there is, only that there is leakage, and the approximate location of that leakage.

You will notice that at this point we have removed our green reference hose from the 'A' channel reference port. You are now able to disconnect yourself from the blower door by removing the pressure hoses from the manometer. DO NOT ADJUST THE RHEOSTAT. If left alone, the blower door will maintain the 50Pa pressure difference between the indoors and outdoors. Though you will no longer see it on your manometer, that pressure is there.

NOTE: This test only works if the home is at 50Pa of pressure. If you could not achieve that pressure you will have to use an alternative method to estimate duct leakage or temporarily seal shell leakage, or run a second blower door so that you can achieve 50Pa of pressure.

You must now hook up your pressure pan to the 'B' channel input tap with a pressure hose. Starting from the blower door, you will want to go clockwise around the house,



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Pressure Pan Testing

ground floor first then second floor clockwise from the top of the stairs and record ALL the pressures you find in EVERY supply and return register. Any reading of 1.0Pa and over is an indication of a leaky duct system. The larger the number the closer to the leak you are in most cases. The goal of the WAP program is to see the duct system become as leak free as possible. Less than 1pa at all supply and return registers indicates a “relatively leak free system”.

Note: If two registers are within 6’ of each other in the same run, you should tape one register off completely and just record the pressure in the other register. If your pressure pan does not completely cover any register, it is acceptable to tape that register off enough to where your pressure pan will then completely cover it.

ESTIMATING TOTAL DUCT LEAKAGE

Estimating Total Duct Leakage to the Outside:

Because your priority lists, or a computer modeling software will require a total duct leakage measured @25Pa or @50Pa you can use the “Pressure Pan / Duct Sealing potential calculator” included in this field guide to calculate a total leakage number based on average pressure pan readings collected in this test.



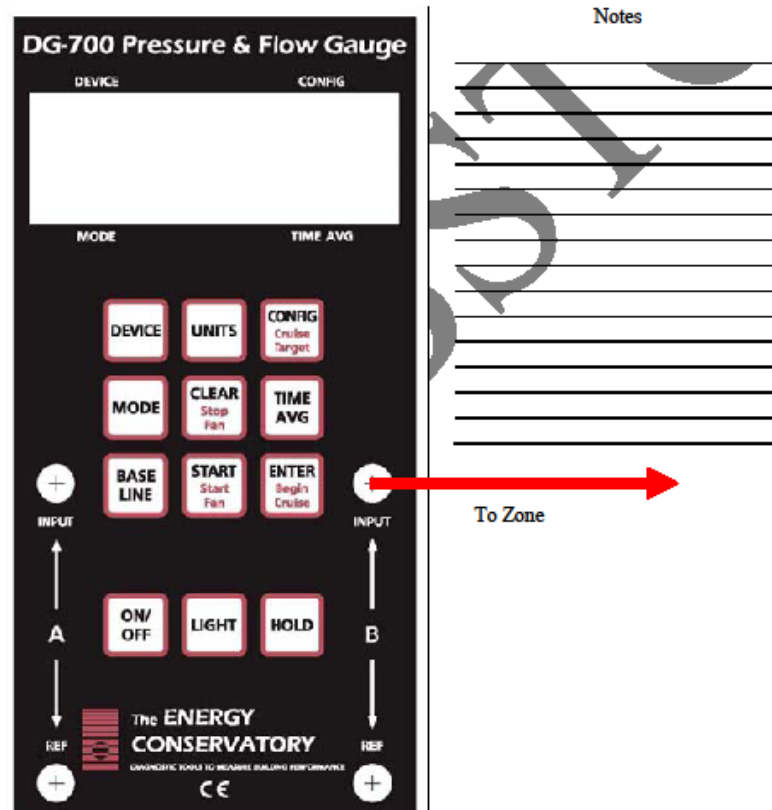
STEP 9 - ZONAL PRESSURES (aka. Pressure mapping)

See FIG 10

Zone Pressures With Blower Door at 50 Pascals

Channel B: Insert probe with hose into zone WRT interior of house to determine if zone is connected more to outside or inside.

- 0-10 Pascals indicates zone is inside envelope
- 40-50 Pascals indicates zone is outside envelope



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FIG 10



WAP PRESSURE DIAGNOSTIC PROCEDURE

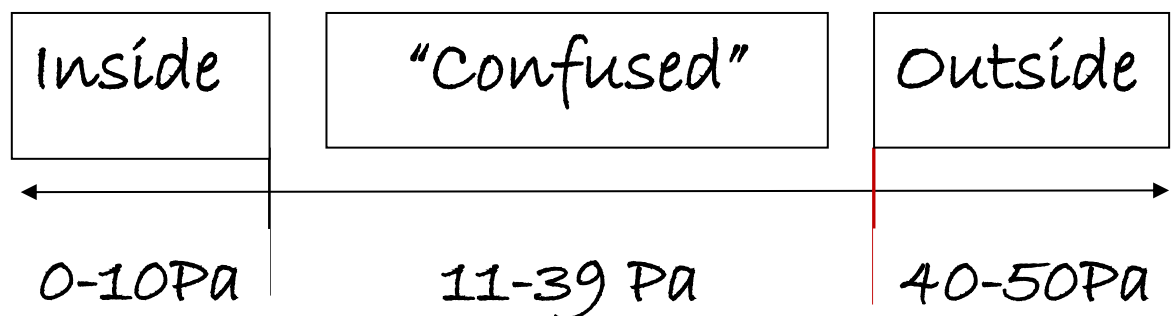
Zonal Testing

NOTE: House must be at 50Pa for this test to work properly.

The Zonal tests or “Pressure Mapping” are the tests that show the energy assessor where the *actual* air barriers of the home are located. Up to this point, we generally assume that the sheetrock on the inside of the exterior walls, the ceiling and the floor make up the surfaces that separate the inside conditioned air from the outside. Zonal tests will demonstrate where the air barriers are located in reality. You cannot visually *see* air barriers, but your manometer can.

Note: Although the WAP only requires you to *report* the zone that contains the duct system, that in no way implies that only one zonal test needs to be taken. A good energy assessor will take upwards of twenty quick tests or more and determine *exactly* where the actual air barriers are for better or worse.

When determining air barriers, there is a scale that tells you what is inside the pressure boundary and what is outside that boundary, and what is neither in nor out, but ‘confused’.





WAP PRESSURE DIAGNOSTIC PROCEDURE

Zonal Testing

With a pressure hose connected to your manometers 'B' Channel 'Input' Tap, and the other end attached to your pressure probe or pressure pan, and with the blower door still running the house at a 50 Pascal pressure difference with the outside. You can begin testing any area's you suspect may have faulty pressure boundaries as well as verifying areas where the pressure boundary should in fact be. Good areas to always test are:

1. Drop soffits
2. Chases
3. Interior walls
4. Archways
5. Wet walls
6. Ceilings
7. Floors (if home is not slab on grade)
8. Interior walls alongside staircases
9. Build-outs around showers and baths

In general, what you are looking for is that anything that *should* be inside your home eg. Interior walls and soffits are in fact inside the pressure boundary. Meaning you see readings of 10 or less Pascal's on your manometer. Whereas areas that *should* be outside the home e.g. Attics, attached garages and crawlspaces, are reading above 40

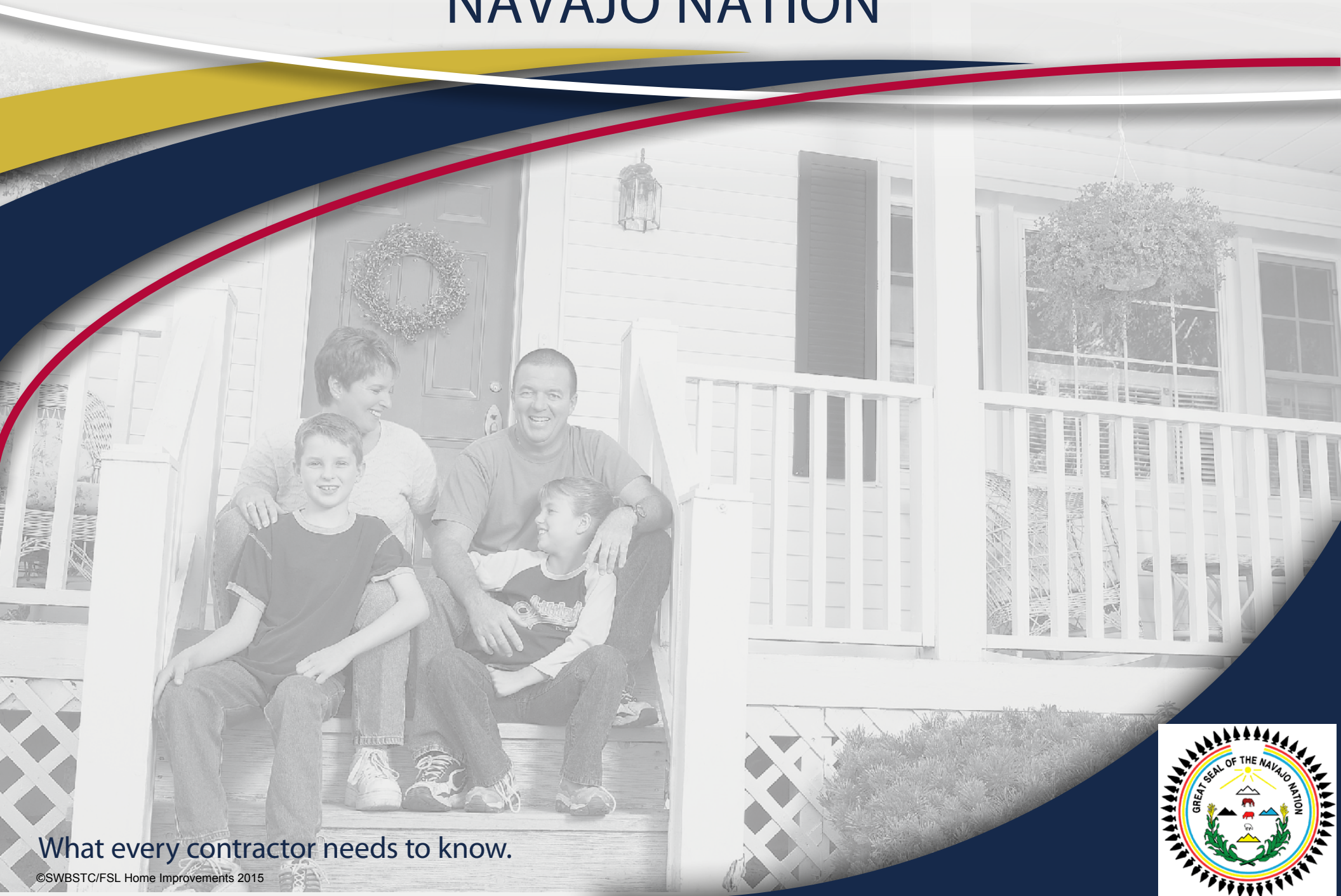


WAP PRESSURE DIAGNOSTIC PROCEDURE

Zonal Testing

Pascal's on your gauge. If you have attended quality professional building science training, you will know that in direct contact with your pressure boundary should always be a continuous thermal boundary. That is easy to spot. It's the insulation. At ANY time, if you know there is insulation covering a plane, and a zonal test shows that plane is less than 40 Pascal's, that insulation is NOT performing properly. Conversely you may test a ceiling plane and get a reading of above 40 showing that the ceiling plane is an effective air barrier, but later on in your audit you see that the insulation is up at the roof deck, you are in fact looking at an un-insulated attic. The thermal boundary must be 100% continuous around the envelope of the building (exterior walls, floor and ceiling / roof deck) and the pressure boundary must be 100% continuous around the envelope, and most importantly, the pressure boundary and the thermal boundary must be in 100% contact with each other to perform properly. While your eyes can locate the thermal boundaries, only your manometer and blower door can locate the pressure boundaries. So take lots of tests. Find the pressure boundaries everywhere in that home and determine if it is in contact with the thermal boundary. That is why this test is also known as 'Pressure Mapping'.

SUCCESS WITH WEATHERIZATION NAVAJO NATION



What every contractor needs to know.

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Critical Details Field Guide List

Accessing Duct Leakage Sites **N/A**

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Installing duct straps **3.1601.3**

Installing duct support for flex **3.1601.3**

Install flex duct **3.1601.1**

Installing metal ducts **3.1602.1**

Sealing ducts **3.1602.1**

Sealing platform return **3.1602.5**

Sealing small medium and large holes (ducts) **3.1602.1**

Ventilation:

Install jump ducts **6.6201.2**

Install roof termination **6.6002.2**

Install wall terminations **6.6002.2**

Install wall transfers **6.6201.2**

Install bath exhaust fan **6.6003.1**

Replacing bath exhaust fan ***6.6003.1**

Pressure balancing rooms **6.6201.2**

Air sealing:

Sealing Knee Walls **3.1001.3**

Capping Chases **3.1001.2**

Cap soffit **3.1003.6**

Cap stairwells **3.1002.1**

Sealing balloon framing **3.1001.3**

Sealing cathedral skylights **3.1005.2**

Sealing garage penetrations **3.1501.1**

Sealing penetrations **3.1001.4**

Sealing tongue and groove ceiling **3.1005.1**

Prep & Insulation:

Enclose knee wall with strapping **4.1004.3**

Enclose knee wall with flexible backing (Blown) **4.1004.1**

Enclose knee wall with flexible backing (batt) **4.1004.1**

Enclose knee wall with rigid backing (Blown) **4.1004.1**

Enclose knee wall with rigid backing (Batt) **4.1004.1**

Enclose skylight shaft **4.1088.3**

Enclose uninsulated non-IC recessed lights **3.1001.10**

Installing dams around chimneys and flues **4.1001.3**

Install Radiant barriers **4.1001.4**

Install vent baffles **4.1001.4**

Insulating access doors **4.1006.25 Vertical**

Insulate attic access hatch **4.1006.25 Horizontal**

Insulate attic platform **4.1005.6**

Insulate pull down stairs **4.1006.1**

Insulate with blown **4.1005.2**

Insulate with blown over existing batts **4.1005.4**

Insulate floor cavities above garages dense pack **4.1005.5**

Insulate manufactured knee walls **4.1004.4**

Replace knob and tube **4.1001.2**

Treating soffit penetrations **3.1003.6**

Treating stairwell perimeters **3.1002.2**

Installing insulation **N/A**



SUCCESS WITH WEATHERIZATION

Non Critical Details - Quick Links

While this guide contains the most common weatherization measures you would perform in a DOE weatherization project in the South West region, for practical reasons we cannot include *every* measure, nor could any single Critical Detail sheet encompass every possible variation you might find in a home. For that reason, you may have need to directly access the NREL SWS specs themselves to make a determination of how to properly deal with a unique situation. These links will bring you to the main parts of the SWS site to speed up that process.

HEALTH AND SAFETY	https://sws.nrel.gov/spec/2
AIR SEALING	https://sws.nrel.gov/spec/3
INSULATION	https://sws.nrel.gov/spec/4
HEATING AND COOLING	https://sws.nrel.gov/spec/5
VENTILATION	https://sws.nrel.gov/spec/6
BASELOAD	https://sws.nrel.gov/spec/7

Combustion Safety Testing is accomplished by following the procedure highlighted in the “Combustion Safety App”



OSHA REGULATIONS

OSHA regulations must always be followed when completing any home energy upgrades. Ensure the measures below are addressed:

- Work site operations are conducted in compliance with OSHA regulatory requirements.
- Workers are trained in the hazards of their job and the methods to protect themselves.
- Workers are provided the protective equipment needed to reduce site exposures.

EPA GUIDELINES

EPA has developed the Healthy Indoor Environment Protocols for Home Energy Upgrades to provide guidance on improving or maintaining indoor air quality and indoor environments during home energy upgrades and retrofits. It addresses these measures:

- Contaminants
- Critical Building Systems
- Safety

Health + Safety: Introduction

Home energy upgrades can decrease an occupant's energy bills while increasing the comfort of the home. However, home energy upgrade activities may negatively affect indoor air quality if appropriate health and safety measures are not put in place. It is important for an assessment to be completed prior to beginning any work. As always, it is required for all contractors to follow OSHA regulations. By law, employers and supervisors are required to ensure that:

1. Work site operations are conducted in compliance with OSHA regulatory requirements.

Site plans should address safety and health and should include precautions to address multiple construction issues. Measures an employer needs to take to evaluate existing and potential health concerns, as well as recommended actions to ensure worker safety, are also included in Table 2. Free help with developing these plans is often available from state or federal training (consulting) programs.

2. Workers are trained in the hazards of their job and the methods to protect themselves.
3. Workers are provided the protective equipment needed to reduce site exposures.

When possible, choose construction products whose manufacturers disclose all ingredients and verify that they are free of formaldehyde, mercury and other known toxic substances.

When known pollutants are being produced or disturbed during retrofit activities, follow appropriate standards (including OSHA, NIOSH, EPA lead safe, and BPI) to minimize worker and occupant exposure.

SUCCESS WITH WEATHERIZATION

Health + Safety Information Sheet

The U.S. Environmental Protection Agency (EPA) has developed a guide specific to the home energy retrofit industry to supplement OSHA requirements. This guide, the Healthy Indoor Environment Protocols for Home Energy Upgrades provides practical guidance on improving or maintaining indoor air quality and indoor environments during home energy upgrades, retrofits or remodeling.

These protocols apply to existing single-family and multi-family low-rise residential buildings and are intended for use by the home energy retrofit industry. They provide guidance for conducting home assessments and undertaking the responses necessary to maintain or improve indoor air quality and safety. The protocols also can help improve the quality of home weatherization projects and other energy-efficiency retrofit or remodeling jobs, thus reducing failures and call-backs.

The full document may be found in the appendix or online here:

http://www.epa.gov/iaq/pdfs/epa_retrofit_protocols.pdf

Healthy Indoor Environment Protocols

The Healthy Indoor Environment Protocols for Home Energy Upgrades includes the topics listed below:

- Contaminants

This section contains information on common contaminants, such as lead, mold, asbestos, pests and radon. For each contaminant, it provides information on how to assess if the contaminant exists and how to mitigate issues.

- Critical Building Systems For Healthy Indoor Environments

This section contains information on heating and ventilation systems in a home. Each measure provides a list of items



SUCCESS WITH WEATHERIZATION

Health + Safety Information Sheet

to assess and actions to take if the measure is not working properly.

- Safety

This section contains information on creating a safe environment for both the occupants and the contractors completing home energy upgrades.

In the appendix, we have included the complete Healthy Indoor Environment Protocols for Home Energy Upgrades for your use. We recommend that both assessors and installers keep the guide with them during on-site visits for guidance. Note this document should be used in addition to OSHA regulations.

Occupant Health + Safety

Advanced Energy believes that every retrofit project should result in a more healthy, safe, comfortable, durable, energy efficient and environmentally responsible home. We also believe a house is a system, meaning all parts of the house are interactive and interdependent. Proper air sealing of a house includes ensuring combustion appliances work properly and considering fresh air ventilation. It's important to realize air sealing can affect each part of the house in an adverse way, creating unhealthy conditions for the occupants, durability issues for the home and considerable risk and liability for you the retrofit contractor.



DUCT REPAIR

SUCCESS WITH WEATHERIZATION

What every contractor needs to know.



Duct Repair + Sealing Contents

Duct repair and sealing is a challenging and important job. Done right it can bring increased comfort, safety and health to the home's occupant while saving them money on their heating and cooling bills. The purpose of this guide is to assist you, the duct repair and sealing professional, with getting the job done right the first time – every time. Below is a list of provided materials in this section

Health + Safety	8
Duct Sealing Checklist	9
Critical Detail: Sealing Ducts	12
Additional Job Aids	
Critical Detail: Installing Metal Ducts	14
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SUCCESS WITH WEATHERIZATION

Health + Safety Information Sheet

Health + Safety: Introduction

The introduction to this manual introduced EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades. The document is a useful tool for finding solutions for common issues that arise when completing home energy upgrades. This page will highlight some important details in the document in relation to safety when duct sealing.

Health + Safety: Worker Safety

As mentioned in the introduction, it is required for all contractors to follow OSHA regulations. By law, employers and supervisors are required to ensure that all workers have the correct personal protective equipment. These items include, but aren't limited to:

- Gloves
- Protective clothing
- Knee pads
- Eye protection
- Respirators: Different types of respirators are required for different jobs. Use the Healthy Indoor Environment Protocols for Home Energy Upgrades to verify that your current respirator is compliant with the job.
- Non-contact voltage detectors

Tip: It is important to keep your PPE in good condition. Having a bag that stores all of your PPE and supplies for cleaning the items will save you time and keep you safe.

Health + Safety: Health Hazards

It is important to look for hazards and create a mitigation plan before beginning work. The list below highlights the most important items to identify and mitigate for all duct repair jobs:

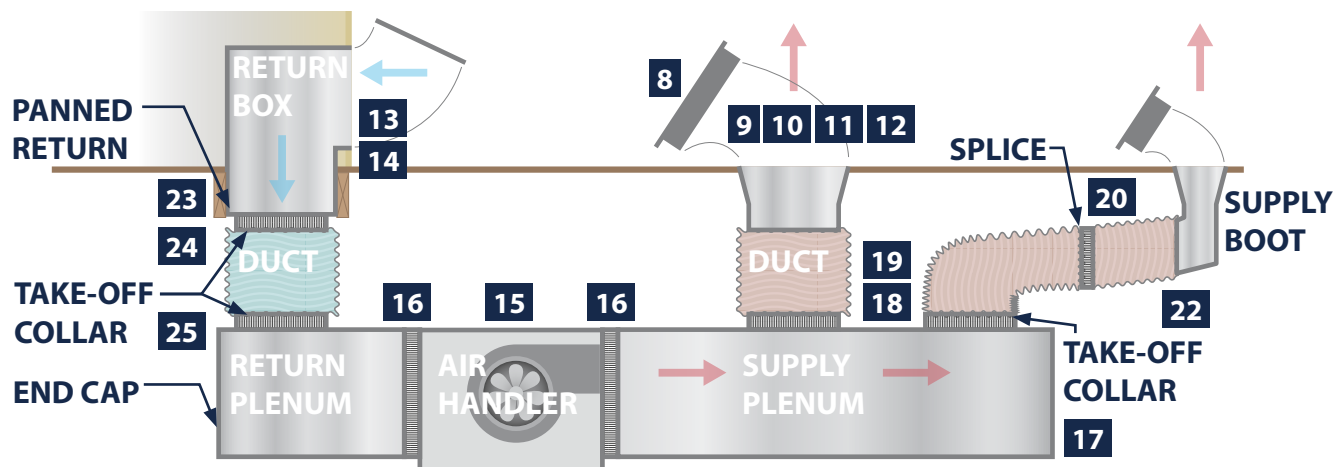
- Sewer gases, fuel oil, chemicals and other pollutants in crawl spaces or attics
- Mold-like growth in attics and crawl spaces
- Presence of pest/rodents in crawl spaces or attics
- Lack of CO alarm in all houses
- Unvented combustion appliances
- Duct tapes and wrappings that are likely to contain asbestos

If any of these conditions exist, follow action items listed in the Healthy Indoor Environment Protocols for Home Energy Upgrades before beginning work.



CHECKLIST: DUCT SEALING

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N/A

PREP



1. Complete a combustion safety test and record the results.



2. Verify that a ventilation plan is established.



3. Put on all personal protection equipment (PPE).



4. Identify all worker and occupant safety hazards.



5. Identify all potential durability issues.



6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. **Do not complete work if a life safety hazard is identified.**



N/A

INSIDE THE LIVING SPACE



7. Turn the HVAC fan on and feel for air flowing out of each supply with your hand. Note any supply lines not providing air. Turn the fan off.



8. Remove all supply registers and return grilles.



9. Fasten all supply boots to subfloor with screws.



10. Seal all duct inner liners to each supply boot.



11. Seal all seams of each supply boot.



CHECKLIST: DUCT SEALING

SUCCESS WITH WEATHERIZATION

- | | | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | 12. Seal all gaps between the subfloor or ceiling and the supply boot. |
| <input type="checkbox"/> | <input type="checkbox"/> | 13. Seal all seams of each return box. |
| <input type="checkbox"/> | <input type="checkbox"/> | 14. Seal all gaps between the subfloor, wall or ceiling and the return box. |

✓ N/A OUTSIDE THE LIVING SPACE

- | | | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | 15. Tape the air handler cabinet panels and seal all penetrations. |
| <input type="checkbox"/> | <input type="checkbox"/> | 16. Mechanically fasten and seal the connection between the air handler and the plenums. |
| <input type="checkbox"/> | <input type="checkbox"/> | 17. Mechanically fasten and seal all supply plenum seams and end caps. |
| <input type="checkbox"/> | <input type="checkbox"/> | 18. Mechanically fasten and seal the connection between supply take-off collars and plenums. |
| <input type="checkbox"/> | <input type="checkbox"/> | 19. Mechanically fasten and seal inner liner of all supply ducts to supply take-off collars. |
| <input type="checkbox"/> | <input type="checkbox"/> | 20. Inspect all supply ducts for disconnects, tears and/or holes and pay attention to supply lines that were not providing air inside the house. Fix by reconnecting ducts and patching holes. If flex duct, remove section with hole or tear and replace with a sealed spliced collar. |
| <input type="checkbox"/> | <input type="checkbox"/> | 21. Fasten and seal all sectioned metal elbows to supply ducts and take-off collars. |
| <input type="checkbox"/> | <input type="checkbox"/> | 22. Fasten and seal inner liner of all supply ducts to supply boots. Skip this step if sealed from inside the living space. |
| <input type="checkbox"/> | <input type="checkbox"/> | 23. Seal all panned returns. |
| <input type="checkbox"/> | <input type="checkbox"/> | 24. Inspect all return ducts for disconnects, tears and/or holes. Fix by reconnecting, patching or fastening ducts together then sealing the connections. If flex duct, remove section with hole or tear and replace with a sealed spliced collar. |
| <input type="checkbox"/> | <input type="checkbox"/> | 25. Seal the connection between supply take-off collars and plenums. |

✓ N/A CLOSE OUT

- | | | |
|--------------------------|--------------------------|---|
| <input type="checkbox"/> | <input type="checkbox"/> | 26. Clean the work area. |
| <input type="checkbox"/> | <input type="checkbox"/> | 27. Complete a combustion safety test and record the results. |
| <input type="checkbox"/> | <input type="checkbox"/> | 28. Educate occupants on the work completed. |

JOB INFORMATION

Name

Initials



CHECKLIST: DUCT SEALING

SUCCESS WITH WEATHERIZATION

NOTES

Location (e.g., NW corner of house)	Issue (e.g., disconnect, crimped duct)

DUCT SEALING GUIDELINES

For seams, cracks joints, holes and penetrations that are:

1/4-inch or less (small)

Seal with mastic.

BEFORE



AFTER



1/4-inch to 3/4-inch (medium)

Install temporary tape. Apply a base coat of mastic. Apply fiberglass mesh tape. Apply mastic atop fiberglass mesh tape.

BEFORE



AFTER



3/4-inch or greater (large)

Mechanically fasten rigid support material that is at least 1 in. larger than the hole. Apply base coat of mastic, fiberglass mesh tape and top coat of mastic.

BEFORE



AFTER





CRITICAL DETAIL: SWS 3.1602.c

SEALING DUCTS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Ducts and plenums sealed to prevent leakage.

Duct and plenum not sealed.

Duct and plenum sealed.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1602.1c

SEALING DUCTS

SUCCESS WITH WEATHERIZATION

Seal plenum with mastic.
Choose the appropriate sealing
technique based on hole size.

Peel back outer liner and
insulation.

Install nylon tie band around
inner liner using a tie band
tensioning tool.

Seal inner liner with mastic.
Choose the appropriate sealing
technique based on hole size.

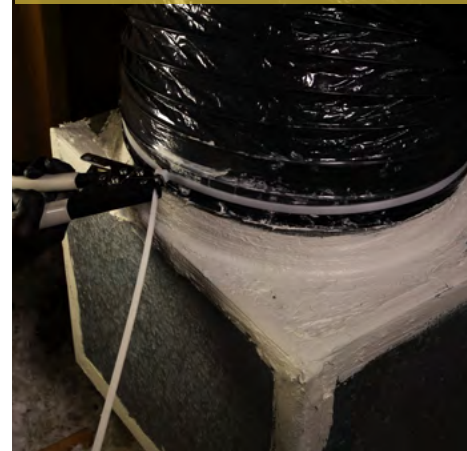
1 SEAL PLENUM



2 GAIN ACCESS



3 STRAP



4 SEAL



Replace outer liner and
insulation.

Install nylon tie band around
inner liner using a tie band
tensioning tool.

5 REPLACE



6 STRAP



Notes:



CRITICAL DETAIL: SWS 3.1602.1a INSTALLING METAL DUCTS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Ducts properly installed and sealed to prevent leakage.

MATERIALS

TOOLS

Duct not sealed.

Duct sealed and insulated.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1602.1a

INSTALLING METAL DUCTS

SUCCESS WITH WEATHERIZATION

Roof termination fittings: use 90° fitting first. Wall termination fittings: use a straight fitting.

If a termination is not installed, follow the exhaust fan termination installation critical detail.

Install duct pieces with crimped ends pointed in the direction of air flow. Cut pieces to fit.

For the connection between the duct and the termination, install the termination cap adaptor.

1 MEASURE + SELECT



2 INSTALL TERMINATION



3 ASSEMBLE DUCT



4 INSTALL ADAPTOR



Fasten duct connections with a minimum of three equally spaced screws.

Seal all seams and joints.

If installing duct in unconditioned space, wrap the duct with insulation and seal the seams.

5 INSTALL SCREWS



6 SEAL WITH MASTIC



7 INSTALL INSULATION



Notes:



CRITICAL DETAIL: SWS 3.1601.1c

INSTALLING FLEX DUCTS

SUCCESS WITH WEATHERIZATION

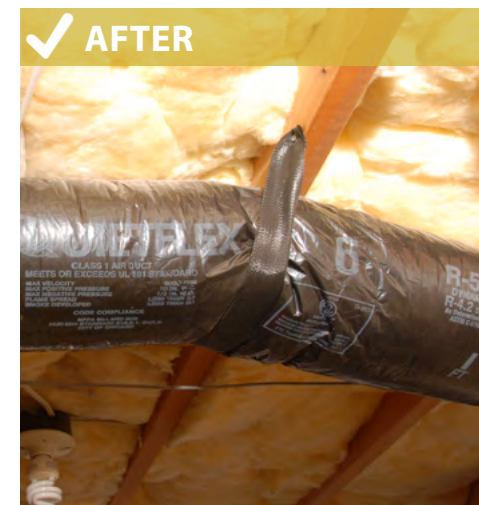
DESIRED OUTCOME: Ducts properly installed and sealed to prevent leakage.

MATERIALS

TOOLS

Duct not sealed.

Duct sealed and insulated.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1601.1c

INSTALLING FLEX DUCTS

SUCCESS WITH WEATHERIZATION

Roof termination fittings: use 90° fitting first. Wall termination fittings: use a straight fitting.

1 INSTALL METAL DUCT



2 INSTALL TERMINATION



Measure and cut flex duct to run between the termination and the metal fitting attached to the fan.

3 MEASURE + CUT DUCT



Seal the collar of the metal duct and the termination connection with mastic.

4 MASTIC COLLAR



Connect the flex duct at both ends using flex duct ties.

5 INSTALL ZIP TIES



Seal each flex duct connection with mastic.

6 SEAL WITH MASTIC



Pull flex duct insulation into place and seal with mastic.

7 SEAL WITH MASTIC



Support the duct at least every 4 ft.

8 SUPPORT DUCT





CRITICAL DETAIL: SWS 3.1601.3a

SUCCESS WITH WEATHERIZATION

INSTALLING DUCT SUPPORT FOR FLEX DUCTS

DESIRED OUTCOME: Ducts and plenums properly supported.

Flex duct needing support straps.

Flex duct supported every 4' using a minimum of 1 1/2" wide material, creating no crimps or interior dimension reduction.

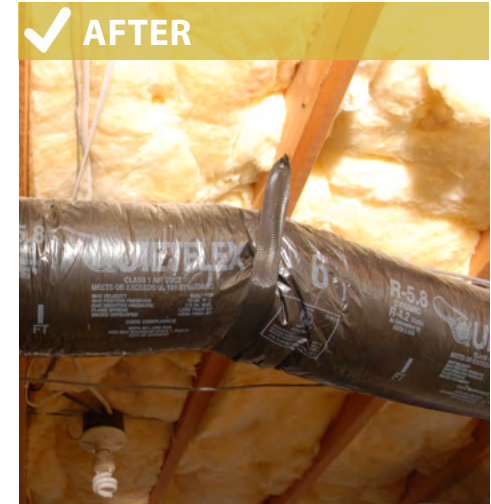
MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CRITICAL DETAIL: SWS 3.1601.3

SUCCESS WITH WEATHERIZATION

INSTALLING DUCT SUPPORT FOR FLEX DUCTS

Attach support material to framing (i.e., truss, rafter or joist).

Run support material under flex duct and lift into correct position.

Attach support material to framing (i.e., truss, rafter or joist).

Flex duct supported every 4' having no crimps or interior dimension reduction.

1 ATTACH SUPPORT



2 RUN SUPPORT



3 ATTACH SUPPORT



4 SUPPORT SPACING



Notes:



CRITICAL DETAIL: SWS 3.1601.3

INSTALLING DUCT STRAPS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Ducts and plenums properly fastened to prevent leakage.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



Joints fastened with tie bands using a tie band tensioning tool. Metal ducts will be supported at intervals not exceeding 10 feet.

SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CRITICAL DETAIL: SWS 3.1601.3

INSTALLING DUCT STRAPS

SUCCESS WITH WEATHERIZATION

Place tie ban being used around the connection.

Tighten tie ban using tie band tensioning tool.

Cut off tie ban tail using tie band tensioning tool.

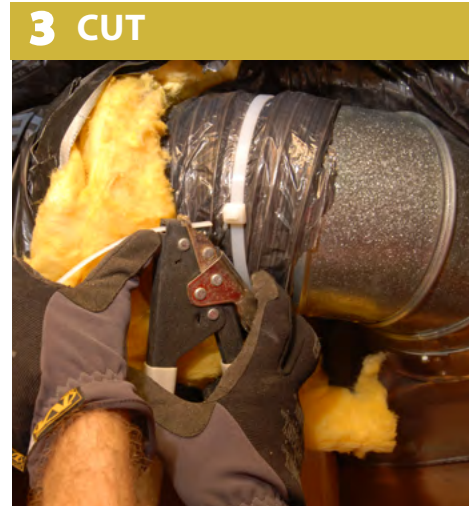
1 PLACE



2 TIGHTEN



3 CUT



Notes:



SUCCESS WITH WEATHERIZATION

Accessing Duct Leakage Sites

DUCT LEAKAGE SITES

These tech tips show how to access the areas listed below:

- A. Air Handler to Plenum
- B. S and Drive Connections
- C. Take Off Collar to Plenum
- D. Splices
- E. Return Platform
- F. Metal Plenums
- G. Duct Board Plenums
- H. Panned Returns
- I. Inner Liner to Boot Connections
- J. Package Units

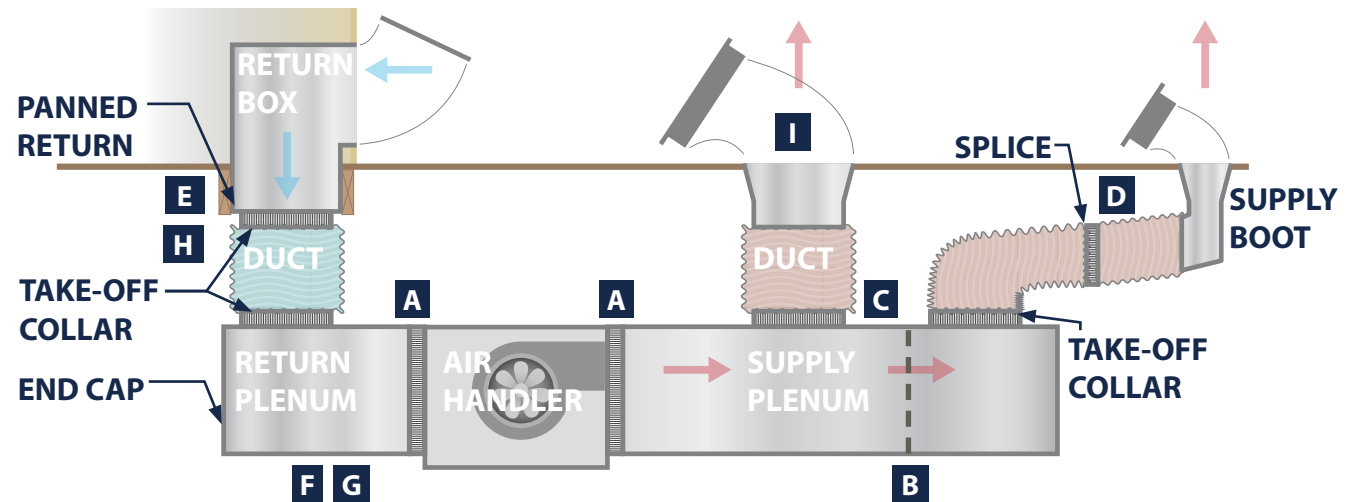
HEALTH + SAFETY

Put on all PPE before beginning any work. Place duct tape over sharp metal edges during work.

TOOLS

Be sure to have, at a minimum, these tools:

- Utility knife or Scissors
- Screwdrivers
- Drill
- Flashlight
- Cutter
- Tin snips



Introduction

One of the first steps to sealing a duct system is gaining access to the leakage site. Reference the following TECH TIPS for before and after illustrations on how and where to gain access at various duct leakage sites. Illustrations are provided for the following sites:

- A. Air Handler to Plenum
- B. S and Drive Connections
- C. Take Off Collar to Plenum
- D. Splices
- E. Return Platform
- F. Metal Plenums
- G. Duct Board Plenums
- H. Panned Returns
- I. Inner Liner to Boot Connections
- J. Package Units

Health + Safety

Prior to starting work, make sure to have all the necessary PPE equipment (gloves, appropriate respirator, safety glasses, etc.). While accessing these locations, place duct tape over the sharp metal edges where access holes have been cut can help protect the worker from injury.

Tools

It is important to gather all necessary materials and tools before accessing duct leakage sites. Some necessary tools include utility knives, screwdrivers, a drill, flashlights, sheet metal hole or circle cutter and tin snips.

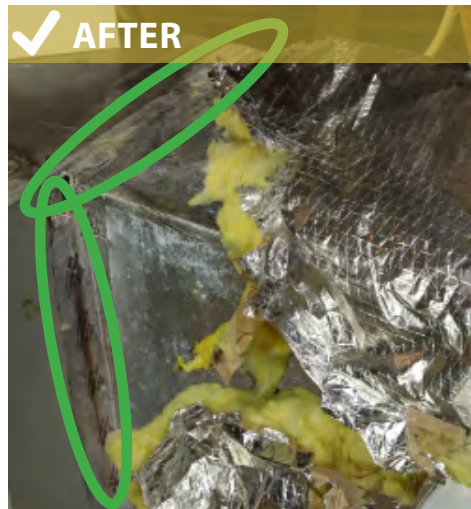
For more information about how to seal these locations please reference our Sealing Duct Leakage Sites CRITICAL DETAILS.



TECH TIPS: ACCESSING DUCT LEAKAGE SITES

SUCCESS WITH WEATHERIZATION

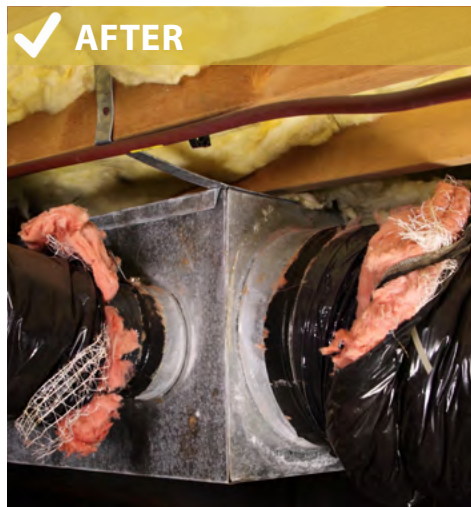
- A. Air Handler to Plenum (Externally insulated metal): Gain access to joint by peeling back plenum insulation.



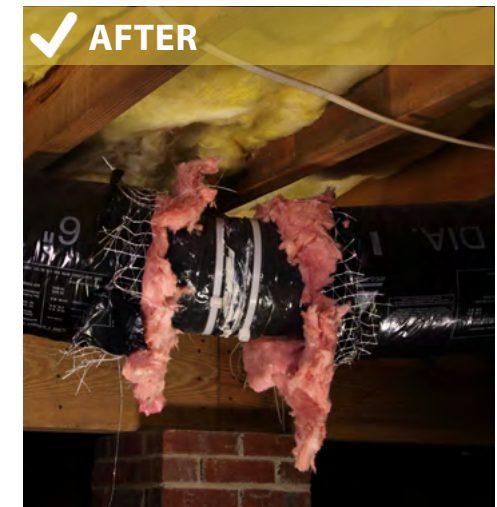
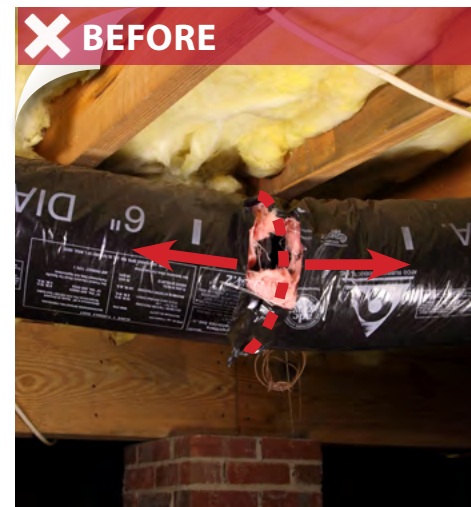
- B. S and Drive Connections in Plenum (Externally insulated metal): Gain access to joint by peeling back plenum insulation.



- C. Take Off Collar to Plenum: Gain access to joint by removing outer nylon tie band or tape and peeling back insulation.



- D. Splices: Gain access to connection by removing outer nylon tie band or tape and peeling back insulation.





TECH TIPS

SUCCESS WITH WEATHERIZATION

ACCESSING DUCT LEAKAGE SITES

- E. Return Platform: Create temporary access hole by removing or cutting cladding of return platform.

✗ BEFORE

✓ AFTER

- F. Metal Plenums: Create temporary access hole by cutting hole through accessible side of plenum.

✗ BEFORE

✓ AFTER

- G. Duct Board Plenums: Create temporary access hole by cutting hole through accessible side of plenum. Make sure to “pumpkin cut” for ease of patching hole.

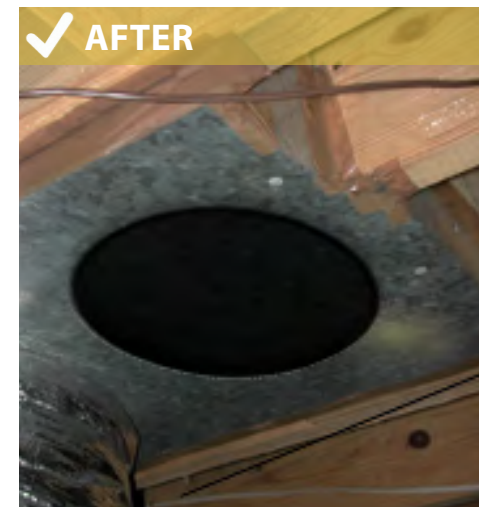
✗ BEFORE

✓ AFTER

- H. Panned Returns: Create temporary access hole by cutting hole through accessible area of return.

✗ BEFORE

✓ AFTER

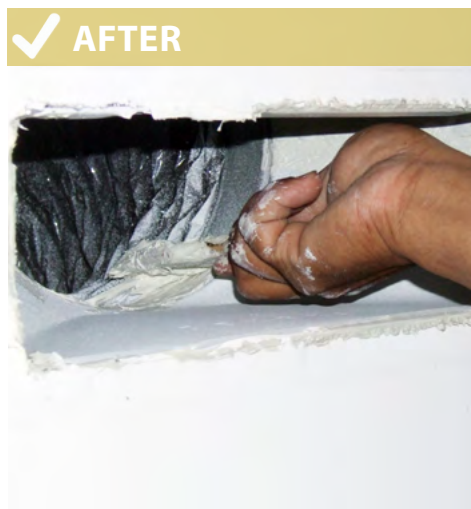




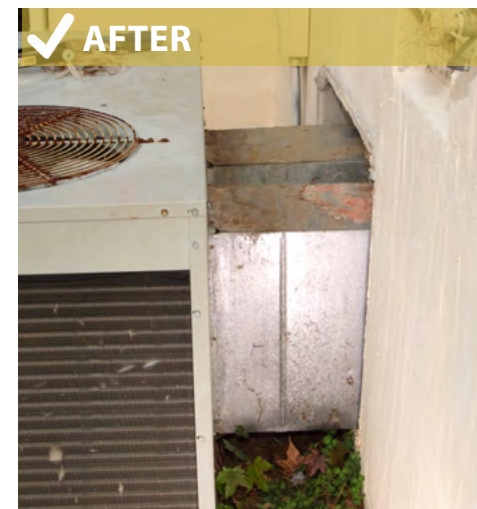
CRITICAL DETAILS: ACCESSING DUCT LEAKAGE SITES

SUCCESS WITH WEATHERIZATION

- I. Inner Liner to Boot: Gain access to connection from inside home by removing supply grill.



- J. Package Units (Ground level): Gain access to connections by removing shroud.



- J. Package Units (Ground level): Gain access to connections by removing shroud and cutting holes in supply and return ducts.



Notes:



CRITICAL DETAIL: SWS 3.1602.1

SEALING SMALL HOLES

SUCCESS WITH WEATHERIZATION

Seams, cracks, joints, holes and penetrations that are 1/4-inch or less.

Seal with mastic.

1 SMALL HOLE



2 MASTIC



Notes:



CRITICAL DETAIL: SWS 3.1602.1

SEALING MEDIUM HOLES

SUCCESS WITH WEATHERIZATION

Seams, cracks, joints, holes and penetrations that are 1/4-inch to 3/4-inch.

Install temporary tape over seams, cracks, joints, holes and penetrations.

Apply a base coat of mastic to completely cover and extend beyond tape.

Apply fiberglass mesh tape to completely cover and extend beyond mastic.

1 MEDIUM HOLE



2 TEMPORARY TAPE



3 MASTIC



4 MESH TAPE



Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.

5 MASTIC



Notes:

- Temporary tape can be a variety of different types of tape. It is used to prevent mastic from falling into the hole and should only be used if also using mesh tape for reinforcement.



CRITICAL DETAIL: SWS 3.1602.1

SEALING LARGE HOLES

SUCCESS WITH WEATHERIZATION

Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

Install rigid duct support material that is at least 1 inch larger than the hole.

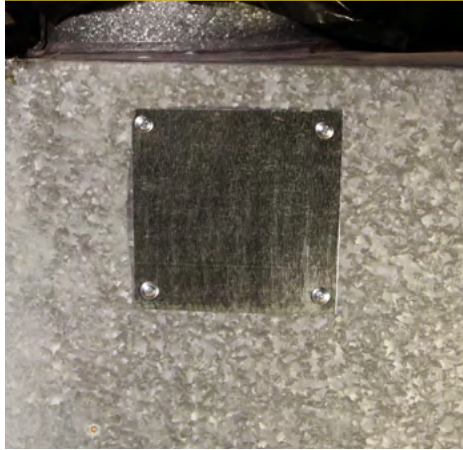
Apply a base coat of mastic to completely cover and extend beyond support material.

Apply fiberglass mesh tape to completely cover and extend beyond mastic.

1 LARGE HOLE



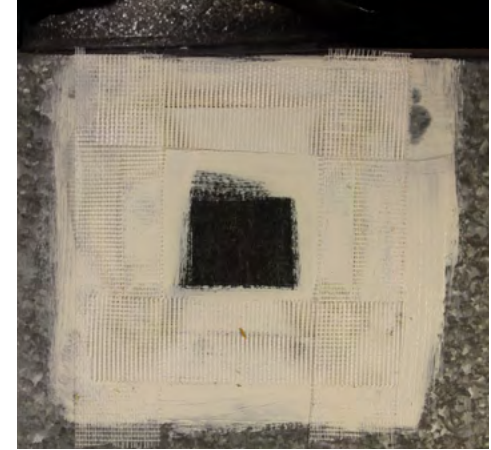
2 SUPPORT MATERIAL



3 MASTIC



4 MESH TAPE



Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.

Notes:

5 MASTIC





SEALING LARGE HOLES

Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

Install rigid duct support material that is at least 1 inch larger than the hole.

Apply a coat of mastic to completely cover and extend beyond support material.

Apply fiberglass mesh tape to completely cover and extend beyond mastic.

1 LARGE HOLE



2 SUPPORT MATERIAL



3 MASTIC



4 MESH TAPE



Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.

Notes:

5 MASTIC





SEALING LARGE HOLES

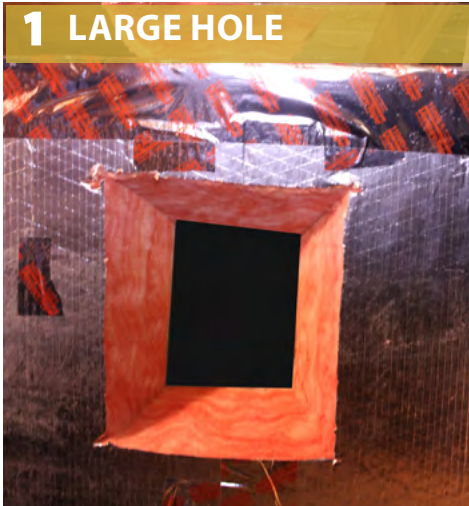
Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

Replace cut out. Make sure to "pumpkin cut" for ease of patching hole.

Apply a coat of mastic to completely cover and extend beyond support material.

Apply fiberglass mesh tape to completely cover and extend beyond mastic.

1 LARGE HOLE



2 REPLACE CUT OUT



3 MASTIC



4 MESH TAPE



Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.

Notes:

5 MASTIC





CRITICAL DETAIL: SWS 3.1602.1

SUCCESS WITH WEATHERIZATION

SEALING LARGE HOLES

Seams, cracks, joints, holes and penetrations that are larger than 3/4-inch.

Install rigid duct support material that is at least 1 inch larger than the hole.

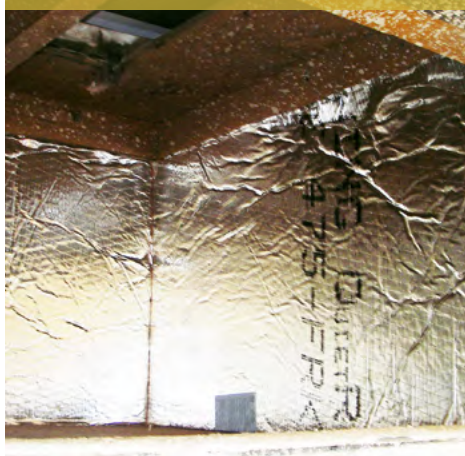
Apply a base coat of mastic to completely cover and extend beyond support material.

Apply fiberglass mesh tape to completely cover and extend beyond mastic.

1 HOLE SIZE



2 BACKING



3 MASTIC



4 MESH TAPE



Apply a second coat of mastic atop fiberglass mesh tape to completely cover and extend beyond tape.

5 MASTIC



Notes:

BAR-FACED GRILLE INSTALLATION

DESIRED OUTCOME: Increase air flow through the return grille

Stamp-faced return grille.

Bar-faced return grille.

MATERIALS

TOOLS

✖ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 5.3003.3

SUCCESS WITH WEATHERIZATION

BAR-FACED GRILLE INSTALLATION

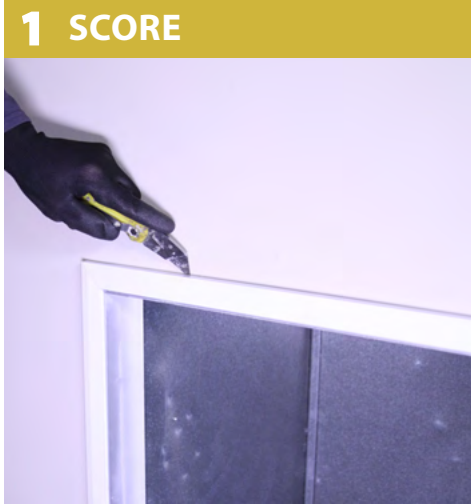
If present, score any caulk or paint sealing between return grille and interior surface.

Remove filter and grill.

If present, score any mastic or duct tape sealing between return grill flange and return. Remove screws.

Remove frame.

1 SCORE



2 REMOVE FILTER



3 REMOVE FASTENERS



4 REMOVE FRAME



Seal return to sheetrock connection.

Install new grille and filter.

Notes:

5 SEAL



6 INSTALL GRILLE





CRITICAL DETAIL: SWS 3.1602.5

SUCCESS WITH WEATHERIZATION

SEALING FRAMED RETURN PLATFORMS

DESIRED OUTCOME: Return air sealed to minimize air leakage

MATERIALS

TOOLS

Rough frame support platform.

Platform completely lined and air sealed.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CRITICAL DETAIL: SWS 3.1602.5

SUCCESS WITH WEATHERIZATION

SEALING FRAMED RETURN PLATFORMS

Remove grille or cut access hole into framed platform.

Clean out debris and dirt from return platform.

Line plenum with duct board.
Mechanically fasten duct board to framing.

Seal the inside of the return.
Choose the appropriate sealing technique based on hole size.

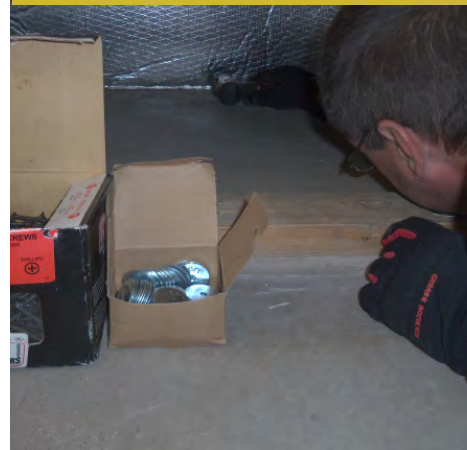
1 ACCESS RETURN



2 PREP RETURN



3 INSTALL DUCT BOARD



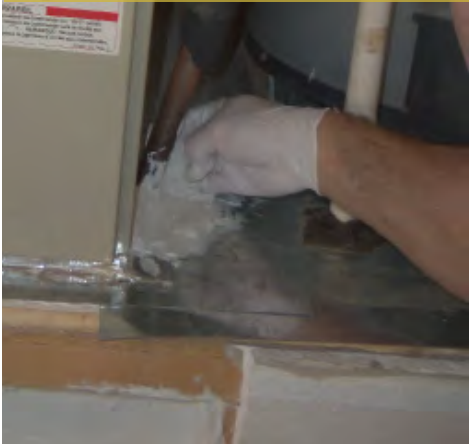
4 FIBERGLASS



If refrigerant and condensate lines penetrate the platform return, provide infill and seal as needed.

If refrigerant and condensate lines terminate to the outside, install hardware cloth or equivalent rodent barrier.

5 SEAL PENETRATIONS



6 SEAL PENETRATIONS



Notes:

Scrap flashing material can make great washers for use when securing duct board. If using this technique, exercise caution and make sure to wear gloves to protect your hands from the sharp edges.

VENTILATION



SUCCESS WITH WEATHERIZATION

What every contractor needs to know.



Ventilation Contents

Ventilation is a chaLLenging and important joB. Done right it can Bring increased comfort, safety and heaLth to the home's occupant whiLe saVing them money on their heating and cooLing BiLLs. The purpose of this guide is to assist you, the duct repair and seaLing professional, with getting the joB done right the first time – eVery time. BeLow is a List of proVided materiaLs in this section

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SUCCESS WITH WEATHERIZATION

Health + Safety Information Sheet

Health + Safety: Introduction

The introduction to this manual introduced EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades. The document is a useful tool for finding solutions for common issues that arise when completing home energy upgrades. This page will highlight some important details in the document in relation to safety when duct sealing.

Health + Safety: Worker Safety

As mentioned in the introduction, it is required for all contractors to follow OSHA regulations. By law, employers and supervisors are required to ensure that all workers have the correct personal protective equipment. These items include, but aren't limited to:

- Gloves
- Protective clothing
- Knee pads
- Eye protection
- Respirators: Different types of respirators are required for different jobs. Use the Healthy Indoor Environment Protocols for Home Energy Upgrades to verify that your current respirator is compliant with the job.
- Non-contact voltage detectors

Tip: It is important to keep your PPE in good condition. Having a bag that stores all of your PPE and supplies for cleaning the items will save you time and keep you safe.

Health + Safety: Health Hazards

It is important to look for hazards and create a mitigation plan before beginning work. The list below highlights the most important items to identify and mitigate for all duct repair jobs:

- Sewer gases, fuel oil, chemicals and other pollutants in crawl spaces or attics
- Mold-like growth in attics and crawl spaces
- Presence of pest/rodents in crawl spaces or attics
- lack of CO alarm in all houses
- Unvented combustion appliances
- Duct tapes and wrappings that are likely to contain asbestos

If any of these conditions exist, follow action items listed in the Healthy Indoor Environment Protocols for Home Energy Upgrades before beginning work.



CHECKLIST: BATHROOM EXHAUST FAN REPLACEMENT

SUCCESS WITH WEATHERIZATION

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1. Verify current fan does not meet program requirements.
<input type="checkbox"/>	<input type="checkbox"/>	2. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	3. Verify that the selected fan will exhaust the required amount of air and has a back-draft damper.
<input type="checkbox"/>	<input type="checkbox"/>	4. Verify that the selected fan can be properly installed in the selected location.
<input type="checkbox"/>	<input type="checkbox"/>	5. Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	6. Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	7. Identify all potential durability issues.
<input type="checkbox"/>	<input type="checkbox"/>	8. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.

✓	N/A	WORK
<input type="checkbox"/>	<input type="checkbox"/>	9. Turn off power to the existing fan at the electrical panel.
<input type="checkbox"/>	<input type="checkbox"/>	10. Remove the existing fan and install the new fan. Notice: All electrical work must be completed by a licensed electrician.
<input type="checkbox"/>	<input type="checkbox"/>	11. Install duct work with appropriate fittings by following the Duct Repair Critical Details.
<input type="checkbox"/>	<input type="checkbox"/>	12. Install a termination to the outside.
<input type="checkbox"/>	<input type="checkbox"/>	13. Set the ventilation rate on the fan or fan switch to the required air flow.
<input type="checkbox"/>	<input type="checkbox"/>	14. Verify the air flow matches the program requirement by completing an air flow test.

✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	15. Clean the work area.
<input type="checkbox"/>	<input type="checkbox"/>	16. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	17. Educate occupants on the work completed. Notice: It is important to inform them that the fan may run after the switch has been turned off.



CHECKLIST: BATHROOM EXHAUST FAN REPLACEMENT

SUCCESS WITH WEATHERIZATION

JOB INFORMATION

Name	Initials
Address	Date



CHECKLIST: BATHROOM EXHAUST FAN INSTALLATION

SUCCESS WITH WEATHERIZATION

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	2. If the fan is the primary ventilation strategy, select a centrally-located bathroom for installation.
<input type="checkbox"/>	<input type="checkbox"/>	3. Verify that the selected fan will exhaust the required amount of air and has a back-draft damper.
<input type="checkbox"/>	<input type="checkbox"/>	4. Verify that the selected fan can be properly installed in the selected location.
<input type="checkbox"/>	<input type="checkbox"/>	5. Verify that the exterior termination for the selected fan can be properly installed in the selected location.
<input type="checkbox"/>	<input type="checkbox"/>	6. Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	7. Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	8. Identify all potential durability issues.
<input type="checkbox"/>	<input type="checkbox"/>	9. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.

✓	N/A	WORK
<input type="checkbox"/>	<input type="checkbox"/>	10. Install the fan. Notice: All electrical work must be completed by a licensed electrician.
<input type="checkbox"/>	<input type="checkbox"/>	11. Install duct work with appropriate fittings by following the Duct Repair Critical Details.
<input type="checkbox"/>	<input type="checkbox"/>	12. Install a termination to the outside.
<input type="checkbox"/>	<input type="checkbox"/>	13. Set the ventilation rate on the fan or fan switch to the required air flow.
<input type="checkbox"/>	<input type="checkbox"/>	14. Verify the air flow matches the program requirement by completing an air flow test.

✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	15. Clean the work area.
<input type="checkbox"/>	<input type="checkbox"/>	16. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	17. Educate occupants on the work completed.



CHECKLIST: BATHROOM EXHAUST FAN INSTALLATION

SUCCESS WITH WEATHERIZATION

JOB INFORMATION

Name	Initials
Address	Date



REPLACING BATHROOM EXHAUST FANS

DESIRED OUTCOME: Surface mounted ducted fans installed to specification.

Bath exhaust fan does not meet air flow requirement.

Bath exhaust fan meets air flow requirement.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



REPLACING BATHROOM EXHAUST FANS

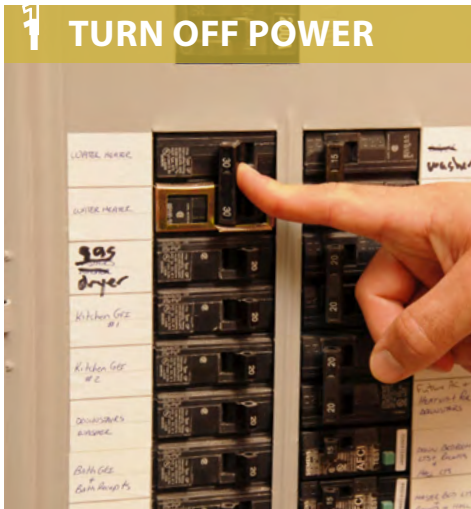
Turn off power to the fan at electrical panel.

Identify/test wires. If the fan is separately wired for a light, mark. Notice: Licensed electrician only.

Disconnect the wires and remove from housing. Notice: Licensed electrician only.

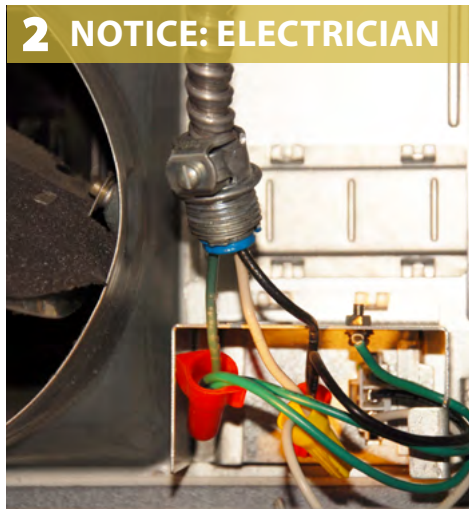
Remove the fan and housing.

1 TURN OFF POWER



Measure the new fan housing and the existing hole. Carefully trim the hole no greater than a 1/4" greater than assembly to fit the new housing.

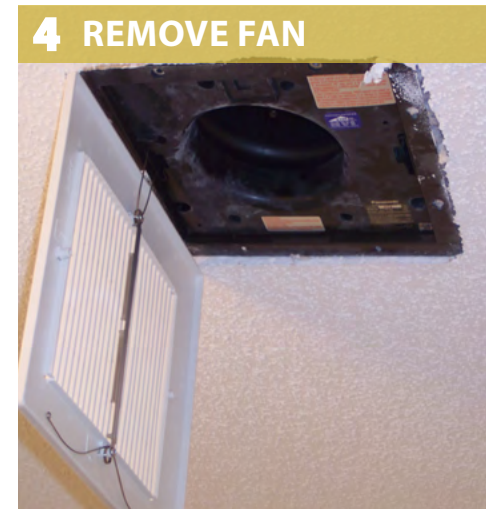
2 NOTICE: ELECTRICIAN



3 NOTICE: ELECTRICIAN



4 REMOVE FAN



5 MEASURE + TRIM HOLE



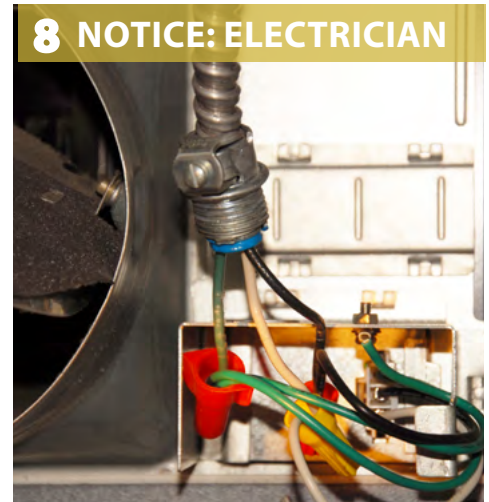
6 INSTALL DAMPER



7 INSTALL FAN



8 NOTICE: ELECTRICIAN





CRITICAL DETAIL: SWS 6.6003.1

SUCCESS WITH WEATHERIZATION

REPLACING BATHROOM EXHAUST FANS

Caulk all of the cracks between the drywall and the housing unit and all holes in the housing unit.

Select the type of duct to install and follow the appropriate critical detail. Turn power on.

Verify air flow matches the program requirement by completing an air flow test.

9 AIR SEAL



10 INSTALL DUCT



11 TEST AIR FLOW



Notes:



INSTALLING BATHROOM EXHAUST FANS

DESIRED OUTCOME: Surface mounted ducted fans installed to specification.

MATERIALS

TOOLS

No bathroom exhaust fan.

Bathroom exhaust fan installed.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CRITICAL DETAIL: SWS 6.6003.1

SUCCESS WITH WEATHERIZATION

INSTALLING BATHROOM EXHAUST FANS

Select the bath fan location close to the tub or shower. Trace the outline of the fan onto the drywall.

1 LOCATE FAN



In the attic, drill two small pilot holes in opposite corners of the traced template.

2 DRILL PILOT HOLES



In the bathroom, trace the outline of the fan on the ceiling, using the pilot holes as a guide.

3 TRACE OUTLINE



In the bathroom or attic, carefully cut the fan hole no greater than a 1/4" greater than assembly. Support the piece while cutting.

4 CUT HOLE



If the new fan does not have a damper, install a back-draft damper.

5 INSTALL DAMPER



Install the fan according to the mfg's specs and with the exhaust port aimed at the termination.

6 INSTALL FAN



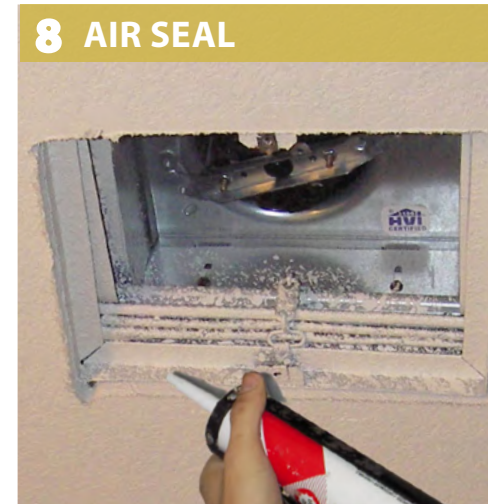
Connect the wires to the fan.
Notice: Licensed electrician only.

7 NOTICE: ELECTRICIAN



Caulk all of the cracks between the drywall and the housing unit and all holes in the housing unit.

8 AIR SEAL





CRITICAL DETAIL: SWS 6.6003.1

SUCCESS WITH WEATHERIZATION

INSTALLING BATHROOM EXHAUST FANS

Select the type of duct to install and follow the appropriate critical detail. Turn power on.

Verify air flow matches the program requirement by completing an air flow test.

9 INSTALL DUCT



10 TEST AIR FLOW



Notes:

INSTALLING ROOF TERMINATIONS FOR EXHAUST FANS

DESIRED OUTCOME: Securely installed termination fittings with unrestricted air flow

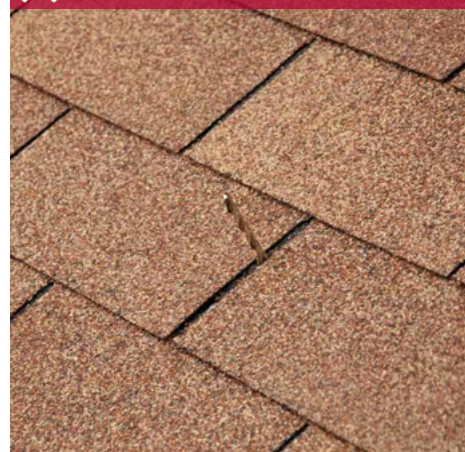
Roof without an exhaust fan termination.

Roof with an exhaust fan termination.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



INSTALLING ROOF TERMINATIONS FOR EXHAUST FANS

Choose location to minimize length of duct, turns and bends. Trace outline at the location.

Drill small pilot holes along the edges of the traced template.

Outside of the house, trace the outline of the duct, using the pilot holes as a guide.

From the exterior roof surface side, cut out the round duct hole no greater than a 1/4" greater than assembly.

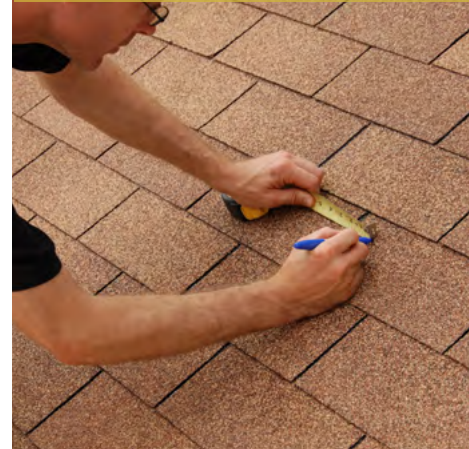
1 TRACE OUTLINE



2 DRILL PILOT HOLES



3 TRACE OUTLINE



4 CUT HOLE



For roof holes, pry up and break shingle tab seals around the hole. Do not damage the shingles.

Install a collar the same diameter as the outlet; if it is larger than outlet, use a rigid metal transition.

Install a vent cap under shingles and directly over the hole. Trim shingles as necessary.

Seal the underside of the flange vent cap, nail holes and roof shingles with roof sealant.

5 PRY SHINGLES



6 NOTICE: COLLAR



7 INSTALL VENT CAP



8 SEAL VENT CAP





INSTALLING ROOF TERMINATIONS FOR EXHAUST FANS

Notice: Install vent 3' away from property lines and openings and 10' away from air intakes

Install screen material with no less than $\frac{1}{4}$ " and no greater than $\frac{1}{2}$ " hole size in any direction.

9 NOTICE: LOCATION



10 INSTALL SCREEN



Notes:



INSTALLING WALL TERMINATIONS FOR EXHAUST FANS

DESIRED OUTCOME: Securely installed termination fittings with unrestricted air flow

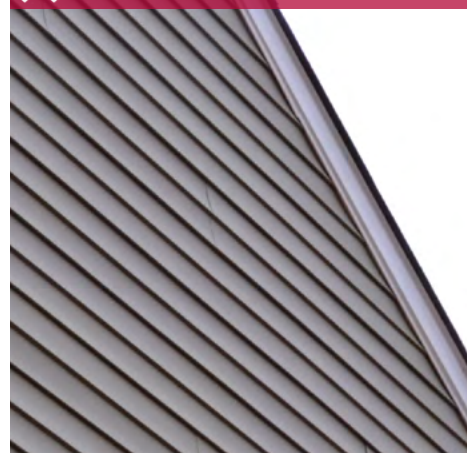
MATERIALS

TOOLS

Wall without an exhaust fan termination.

Wall with an exhaust fan termination.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



INSTALLING WALL TERMINATIONS FOR EXHAUST FANS

Find location of termination in the attic or crawlspace. Note structural member locations.

Locate the duct termination on the exterior and position it in the center of a course of siding.

Outside of the house, trace the outline of the duct, avoiding structural members.

If installing the termination through the attic, cut a hole no greater than a 1/4" greater than the diameter of the duct.

1 LOCATE STRUCTURE



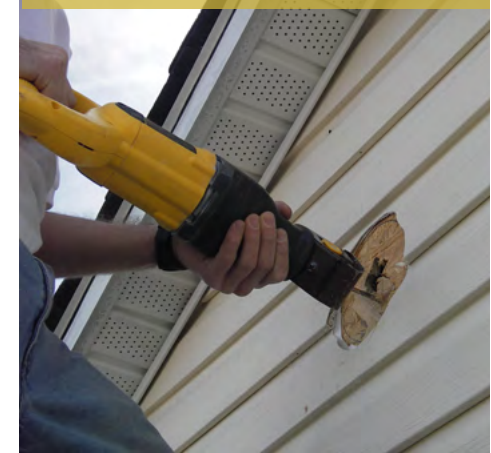
2 LOCATE HOLE



3 TRACE OUTLINE



4 CUT HOLE



If installing termination through the crawlspace, use hammer drill to cut hole.

Notice: Install proper flashing around termination hole.

Install a collar the same diameter as the outlet; if it is larger than outlet, use a rigid metal transition.

Fasten steel flange vent cap. Caulk the underside of the steel flange vent cap and verify it moves freely.

5 DRILL HOLE



6 NOTICE: FLASHING



7 NOTICE: COLLAR



8 INSTALL VENT CAP





Install screen material with no less than ¼" and no greater than ½" hole size in any direction.

Notice: Install vent 3' away from property lines and openings and 10' away from air intakes

9 INSTALL SCREEN



10 NOTICE: LOCATION



Notes:



CRITICAL DETAIL: SWS 6.6201.2 INSTALLING WALL TRANSFERS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: To reduce pressure between two zones.

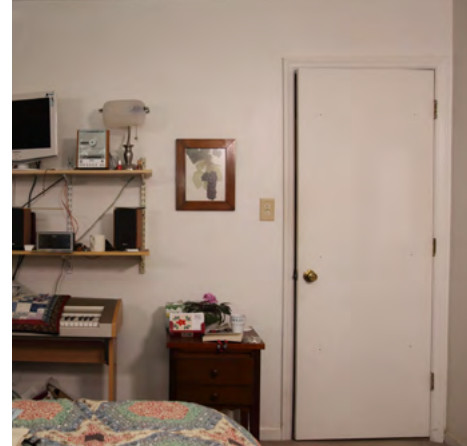
No pressure relief.

Wall transfer installed.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Before beginning work ensure that wall transfer materials meet the prescribed pressure relief per the scope of work. Note selection of net-free area of the grill.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 6.6201.2 INSTALLING WALL TRANSFERS

SUCCESS WITH WEATHERIZATION

Select location.

Draw outline of hole for transfer onto drywall.

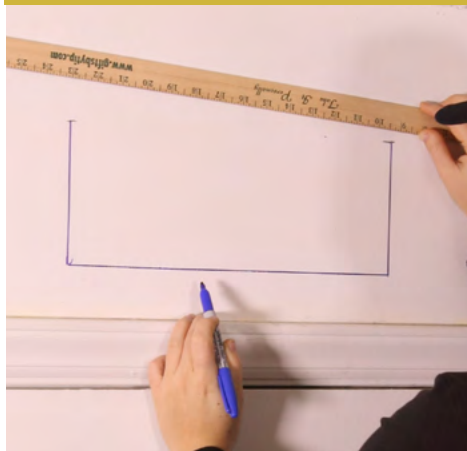
Carefully cut the transfer grill hole. Support the piece while cutting to prevent chipping or tearing.

NOTICE: If wiring, venting, plumbing, or piping are now visible, blocking and sealing must be done to separate from living space.

1 LOCATION



2 OUTLINE



3 CUT HOLE



4 NOTICE: BLOCKING



Seal the entire cavity

Mechanically fasten grills with louvers pointing upward.

Notes:

When determining placement of wall transfers, consider light and sound transmission issues, as well as potential blocking by furniture and doors.

5 SEAL TOP PLATE



6 INSTALL GRILLES





CRITICAL DETAIL: SWS6.6201.2 INSTALLING JUMP DUCTS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: To reduce pressure between two zones.

No pressure relief.

Jump duct installed.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Before beginning work ensure that jump duct materials meet the prescribed pressure relief per the scope of work. Note selection of boot size, duct diameter and R-value and net-free area of the grill.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS6.6201.2

SUCCESS WITH WEATHERIZATION

INSTALLING JUMP DUCTS

Select the jump duct location in the attic. Clear attic insulation away from work area.

Trace the outline of the boots onto the drywall.

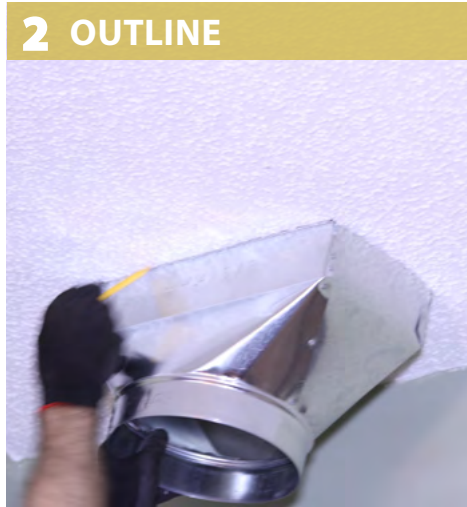
Carefully cut the jump duct hole. Support the piece while cutting to prevent chipping or tearing.

Install the jump duct boots to adjacent framing with screws or nails so boots don't bend or move.

1 LOCATION



2 OUTLINE



3 CUT HOLE



4 INSTALL BLOCKING



Mechanically fasten, support and seal flex duct to both boots.

Replace flex duct insulation and insulate boots using duct wrap with vapor retarder.

Seal boot to drywall connection.

Install grills.

5 FASTEN DUCT



6 INSULATION



7 SEAL



8 INSTALL GRILLE





AIR SEALING

SUCCESS WITH WEATHERIZATION

What every contractor needs to know.



Air Sealing Contents

Air sealing is a challenging and important job. Done right it can bring increased comfort, safety and health to the home's occupant while saving them money on their heating and cooling bills. The purpose of this guide is to assist you, the air sealing professional, with getting the job done right the first time – every time. Below is a list of provided materials in this section:

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SUCCESS WITH WEATHERIZATION

Health + Safety Information Sheet

Health + Safety: Introduction

The introduction to this manual introduced EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades. The document is a useful tool for finding solutions for common issues that arise when completing home energy upgrades. This page will highlight some important details in the document in relation to safety when duct sealing.

Health + Safety: Worker Safety

As mentioned in the introduction, it is required for all contractors to follow OSHA regulations. By law, employers and supervisors are required to ensure that all workers have the correct personal protective equipment. These items include, but aren't limited to:

- Gloves
- Protective clothing
- Knee pads
- Eye protection
- Respirators: Different types of respirators are required for different jobs. Use the Healthy Indoor Environment Protocols for Home Energy Upgrades to verify that your current respirator is compliant with the job.
- Non-contact voltage detectors

Tip: It is important to keep your PPE in good condition. Having a bag that stores all of your PPE and supplies for cleaning the items will save you time and keep you safe.

Health + Safety: Health Hazards

It is important to look for hazards and create a mitigation plan before beginning work. The list below highlights the most important items to identify and mitigate for all duct repair jobs:

- Sewer gases, fuel oil, chemicals and other pollutants in crawl spaces or attics
- Mold-like growth in attics and crawl spaces
- Presence of pest/rodents in crawl spaces or attics
- lack of CO alarm in all houses
- Unvented combustion appliances
- Combustion air intakes
- Knob and tube wiring
- Vermiculite insulation
- Pipe insulations that are likely to contain asbestos
- Deteriorated interior finishes that may contain asbestos in a friable condition

If any of these conditions exist, follow action items listed in the Healthy Indoor Environment Protocols for Home Energy Upgrades before beginning work.



CHECKLIST: AIR SEALING SURVEY

SUCCESS WITH WEATHERIZATION

HOUSE FLOOR PLAN

Create a diagram of the house below:



CHECKLIST: AIR SEALING SURVEY

SUCCESS WITH WEATHERIZATION

✓	N/A	ASSESSMENT
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete combustion safety testing before starting work and inform occupant if problems are found.
<input type="checkbox"/>	<input type="checkbox"/>	2. Create a rough sketch of the house floor plan, including all interior walls.
<input type="checkbox"/>	<input type="checkbox"/>	3. Mark areas on the floor plan that may be chases, dropped ceilings and soffits that are adjacent to the attic.
<input type="checkbox"/>	<input type="checkbox"/>	4. Draw conditioned and unconditioned spaces on the floor plan .
<input type="checkbox"/>	<input type="checkbox"/>	5. Mark location of fire hazards (combustion flues, can lights, etc.).
<input type="checkbox"/>	<input type="checkbox"/>	6. Mark remaining areas on the floor plan that need to be sealed.
<input type="checkbox"/>	<input type="checkbox"/>	7. Create a Scope of Work based on the interior assessment

AIR SEALING LOCATIONS

Look for seams, cracks joints, holes in these locations:

ATTIC		
Top plates of all walls Tongue + Groove Ceilings Chases Soffits Attic Hatches	Can Lights Plumbing Vent Pipes Exhaust Fans Missing wall cavity top plates	Dropped Ceilings Stairwells Chimney/Flue Ductwork
WALL		
Electrical Wire Bottom plates of knee walls	Missing knee wall cavity bottom plates Missing wall cavity top plates	Attic Doors CMU Hollow Cores
FLOOR		
Chases Plumbing	Electrical Blocking of all floor cavities	

JOB INFORMATION	
Assessor Name	Initials
Address	Date



CHECKLIST: AIR SEALING

SUCCESS WITH WEATHERIZATION



N/A

PREP



1. Complete a combustion safety test and record the results.



2. Verify that a ventilation plan is established.



3. Put on all personal protection equipment (PPE).



4. Identify all worker and occupant safety hazards.



5. Identify all potential durability issues.



6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. **Do not complete work if a life safety hazard is identified.**



7. Create a diagram of the attic, walls and/or floor, identifying area needing sealing.



N/A

AIR SEALING



8. Remove existing insulation at air sealing locations.



9. For homes with vented exterior soffits, install protective baffling.



10. Install insulation dams.



11. Verify that all wall cavities have six sides. Install additional blocking where necessary.



12. Install infill material in all extra large holes.



13. Seal all small, medium and large holes between the unconditioned and conditioned space.



14. Reinstall removed insulation and install new insulation to align with the air barrier and according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.



N/A

CLOSE OUT



15. Clean the work area.



16. Complete a combustion safety test and record the results.



17. Educate occupants on the work completed.

JOB INFORMATION

Installer Name

Initials

Address

Date




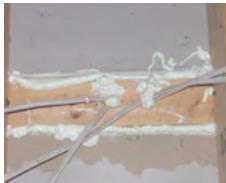




CHECKLIST: AIR SEALING

SUCCESS WITH WEATHERIZATION

AIR SEALING GUIDELINES

For seams, cracks, joints, holes and penetrations that are:

1/4-inch or less (small)		1/4 inch to 2 inches (medium)		2 to 3 inches (large)		3 inches or more (extra large)
Seal with caulk.*		Seal with one component foam or mastic.*		Seal with two component foam.		Install an infill material that will not bend, sag or move. Follow guidelines for applicable hole size.
BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	
						

* Sealants used for larger holes may also be used in these conditions.

AIR SEALING LOCATIONS

Look for seams, cracks joints, holes in these locations:

ATTIC		
Top plates of all walls	Can Lights	Dropped Ceilings
Tongue + Groove Ceilings	Plumbing Vent Pipes	Stairwells
Chases	Exhaust Fans	Chimney/Flue
Soffits	Missing wall cavity top plates	Ductwork
Attic Hatches		
WALL		
Electrical Wire	Missing knee wall cavity bottom plates	Attic Doors
Bottom plates of knee walls	Missing wall cavity top plates	CMU Hollow Cores
FLOOR		
Chases	Electrical	
Plumbing	Blocking of all floor cavities	



SEALING CATHEDRAL CEILING SKYLIGHTS

Prepare skylight shaft for air sealing. Remove trim as needed.

Install backer rod or infill, if needed.

Reinstall trim around perimeter of skylight.

1 PREPARE



2 SEAL SKYLIGHT



3 TRIM



Notes:



CRITICAL DETAIL: SWS 3.1001.4

SEALING PENETRATIONS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Penetrations sealed to prevent leakage and moisture movement between the attic and conditioned space.

MATERIALS

TOOLS

Leaking wiring penetration.

Penetration air sealed.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Select a sealant that meets local code requirements regarding flammability.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1001.4

SUCCESS WITH WEATHERIZATION

SEALING PENETRATIONS

Leaking wiring penetration.

Seal penetration with caulk or foam.

Penetration air sealed.

1 FIND PENETRATION



2 SEAL PENETRATION



3 SEALED



Notes:

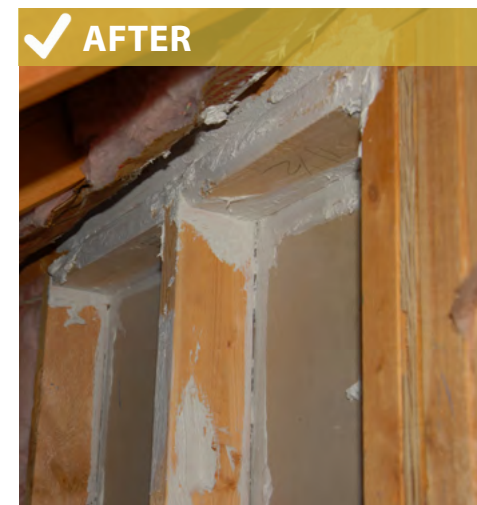


DESIRED OUTCOME: Attic knee walls framed to prevent thermal bypass and sealed to prevent air leakage between attic and conditioned space.

TOOLS

Knee wall with incomplete or missing top and bottom plate and no air sealing.

Knee wall with both a top and bottom plate and air sealed.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



SEALING KNEE WALLS

Remove or adjust insulation to allow access to top and/or bottom of knee wall.

Install top plate or blocking.

Air seal joints, cracks and penetrations including connection between interior surface and framing.

1 REMOVE BATT



2 INSTALL TOP PLATE



3 SEAL



Notes:



CRITICAL DETAIL: SWS 3.1005.1

SUCCESS WITH WEATHERIZATION

SEALING TONGUE + GROOVE CEILINGS

DESIRED OUTCOME: Tongue and groove ceilings sealed to prevent air leakage and moisture movement between the attic and conditioned space

MATERIALS

TOOLS

Unsealed tongue and groove ceiling.

Air sealed tongue and groove ceiling.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

NOTICE: No sealant should be visible in the living space.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



SEALING TONGUE + GROOVE CEILINGS

Option A: Air seal tongue and groove ceiling.

NOTICE: If air sealant is a foam plastic, it must be covered with an approved thermal barrier (e.g. rockwool, slag wool).

Option B: Install air barrier that is approved for attic exposure.

Air seal backing using a sealant that meets fire barrier specifications.

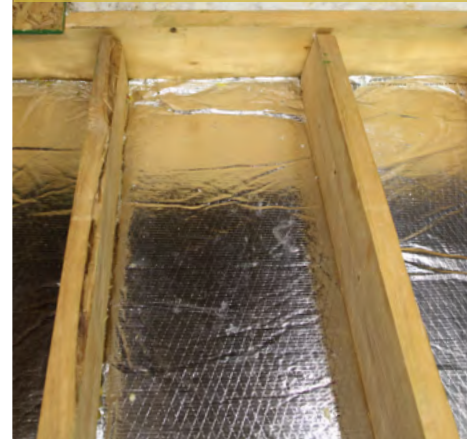
1 SEAL



2 INSULATE



3 INSTALL BACKING



4 SEAL



Notes:

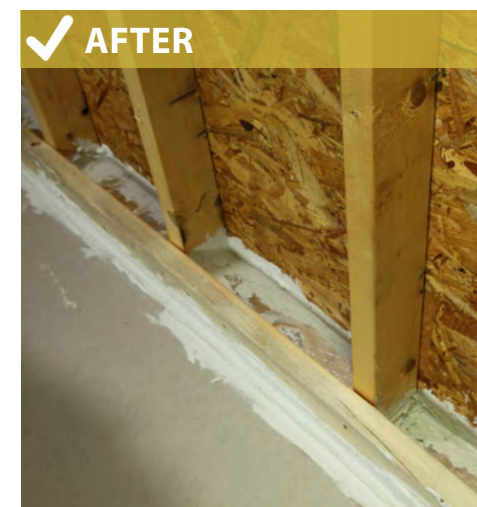


DESIRED OUTCOME: Open wall cavities sealed to prevent air leakage and moisture movement between the attic and conditioned space

TOOLS

Wall cavities open to attic.

Wall cavities blocked and sealed.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1001.3

SUCCESS WITH WEATHERIZATION

SEALING BALLOON FRAMING

Prepare work area.

Cover or fill cavity at ceiling height with rigid material. Fasten as needed.

Seal all seams, gaps, and holes in blocking.

Seal all gaps, holes and seams in adjacent framing.

1 PREPARE



2 INSTALL BLOCKING



3 SEAL BLOCKING



4 SEAL FRAMING



Notes:



CRITICAL DETAIL: SWS 3.1001.2

CAPPING CHASES

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Chase capped to prevent air leakage and moisture movement between the attic and conditioned space.

MATERIALS

TOOLS

Chase open to the attic.

Chase completely capped and air sealed.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Any evidence of roof leak must be fixed prior to air sealing.

If interior surface covering in chase is not appropriately fire rated, the material used to cap the chase must be appropriately fire rated.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CAPPING CHASES

Chase open to the attic.

Install cap to cover entire chase.
Install support material as needed.
Fasten in place.

Seal all cracks, seams, and holes at
chase and adjacent framing.

1 OPEN CHASE



2 CAPPED CHASE



3 AIR SEALED CHASE



Notes:



CRITICAL DETAIL: SWS 3.1003.6

CAPPING SOFFITS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Soffit is capped to prevent air leakage or moisture movement between the attic and conditioned space

Wall cavities within the SOFFIT/
DROPPED CEILING are open to the
attic.

Wall cavities capped and air-sealed.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

*If interior surface covering in soffit is not appropriately
fire rated, the material used to cap the soffit must be
appropriately fire rated.*

** Materials and tools listed are only recommendations and may not include
everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1003.6

SUCCESS WITH WEATHERIZATION

CAPPING SOFFITS

Prepare work area.

Install support material (e.g., 2X) for spans wider than 24 inches.

NOTICE: If air sealant is a foam plastic, it must be covered with an approved thermal barrier (e.g. rockwool, slag wool).

Install and fasten rigid sheathing over soffit/dropped ceiling.

1 PREPARE



2 INSTALL SUPPORT



3 FIRE RATING



4 RIGID SHEATHING



Air-seal all gaps, holes and seams of rigid sheathing.

Seal all gaps, holes and seams in adjacent framing.

Notes: Be cautious when installing support material since excessive hammering may crack interior surfaces

(e.g. drywall)

5 SEAL SHEATHING



6 SEAL FRAMING





CRITICAL DETAIL: SWS 3.1002.1

CAPPING STAIRWELLS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Stairwells sealed to prevent air leakage and moisture movement between the attic and conditioned space

Wall cavities within the stairwell open to the attic.

Whole stairwell capped and air sealed.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

If interior surface covering in stairwell is not appropriately fire rated, the material used to cap the stairwell must be appropriately fire rated.

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CAPPING STAIRWELLS

Install support material (e.g., 2X) for spans wider than 24 inches.

IMPORTANT: Rigid sheathing must have 15-minute fire rating if interior walls are not fire rated.

Install and fasten rigid sheathing over stairwell.

Air seal all gaps, holes and seams of rigid sheathing.

1 INSTALL SUPPORT



2 FIRE RATING



3 RIGID SHEATHING



4 SEAL SHEATHING



Seal all gaps, holes and seams in adjacent framing at top of stairwell.

Notes: Be cautious when installing support material since

excessive hammering may crack interior surfaces

(e.g. drywall)

5 SEAL FRAMING





PREP + INSULATION

SUCCESS WITH WEATHERIZATION

What every contractor needs to know.



Prep + Insulation Contents

Prep and Insulation sealing is a challenging and important job. Done right it can bring increased comfort, safety and health to the home's occupant while saving them money on their heating and cooling bills. The purpose of this guide is to assist you, the air sealing professional, with getting the job done right the first time – every time. Below is a list of provided materials in this section:

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OSHA REGULATIONS

Health + Safety: Introduction

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As mentioned in the introduction, it is required for all contractors to follow OSHA regulations. By law, employers and supervisors are required to ensure that all workers have the correct personal protective equipment. These items include, but aren't limited to:

- Gloves
- Protective clothing
- Knee pads
- Eye protection
- Respirators: Different types of respirators are required for different jobs. Use the Healthy Indoor Environment Protocols for Home Energy Upgrades to verify that your current respirator is compliant with the job.
- Non-contact voltage detectors

Tip: It is important to keep your PPE in good condition. Having a bag that stores all of your PPE and supplies for cleaning the items will save you time and keep you safe.

Health + Safety: Health Hazards

It is important to look for hazards and create a mitigation plan before beginning work. The list below highlights the most important items to identify and mitigate for all duct repair jobs:

SUCCESS WITH WEATHERIZATION

Health + Safety Information Sheet

- Sewer gases, fuel oil, chemicals and other pollutants in crawl spaces or attics
- Mold-like growth in attics and crawl spaces
- Presence of pest/rodents in crawl spaces or attics
- Lack of CO alarm in all houses
- Unvented combustion appliances
- Combustion air intakes
- Knob and tube wiring
- Vermiculite insulation
- Pipe insulations that are likely to contain asbestos
- Deteriorated interior finishes that may contain asbestos in a friable condition

If any of these conditions exist, follow action items listed in the Healthy Indoor Environment Protocols for Home Energy Upgrades before beginning work.



CHECKLIST: ROOF DECK INSULATION

SUCCESS WITH WEATHERIZATION

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	2. Verify that a ventilation plan is established.
<input type="checkbox"/>	<input type="checkbox"/>	3. Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	4. Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	5. Identify all potential durability issues.
<input type="checkbox"/>	<input type="checkbox"/>	6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.

✓	N/A	WORK
<input type="checkbox"/>	<input type="checkbox"/>	7. Identify how vapor will flow through the roof. Do not install an insulation material that will create a moisture issue.
<input type="checkbox"/>	<input type="checkbox"/>	8. Remove all existing insulation that touches the interior ceiling from the attic.
<input type="checkbox"/>	<input type="checkbox"/>	9. Address all combustion safety, worker safety, occupant safety and durability issues uncovered by insulation removal prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
<input type="checkbox"/>	<input type="checkbox"/>	10. Identify roof deck areas where insulation must not be installed.
<input type="checkbox"/>	<input type="checkbox"/>	11. Ensure all ventilation fans are ducted to the outside and seal all holes between the attic and the outside.
<input type="checkbox"/>	<input type="checkbox"/>	12. Install insulation according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.

✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	13. Clean the work area.
<input type="checkbox"/>	<input type="checkbox"/>	14. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	15. Educate occupants on the work completed.

JOB INFORMATION	
Name	Initials
Address	Date



CHECKLIST: ATTIC INSULATION

SUCCESS WITH WEATHERIZATION

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	2. Verify that a ventilation plan is established.
<input type="checkbox"/>	<input type="checkbox"/>	3. Put on all personal protection equipment (PPE).
<input type="checkbox"/>	<input type="checkbox"/>	4. Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	5. Identify all potential durability issues.
<input type="checkbox"/>	<input type="checkbox"/>	6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
✓	N/A	WORK
<input type="checkbox"/>	<input type="checkbox"/>	7. Identify areas where insulation will not be installed.
<input type="checkbox"/>	<input type="checkbox"/>	8. Seal all holes between the interior of the house and the attic.
<input type="checkbox"/>	<input type="checkbox"/>	9. For homes with vented exterior soffits, install protective baffling.
<input type="checkbox"/>	<input type="checkbox"/>	10. Install insulation dams.
<input type="checkbox"/>	<input type="checkbox"/>	11. Install insulation according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.
✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	12. Clean the work area.
<input type="checkbox"/>	<input type="checkbox"/>	13. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	14. Educate occupants on the work completed.

JOB INFORMATION	
Name	Initials
Address	Date



CHECKLIST:

SUCCESS WITH WEATHERIZATION

CRAWLSPACE AND/OR BASEMENT INSULATION



N/A

PREP



1. Complete a combustion safety test and record the results.



2. Verify that a ventilation plan is established.



3. Put on all personal protection equipment (PPE)



4. Identify all worker and occupant safety hazards.



5. Identify all potential durability issues.



6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. **Do not complete work if a life safety hazard is identified.**



N/A

WORK



7. Remove existing damaged insulation from the crawlspace and/or basement.



8. Address all combustion safety, worker safety, occupant safety and durability issues uncovered by insulation removal prior to starting work and notify the occupant. **Do not complete work if a life safety hazard is identified.**



9. Identify areas where insulation must not be installed.



10. Seal all holes between the crawlspace and/or basement and the interior and exterior of the house.



11. Install insulation according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.



N/A

CLOSE OUT



12. Clean the work area.



13. Complete a combustion safety test and record the results.



14. Educate occupants on the work completed.

JOB INFORMATION

Name	Initials
Address	Date



CHECKLIST: OPEN WALL CAVITY INSULATION

SUCCESS WITH WEATHERIZATION

✓	N/A	PREP
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	2. Verify that a ventilation plan is established.
<input type="checkbox"/>	<input type="checkbox"/>	3. Put on all personal protection equipment (PPE)
<input type="checkbox"/>	<input type="checkbox"/>	4. Identify all worker and occupant safety hazards.
<input type="checkbox"/>	<input type="checkbox"/>	5. Identify all potential durability issues.
<input type="checkbox"/>	<input type="checkbox"/>	6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
✓	N/A	WORK
<input type="checkbox"/>	<input type="checkbox"/>	7. Remove existing damaged insulation. Address all combustion safety, worker safety, occupant safety and durability issues uncovered by insulation removal prior to starting work and notify the occupant. Do not complete work if a life safety hazard is identified.
<input type="checkbox"/>	<input type="checkbox"/>	8. Identify wall cavities without top and bottom plates and install blocking.
<input type="checkbox"/>	<input type="checkbox"/>	9. Seal all holes in the wall.
<input type="checkbox"/>	<input type="checkbox"/>	10. Install insulation according to the manufacturer's specifications. Verify that all insulation has no gaps, voids, compression or misalignment.
<input type="checkbox"/>	<input type="checkbox"/>	11. Install a backing material to enclose insulation.
<input type="checkbox"/>	<input type="checkbox"/>	12. Seal all holes in the backing material.
✓	N/A	CLOSE OUT
<input type="checkbox"/>	<input type="checkbox"/>	13. Clean the work area.
<input type="checkbox"/>	<input type="checkbox"/>	14. Complete a combustion safety test and record the results.
<input type="checkbox"/>	<input type="checkbox"/>	15. Educate occupants on the work completed.

JOB INFORMATION	
Name	Initials
Address	Date



CHECKLIST:

SUCCESS WITH WEATHERIZATION

ENCLOSED WALL CAVITY INSULATION (DENSE PACK)



N/A

PREP



1. Complete a combustion safety test and record the results.



2. Verify that a ventilation plan is established.



3. Put on all personal protection equipment (PPE)



4. Identify all worker and occupant safety hazards.



5. Identify all potential durability issues.



6. Address all combustion safety, worker safety, occupant safety and durability issues prior to starting work and notify the occupant. **Do not complete work if a life safety hazard is identified.**



N/A

WORK



7. Gain access to all wall cavities and probe for obstructions and/or hazards.



8. Install insulation according to the manufacturer's specifications.



9. View completed sections using an IR camera with a blower door operating. Drill and repack any voids or low density areas.



10. Seal access points of all wall cavities. Patch exterior holes with a weather barrier. Patch and coat holes to match original interior surface.



11. Repair the visible surface of access locations.



N/A

CLOSE OUT



12. Clean the work area.



13. Complete a combustion safety test and record the results.



14. Educate occupants on the work completed.

JOB INFORMATION

Name

Initials

Address

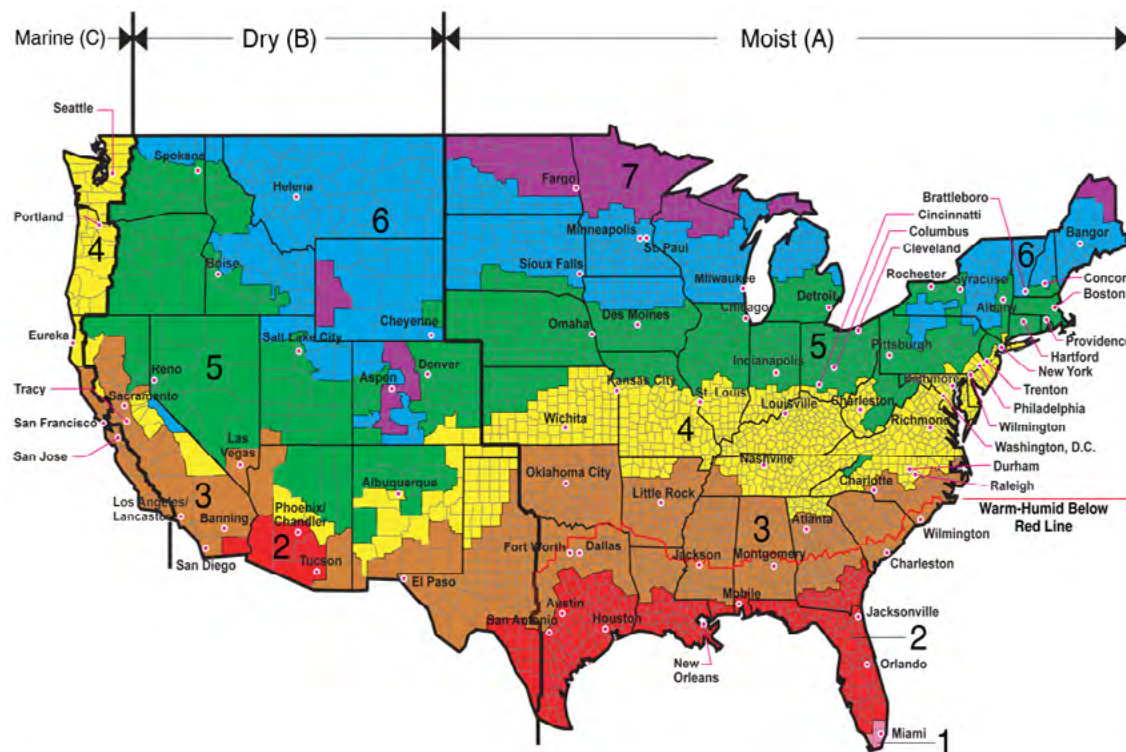
Date



INFORMATION SHEET: 2009 IECC INSULATION LEVELS

SUCCESS WITH WEATHERIZATION

CLIMATE ZONE	CEILING	FRAME WALL	MASS WALL ^c	FLOOR	BASEMENT WALL ^e	CRAWL SPACE WALL ^e	SLAB ^{g,h}
Zone 1	R-30	R-13	R-3	R-13	R-0	R-0	0
Zone 2	R-30	R-13	R-4	R-13	R-0	R-0	0
Zone 3	R-30	R-13	R-5	R-19	R-5/13 ^f	R-5/13	0
Zone 4	R-38	R-13	R-5	R-19	R-10/13	R-10/13	10, 2 ft.
Zone 5	R-38	R-20 or R-13+R-5 ^b	R-13	R-30 ^d	R-10/13	R-10/13	10, 2 ft.
Zone 6	R-49	R-20 or R-13+R-5 ^b	R-15	R-30 ^d	R-15/19	R-10/13	10, 4 ft.
Zone 7	R-49	R-21	R-19	R-38 ^d	R-15/19	R-10/13	10, 4 ft.



- R-Values are minimums.
- "R-13+R-5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulated sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of the exterior, structural sheathing shall be supplemented with insulation sheathing of at least R-2.
- The second R-value applies when more than half of the insulation is on the interior of the mass wall.
- Sufficient insulation to fill the cavity, R-19 minimum.
- "R-15/19" means R-15 continuous insulation sheathing on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "R-10/13" means R-10 continuous insulated sheathing or R-10 cavity insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.
- Basement wall insulation is not required in warm-humid locations defined by Figure 301.1 and Table 301.1 of the IECC.
- R-values are minimums.
- R-5 shall be added to the required slab edge R-values for heated slabs. Insulation depth shall be the depth of the footing or two feet, whichever is less in Climate Zones 1-3 for heated slabs.

Interactive Map:

<http://energycode.pnl.gov/EnergyCodeReqs/>

All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dillingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands



WHAT TYPE OF INSULATION?

It is more important that the insulation is properly installed rather than the specific type being used. Avoid these five flaws when installing insulation to achieve a Grade I installation:

- Gaps
- Voids
- Misalignment
- Compression
- Wind Intrusion

Grade I Insulation Installation

It is important to install all ceiling, wall, floor and slab insulation to achieve RESNET-defined Grade I installation or Grade II for surfaces with insulated sheathing. By installing the insulation to meet these standards, you can ensure that it will work properly. According to the RESNET Mortgage Industry National HERS Standards:

“Grade I” installation requires that the insulation material uniformly fills each cavity side-to-side and top-to-bottom, without substantial gaps or voids around obstructions (such as blocking or bridging), and is split, installed and/or fitted tightly around wiring and other services in the cavity.

To attain a rating of “Grade I”, wall insulation shall be enclosed on all six sides, and shall be in substantial contact with the sheathing material on at least one side (interior or exterior) of the cavity.

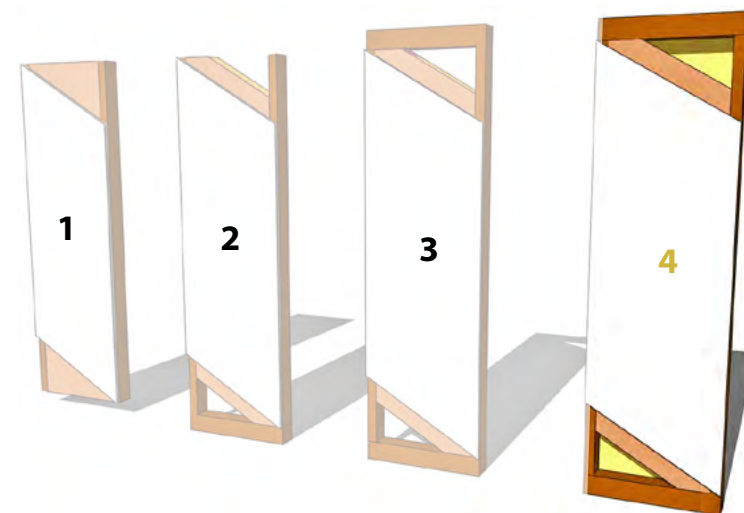
Exception: The interior sheathing/enclosure material is optional in climate zones 1-3, provided insulation is adequately supported and meets all other requirements.

Proper Installation: Framing

Properly installed insulation consists of insulation framed on all six sides, including top and bottom plates, rigid backing and sheathing. Ensure that framing is correctly installed prior to the start of insulation. By verifying that the framer has created six-sided wall cavities, insulators will save time and money through preventive measures. The images to the right illustrate how framing must be installed for insulation to meet the required Grade I installation.

SUCCESS WITH WEATHERIZATION

Insulation Information Sheet



Improper Framing - Insulation will not meet Grade I

1. No top or bottom plate and no backing
2. Bottom plate, but no top plate and no backing
3. Top and bottom plate, but no backing

Proper Framing - Insulation will meet Grade I

4. Top and bottom plate, includes backing (best design)

Proper Installation: Insulation

Once the framing has been verified as properly installed, it is more important that the insulation is properly installed. It is not important which type of insulation is used, but it is important to train installers. Training on how to properly install the type of insulation to avoid flaws will create a Grade I installation as well as a more comfortable and durable home.



Insulation Information Sheet

Train installers on these five flaws and how to avoid them:

- **Gaps:** Ensure the insulation fills the entire exterior wall, ceiling or floor cavity
- **Voids:** Verify all exterior wall, ceiling and floor cavities have insulation
- **Misalignment:** Ensure all insulation is touching the air barrier
- **Compression:** Verify that insulation is installed without compression
- **Wind Intrusion:** Ensure there is a physical separation (such as wind baffles) between insulation in the attic and weather conditions

To better understand what improper and proper installation looks like for each of these five flaws, refer to the images and text on the Tech Tips in this section.



TECH TIPS: INSTALLING INSULATION

SUCCESS WITH WEATHERIZATION

Install insulation to fill the cavity between conditioned and unconditioned space without gaps, voids, misalignments or compression.

Install insulation to fill the cavity between conditioned and unconditioned space without gaps, voids, misalignments or compression.

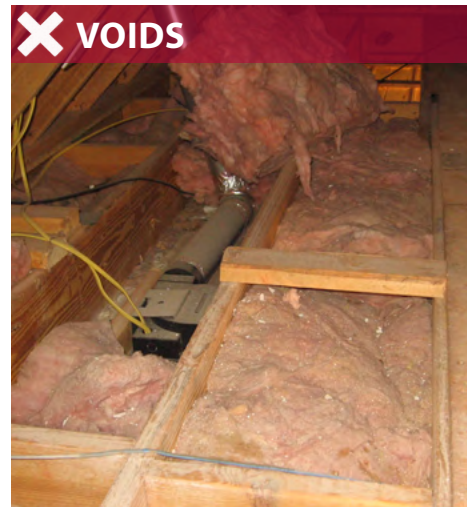
✗ GAPS



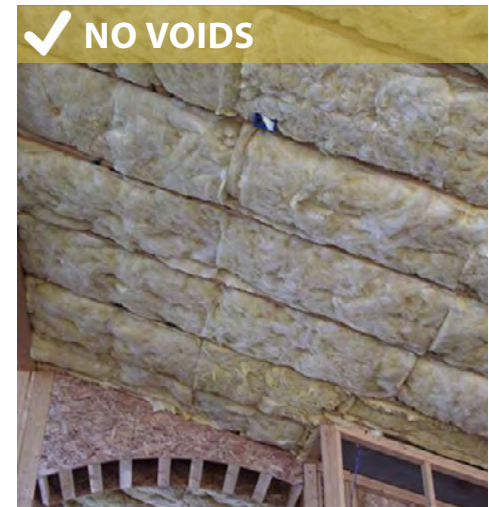
✓ NO GAPS



✗ VOIDS



✓ NO VOIDS



Install insulation to fill the cavity between conditioned and unconditioned space without gaps, voids, misalignments or compression.

Install insulation to fill the cavity between conditioned and unconditioned space without gaps, voids, misalignments or compression.

✗ MISALIGNMENT



✓ NO MISALIGNMENT



✗ COMPRESSION



✓ NO COMPRESSION



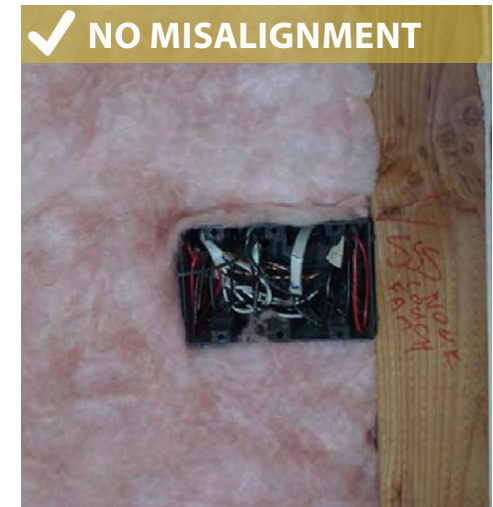
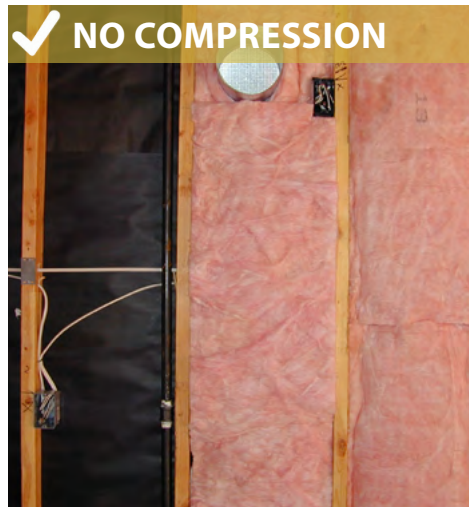


TECH TIPS: INSTALLING INSULATION

SUCCESS WITH WEATHERIZATION

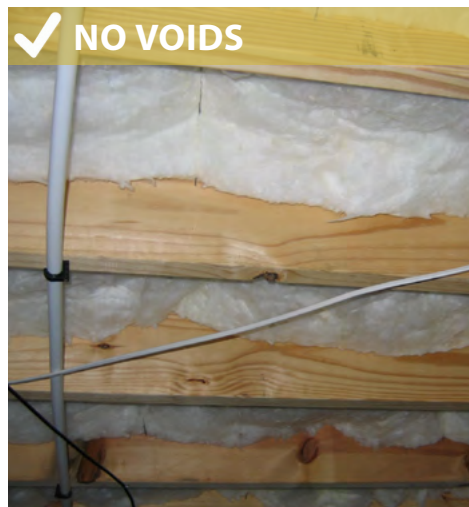
Cut and split insulation around blocking, plumbing, HVAC and electrical components.

Cut and split insulation around blocking, plumbing, HVAC and electrical components.



Install insulation to completely fill floor and/or cantilever framing or to maintain permanent contact with the subfloor.

Install insulation to completely fill floor and/or cantilever framing or to maintain permanent contact with the subfloor.





CRITICAL DETAIL: SWS 4.1001.2

SUCCESS WITH WEATHERIZATION

REPLACING KNOB + TUBE WIRING

DESIRED OUTCOME: Insulation kept away from contact with live wiring

House visually inspected to identify knob and tube wiring.

Documented inspection.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

**NOTICE: Use a non-contact voltage tester (clamp style or surface style).*

Option: If wiring must remain, install insulation dams around the wiring to prevent contact.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 4.1001.2

SUCCESS WITH WEATHERIZATION

REPLACING KNOB + TUBE WIRING

Visually inspect to identify knob and tube wiring.

Use non-contact testing method to identify live wiring.

Replace knob and tube wiring with new appropriate wiring by a licensed electrician per local codes.

1 INSPECT WIRING



2 TEST WIRING



3 REPLACE WIRING



Notes:

ENCLOSING UNINSULATED (NON-IC RATED) RECESSED LIGHTS

DESIRED OUTCOME: Sealed light boxes safely prevent air leakage and moisture movement between the attic and conditioned space.

Dropped ceiling open to the attic having uninsulated recessed lights.

Air tight enclosure above finished insulation.

MATERIALS

TOOLS

✗ BEFORE

✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



ENCLOSING UNINSULATED (NON-IC RATED) RECESSED LIGHTS

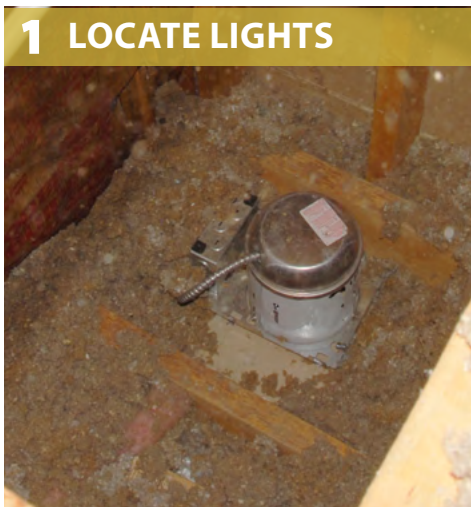
Dropped ceiling open to the attic having uninsulated non-IC rated light.

Clear area around fixture of insulation at a minimum of 3".

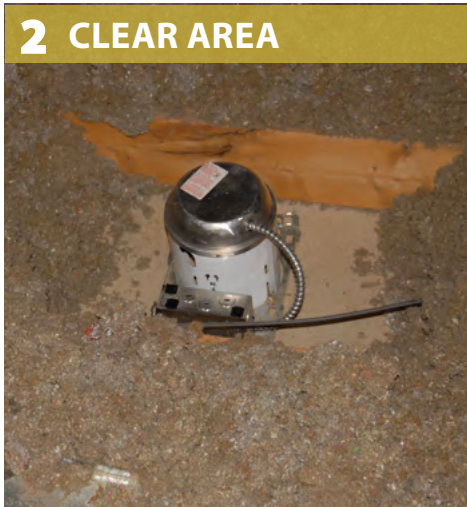
Construct enclosure with a height above insulation and with a R-value no greater than 0.5.

Air seal enclosure.

1 LOCATE LIGHTS



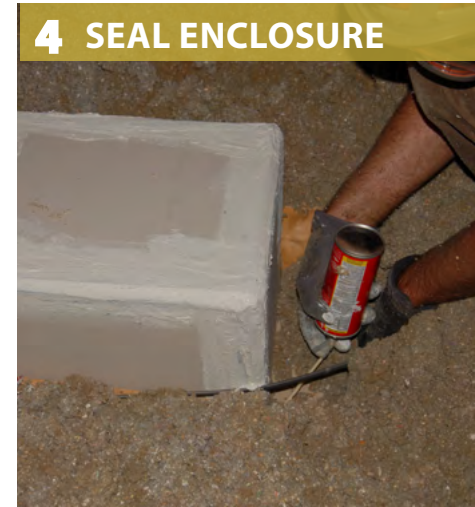
2 CLEAR AREA



3 BUILD ENCLOSURE



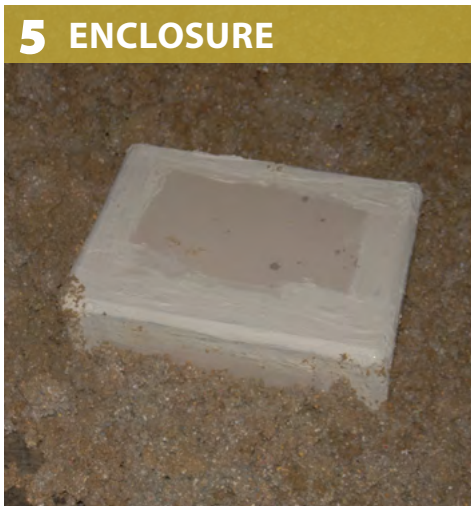
4 SEAL ENCLOSURE



Finished air tight enclosure. No insulation on top.

Notes:

5 ENCLOSURE





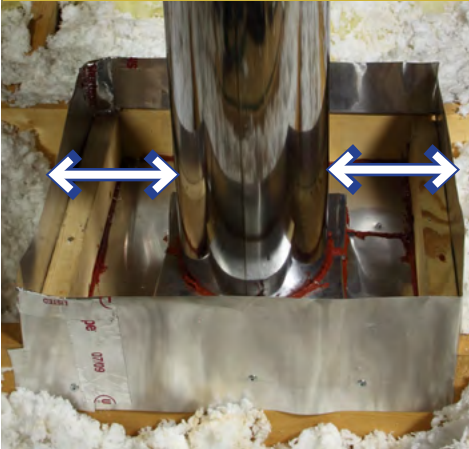
INSTALLING DAMS AROUND CHIMNEYS + FLUES

Dam constructed to ensure a 3-inch clearance between chimney and dam.

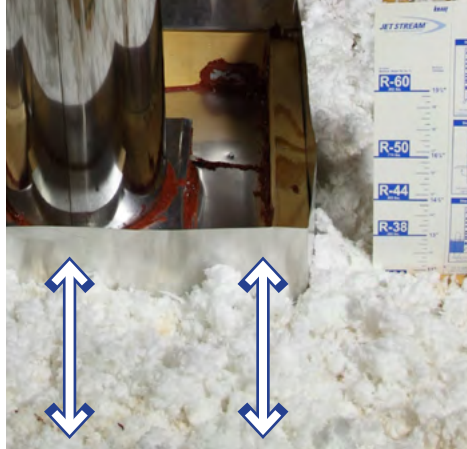
Dams constructed to have a height greater than the insulation.

Do not allow insulation between chimney and dam.

1 DAM WIDTH



2 DAM HEIGHT



3 ATTENTION



Notes:



INSTALLING VENTILATION BAFFLES

Baffles will be installed to maintain a minimum 1-inch clearance between roof deck and baffle.

Baffles stapled in place to block wind entry into insulation and prevent insulation from blowing back into the attic.

Baffle installed to the exterior side of the top plate to allow for the highest possible R-value.



Notes:

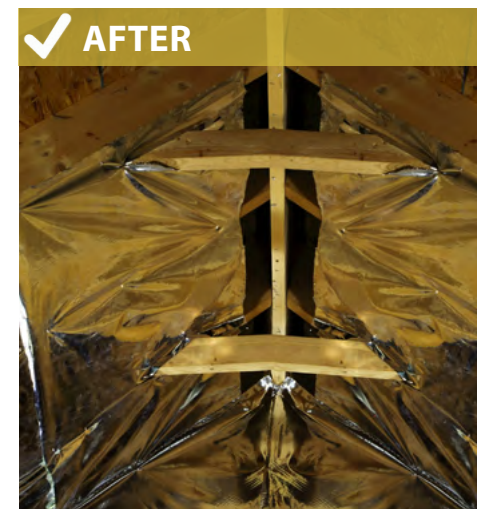


DESIRED OUTCOME: Radiant heat flow reduced

TOOLS

Roof deck with no radiant barrier.

Radiant barrier installed only at the roof deck.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Reference these standards ASTM C1158; C1313

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 4.1001.4

SUCCESS WITH WEATHERIZATION

INSTALLING RADIANT BARRIERS

Install radiant barrier material per manufacturers' specifications.

Maintain air space no less than $\frac{3}{4}$ -inch between barrier and bottom of the roof deck.

Maintain minimum of 3-inch clearance from ridge vents.

Maintain minimum of 3-inch clearance from soffit vents.

1 INSTALL BARRIER



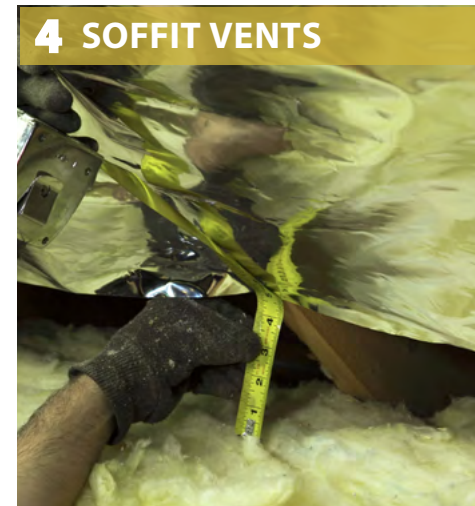
2 AIR SPACE



3 RIDGE VENTS



4 SOFFIT VENTS



Apply radiant barrier to gable walls while maintaining $\frac{3}{4}$ -inch air space. Radiant barrier should not block gable vents.

Install radiant barrier to separate attic above conditioned space from adjacent attics. Should be installed to withstand local wind loads.

NOTICE: Radiant barrier should not be installed until any issues with electrical system are resolved.

NOTICE: Radiant barrier should not cover any wiring.

5 GABLE VENTS



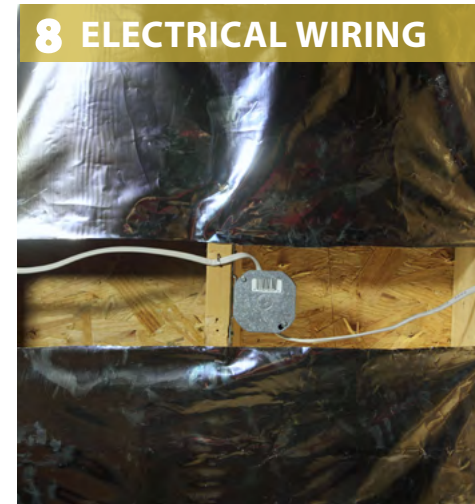
6 SEPARATE ATTICS



7 SAFETY HAZARDS



8 ELECTRICAL WIRING





CRITICAL DETAIL: SWS 4.1001.4 INSTALLING RADIANT BARRIERS

SUCCESS WITH WEATHERIZATION

NOTICE: Radiant barrier should not be installed on the attic floor/insulation.

9 NOTICE: ATTIC FLOOR



Notes:



CRITICAL DETAIL: SWS 4.1006.2

SUCCESS WITH WEATHERIZATION

INSULATING ATTIC ACCESS HATCHES

DESIRED OUTCOME: Attic access door or hatches properly sealed and insulated to minimize heat loss or gain

Attic hatches that are uninsulated and undammed.

Attic hatch insulated, dammed and weatherstripped.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Dam materials must be constructed to allow repeated access without compromising the dam durability (e.g., 2X, OSB, plywood)*

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



INSULATING ATTIC ACCESS HATCHES

Insulate attic hatch with rigid insulation to same R-value as adjoining insulated assembly.

Install dams to prevent insulation from falling out of attic.

Install and weatherstrip access hatch or trim. Verify seal.

Air seal trim in place.

1 INSULATE HATCH



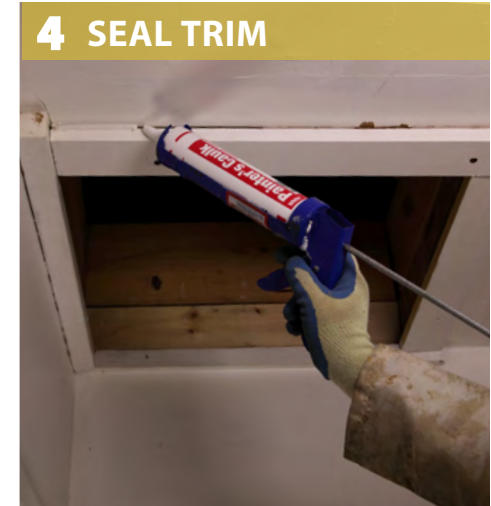
2 INSTALL DAMS



3 WEATHERSTRIP



4 SEAL TRIM



Notes:



CRITICAL DETAIL: SWS 4.1006.1

SUCCESS WITH WEATHERIZATION

INSULATING ATTIC PULL-DOWN STAIRS

DESIRED OUTCOME: Attic access door or hatches properly sealed and insulated to minimize heat loss or gain

Attic pull-down stairs that are improperly insulated and undammed.

Attic pull-down stair insulated, dammed and weatherstripped.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Dam materials must be constructed to allow repeated access without compromising the dam durability (e.g., 2X, OSB, plywood)*

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



INSULATING ATTIC PULL-DOWN STAIRS

Insulate attic pull-down stairs with rigid insulation to specified R-value.

Install dams to prevent insulation from falling out of attic.

Air seal between attic pull-down stairs framing and drywall.

Install and weatherstrip stair or trim. Verify seal.

1 INSULATE STAIRS



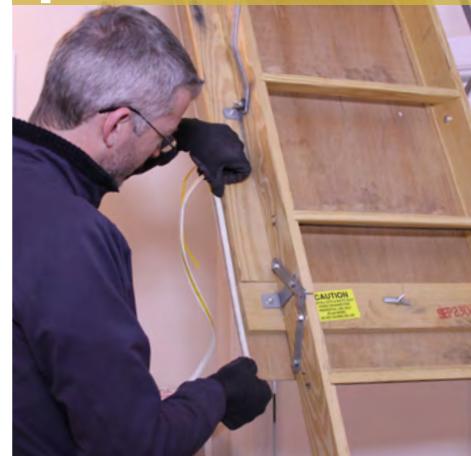
2 INSTALL DAMS



3 SEAL FRAMING



4 WEATHERSTRIP



Air seal trim in place.

Notes:

5 SEAL TRIM





CRITICAL DETAIL: SWS 4.1006.2

INSULATING ACCESS DOORS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Attic access door or hatches properly sealed and insulated to minimize heat loss or gain

MATERIALS

TOOLS

Attic doors that are uninsulated.

Attic doors that are insulated and weatherstripped.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



INSULATING ACCESS DOORS

Insulate attic door stairs with rigid insulation to specified R-value.

Air seal between attic door stairs framing and drywall.

Install and weatherstrip stair or trim. Verify seal.

Air seal trim in place.

1 PREPARE



2 SEAL FRAMING



3 WEATHERSTRIP



4 RIGID SHEATHING



Notes:



CRITICAL DETAIL: SWS 3.1003.6

TREATING SOFFIT PERIMETERS

SUCCESS WITH WEATHERIZATION

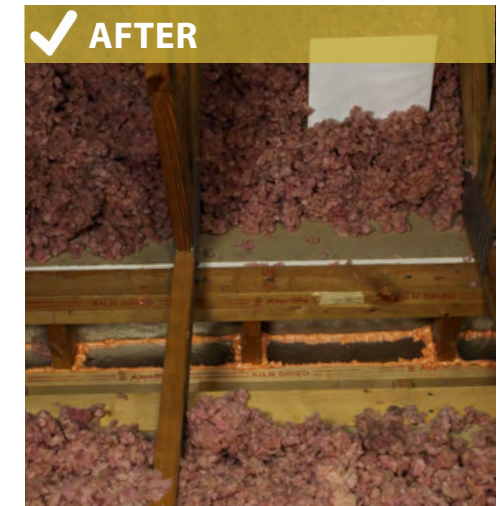
DESIRED OUTCOME: Chase capped to prevent air leakage and moisture movement between the attic and conditioned space.

MATERIALS

TOOLS

Wall cavities within the SOFFIT/
DROPPED CEILING are open to the
attic.

Wall cavities capped and air-sealed.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Any evidence of roof leak must be fixed prior to air sealing.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1003.6

SUCCESS WITH WEATHERIZATION

TREATING SOFFIT PERIMETERS

Prepare work area and remove debris.

If insulation is on exterior wall, cut at ceiling level.

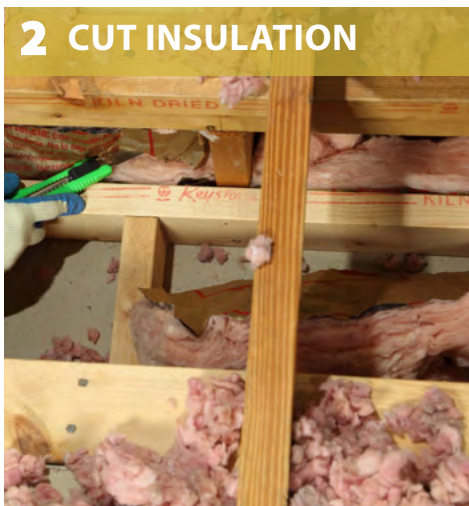
Install blocking in each wall cavity.

Air seal all gaps, holes and seams.

1 PREPARE



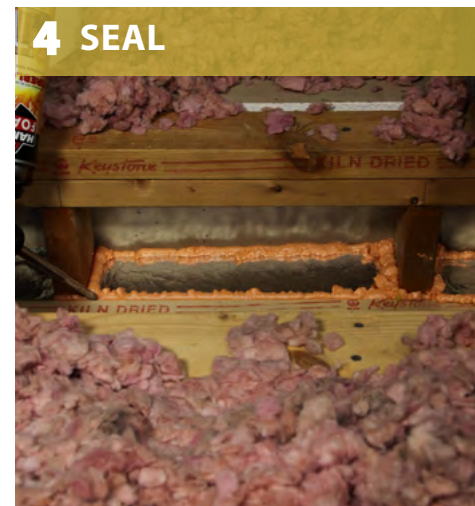
2 CUT INSULATION



3 INSTALL BLOCKING



4 SEAL



Notes:



CRITICAL DETAIL: SWS 3.1002.2

SUCCESS WITH WEATHERIZATION

TREATING STAIRWELL PERIMETERS

DESIRED OUTCOME: Stairwells sealed to prevent air leakage and moisture movement between the attic and conditioned space

Wall cavities within the stairwell open to the attic.

Wall cavities insulated and air sealed.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

If interior surface covering in stairwell is not appropriately fire rated, the rigid material used must be appropriately fire rated.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 3.1002.2

SUCCESS WITH WEATHERIZATION

TREATING STAIRWELL PERIMETERS

Prepare work area.

Install blocking in each wall cavity.

Air seal all gaps, holes and seams.

Reinstall batt insulation in full contact with all sides of cavities without gaps, voids, compressions, misalignments or wind intrusions.

1 INSULATE STAIRS



2 INSTALL DAMS



3 SEAL FRAMING



4 INSULATE



Fasten rigid material to ensure batt insulation stays in place and seal all seams.

Seal all gaps, holes and seams in adjacent framing at top of stairwell.

Notes:

5 INSTALL MATERIAL



6 SEAL





CRITICAL DETAIL: SWS 4.1004.1

SUCCESS WITH WEATHERIZATION

ENCLOSING KNEE WALLS WITH RIGID BACKING

DESIRED OUTCOME: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

MATERIALS

TOOLS

Prepped wall.

Insulation backed with rigid material.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

If interior surface covering of knee wall is not appropriately fire rated, the rigid material used must be appropriately fire rated.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 4.1004.1

SUCCESS WITH WEATHERIZATION

ENCLOSING KNEE WALLS WITH RIGID BACKING

Install batt insulation in full contact with all sides of existing cavities without gaps, voids, compressions, misalignments or wind intrusions.

Fasten rigid material to ensure batt insulation stays in place.

1 INSULATE



2 FASTEN BACKING



Notes:



CRITICAL DETAIL: SWS 4.1004.1

SUCCESS WITH WEATHERIZATION

ENCLOSING KNEE WALLS WITH FLEXIBLE BACKING

Install batt insulation in full contact with all sides of existing cavities without gaps, voids, compressions, misalignments or wind intrusions.

Fasten non-rigid material to ensure batt insulation stays in place.

1 INSULATE



2 FASTEN BACKING



Notes:



CRITICAL DETAIL: SWS 4.1004.3

SUCCESS WITH WEATHERIZATION

ENCLOSING KNEE WALLS WITH STRAPPING

DESIRED OUTCOME: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

MATERIALS

TOOLS

Prepped wall.

Insulation strapped in place.

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CRITICAL DETAIL: SWS 4.1004.3

SUCCESS WITH WEATHERIZATION

ENCLOSING KNEE WALLS WITH STRAPPING

Install batt insulation in full contact with all sides of existing cavities without gaps, voids, compressions, misalignments or wind intrusions.

Fasten strapping material to ensure batt insulation stays in place.

1 INSTALL INSULATION



2 FASTEN STRAPPING



Notes:



CRITICAL DETAIL: SWS 4.1004.4

SUCCESS WITH WEATHERIZATION

INSULATING MANUFACTURED KNEE WALLS

DESIRED OUTCOME: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Manufactured truss knee wall does not have cavities that can be air sealed or insulated.

Knee wall fully air sealed and insulated.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



INSULATING MANUFACTURED KNEE WALLS

Air seal existing holes and penetrations.

Fasten fire-rated foam sheathing, covering 100% of the knee wall, to prescribed R-value.

Air seal all seams, gaps or holes in, or adjacent to, foam sheathing. Provide infill as needed.

1 SEAL PENETRATIONS



2 INSTALL INSULATION



3 SEAL



Notes:

ENCLOSING KNEE WALLS WITH RIGID BACKING AND BLOWING INSULATION

DESIRED OUTCOME: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

Prepped wall.

Insulation backed with rigid backing.

MATERIALS

TOOLS

✗ BEFORE

✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



ENCLOSING KNEE WALLS WITH RIGID BACKING AND BLOWING INSULATION

Fasten rigid material to ensure blown insulation stays in place.

Blown insulation installed to manufacturers' specified density.

1 FASTEN BACKING



2 BLOW INSULATION



Notes:



ENCLOSING KNEE WALLS WITH FLEXIBLE BACKING AND BLOWING INSULATION

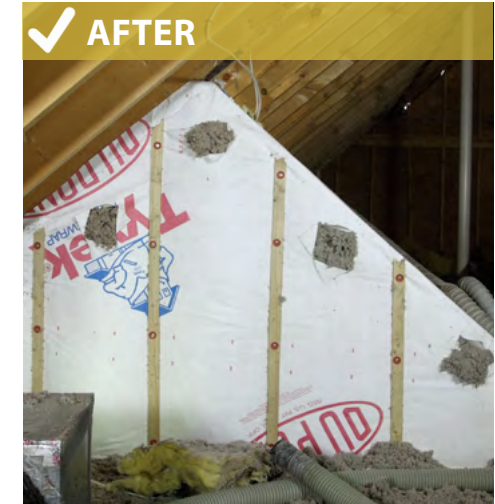
DESIRED OUTCOME: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

MATERIALS

TOOLS

Prepped wall.

Insulation backed with non-rigid material.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



ENCLOSING KNEE WALLS WITH FLEXIBLE BACKING AND BLOWING INSULATION

Fasten non-rigid material to ensure blown insulation stays in place.

Reinforce non-rigid backing at every stud with wood strips.

Blown insulation installed to manufacturers' specified density.

1 FASTEN BACKING



2 REINFORCE BACKING



3 BLOW INSULATION



Notes:



CRITICAL DETAIL: SWS 4.1088.3

ENCLOSING SKYLIGHT SHAFTS

SUCCESS WITH WEATHERIZATION

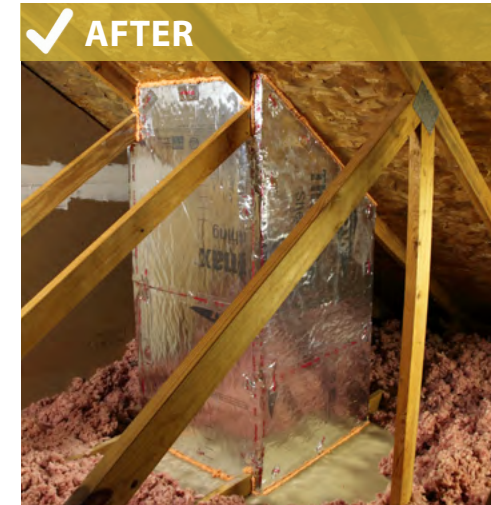
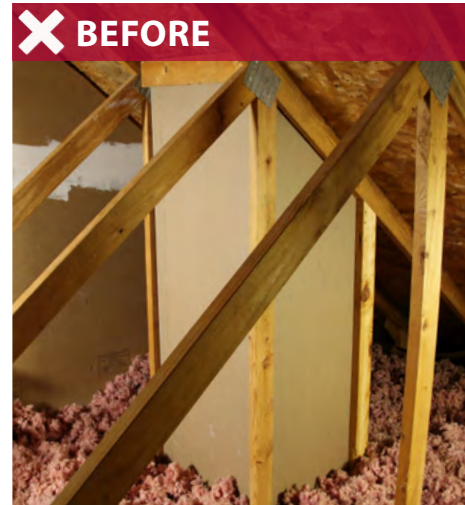
DESIRED OUTCOME: Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

MATERIALS

TOOLS

Skylight shaft not air sealed or insulated.

Skylight fully air sealed and insulated.



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses
Any evidence of roof leak must be fixed prior to air sealing.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 4.1088.3

SUCCESS WITH WEATHERIZATION

ENCLOSING SKYLIGHT SHAFTS

Air seal holes and penetrations.

Fasten insulation around entire skylight with fire rated foam sheathing covering 100% of the surface area to prescribed R-value.

Air seal all seams, gaps or holes as well as roof deck and ceiling connections.

1 SEAL HOLES



2 FASTEN INSULATION



3 SEAL



Notes:



CRITICAL DETAIL: SWS 4.1005.6 INSULATING ATTIC PLATFORMS

SUCCESS WITH WEATHERIZATION

DESIRED OUTCOME: Reduce heat flow beneath floored portions of attic

Attic platform with little to no insulation beneath it.

Attic platform cavity fully insulated.

MATERIALS

TOOLS

✗ BEFORE



✓ AFTER



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

* Materials and tools listed are only recommendations and may not include everything needed to complete job.



CRITICAL DETAIL: SWS 4.1005.6

SUCCESS WITH WEATHERIZATION

INSULATING ATTIC PLATFORMS

Gain access to cavities beneath platform.

Inspect along and beneath platform for possible safety hazards (e.g., flue pipes, uncovered junction boxes, etc.).

NOTICE: Do not insulate cavity until safety hazards are corrected (e.g., flue pipes, uncovered junction boxes, etc.).

NOTICE: If attic has existing blow-in insulation, block ends of platform cavities before installing insulation.

1 GAIN ACCESS



2 INSPECT



3 SAFETY HAZARDS



4 BLOW-IN INSULATION



Insulate cavities.

Replace or restore insulation along sides of platform.

5 INSULATE



6 RESTORE INSULATION



Notes:



CRITICAL DETAIL: SWS 4.1005.5

SUCCESS WITH WEATHERIZATION

INSULATING FLOOR CAVITIES ABOVE GARAGES WITH DENSE PACK INSULATION

Inspect along and beneath floor for possible safety hazards (e.g., flue pipes, electrical issues, can lights, etc.).

Do not insulate cavity until safety hazards are corrected (e.g., flue pipes, electrical issues, can lights, etc.).

Install and seal blocking as needed to contain dense pack insulation.

Fill cavities to recommended density for material.

1 INSPECT



2 SAFETY HAZARDS



3 BLOCKING



4 DENSE PACK



Install and seal blocking as needed to maintain dense pack insulation.

Fill out attic insulation card and post in attic near access.

Notes:

5 BLOCKING



6 INSULATION CARD





CRITICAL DETAIL: SWS 4.1005.2

SUCCESS WITH WEATHERIZATION

INSULATING ATTICS WITH BLOW-IN INSULATION

Open electrical junction boxes will have covers installed

All electrical junctions will be flagged to be seen above the level of the insulation

Insulation dams and enclosures will be installed as required

Install insulation depth markers beginning at the air barrier (1 every 300 square feet)

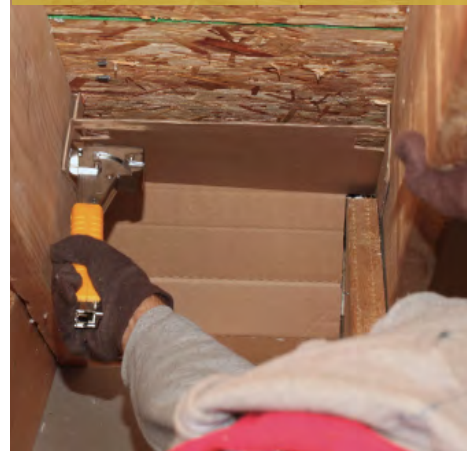
1 SAFETY HAZARDS



2 FLAG JUNCTIONS



3 INSTALL DAMS



4 INSTALL MARKERS



Blow insulation to the depth indicated on the manufacturer coverage chart for desired R-value

Fill out attic insulation card and post in attic near access

NOTICE: Do not use loose fill when pitch exceeds 3/12

Notes:

5 BLOW INSULATION



6 INSULATION CARD



7 NOTICE: CEILING PITCH



INSULATING ATTICS WITH BLOW-IN INSULATION OVER EXISTING BATTS

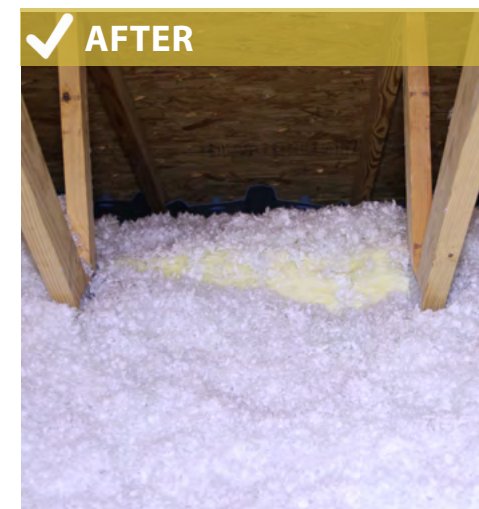
DESIRED OUTCOME: Insulation controls heat transfer through ceiling

Poorly installed batts.

Upgraded insulation.

MATERIALS

TOOLS



SAFETY + NOTES

Gloves, appropriate respirator, safety glasses

Do not use loose fill when pitch exceeds 3/12.

** Materials and tools listed are only recommendations and may not include everything needed to complete job.*



CRITICAL DETAIL: SWS 4.1005.4

SUCCESS WITH WEATHERIZATION

INSULATING ATTICS WITH BLOW-IN INSULATION OVER EXISTING BATTS

Option 1: Realign batts with air barrier.

Option 2: Move batts to a homeowner-approved area (e.g., porch attic, garage attic, etc.).

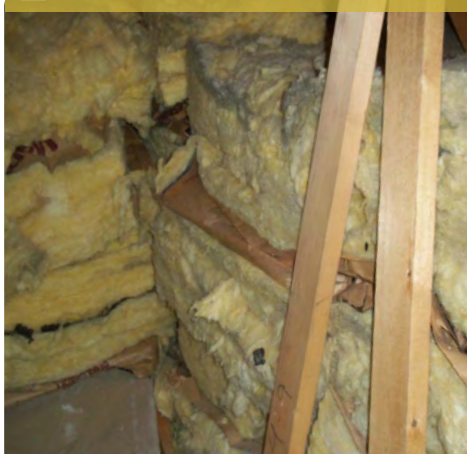
Install covers on opened electrical junction boxes.

Flag all electrical junctions so they are seen above the level of the insulation.

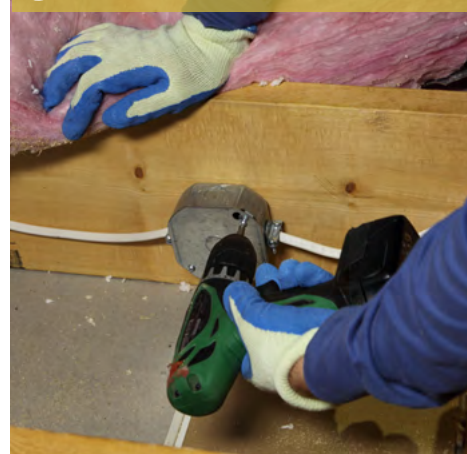
1 OPTION 1: REALIGN



2 OPTION 2: MOVE



3 SAFETY HAZARDS



4 FLAG JUNCTIONS



Install insulation dams and enclosures as required.

Install insulation depth markers beginning at the air barrier (1 every 300 square feet).

Blow insulation to the depth indicated on the manufacturer coverage chart for desired R-value.

Fill out attic insulation card and post in attic near access.

5 INSTALL DAMS



6 INSTALL MARKERS



7 BLOW INSULATION



8 INSULATION CARD





INSULATING ATTICS WITH BLOW-IN INSULATION OVER EXISTING BATTS

NOTICE: Do not use loose fill when ceiling pitch exceeds 3/12.

9 NOTICE: CEILING PITCH



Notes:



APPENDIX

SUCCESS WITH WEATHERIZATION

What every contractor needs to know.



-
- EPA Healthy Indoor Environment Protocols for Home Energy Upgrades

Healthy Indoor Environment Protocols for Home Energy Upgrades



GUIDANCE FOR ACHIEVING SAFE AND HEALTHY
INDOOR ENVIRONMENTS DURING HOME ENERGY
RETROFITS

HEALTHY INDOOR ENVIRONMENT PROTOCOLS FOR HOME ENERGY UPGRADES

Purpose and Scope

Millions of American homes will be retrofitted in the coming years to improve their energy efficiency, make them more “green” or add features their owners want. Integrated healthy home and energy-efficiency retrofit activities can simultaneously lower utility costs and improve indoor air quality. Leading energy-efficiency retrofit programs have demonstrated the feasibility of integrating many indoor air quality and safety improvements. However, home energy retrofit activities might negatively affect indoor air quality if the appropriate home assessment is not made before work begins and issues that may affect indoor air quality are not identified and properly addressed. The U.S. Environmental Protection Agency (EPA) developed **Healthy Indoor Environment Protocols for Home Energy Upgrades** to provide practical guidance on improving or maintaining indoor air quality and indoor environments during home energy upgrades, retrofits or remodeling.

The protocols apply to existing single-family and multi-family low-rise residential buildings. They provide guidance for conducting home assessments and undertaking the responses necessary to maintain or improve indoor air quality and safety. The protocols also can help improve the quality of home weatherization projects and other energy-efficiency retrofit or remodeling jobs, thus reducing failures and call-backs.

The protocols are intended for use by the home energy retrofit industry, including energy-efficiency retrofit and housing rehabilitation professionals and contractors, and others engaged in energy-focused residential retrofit, renovation or remodeling efforts. They are also intended for voluntary adoption by federal, state, tribal and local weatherization assistance programs, federally funded housing programs, industry standards organizations, private sector home performance contracting organizations and public and environmental health professionals.

EPA developed these voluntary protocols in coordination with the U.S. Department of Energy (DOE) Workforce Guidelines for Home Energy Upgrades (http://www.weatherization.energy.gov/retrofit_guidelines) and the White House Council on Environmental Quality (CEQ) Recovery Through Retrofit initiative (http://www.whitehouse.gov/sites/default/files/Recovery_Through_Retrofit_Final_Report.pdf).

Programs and contractors undertaking energy retrofits and renovations are encouraged to coordinate their services with local health and housing resources to provide families the support they may need.

This document is not intended to 1) set new EPA regulatory standards, 2) provide guidance on diagnosing occupant health problems or building-related illness, 3) address emerging issues that have not been linked to adverse health effects, 4) make training or training documents unnecessary, 5) provide detailed guidance on how to achieve the intent of each recommendation in all situations or 6) identify funding availability or which programmatic funding sources should be used.

How the Protocols Are Organized

This document is organized into four sections to highlight priority indoor environmental issues that may relate to home energy-efficiency retrofits.

1. **Priority Issues** are listed in Column 1.
2. The **Assessment Protocols** in Column 2 are EPA-recommended or EPA-required protocols for evaluating existing conditions of concern and the potential for additional concerns that may arise from retrofit activities.
3. The **Minimum Actions** in Column 3 include critical actions that home energy retrofit contractors should take to help ensure their work does not introduce new indoor air quality concerns or make existing conditions worse. These actions often refer to national standards and guidance; however, work should be conducted in compliance with state and local requirements as well. All equipment removals should include proper disposal so that hazardous units are not reinstalled or used elsewhere.
4. The **Expanded Actions** in Column 4 include additional actions to promote healthy indoor environments that can be taken during many home energy retrofit projects. They can be performed by properly trained home energy retrofit workers who have sufficient resources. National standards and guidance are also referenced; however, work should be conducted in compliance with state and local requirements as well. All equipment removals should include proper disposal so that hazardous units are not reinstalled or used elsewhere.

Relevant standards and guidance documents are listed in the Assessment Protocols, Minimum Actions and Expanded Actions columns for each priority issue in an abbreviated format that can be identified with more detailed information in the References section.

The icons used in these protocols are:



Indicates an issue where worker safety is a primary concern. See **Appendix A: Worker Protection** for information on assessing the risks to workers, recommended actions to minimize risks to workers' health and safety and additional resources.





Indicates an issue where occupant education is especially important. If the icon appears in a priority issue section, appropriate occupant education about health and safety is strongly recommended as part of the retrofit activities. See **Appendix B: Client Education** for recommended occupant health messages and additional resources.






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HEALTHY INDOOR ENVIRONMENT PROTOCOLS FOR HOME ENERGY UPGRADES

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
	Measures to help home energy retrofit contractors identify common indoor air quality and safety concerns in homes. This document is not a guide to diagnosing occupant health problems or building-related illnesses.	Critical actions intended to ensure work does not potentially cause or worsen indoor air quality or safety problems for occupants or workers (i.e., “Do No Harm”). EPA recommends these protections for ALL retrofit projects.	Additional actions to promote healthy indoor environments that can be taken during energy-efficiency retrofit projects. EPA recommends considering these improvements when feasible.
CONTAMINANTS			
ASBESTOS			
	<p>Determine potential asbestos hazard. Consider the age of the structure; homes built after 1930 and before the 1970s especially may have asbestos insulation. Asbestos may also be present in other building materials in homes built or renovated prior to the 1990s.</p> <p>Note Possible sources of asbestos are:</p> <ul style="list-style-type: none"> • Attic insulation (especially vermiculite). • Wall insulation (e.g., vermiculite, insulation blocks). • Insulation on steam pipes, boilers and furnace ducts. • Vinyl flooring (including 9-inch by 9-inch or 12-inch by 12-inch floor tiles, vinyl sheet flooring and the mastics and other adhesives used to secure the flooring). • Cement sheet, millboard and paper used as insulation around furnaces and wood- or coal-burning appliances. • Door gaskets in furnaces and wood- or coal-burning appliances (seals may contain asbestos). • Soundproofing or decorative surface materials sprayed on walls or ceilings, including popcorn ceilings. • Patching and joint compounds and textured paints on walls and ceilings. • Roofing, shingles and siding (including cement or adhesives). • Artificial ashes and embers (used in gas-fired fireplaces). • Transite (cement and asbestos) combustion vent or transite flue. • Original plaster or plaster that is old enough to potentially contain asbestos. 	<p>If suspected asbestos-containing material (ACM) is in good condition, do not disturb.</p> <p>If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s). For example, separate work area in question from occupied portions of the building using appropriate containment practices AND do not disturb. For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair, in accordance with federal, state and local requirements. Only a licensed or trained professional may abate, repair or remove ACM. </p> <p>Note Typically, trained professionals can repair asbestos by:</p> <ul style="list-style-type: none"> • <i>Sealing or Encapsulating:</i> Treating the material with a sealant that either binds the asbestos fibers together or coats the material so fibers are not released. Pipe, furnace and boiler insulation can often be repaired this way. • <i>Covering or Enclosing:</i> Placing a protective layer over OR around the ACM to prevent release of fibers. Exposed insulated piping may be covered with a protective wrap or jacket. • <i>Removing:</i> Removing ACM may be advantageous when remodeling OR making major changes to a home that will disturb ACM, or if ACM is damaged extensively and cannot be otherwise repaired (by covering, enclosing, sealing or encapsulating). 	<p>This cell is intentionally blank.</p>

(Continued on next page)


PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
ASBESTOS (continued)	<p>If unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material. Sample and test as needed. </p> <p>Note <i>The EPA vermiculate guidance referenced below includes photos to aid the identification of vermiculite insulation.</i></p> <p>Relevant Guidance/Standards The National Institute of Standards and Technology (NIST) maintains a list of asbestos laboratories accredited under the National Voluntary Laboratory Accreditation Program (NVLAP):</p> <ul style="list-style-type: none"> • Call NIST at (301) 975-4016 or email NVLAP@nist.gov. • NIST/NVLAP: Accredited Laboratories for the Polarized Light Microscopy (PLM) Test Method. • NIST/NVLAP: Accredited Laboratories for the Transmission Electron Microscopy (TEM) Test Method. <p>DOL, OSHA, 29 CFR Part 1926, subpart Z.</p> <p>EPA Asbestos: Asbestos in Your Home.</p> <p>EPA Asbestos: Regional and State Asbestos Contacts.</p> <p>EPA Vermiculite.</p> <p>If working in a pre-1980 building, see: Appendix A: Worker Protection – Asbestos and Confined Spaces. </p>	<p>When working around ACM, do not:</p> <ul style="list-style-type: none"> • Dust, sweep or vacuum ACM debris. • Saw, sand, scrape or drill holes in the material. • Use abrasive pads or brushes to strip materials. <p>Do not remove OR disturb attic insulation that looks like vermiculite unless the material has been tested and found not to contain asbestos.</p> <p>Any asbestos abatement or repair work should be completed prior to blower door testing. Exercise appropriate caution when conducting blower door testing where friable asbestos or vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing) unless the material has been tested and found not to contain asbestos.</p> <p>Notes <i>Appropriate identification of ACM is necessary to ensure the continued safety of the occupants and the safety of workers, who may not be aware of asbestos hazards. </i></p> <p><i>If ACM may be disturbed during a planned retrofit, a competent person needs to conduct an initial exposure assessment to determine potential worker exposures and required exposure controls. </i></p> <p><i>Asbestos awareness training is recommended for retrofit workers, especially auditors and crew chiefs. </i></p> <p>Relevant Guidance/Standards BPI Technical Standards: Technical Standards for the Heating Professional.</p> <p>DOL, OSHA, Asbestos.</p> <p>DOL, OSHA, Asbestos – Construction.</p> <p>EPA Asbestos: Asbestos in Your Home.</p> <p>EPA Vermiculite.</p>	



PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
BELOWGROUND CONTAMINANTS (except radon)			
	<p>Visually evaluate potential sources AND check for odors of gasoline, sewer gas or fuel oil.</p> <p>Visually evaluate the integrity of sewer vent system (e.g., ensure drain traps have water in them, inspect drain lines for breaks or leaks), particularly if there is the odor of sewer gas in the home (e.g., during the initial assessment or a fan depressurization test).</p> <p>If you detect an odor but cannot identify its source and the house is in a known contaminated area, notify local or state authorities AND/OR pursue additional assessment before making additional energy upgrades.</p> <p>If soil or groundwater contamination is suspected on or near the building site (e.g., former industrial site), volatile contaminants or breakdown products may pose an indoor air quality risk through soil gas intrusion. In such cases, EPA recommends further assessment before air sealing. Consult your state OR tribal voluntary brownfield cleanup program OR environmental regulatory agency for information on the risks of vapor intrusion in your area.</p> <p>Relevant Guidance/Standards ASTM E2600.</p> <p>EPA OSWER Draft Guidance for Evaluating Vapor Intrusion.</p>	<p>Repair or replace failed or unattached sewer vent system components before proceeding with energy retrofits.</p> <p>If the assessments reveal sewer gas odors from drain traps that are dry due to infrequent use, fill the traps with a non-toxic liquid that has a slow evaporation rate (e.g., mineral oil).</p> <p>If soil gas vapor intrusion is suspected, assess AND mitigate in compliance with state or local standards. If there are no such standards, follow EPA guidance, below, for vapor intrusion evaluation and mitigation.</p> <p>Note <i>The causes or sources of contaminants must be identified and corrected before air sealing or other weatherization retrofit actions are performed to ensure the problem is not exacerbated.</i></p> <p>Relevant Guidance/Standards ASPE Data Book.</p> <p>Conduct work in compliance with state and local standards. Otherwise follow: ASTM E2600. EPA OSWER Draft Guidance for Evaluating Vapor Intrusion. EPA Vapor Intrusion Mitigation Approaches.</p>	<p>If there is an untrapped floor drain, consider installing a low-cost floor drain seal like those often used during radon mitigations, as described in ASTM E2121.</p> <p>Relevant Guidance/Standards ASTM E2121.</p>

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
BUILDING PRODUCTS/ MATERIALS EMISSIONS			
	<p>Review information on the contents of products being considered for purchase and installation during an energy upgrade project to determine whether they contain potentially hazardous compounds. Many of these products and materials (e.g., paints, particle board, pressed wood, insulation, sealants, plywood and cleaning supplies) may contain volatile organic compounds (VOCs), including formaldehyde, or other hazardous compounds to which exposure should be minimized or eliminated during and after an energy upgrade.</p> <p>Assess ventilation to determine compliance with the Minimum Actions and Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p> <p>Note: <i>Dilution using whole-house ventilation will help reduce VOCs and other airborne contaminants from indoor sources in most homes.</i></p> <p>In most circumstances, testing for VOCs is not necessary. If odors or occupant complaints indicate potential VOCs or other airborne contaminants, follow the source control and ventilation actions under Minimum Actions and Expanded Actions.</p> <p>If working with materials associated with chemical emissions or dust generation, including spray polyurethane foam insulation, see Jobsite Safety (page 24) and Appendix A: Worker Protection. </p> <p>Relevant Guidance/Standards American Chemistry Council: Spray Polyurethane Foam Health and Safety. DOL, OSHA, Green Jobs Hazards. EPA SPF: Spray Polyurethane Foam, Building Occupants and Other Workers Should Vacate During SPF Installation. Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p>	<p>Minimize occupant and worker exposure to VOCs or other airborne contaminants by:</p> <ul style="list-style-type: none">• Ensuring that work areas are properly isolated (e.g., by sealing with plastic sheeting) and ventilated to the outdoors during activities that result in VOC emissions (e.g., installing spray foam insulation, painting, sealing, finishing) AND that they are ventilated as close as possible to the source of those emissions.• Using appropriate dust-control and protective equipment.• Thoroughly cleaning work areas and allowing any odors to dissipate before re-occupancy.• Following manufacturers’ recommendations, which may indicate the need to evacuate building occupants and other unprotected individuals from work areas during and for some period after the use of a product. <p>Source Control When installing new products and materials, consider using the least toxic product or material feasible to effectively do the job. For example, use products and materials that indicate they have (or are certified as having) low VOC content or low VOC emissions. </p> <p>Note: <i>California Title 17 requires reduced formaldehyde emissions from composite wood products and finished goods that contain composite wood products sold, offered for sale, supplied, used or manufactured for sale in California.</i></p> <p>Ventilation Ensure the home meets the Minimum Actions in the Whole-House Ventilation for Distributed Contaminant Sources section (page 22).</p> <p>Ventilate the building with as much outside air as possible before permanently occupying. Do not conduct a “bake-out” in an attempt to reduce VOC emissions after the building is occupied, because it may cause VOCs to be absorbed by other interior materials and may damage building components. </p>	<p>New Products Source Control When available, specify products and materials that meet independent certification and testing protocols, such as:</p> <ul style="list-style-type: none">• California Department of Public Health, Emission Testing Method for California Specification 01350.• Carpet and Rug Institute (CRI) Green Label or Green Label Plus program criteria or equivalent standards for carpet.• Collaborative for High Performance Schools (CHPS) High Performance Products Database.• Green Seal Standard GS-11.• Greenguard Children and Schools Certification Program.• Master Painters Institute (MPI) Green Performance Standards GPS-1 or GPS-2.• Scientific Certification Systems (SCS) Standard EC-10.2-2007, Indoor Advantage Gold. <p>When installing structural plywood or pressed or composite wood products, select those that are certified compliant with California Title 17. If California Title 17 compliant materials are not available, use products that meet section 6.1 of EPA’s Indoor airPLUS Construction Specifications.</p> <p>Existing Condition Source Control/ Supplemental Ventilation If odors, complaints or testing indicate potential VOCs or other airborne contaminants, remove any potential sources (e.g., hobby materials, fiberglass that may contain formaldehyde) from the room or area. If removal is not feasible, consider installing local exhaust ventilation for sources that are isolated in a specific room or area.</p>



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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
BUILDING PRODUCTS/ MATERIALS EMISSIONS <i>(continued)</i>		<p>Relevant Guidance/Standards American Chemistry Council: Spray Polyurethane Foam Health and Safety. California Title 17. EPA SPF: Spray Polyurethane Foam. Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p>	<p>Seal composite wood products (e.g., particle board and pressed wood) that are not compliant with California Title 17 or that do not meet section 6.1 of EPA's Indoor airPLUS Construction Specifications with a sealant intended to reduce VOC emissions. Seal all exposed surfaces and holes, as appropriate. Check with vendors for recommendations on sealing their engineered wood products. If these actions do not solve the problem (e.g., persistent odors, occupant complaints), hiring an environmental professional and testing may be necessary.</p> <p>Testing If VOCs appear to be present based on odors or complaints and source control or ventilation do not alleviate the problem, testing by a qualified professional may be useful.</p> <p>Relevant Guidance/Standards California Department of Public Health, Emission Testing Method for California Specification 01350. California Title 17. CARB: Formaldehyde. CHPS. CRI. EPA Design for the Environment. EPA Indoor airPLUS Specification Section 6. Green Seal Standard GS-11. Greenguard Children and Schools Certification Program. MPI GPS-1 and GPS-2. SCS Standard EC-10.2-2007. Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p>

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
CARBON MONOXIDE (CO) AND OTHER COMBUSTION APPLIANCE EMISSIONS (NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS [VOCs] AND PARTICULATES)			
	<p>Locate and identify any fuel-burning combustion appliances in the home (e.g., gas, oil, kerosene, wood- or coal-burning appliances). See Combustion Safety (page 18) and Wood Smoke and Other Solid Fuel Emissions (page 16) for assessment protocols to complete safety inspections of all combustion appliances in a dwelling.</p> <p>Determine if there is an attached garage. See Garage Air Pollutants (page 8) for ways to locate air leaks from a garage to occupied spaces.</p> <p>Determine whether there are working carbon monoxide (CO) alarms and smoke alarms. </p> <p>Ask occupants whether they have supplemental portable combustion equipment (e.g., generators, unvented gas or kerosene space heaters). </p> <p>Test interior living space for CO. Avoid testing near combustion equipment that has already undergone CO testing.</p> <p>Test for CO outside of the home (e.g., near front entrance) to document general outdoor levels. Avoid testing near obvious sources of CO (e.g., motor vehicles, lawn equipment).</p> <p>Relevant Guidance/Standards BPI-1100-T-2010, Combustion Appliance Testing section.</p> <p>Combustion Safety (page 18).</p> <p>Garage Air Pollutants (page 8).</p> <p>Wood Smoke and Other Solid Fuel Emissions (page 16).</p>	<p>If CO levels in interior living spaces exceed outdoor levels, investigate potential sources and take appropriate action to reduce them (e.g., have a qualified professional tune, repair or replace improperly operating combustion appliances; apply weatherstripping or conduct air sealing between the garage and the home).</p> <p>Specify and install CO alarms in all homes. See Home Safety (page 23) for details. </p> <p>See Garage Air Pollutants (page 8) for recommendations on how to minimize the movement of air and contaminants (including CO and other combustion appliance emissions) from the garage to the house.</p> <p>See Combustion Safety (page 18) and Heating, Ventilating and Air Conditioning (HVAC) Equipment (page 17), as appropriate, for recommendations on repairing, removing or replacing combustion appliances.</p> <p>Relevant Guidance/Standards Combustion Safety (page 18).</p> <p>Garage Air Pollutants (page 8).</p> <p>Heating, Ventilating and Air Conditioning (HVAC) Equipment (page 17).</p> <p>Home Safety (page 23).</p>	<p>See Home Safety (page 23) for recommended installation of CO alarms that can detect and store peak CO levels of less than 30 ppm. </p> <p>See the Expanded Actions for Garage Air Pollutants (page 8) for additional recommendations on minimizing airflow from the garage to the house.</p> <p>See the Expanded Actions for Combustion Safety (page 18) for additional recommendations on repairing, removing or replacing combustion appliances.</p> <p>Relevant Guidance/Standards Combustion Safety (page 18).</p> <p>Garage Air Pollutants (page 8).</p> <p>Home Safety (page 23).</p>





PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
ENVIRONMENTAL TOBACCO SMOKE (ETS)			
	<p>Single Family Dwelling: Look for signs of smoking indoors (e.g., ashtrays, cigarette packs, odors).</p> <p>Multi-Family Dwelling: Determine whether there is a smoke-free housing policy. Determine whether tenants have complained about smoking odors or smoking related concerns.</p>	<p>Single-Family Dwelling: See Appendix B: Client Education. </p> <p>Multi-Family Dwelling: If there have been complaints, ask the owner if a smoke-free housing policy is being considered. If a policy has not been adopted, address the complaints through the following actions:</p> <ul style="list-style-type: none"> • Reduce unintended excess airflow from common exhaust ventilation systems due to duct and shaft leakage, excess fan flow and unbalanced unit flows. • Seal enough to enable ventilation systems to increase capture in smokers' units, match flows to remove fan-induced pressure difference between units, and increase outdoor air supply ventilation rates in non-smokers' units. • Reduce ETS transfer from smokers' units by: <ul style="list-style-type: none"> • Air sealing the walls, ceilings and floors that separate the unit from neighboring units, corridors, chases and stairwells. Seal smoker's unit as tightly as possible. • Adjusting outdoor air and exhaust flows so the unit is negative relative to bounding wall and ceiling cavities and the overall ventilation rate for the unit has increased. Smoke current tubes or other air flow tests should show that air flows into the dwelling unit through openings in bounding walls (e.g., electrical outlets). <p>Note <i>The above air sealing strategies are intended to help reduce the exposure of occupants in the non-smoking units adjacent to the smokers' units. These actions may not reduce the risks of ETS to occupants living in the smokers' units.</i></p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010. MNCEE: Reduction of Environmental Tobacco Smoke Transfer in Minnesota Multifamily Buildings Using Air Sealing and Ventilation Treatments.</p>	<p>This cell is intentionally blank.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
ENVIRONMENTAL TOBACCO SMOKE (ETS) <i>(continued)</i>			
		<p>NCHH Fact Sheet: Improving Ventilation in Existing or New Buildings with Central Roof Exhaust.</p> <p>NCHH Fact Sheet: Improving Ventilation in Multi-Family Buildings That Do Not Have Fan-Powered Ventilation Systems.</p> <p>NCHH Fact Sheet: Improving Ventilation in New and Existing Multi-Family Buildings with Individual Unit Ventilation Systems.</p>	
GARAGE AIR POLLUTANTS (CO, BENZENE AND VOCs)			
	<p>If there is an attached garage (i.e., sharing at least one wall, ceiling, ductwork, etc.), identify the location of any air leaks from the garage to the occupied spaces that may provide pathways for hazardous emissions to enter the occupied spaces. Look for leaks around walls, doors, ceilings, ductwork, air conditioners, furnaces, chimneys and electrical and pipe penetrations.</p> <p>Determine (visual inspection and/or occupant inquiry) if there are unvented combustion appliances or hobby equipment that may be used in the garage.</p> <p>Note <i>If combustion appliances are present, see Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6), Vented Combustion Appliances (page 18) and Unvented Combustion Appliances (page 20) for recommended actions.</i></p> <p>Relevant Guidance/Standards Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6). Energy Conservatory: Blower Door. Unvented Combustion Appliances (page 20). Vented Combustion Appliances (page 18).</p>	<p>To minimize the movement of air and contaminants from the attached garage to the house, air seal walls and ceilings separating the garage from the living spaces. </p> <p>At a minimum, air seal these locations (if present):</p> <ul style="list-style-type: none"> • Doors (ensure tight closure AND install weather-stripping). • Electrical, plumbing and duct penetrations. • Cracks between mud sill, rim joists, subfloors and/or bottom of gypsum board. • Leaks in the ductwork and air handlers and gaps around the ductwork penetrating from the garage to the occupied space. <p>To keep garage air from being drawn into the home, eliminate or disconnect supply diffusers and return grilles in the garage that connect to air handlers serving the occupied space.</p> <p>If heat is needed in the garage, use a properly installed supplemental heating system.</p> <p>Relevant Guidance/Standards ACCA 5 QI-2010. ASHRAE 62.2-2010.</p>	<p>Steps that can reduce air pressure in the garage and minimize flow from the garage to the house include the following:</p> <ul style="list-style-type: none"> • If occupants spend significant time in the garage (e.g., the garage is used as a workshop or playroom), at a minimum, install local exhaust fan(s) rated for continuous operation and vented outdoors in attached garages in accordance with section 5.6 of EPA's Indoor airPLUS Construction Specifications or 2009 International Mechanical Code, table 403.3. • Relocate the air handling equipment and associated ductwork from the garage to an area within a conditioned space. • If accessible, add blocking in the floor system to assist with air sealing between the garage and living space in homes that have a room above the garage. • Use advanced blower door techniques (see guidance listed below) to identify air leakage pathways between the house and garage and to verify the effectiveness of air sealing. <p>Relevant Guidance/Standards EPA Indoor airPLUS Specification 5.6. Home Energy, Advanced Blower Door Techniques. International Mechanical Code, 2009.</p>

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
LEAD			
	<p>Assume there is lead-based paint in homes built before 1978 unless testing shows otherwise. Determine whether paint will be disturbed by the work or the assessment.</p> <p>Consider using an EPA-recognized testing method (e.g., X-ray fluorescence [XRF] testing, or an on-site test kit) on suspect surfaces that will be disturbed in order to determine whether the paint is lead-based. The lead-safe work practices minimum and expanded actions apply only to paint assumed to be or tested to confirm that it is lead-based.</p> <p>Relevant Guidance/Standards HUD Title 24.</p> <p>EPA Renovation, Repair and Painting (RRP) Program Rule: 24 CFR Part 25, subpart J.</p> <p>EPA Lead.</p> <p>EPA Lead-Based Paint Renovation, Repair, and Painting Program: Small Entity Compliance Guide to Renovate Right.</p> <p>If working in a pre-1978 building, see Appendix A: Worker Protection – Lead. </p>	<p>Comply with EPA's Lead-Based Paint Renovation, Repair, and Painting (RRP) Program Rule. Among the rule's key elements are:</p> <ul style="list-style-type: none"> • Use a Certified Renovator. • Follow lead-safe work practices if disturbing more than 6 ft² of interior or 20 ft² of exterior painted surfaces. • Contain the work area to avoid resident exposure. • Minimize lead dust and leave no dust or debris behind. • Achieve visual post-cleaning criteria. <p>Comply with state and local lead-related regulations, which may be applicable to lead hazard reduction activities and may require additional certified personnel.</p> <p>Note <i>This is not a complete summary of the regulatory requirements. The intent of this protocol is to promote the most health-protective steps that are feasible and practical. The minimum action recommended in this protocol is to comply with whatever the most current version of the RRP Program Rule prescribes.</i></p> <p>Relevant Guidance/Standards DOL, OSHA, Lead.</p> <p>EPA Renovation, Repair and Painting (RRP) Program Rule: 24 CFR Part 25, subpart J.</p> <p>EPA Renovation, Repair and Painting (RRP) Program Rule: 40 CFR Part 745.</p> <p>EPA Lead Accredited Training Programs.</p>	<p>Follow the U.S. Department of Housing and Urban Development (HUD) lead-safe rehabilitation practices. In addition to EPA's RRP, these HUD practices:</p> <ul style="list-style-type: none"> • Lower the thresholds for interior painted surface area from 6 ft² to 2 ft². • Require repair of painted surfaces that are disturbed when using lead-safe work practices. • Require meeting lead dust clearance testing standards if more than 2 ft² of paint is disturbed. <p>Note <i>Lead dust clearance testing includes measuring for lead dust on floors, windowsills and window troughs. See NCHH Fact Sheet: Testing for Lead-Contaminated Dust.</i></p> <p>Relevant Guidance/Standards EPA Renovation, Repair and Painting (RRP) Program Rule: 24 CFR Part 25, subpart J.</p> <p>HUD Lead Safe Work Practices.</p> <p>NCHH Fact Sheet: Testing for Lead-Contaminated Dust.</p>
MOISTURE (MOLD AND OTHER BIOLOGICALS)			
	<p>Inspect the interior and exterior of the building for evidence of moisture problems. Document the extent and location of the problems, and the proposed repairs, to avoid exacerbating the problems when the repairs are made. Examples of moisture and mold problems are:</p> <ul style="list-style-type: none"> • Water damage or stains. • Foundation cracks that leak water. • Visible mold growth. 	<p>Repair roof leaks before air sealing or insulating the attic.</p> <p>Address surface water pooling near the foundation before insulating basement or crawlspace walls near wet areas.</p>	<p>Repair additional moisture problems identified during the assessment (e.g., plumbing leaks, rain leaks including leaks around windows and flashing, and foundation leaks).</p> <p>Retrofit crawlspaces so that they are unvented, sealed, insulated, properly drained and waterproofed, following guidance in section 1.4 of EPA's Indoor airPLUS Construction Specifications.</p>




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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
MOISTURE (MOLD AND OTHER BIOLOGICALS) <i>(continued)</i>			
	<ul style="list-style-type: none"> • Wet or damp spots. • Musty odor. • Moisture damage on windows. • Groundwater, surface water and rainwater intrusion. • Plumbing leaks. • Condensation. • Consider temperature, relative humidity and absolute humidity (e.g., dew point temperature and humidity ratio [i.e., pounds or grains of water vapor per pound of dry air]). <p>Determine whether the project requires mold remediation and additional moisture control measures (e.g., as determined during a Weatherization Assistance Program audit).</p> <p>Document which moisture problems will be addressed as part of the energy-conserving project, and which must be repaired by the homeowner or another contractor before certain, specific energy conserving measures can be implemented.</p> <p>If moisture issues cannot be addressed, do not install energy upgrades that will reduce the home's air infiltration rate. Homes where this may be the case include those that have significant condensation or humidity problems, such as condensation on multiple windows, condensation in attics or significant moisture or mold problems that are beyond the scope of the remedies under Minimum Actions.</p> <p>See Appendix A: Worker Protection – Mold and Confined Spaces as appropriate. </p>	<p>Manage rainwater in assemblies receiving retrofits (e.g., drainage planes and flashings), following guidance in EPA's Indoor airPLUS Construction Specifications 1.5 and 1.6.</p> <p>Ensure proper HVAC condensate drainage.</p> <p>Prevent condensation in the enclosure by:</p> <ul style="list-style-type: none"> • Air sealing the enclosure. <i>Note: This also prevents ice dams in cold, snowy climates.</i> • Managing water vapor flow and condensing surface temperatures to avoid dew point conditions (achieved by selection of materials with appropriate combination of R-value and vapor permeability). • Managing air pressure relationships as needed. • Controlling indoor humidity sources, for example: <ul style="list-style-type: none"> • Ensuring bath fans are operating properly and vented to the outdoors. • Ensuring clothes dryers are correctly vented to the outdoors. • Covering earthen floors in basements and crawlspaces with sealed vapor barriers; seal sump crocks. • If adding an air conditioning (AC) unit, ensure it is sized properly. If the relative humidity or moisture in the air is high, evaluate whether the AC unit is oversized. • Install dehumidifiers, if appropriate. • Remove unvented combustion space heaters. • Ensure proper crawlspace ventilation. • Ensure proper attic ventilation, unless sealed or conditioned. <p>Conduct any required mold remediation following EPA or other professional guidance (see see Appendix A, Mold section, page 34). </p> <p>See Mold and Moisture section in Appendix B: Client Education. </p>	<p>Perform additional activities, beyond those required for the weatherization project, in order to remediate any mold growth. Follow EPA or other professional guidance (see Appendix A, Mold section, page 34). </p> <p>Relevant Guidance/Standards EPA Indoor airPLUS Specification: 1.4. EPA Mold Remediation.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
MOISTURE (MOLD AND OTHER BIOLOGICALS) <i>(continued)</i>			
	Relevant Guidance/Standards DOE: Workforce Guidelines for Home Energy Upgrades (under development).	Notes <i>Replacing an atmospherically vented or fan-powered combustion device that draws combustion air from inside the home with a high-efficiency sealed combustion device can reduce the ventilation rate, which could result in cold-weather condensation in some building enclosures.</i> <i>If an atmospherically vented combustion device is causing an indoor humidity problem, it should be repaired in accordance with the Combustion Safety section (page 18).</i> Relevant Guidance/Standards Combustion Safety (page 18). DOE: Workforce Guidelines for Home Energy Upgrades (under development). EPA Indoor airPLUS Specifications 1.5 and 1.6.	
OZONE			
	Determine if there is any air-cleaning equipment designed to intentionally produce ozone (i.e., ozone generators) in the house. Relevant Guidance/Standards CARB: Ozone.	Do not install air-cleaning equipment designed to intentionally produce ozone (i.e., ozone generators). Recommend removal of air-cleaning equipment designed to intentionally produce ozone, if present. Relevant Guidance/Standards EPA Indoor airPLUS Specification 4.7. EPA IAQ: Ozone Generators that are Sold as Air Cleaners.	This cell is intentionally blank.
PESTS			
	Identify evidence of mice, squirrels or other rodents; termites; birds; bats; cockroaches or other pests. Note the location and identify pest-contaminated materials (e.g., nests, feces). Determine whether rodenticides or pesticides are being used. Remove pest-infested materials OR determine if professional assistance is needed to do so before conducting energy retrofit work in pest-infested areas.	Alert owner of any termite infestations and inform owner of the need to seek assistance from an integrated pest management (IPM) professional (e.g., Greenpro, Greenshield or equivalently trained IPM professional). In areas with evidence of rodent infestations, patch with pest-resistant materials (e.g., copper mesh, hardware cloth, sheet metal, concrete) exterior holes that are larger than ¼ inch by ¾ inch before applying air sealing materials (e.g., caulk or foam) OR before insulating.	Protect air intakes from potential bird and pest entry (e.g., cover openings with ½-inch screen or galvanized mesh). Protect exhaust vents from rodent, bird and pest entry (e.g., cover openings with louvers). Avoid creating conditions that can clog exhaust, particularly dryer vents.

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
PESTS (continued)			
	<p>Note Termite and some other types of pest infestations are often an indication of moisture problems. See Moisture (page 9) for diagnosing moisture problems.</p> <p>Relevant Guidance/Standards AFHH. CDC Resource on Rodents.</p>	<p>Advise owner/resident to regularly clean/fix screens or dampers over exterior air intakes and exhausts (e.g., at least semi-annually or when replacing HVAC filters). Remove clutter, eliminate wood piles near house, and remove bushes, trees or other vegetation closer than two feet from the structure. </p> <p>Relevant Guidance/Standards EPA IPM. NCHH IPM. New York City Department of Health and Mental Hygiene.</p>	<p>Follow IPM guidelines for roach control AND, if feasible, apply boric acid or gels in holes for roach issues. Follow relevant state pesticide applicator standards.</p> <p>Note Some states require that pest management professionals be licensed.</p> <p>Provide sealable outside garbage cans OR advise clients to use them.</p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010. EPA IPM. New York City Department of Health and Mental Hygiene.</p>
POLYCHLORINATED BIPHENYLS (PCBs)			
	<p>Determine whether fluorescent light ballasts containing polychlorinated biphenyls (PCBs) are present.</p> <p>Note Some homes may contain fluorescent light fixtures with ballasts manufactured before 1979 that contain polychlorinated biphenyls (PCBs). Ballasts manufactured between 1979 and 1998 that do not contain PCBs were required to be labeled “No PCBs.” Newer fluorescent lighting typically uses electronic ballasts that do not contain PCBs and should be clearly marked as electronic.</p> <p>Relevant Guidance/Standards EPA PCB-Containing Light Ballasts.</p>	<p>If fluorescent light ballasts do not have the statement “No PCBs” or are not marked as electronic, assume that the ballasts contain PCBs and replace with new lighting fixtures OR contact the manufacturer to determine whether the ballasts contain PCBs. If the manufacturer is not sure whether the ballasts contain PCBs, assume that they do and replace with new lighting fixtures.</p> <p>Relevant Guidance/Standards EPA PCB. EPA PCB-Containing Light Ballasts.</p>	<p>The presence of PCBs may not be limited to fluorescent light ballasts. PCBs were also used in other products, including caulk. See EPA’s website on PCBs for a complete list of products of concern, and where possible, remove and replace them.</p> <p>Relevant Guidance/Standards EPA PCB. EPA PCBs in Caulk.</p>
RADON			
	<p>Follow one of two testing options to determine the radon level as summarized below and in Table 1.</p> <p>Option 1: Test-In/Test-Out – Test for radon before and after energy upgrade work. Option 2: Post-Work Test – Test for radon only after completing energy upgrade work.</p>	<p>Before completing retrofit activities, take precautionary measures listed below in Column 1 of Table 1, depending on pre-work test results. After work, follow the appropriate Minimum and/or Expanded Actions outlined in Table 1, depending on post-work test results.</p>	<p>Additional actions to reduce radon exposure are summarized below and outlined in Table 1.</p> <ul style="list-style-type: none"> • Mitigate according to ASTM E2121 when the post-work radon level is ≥ 4 pCi/L. • If the post-work radon level is between 2 and 4 pCi/L, refer the client to EPA’s Citizen’s Guide to Radon or mitigate in accordance with ASTM E2121.

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
RADON <i>(continued)</i>	<p>Perform radon testing in accordance with applicable state requirements or federal guidance. Individuals conducting tests should be trained or certified by either of these groups:</p> <ul style="list-style-type: none"> National Environmental Health Association (NEHA) National Radon Proficiency Program. National Radon Safety Board (NRSB). <p>Notes</p> <p><i>Two radon tests may be performed simultaneously and averaged to increase confidence in the short-term test result. This approach can be used for both pre- and post-work testing. Another option is to take two tests sequentially. DO NOT average the pre-work and post-work test results.</i></p> <p><i>Long-term testing is the most accurate way to test for radon, but it may not be feasible. See EPA's Citizen's Guide to Radon for information on long-term testing.</i></p> <p><i>The recommended testing protocols are designed to ensure that radon exposure does not increase above EPA thresholds in homes where radon levels are initially below those thresholds. This protocol is not designed to mitigate radon risks that existed prior to the energy upgrade. All clients should be provided with radon testing results.</i></p> <p>Determine whether the home has an active or passive radon mitigation system.</p> <p>Note</p> <p><i>Active mitigation systems include a radon vent fan, usually located in an attic, in an attached garage or on the building exterior.</i></p> <p>Relevant Guidance/Standards</p> <p>ASHI Radon Mitigation System Inspection Checklist.</p> <p>EPA Radon Guidance: Guidance for Radon Testing and Mitigation.</p> <p>EPA Radon: State Radon Contact Information.</p>	<p>When the pre-work radon level is ≥ 2 pCi/L, complete precautionary foundation air sealing strategies:</p> <ul style="list-style-type: none"> Cover exposed earthen floors in basements and crawlspaces according to section 1.2 of EPA's Indoor airPLUS Construction Specifications. Air seal sumps (e.g., install an airtight sump cover) in such a way that water can drain from above and below the sump cover. Install airtight drain fittings (e.g., trap or flange system) in foundation floor drains. Seal and caulk penetrations, openings or cracks in below-grade walls and floors that contact the ground with a sealant that meets the requirements of ASTM C920. <p>Note</p> <p><i>These foundation air sealing strategies are also important elements of radon mitigation according to ASTM E2121, which addresses both foundation air sealing and fan-powered radon mitigation systems.</i></p> <p>Educate the client about the test results and radon reduction measures that were followed. Inform the client that the radon testing protocols were completed to ensure that the energy upgrade work did not introduce indoor radon problems, but the protocols do not necessarily mitigate a prior indoor radon problem in the home. Advise the client to refer to EPA's Citizen's Guide to Radon for more information about radon risk. 🏠</p> <p>Mitigate in accordance with ASTM E2121 if:</p> <ul style="list-style-type: none"> Option 1: Post-work radon level is ≥ 4pCi/L AND it exceeds the pre-work radon level OR Option 2: Post-work radon level is ≥ 4pCi/L AND no pre-work levels were taken. 	<p>Relevant Guidance/Standards</p> <p>ASTM C920.</p> <p>ASTM E2121.</p> <p>EPA Radon. State Radon Contact Information.</p> <p>EPA Radon Guidance: Citizen's Guide to Radon.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
RADON <i>(continued)</i>		<p>For homes equipped with an active radon mitigation system:</p> <ul style="list-style-type: none"> • Verify that the radon vent fan is operating. • If a previously installed radon mitigation system is not operating correctly OR if the post-work tested radon level is ≥ 4 pCi/L, advise the client to consult the state radon office. <p>Relevant Guidance/Standards ASTM C920. ASTM E2121. EPA Indoor airPLUS Specification 1.2. EPA Radon Guidance: Citizen's Guide to Radon.</p>	

Table 1: Radon Testing Options and Reduction Strategies



Pre-Work Test Result and Precautionary Measures	Post-Work Test Result	Minimum Actions	Expanded Actions
<2 pCi/L <i>Consider precautionary radon-reduction actions as part of energy upgrade work, especially covering exposed earth, air sealing open sumps, ensuring floor drains have traps and that traps are not dry.</i>	<2 pCi/L	No action.	
	>2 and <4 pCi/L	Complete foundation air sealing strategies.	For post-work radon levels between 2 and 4 pCi/L, refer client to EPA's Citizen's Guide to Radon and Consumer's Guide to Radon Reduction and/or mitigate in accordance with ASTM E2121.
	≥4 pCi/L ≥4 pCi/L	Mitigate in accordance with ASTM E2121.	
>2 and <4 pCi/L <i>Take precautionary radon-reduction actions: complete foundation air sealing strategies as part of energy upgrade work.</i>	<4 pCi/L and NOT higher than pre-work level.	No further minimum action.	For post-work radon levels between 2 and 4 pCi/L, refer client to EPA's Citizen's Guide to Radon and Consumer's Guide to Radon Reduction and/or mitigate in accordance with ASTM E2121.
	<4 pCi/L AND higher than pre-work level.	Verify that foundation air sealing strategies were completed appropriately and correct deficiencies.	For post-work radon levels between 2 and 4 pCi/L, refer client to EPA's Citizen's Guide to Radon and Consumer's Guide to Radon Reduction and/or mitigate in accordance with ASTM E2121.
	≥4 pCi/L	Mitigate in accordance with ASTM E2121.	
≥4 pCi/L <i>Complete all foundation air sealing strategies as part of energy upgrade work.</i>	<4 pCi/L	No further minimum action.	For post-work radon levels between 2 and 4 pCi/L, refer client to EPA's Citizen's Guide to Radon and Consumer's Guide to Radon Reduction and/or mitigate in accordance with ASTM E2121.
	≥4 pCi/L but NOT higher than pre-work level.	Refer client to EPA's Citizen's Guide to Radon and recommend radon mitigation.	Mitigate in accordance with ASTM E2121.
	≥4 pCi/L AND higher than pre-work level.	Mitigate in accordance with ASTM E2121.	
No Pre-Work Test <i>Consider precautionary radon-reduction actions as part of energy upgrade work, especially covering exposed earth, air sealing open sumps, ensuring floor drains have traps and that traps are not dry.</i>	<4 pCi/L	No further minimum action.	For post-work radon levels between 2 and 4 pCi/L, refer client to EPA's Citizen's Guide to Radon and Consumers Guide to Radon Reduction and/or mitigate in accordance with ASTM E2121.
	≥4 pCi/L	Mitigate in accordance with ASTM E2121.	

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
WOOD SMOKE AND OTHER SOLID FUEL EMISSIONS			
	<p>Determine whether there are wood- or coal-burning appliances (e.g., wood stove or furnace, wood pellet stove, fireplace) in the home.</p> <p>If wood- or coal-burning appliances are present, determine whether there is evidence of wood smoke emissions affecting the home, using any of the following practices or the equivalent (note that many of the following may require input from certified/trained professionals):</p> <ul style="list-style-type: none"> • Look for evidence of soot on the walls or ceiling or creosote staining near the flue pipe. • Determine whether the inside of the home smells like wood smoke. • Ask occupants whether they regularly (i.e., daily) smell wood smoke during the heating season. • If certified/trained professionals are available, consider using a particle counter to quantify particulates in the indoor air. <p>Assess appliance safety by considering:</p> <ul style="list-style-type: none"> • Appliance condition, especially leaks, cracks or faulty flue connections. • Proper distance of appliance to combustible materials (minimum clearances) and/or proper protection of combustibles. • Proper size and materials of floor protection. • Proper venting system (Vented Combustion Appliances [page 18] and Unvented Combustion Appliances [page 20]). <p>Determine whether the wood- or coal-burning appliance is EPA-certified (i.e., more energy efficient and cleaner burning).</p> <p>Determine whether a hydronic heater (e.g., outdoor wood-fired boiler) is present.</p> <p>If the wood- or coal-burning appliance is operating during the assessment, observe the opacity of the smoke leaving the chimney.</p>	<p>Assess what the proper size of any wood- or coal-burning appliances will be after the retrofit is complete. If the current unit is oversized, recommend replacement with a properly sized, EPA-certified appliance.</p> <p>If evidence of soot, wood smoke or other health safety concern is apparent, determine the source of the problem and work with the appropriate certified professional (e.g., NFI, CSIA, etc.) to resolve it.</p> <p>Encourage the homeowner to have a certified professional chimney sweep (e.g., certified by the Chimney Safety Institute of America) inspect the chimney and wood- or coal-burning appliance annually. </p> <p>Share EPA Burn Wise tips with the homeowner: http://www.epa.gov/burnwise/pdfs/BurnWiseTips.pdf. </p> <p>Relevant Guidance/Standards</p> <p>CSIA.</p> <p>EPA Burn Wise Guides: Burn Wise Guide for Best Burn Practices for Wood Stoves.</p> <p>EPA Burn Wise Tips.</p> <p>NESCAUM Regulations.</p> <p>NFPA 211.</p>	<p>Replace non-certified wood- or coal-burning appliances with properly sized and installed EPA-certified wood- or coal-burning appliances after the retrofit is complete. Appliances should be installed according to the manufacturer's instructions.</p> <p>Relevant Guidance/Standards</p> <p>EPA Burn Wise Lists.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
WOOD SMOKE AND OTHER SOLID FUEL EMISSIONS <i>(continued)</i>			
	<p>Note <i>One hundred percent opacity means nothing can be seen through the smoke. At 20% opacity, there is very little smoke and you can see almost completely through it. Smoke with opacity of more than 20% is an indication that unseasoned wood is being burned, a non-EPA approved stove is in use or poor operation.</i></p> <p>Relevant Guidance/Standards EPA Burn Wise Guides: Burn Wise Guide for Identifying Cleaner-Burning Appliances. Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6). NFPA 211. Unvented Combustion Appliances (page 20) Vented Combustion Appliances (page 18)</p>		
CRITICAL BUILDING SYSTEMS FOR HEALTHY INDOOR ENVIRONMENTS			
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) EQUIPMENT			
	<p>Evaluate the condition of the existing HVAC system components (e.g., furnace, boiler, air handler, heat pump, associated ductwork) in accordance with minimum inspection standards of ANSI/ACCA Standard 4 (Maintenance of Residential HVAC Systems), ASHRAE handbooks or other equivalent standards and guidelines.</p> <p>Ventilation requirements are also addressed in Source Ventilation (page 21), Whole-House Ventilation for Distributed Contaminant Sources (page 22) and Multi-Family Ventilation (page 22).</p> <p>The HVAC assessment is to include an evaluation of whether the system is functioning properly, based on ANSI/ACCA checklists appropriate for the type of equipment. Determine whether the HVAC system is properly sized in accordance with ASHRAE handbook, or other equivalent standardized guidelines.</p>	<p>Based on an assessment of equipment condition and sizing, repair, modify or replace equipment to meet minimum corrective actions for proper HVAC function.</p> <p>If repairs are needed to restore HVAC to proper functioning, repair in accordance with ANSI/ACCA Standard 6 (Restoring the Cleanliness of HVAC Systems), ASHRAE handbooks or other equivalent standards and guidelines.</p> <p>If replacing equipment, base sizing calculations on post-retrofit conditions. Refer to Sections 4.1 and 4.2 of EPA Indoor airPLUS Construction Specifications.</p> <p>Install new equipment in accordance with ANSI/ACCA Standard 5 (HVAC Quality Installation Specification) AND verify installation in accordance with ANSI/ACCA Standard 9 (HVAC Quality Installation Verification Protocols), ASHRAE handbooks or other equivalent standards and guidelines.</p>	<p>Replace functioning HVAC equipment that is near the end of its service life with new energy-efficient HVAC equipment and base sizing calculations on post-retrofit conditions. Refer to Sections 4.1 and 4.2 of EPA Indoor airPLUS Construction Specifications.</p> <p>Follow ANSI/ACCA Standard 5 (HVAC Quality Installation Specification), Standard 9 (HVAC Quality Installation Verification Protocols), ASHRAE handbooks or other equivalent standards and guidelines. Consider using filters with a high MERV rating (11 or above) if equipment capacity is sufficient to accommodate the pressure drop. For existing systems, check with the manufacturer to determine whether MERV 11 filters can be installed.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) EQUIPMENT <i>(continued)</i>			
	<p>If HVAC replacement or modification is anticipated, base sizing calculations on post-retrofit conditions. Refer to Sections 4.1 and 4.2 of EPA Indoor airPLUS Construction Specifications.</p> <p>Relevant Guidance/Standards ACCA 4 QM-2007.</p> <p>ASHRAE Handbooks: ASHRAE Handbook Series.</p> <p>EPA Indoor airPLUS Specifications: 4.1 and 4.2.</p> <p>Multi-Family Ventilation (page 22).</p> <p>Source Ventilation (page 21).</p> <p>Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p>	<p>Ensure newly installed central forced-air HVAC systems have a minimum MERV 6 filter, no filter bypass, and no air cleaners designed to intentionally produce ozone.</p> <p>Relevant Guidance/Standards ACCA 5 QI-2010. ACCA 6 QR-2007. ACCA 9 QIVP-2008. ASHRAE 62.2-2010, Section 6.7. ASHRAE Handbooks: ASHRAE Handbook Series. ASHRAE 52.2-2007. EPA Indoor airPLUS Specifications: 4.1, 4.2 and 4.7. EPA IAQ: Residential Air Cleaners.</p>	<p>Relevant Guidance/Standards ACCA 5 QI-2010. ACCA 9 QIVP-2008. ASHRAE Handbooks: ASHRAE Handbook Series. ASHRAE 52.2-2007. EPA Indoor airPLUS Specifications: 4.1, 4.2 and 4.7.</p>
VENTED COMBUSTION APPLIANCES			
	<p>Complete a safety inspection of all vented combustion appliances in the dwelling (e.g., furnaces, boilers, space heaters, water heaters). The inspection shall include observations for proper clearances, condition of venting, assessment of the potential for backdrafting, integrity of fuel lines, safety of electrical connections and the appliance itself.</p> <ul style="list-style-type: none"> For gas-fired appliances and equipment, make this assessment using applicable installation standards, including the National Fuel Gas Code, ANSI Z223.1/NFPA 54, the applicable ANSI Z21 gas-fired appliance safety standard and manufacturer's instructions. Determine whether gas-fired appliance installations comply with Section 9.3 "Air for Combustion and Ventilation" of ANSI Z223.1/NFPA 54 for proper venting, including influences of other building ventilation and exhausting equipment. 	<p>Complete all applicable actions under the Assessment Protocols AND ensure compliance with applicable codes and standards. Test combustion appliances for proper draft and venting under worst case conditions before and after retrofit measures that affect envelope leakage and airflows (e.g., air sealing, insulation, addition or upgrade of exhaust fans). Repair, remove or replace combustion equipment and address other issues or deficiencies as needed to meet the applicable codes and standards.</p> <p>Note: <i>All equipment removals should include proper disposal so that hazardous units are not reinstalled or used elsewhere.</i></p> <p>Address depressurization and potential backdrafting problems (e.g., with combustion make-up air, fan interlocks, transfer grilles, jumper ducts, louvered doors or door undercuts) OR disable the exhaust equipment causing the problems.</p> <p>If a whole-house fan is used for cooling at night, advise occupants to open several windows before operating the fan. </p>	<p>If replacing combustion equipment located in occupied or conditioned spaces as part of the retrofit process, recommend power vented or sealed combustion equipment (see Section 5.1 of EPA's Indoor airPLUS Construction Specifications). Install new combustion equipment in accordance with ANSI/ACCA 5 QI 2010 HVAC Quality Installation Specifications.</p> <p>Relevant Guidance/Standards ACCA 5 QI-2010. EPA Indoor airPLUS Specification 5.1.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
VENTED COMBUSTION APPLIANCES <i>(continued)</i>			
	<ul style="list-style-type: none"> For oil-fired appliances and equipment, make this assessment using applicable installation standards, including the Standard for the Installation of Oil-Burning Equipment, ANSI/NFPA 31, the applicable ANSI/UL oil-fired appliance safety standard and manufacturer's instructions. <p>Performance test vented combustion appliances (e.g., boilers, furnaces, space heaters and water heaters) to ensure proper draft under worst case depressurization and perform CO testing.</p> <p>Conduct Combustion Appliance Zone (CAZ) Worst Case Depressurization testing in accordance with BPI-1100-T-2010, Section 7.5, to determine whether there are any combustion safety issues that may result from changes to the building envelope.</p> <p>Note <i>When conducting CAZ testing, a 5 Pa depressurization limit may not be appropriate for all venting conditions. See the BPI CAZ Depressurization Limits table referenced below.</i></p> <p>Relevant Guidance/Standards ANSI Z223.1/NFPA 54. ANSI Z21 Series Standards for Residential Gas-Fired Appliances. BPI-1100-T-2010, Combustion Appliance Testing section. BPI Technical Standards: Technical Standards for the Building Analyst Professional, CAZ Depressurization Limits Table. Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6). NFPA 31. NFPA 211.</p>	<p>Relevant Guidance/Standards ANSI Z223.1/NFPA 54. ANSI Z21 Series Standards for Residential Gas-Fired Appliances. ASHRAE 62.2-2010 Section 6.4. BPI-1100-T-2010, Combustion Appliance Testing section. BPI Technical Standards: Technical Standards for the Building Analyst Professional, CAZ Depressurization Limits Table. Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6). NFPA 31. NFPA 211.</p>	

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
UNVENTED COMBUSTION APPLIANCES			
	<p>Identify any unvented gas or kerosene space heaters or vent-free combustion appliances (e.g., fireplaces, cooktops, ovens, kerosene or gas space heaters).</p> <p>Determine whether any state or local regulations prohibiting these devices apply.</p> <p>Relevant Guidance/Standards Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6).</p> <p>State or local regulations.</p>	<p>Verify that the kitchen exhaust fan vents to the outdoors. If not, see Source Ventilation (page 21) for recommended actions.</p> <p>Identify illegal unvented gas or kerosene space heaters that do not conform to state and local regulations and, with the occupant's permission, remove them as appropriate. If the space heaters are the primary source of heat, replace them with electric or vented, code-compliant heating systems.</p> <p>Note: <i>All equipment removals should include proper disposal so that hazardous units are not reinstalled or used elsewhere.</i></p> <p>With the occupant's permission, remove other unvented heaters, except when used as a secondary heat source AND when it can be confirmed that the unit is being used in conformance with ANSI Z21.11.2. Units that are not being operated in compliance with ANSI Z21.11.2 should be removed prior to the retrofit, but may remain until a replacement heating system is in place.</p> <p>If the occupant objects to these recommendations:</p> <ul style="list-style-type: none"> • Provide the occupant with information about the hazards of operating illegal unvented space heaters or operating vent-free appliances contrary to manufacturers' instructions. For example, the manufacturers' instructions may call for open windows because use of the device requires adequate or additional ventilation to remove products of combustion such as CO, nitrogen oxides, CO₂, PM and water vapor. 🏠 • For gas-fired unvented space heaters without an oxygen depletion sensor (ODS) shutoff system, suggest the occupant replace with a vented appliance or, at a minimum, consider upgrading the heater to a new model consistent with ANSI Z21.11.2/CSA. • For gas-fired unvented space heaters and vent-free fireplaces that are oversized for the application, advise the occupant of the improper sizing of the appliance. 	<p>This cell is intentionally blank.</p>



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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
UNVENTED COMBUSTION APPLIANCES <i>(continued)</i>			
		<ul style="list-style-type: none"> Advise the occupant that it is always important to consult and follow the manufacturer's instructions for proper operation and maintenance. If the manufacturer's instructions are not available to the occupant, advise or assist the occupant in obtaining replacement instructions or contacting the Air-Conditioning, Heating and Refrigeration Institute (AHRI) for information on obtaining these instructions for gas appliances. <p>Relevant Guidance/Standards AHRI. ANSI Z21.11.2/CSA. Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6). Source Ventilation (page 21).</p>	
SOURCE VENTILATION			
	<p>Determine whether the home complies with the local exhaust requirements for kitchens and baths of ASHRAE Standard 62.2-2010, Section 5 and Appendix A, as applicable. Determine whether kitchen and bath exhausts are present and vent to the outdoors.</p> <p>Determine whether the home complies with the local exhaust requirements for clothes dryers in ASHRAE Standard 62.2-2010, Section 6. Determine whether clothes dryers vent to the outdoors. (Condensing dryers are exempt.) Inspect or verify that clothes dryer exhaust duct(s) do not discharge into crawlspaces or attics or within walls. Inspect clothes dryer vents for restrictions and lint buildup.</p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010. BPI-1100-T-2010, Indoor Air Quality and Ventilation and Baseload Energy Efficiency sections.</p>	<p>If ASHRAE Standard 62.2-2010 requirements for bathroom, kitchen and clothes dryer exhaust requirements are not met, repair, replace or install local exhaust ventilation to meet the requirements, ensuring ducts are sized, installed and vented properly to the outdoors, OR increase whole-house ventilation airflow to compensate for deficiencies of local exhaust in bathrooms and kitchens using the alternative compliance method (Appendix A of Standard 62.2-2010).</p> <ul style="list-style-type: none"> In multi-family buildings, common spaces should be served by dedicated ventilation systems. Ensure that all clothes dryers exhaust to the outdoors and cannot be readily diverted indoors. (Condensing dryers are exempt.) <p>Relevant Guidance/Standards ASHRAE 62.2-2010. BPI-1100-T-2010, Indoor Air Quality and Ventilation section.</p>	<p>If the home is in compliance with ASHRAE Standard 62.2-2010 without bathroom or kitchen exhaust fans (i.e., using Appendix A), EPA recommends installation of exhaust fans vented to the outdoors, in accordance with Section 5 of ASHRAE Standard 62.2-2010 requirements, to improve pollutant source removal.</p> <p>For spaces with strong, localized pollutant sources, consider installing additional (dedicated) local exhaust ventilation.</p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010.</p>





PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
WHOLE-HOUSE VENTILATION FOR DISTRIBUTED CONTAMINANT SOURCES			
	<p>Determine whether the home complies with the ventilation requirements of ASHRAE Standard 62.2-2010:</p> <ul style="list-style-type: none"> • Use Section 4 requirements OR use Appendix A – Existing Buildings if local exhaust ventilation in bathrooms and kitchens is deficient. Blower door testing and measuring fan flows (e.g., bathroom or kitchen exhaust) will be required. • Determine whether additional ventilation measures are needed to meet the ASHRAE Standard 62.2-2010 requirements. <p>Relevant Guidance/Standards ASHRAE 62.2-2010.</p>	<p>Install additional ventilation measures as necessary to meet ASHRAE Standard 62.2-2010 requirements for whole-building ventilation.</p> <p>If the local exhaust ventilation in bathrooms and kitchens is deficient, use the alternative compliance supplement (Appendix A of Standard 62.2-2010).</p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010.</p>	<p>Install a balanced, whole-house ventilation system (e.g., heat recovery ventilator [HRV]).</p> <p>Relevant Guidance/Standards NAHB Research Center, http://www.toolbase.org. Search “whole-house ventilation” and “HRV” for additional resources.</p>
MULTI-FAMILY VENTILATION			
	<p>Determine ventilation system type (e.g., fan-powered exhaust, fan-powered outdoor supply or a combination of the two) and whether each system serves individual units, each floor or the entire building.</p> <p>Determine whether existing ventilation meets ASHRAE Standard 62.2-2010 requirements using Appendix A – Existing Buildings for each unit. Determine whether all doors between dwelling units and common hallways are gasketed and airtight with weather stripping (except when the ventilation system design requires air transfer from corridors to units). See ASHRAE Standard 62.2-2010 for additional requirements for each dwelling unit.</p> <p>Determine whether ventilation for common corridors meets ASHRAE 62.1-2010 Table 6-1 (0.06 cfm/ft² floor area).</p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010. ASHRAE 62.1-2010.</p>	<p>If each dwelling unit is served by its own ventilation equipment, follow Minimum Actions for Whole-House Ventilation for Distributed Contaminant Sources (page 22) and Source Ventilation (page 21). Be certain to include the sealing measures between dwelling units required in Section 6.1 of ASHRAE Standard 62.2-2010.</p> <p>If multiple dwelling units are served by a single exhaust fan, fan-powered outdoor air, or combination of the two, meet 62.2-2010 requirements, paying special attention to sealing measures in Section 6.1 plus:</p> <ul style="list-style-type: none"> • Seal all the holes that can be sealed in the ventilation ductwork. • Specify and install a balancing device at each exhaust or supply point that, in combination with a sufficiently high operating pressure, ensures constant continuous ventilation which meets the target ventilation rate during all seasons. • Adjust or replace fans so that outlets or inlets have at least 0.2 inches water column (w.c.) pressure difference across the balancing devices in each dwelling unit. • Ensure that ventilation systems run continuously or have dampers installed that prevent airflow between dwelling units when the system is off. 	<p>If each dwelling unit is served by its own ventilation equipment, follow the Expanded Actions for Whole-House Ventilation for Distributed Contaminant Sources (page 22) and Source Ventilation (page 21).</p> <p>If multiple dwelling units are served by a single exhaust fan, fan-powered outdoor air, or a combination of the two, meet all the Minimum Actions for Multi-Family Ventilation AND conduct extensive air sealing to compartmentalize each dwelling unit OR design and install individual ventilation systems for each unit to meet the requirements of ASHRAE 62.2-2010 as it applies to new construction.</p> <p>Relevant Guidance/Standards ASHRAE 62.2-2010. MNCEE: Reduction of Environmental Tobacco Smoke Transfer in Minnesota Multifamily Buildings Using Air Sealing and Ventilation Treatments. NCHH Fact Sheet: Improving Ventilation in Existing or New Buildings with Central Roof Exhaust. NCHH Fact Sheet: Improving Ventilation in Multi-Family Buildings That Do Not Have Fan-Powered Ventilation Systems.</p>


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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
MULTI-FAMILY VENTILATION <i>(continued)</i>		<ul style="list-style-type: none"> • Use minimum MERV 6 filters on supply ventilation systems. • In buildings where vertical shafts or ducts and passive rooftop ventilators provide non-fan-powered exhaust to multiple dwelling units, add exhaust fans in combination with the above requirements to provide a more effective ventilation system. <p>Relevant Guidance/Standards ASHRAE 62.2-2010.</p> <p>MNCEE: Reduction of Environmental Tobacco Smoke Transfer in Minnesota Multifamily Buildings Using Air Sealing and Ventilation Treatments.</p> <p>NCHH Fact Sheet: Improving Ventilation in Existing or New Buildings with Central Roof Exhaust.</p> <p>NCHH Fact Sheet: Improving Ventilation in Multi-Family Buildings That Do Not Have Fan-Powered Ventilation Systems.</p> <p>Source Ventilation (page 21).</p> <p>Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p>	<p>Source Ventilation (page 21).</p> <p>Whole-House Ventilation for Distributed Contaminant Sources (page 22).</p>

SAFETY			
HOME SAFETY			
	<p>Determine whether there are working smoke alarms and CO alarms.</p> <p>Identify knob and tube electrical wiring.</p> <p>Identify harmful chemicals in accessible locations.</p> <p>Check whether there is a fire extinguisher in the home.</p> <p>Determine whether the hot water heater temperature setting is within the allowable limits of the local and state codes.</p> <p>Document other home safety hazards that are observed during the energy audit/assessment/retrofit (e.g., missing handrails, non-intact stairs, insufficient lighting, holes in floors).</p>	<p>Replace non-working smoke and CO alarms. If smoke alarms or CO alarms are not present, install new alarms. If new batteries are used, install 10-year lithium batteries. (It is recommended that CO alarms have a digital display and provide peak level readings.)</p> <p>Correct life-threatening safety risks (i.e., fall hazards) and provide client education on safety concerns. </p> <p>Do not bury unsafe wiring in attic insulation.</p> <p>Relevant Guidance/Standards CPSC Document #466. NFPA 720.</p>	<p>Install CO alarms that can detect and store peak CO levels of less than 30 ppm.</p> <p>Have qualified personnel replace knob and tube wiring in accordance with applicable electrical codes.</p> <p>For households with small children or elderly occupants, discuss scald prevention with clients AND adjust hot water heater set-point to 120 degrees Fahrenheit to prevent scalding.</p> <p>In homes with elderly persons, install grab bars, handrails and lighting as appropriate.</p>

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PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
HOME SAFETY <i>(continued)</i>			
	Relevant Guidance/Standards CDC Fall Prevention Checklist. CDC Home Safety Checklists. HUD Notice: Public Housing Assessment System Physical Condition Scoring Process Interim Scoring, Corrections and Republication.		<p>For households with small children, recommend installation of gates at the tops of stairs.</p> <p>Recommend installation of light switches at the top and bottom of stairs.</p> <p>Recommend installation of safety lighting above stairs. Consider energy-efficient LED lighting.</p> <p>Recommend repair of malfunctioning doors, windows, roofs and floors.</p> <p>Recommend appropriate and controlled storage of hazardous chemicals (e.g., strong cleaners, household hazardous materials) and pesticides (e.g., remove from accessible locations).</p> <p>Repair identified safety hazards.</p> <p>Relevant Guidance/Standards ANSI/UL 2034. EPA Design for the Environment.</p>
JOBSITE SAFETY			
 	<p>Evaluate existing and potential health concerns and activities. Refer to Appendix A: Worker Protection for recommended evaluation measures and actions. </p> <p>Note <i>By law, employers and supervisors are required to ensure that workers are working with an OSHA written Safety and Health Plan. More details about these requirements and resources are available in Appendix A: Worker Protection.</i></p>	<p>Protect workers and occupants from on-site health and safety hazards by:</p> <ul style="list-style-type: none"> • Ensuring proper isolation (e.g., sealed with plastic sheeting) and ventilation of work area to the outdoors during activities that result in VOC emissions (e.g., installing spray foam insulation, painting, sealing, finishing) AND ventilating as close to the source of VOCs as possible. • Using appropriate dust control and protective equipment. • Thoroughly cleaning work area before re-occupancy. • Adding precautions to protect occupants during and after installation of spray polyurethane foam: <ul style="list-style-type: none"> • Evacuating building occupants and other unprotected trade workers from the work area. 	<p>For additional information on each of the topics, visit the resources provided under each issue in Appendix A: Worker Protection. </p>

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
JOBSITE SAFETY <i>(continued)</i>		<ul style="list-style-type: none"> Using appropriate personal protective equipment (e.g., chemical-resistant [nitrile] gloves, appropriate respirator, chemical-resistant clothing) for anyone in work area. Cleaning the area thoroughly and waiting until the foam cures before allowing unprotected workers or occupants to reoccupy the work area. <p>See Appendix A: Worker Protection for recommended actions to protect worker safety, including available resources. </p>	

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WORKER PROTECTION

Engaging in energy-focused retrofits, home weatherization projects, renovation or remodeling efforts can present risks to occupants, and workers’ health and safety may also be compromised if risks are not appropriately assessed and corrective actions are not taken. This appendix was developed to call attention to issues that are of concern to workers’ health and safety. Information on assessing the risks to workers, recommended actions to minimize risks to workers’ health and safety, and additional resources are provided below.

By law, employers and supervisors are required to ensure that:

- 1) Work site operations are conducted in compliance with OSHA regulatory requirements.
- 2) Workers are trained in the hazards of their job and the methods to protect themselves.
- 3) Workers are provided the protective equipment needed to reduce site exposures.

OSHA regulatory requirements identify the following construction hazards to be addressed:

Chemical Hazards	29 CFR 1926.59
Confined Space	29 CFR 1926.21 (b)(6)(i)
Electrical	29 CFR 1926 Subpart K
Falls	29 CFR 1926.501
Ladders	29 CFR 1926.1053

- Site plans should address safety and health and should include precautions to address multiple construction issues, including the issues outlined below in Table 2. Measures an employer needs to take to evaluate existing and potential health concerns, as well as recommended actions to ensure worker safety, are also included in Table 2. Free help with developing these plans is often available from state or federal training (consulting) programs.
- When known pollutants are being produced or disturbed during retrofit activities, follow appropriate standards (including OSHA, NIOSH, EPA lead safe, and BPD) to minimize worker and occupant exposure.
- When possible, choose construction products whose manufacturers disclose all ingredients and verify that they are free of formaldehyde, mercury and other known toxic substances.

Table 2: Recommended Assessments and Actions for Priority Worker Safety Concerns

<p>Asbestos</p> <p>Assessment: Determine whether workers will be exposed to asbestos-containing material (ACM).</p> <p>Actions:</p> <ul style="list-style-type: none"> • Retrofitting/renovation activities may expose workers to ACM (e.g., if the home was built before 1990) and require compliance with the OSHA rule at 29 CFR 1926.1101, which provides the required protection measures. • See OSHA's website on asbestos for additional information and resources.
<p>Chemical Hazards</p> <p>Assessment: Determine whether workers will be exposed to chemical hazards.</p> <p>Actions:</p> <ul style="list-style-type: none"> • If renovation or retrofitting activities will require the handling of chemical substances, compliance with the OSHA rule at 29 CFR 1926.59 is necessary. It requires that chemical safety information be made available for all chemicals in use, that containers be properly labeled and that workers handling them be properly trained. • See OSHA's website on chemical hazards communication for additional information and resources.
<p>Confined Space</p> <p>Assessment: Determine whether workers will be exposed to confined-space hazards.</p> <p>Actions:</p> <ul style="list-style-type: none"> • Ensure work space has breathable air (i.e., ventilate the work space if necessary). Section 5(a)(1) of OSH ACT requires employers to protect workers from serious workplace hazards. Under the OSHA rule at 29 CFR 1926.21 (b)(6)(i), all employees required to enter confined or enclosed spaces must be instructed as to the nature of the hazards involved, the necessary precautions to be taken and the use of required protective and emergency equipment. • See OSHA's website on confined spaces and OSHA's Confined Spaces E-Tool for additional resources on confined space hazards in general industry. • See OSHA's Protecting Yourself from Carbon Monoxide Poisoning Quick Card for additional information on sources of CO and recommended actions for preventing CO exposure. • See EPA's website on the Design for the Environment Program for more information on selecting less toxic products and materials for use in confined spaces.
<p>Dust</p> <p>Assessment: Determine if the work will create dust.</p> <p>Actions:</p> <ul style="list-style-type: none"> • Workers should know about dust containment procedures and be able to control dust and debris created by equipment used in construction activities. • Use work methods to minimize dust and prevent dust from spreading to other areas of the home. • The rooms or areas where work is being done may need to be isolated (e.g., sealed with plastic sheeting) to contain any dust that is generated. • Turn off forced-air, central heating and air-conditioning systems (including local, window air conditioning units) while work that creates dust is being completed. • Collect and remove all construction debris. • Conduct a careful cleanup. • See OSHA's websites on wood dust, combustible dust, and permissible exposure limits (PELs) for additional information and resources. • See EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) for recommended actions to prevent, contain and clean up dust.

Electrical

Assessment: Determine whether workers will be exposed to electrical hazards.

Actions:

- The OSHA rule at [29 CFR 1926 Subpart K](#) contains requirements for protecting workers from electrical hazards. Employers must make sure that all non-double-insulated electric equipment is equipped with a grounding conductor (three-wire type). Worn or frayed electric cords must not be used. Employers must provide either ground-fault circuit interrupters or an assured equipment grounding conductor program (which includes the regular testing of all equipment grounding conductors) to protect employees from ground faults.
- See [OSHA's Electrical Incidents E-Tool](#) for additional information on electrical safety.

Falls

Assessment: Determine whether workers will be required to work at heights of six feet or more.

Actions:

- If work is required at heights of six feet or more, then the workers must be protected with guard rails or tied off to prevent falling. (See OSHA rule at [29 CFR 1926.501](#) for additional information on requirements.)
- See [OSHA's website on fall protection](#) and [OSHA's Falls E-Tool](#) for additional information on protecting workers from fall hazards.

Ladders

Assessment: Determine whether workers will be using ladders.

Actions:

- If ladders are used, portable ladders must be able to support at least four times the maximum intended load. Ladders that must lean against a wall are to be positioned at a 4:1 angle. Ladders are to be kept free of oil, grease, wet paint and other slipping hazards. The area around the top and bottom of the ladder must be kept clear. Ladders must not be tied or fastened together to provide longer sections. Metal ladders must not be used while working on electrical equipment and electrical wiring. See the OSHA rule at [29 CFR 1926.1053](#) for additional information on requirements.
- See OSHA's publication, [Stairways and Ladders: A Guide to OSHA Rules](#), for additional resources on ladder safety.

Lead

Assessment: Determine whether retrofitting or renovation activities will expose workers to lead dust (paint) (e.g., pre-1978 buildings) according to the Assessment Protocols outlined in the Lead section ([page 9](#)).

Actions:

- If the facility was built before 1978, the existing paint is assumed to contain lead and retrofitting or renovation activities must comply with [EPA's Renovation, Repair and Painting \(RRP\) Program Rule \(40 CFR 745\)](#) and the OSHA rule at [29 CFR 1926.62](#).
- See OSHA's publication [Lead in Construction](#) for information on OSHA requirements to protect workers from lead hazards in the construction industry.

Mold

Assessment: Determine whether workers will be exposed to mold.

Actions:

- All suspected moldy areas should be remediated by properly trained individuals. Moisture problems need to be identified and fixed or mold will return. If mold is expected to be disturbed during activities, refer to [OSHA's A Brief Guide to Mold in the Workplace](#), [NIOSH's Interim Recommendations for Cleaning and Remediation of Flood-Contaminated HVAC Systems: A Guide for Building Owners and Managers](#), [EPA's Mold Remediation in Schools and Commercial Buildings](#), [ACGIH's Bioaerosols Assessment and Control](#), [AIHA's Recognition, Evaluation, and Control of Indoor Mold](#) or [IICRC's S500 Standard and Reference Guide for Professional Water Damage Restoration](#).
- See [EPA's website on mold and moisture](#) for additional information on mold and mold remediation.

Polychlorinated Biphenyls (PCBs)

Assessment: Determine whether workers may be handling PCB-containing or PCB-contaminated building materials, including fluorescent light ballasts and caulk.

Actions:

- See [EPA's website on PCB-Containing Light Ballasts](#) for information on proper maintenance, removal and disposal of PCB-containing fluorescent light ballasts. If leaking ballasts are discovered, wear protective clothing including chemical-resistant (nitrile) gloves, boots and disposable overalls.
- See [EPA's website on PCBs in Caulk](#) – Steps to Safe Renovation and Repair Activities for additional information on the safe renovation and abatement of buildings that have PCB-containing caulk. Work practices to help ensure worker and occupant safety include employing protective measures (both interior and exterior), complying with occupational protective regulations, communicating with building occupants/third parties, setting up the work area to prevent the spread of dust, using appropriate tools that minimize the generation of dust/heat, and leaving the work area clean. See OSHA rule at [29 CFR 1926.28\(a\)](#) for information on suitable personal protective equipment (PPE) for dust-generating work methods.

Spray Polyurethane Foam (SPF)

Assessment: Determine whether workers will be using SPF, which may contain chemicals such as isocyanates (e.g., methylene diphenyl diisocyanate [MDI]), amines, flame retardants and other additives. There are three main types of SPF products (two-component high pressure, two-component low pressure, and one-component foam), each of which has different applications. Determine which of the three main types of SPF products will be used.

Actions:

- Applicators, helpers and building occupants in the work area are required to use protective equipment to prevent exposure to isocyanates and other SPF chemicals. Protective equipment requirements vary depending on SPF product.
- Review label and product information for ingredients, hazards, directions, safe work practices and precautions.
- Ensure health and safety training is completed and safe work practices are followed to prevent eye, skin and inhalation exposures during and after SPF installation.
- Exercise caution when determining a safe re-entry time for unprotected occupants and workers based on the manufacturer's recommendation. If you experience breathing problems or other adverse health effects from weatherizing with SPF, seek immediate medical attention.
- See [OSHA's Green Job Hazards website](#) for additional information on the hazards associated with SPF.
- See [EPA's website on SPF](#) for additional information.
- See [American Chemistry Council's Spray Polyurethane Foam Health and Safety website](#) for additional information.

Worker Protection Resources

General

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Mold

ACGIH: Bioaerosols Assessment and Control. 1999. American Conference of Governmental Industrial Hygienists.
<http://www.acgih.org/store/productdetail.cfm?id=349>

AIHA: Recognition, Evaluation, and Control of Indoor Mold. 2008. American Industrial Hygiene Association.

https://webportal.aiha.org/Purchase/ProductDetail.aspx?Product_code=3f9e0a5a-4778-de11-96b0-0050568361fd

CDC Mold Cleanup: Mold Cleanup. 2010. U.S. Centers for Disease Control and Prevention.
<http://www.cdc.gov/mold/cleanup.htm>

CDC Mold Prevention Strategies: Mold Prevention Strategies and Possible Health Effects in the Aftermath of Hurricanes and Major Floods. 2006. U.S. Centers for Disease Control and Prevention.
<http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5508a1.htm>

CDC, NIOSH, Cleaning and Remediation of HVAC Systems: NIOSH Interim Recommendations for the Cleaning and Remediation of Flood Contaminated HVAC Systems: A Guide for Building Owners and Managers. U.S. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

<http://www.cdc.gov/niosh/nas/rdrp/appendices/chapter10/a10-14.pdf>

DOL, OSHA, Mold in Workplace: A Brief Guide to Mold in the Workplace. U.S. Department of Labor, Occupational Safety and Health Administration.

<http://www.osha.gov/dts/shib/shib101003.html>

EPA Mold: Mold Remediation in Schools and Commercial Buildings. 2010. U.S. Environmental Protection Agency.
http://www.epa.gov/iedmold1/mold_remediation.html

EPA Mold: Mold and Moisture. 2010. U.S. Environmental Protection Agency.
<http://www.epa.gov/mold/>

IICRC: S500 Standard and Reference Guide for Professional Water Damage Restoration. 2006. Institute of Inspection, Cleaning and Restoration Certification.
<http://www.iicrc.org/pdf/buydocs.pdf>

Polychlorinated Biphenyls (PCBs)

EPA PCB-Containing Light Ballasts: Proper Maintenance, Removal, and Disposal of PCB-Containing Fluorescent Light Ballasts. 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/ballasts.htm>

EPA PCBs in Caulk – Steps to Safe Renovation and Repair Activities: 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/pcbsscinalk/guide/guide-sect2.htm>

DOL OSHA, 29 CFR Part 1926.28(a), subpart C: Personal Protective Equipment. Safety and Health Regulations for Construction: Occupational Health and Environmental Controls. U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10614

Spray Polyurethane Foam

American Chemistry Council: Spray Polyurethane Foam Health and Safety. American Chemistry Council.
<http://www.spraypolyurethane.org>

DOL, OSHA, Green Jobs Hazards: Green Jobs Hazards, Weather Insulating/Sealing. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/depr/greenjobs/weather_spf.html

EPA SPF: Spray Polyurethane Foam. 2011. U.S. Environmental Protection Agency.
http://www.epa.gov/dtfe/pubs/projects/spf/spray_polyurethane_foam.html

EPA SPF: Spray Polyurethane Foam, Building Occupants and Other Workers Should Vacate During SPF Installation. 2011. U.S. Environmental Protection Agency.
http://www.epa.gov/dtfe/pubs/projects/spf/spray_polyurethane_foam.html#building

CLIENT EDUCATION

Why Provide Client Education

Home energy upgrades, when completed in accordance with **EPA's Healthy Indoor Environment Protocols for Home Energy Upgrades**, can help improve the indoor air quality and safety in homes. Energy upgrade work also presents a valuable chance to interact with occupants, giving the contractor an opportunity to provide helpful education on indoor air quality and safety to further ensure the positive impact of a more energy efficient, healthier home. With effective education, occupants are better prepared to maintain healthy home improvements and less likely to create new health hazards in their homes.

Key Issues

Programs, crews and contractors are encouraged to incorporate into their client education strategies a set of messages related to 12 topics identified in the protocols for occupant education (presented here alphabetically):

1. Asbestos.
2. Asthma triggers.
3. Carbon monoxide (CO) and other combustion pollutants.
4. Environmental tobacco smoke (ETS).
5. Lead.
6. Mold and moisture.
7. Pests.
8. Polychlorinated biphenyls (PCBs).
9. Radon.
10. Safety.
11. Volatile organic compounds (VOCs) in household products and materials.
12. Wood smoke and solid fuel emissions.

These issues and health messages are described in Table 3, which summarizes how these priority indoor environmental concerns affect occupants and provides suggested occupant education health messages. Occupant health messages can be used to communicate key points regarding these 12 important topics for healthy indoor environments.

EPA has many publications suitable for occupant education on indoor air quality in homes, including **Care for Your Air: A Guide to Indoor Air Quality**, which can be found on EPA's Indoor Air Quality home page, www.epa.gov/iaq.

Table 3: Priority Health Concerns and Recommended Occupant Health Messages

Priority Health Concerns	Recommended Occupant Health Messages
<p>Asbestos – Asbestos-containing materials (ACM) in homes may include pipe and furnace insulation, vermiculite insulation installed before 1990, floor tiles, exterior shingles and roofing. Exposure can cause lung cancer, mesothelioma (cancer of the lining of the chest and abdominal cavity) and asbestosis, in which the lungs become scarred with fibrous tissue.</p>	<ul style="list-style-type: none"> • Do not disturb materials that may contain asbestos including pipe insulation, attic vermiculite insulation, exterior shingles and floor tiles (particularly 9-inch by 9-inch tiles). • Consult state requirements for asbestos testing and mitigation.
<p>Asthma Triggers – Asthma triggers are commonly found in homes, schools and offices and include moisture, mold, dust mites, pests such as cockroaches or mice, secondhand smoke and pet dander. A home may have mold growing on a shower curtain, dust mites in pillows, blankets or stuffed animals, secondhand smoke in the air and cat and dog hairs on the carpet or floors.</p> <p>Asthma triggers cause symptoms including coughing, chest tightness, wheezing and breathing problems. An asthma attack occurs when symptoms keep getting worse or are suddenly very severe. Asthma attacks can be life threatening.</p>	<ul style="list-style-type: none"> • Asthma can be controlled with the right medicines and by reducing asthma triggers. • For dust mites, wash bedding in hot water once a week and dry completely. Use dust-proof (allergen-impermeable) mattress and pillow covers. Choose washable stuffed toys; wash them often in hot water, and dry thoroughly. • Keep pets out of bedrooms and off furniture. Consider keeping pets outside, if possible. • See sections of this table on Environmental Tobacco Smoke, Mold and Moisture, and Pests for recommendations regarding these asthma triggers.
<p>Carbon Monoxide (CO) and Other Combustion Pollutants – Combustion pollutants are gases or particles that come from burning materials. Common combustion pollutants include carbon monoxide (CO) and nitrogen dioxide (NO₂).</p> <p>Exposure to CO can cause headaches, impaired vision and coordination, flu symptoms, dizziness, and at high concentrations, confusion, nausea and death. CO sources include combustion equipment (e.g., furnaces and wood stoves), unvented combustion appliances (e.g., vent-free fireplaces), portable generators, and other combustion equipment and automobiles operated in attached garages.</p> <p>NO₂ is a colorless, odorless gas that causes eye, nose and throat irritation, shortness of breath and an increased risk of respiratory infection.</p>	<ul style="list-style-type: none"> • CO alarms should be installed in all homes. • Annually test CO alarms. Replace every five to seven years. It is recommended that CO alarms have a digital display and provide peak level readings. <i>Note: Some CO alarms can detect and store low level peak CO levels (less than 30 ppm).</i> • Never operate a portable generator or any gasoline engine-powered tool in or near an enclosed space such as a garage, house or other building. Even with open doors and windows, these spaces can trap CO and allow it to quickly build to lethal levels. • Never warm up cars in attached garages, even if the garage door to the outside is open. • For gas vent-free heaters and fireplaces, inform occupant of identified operation or installation issues and suggested actions. • Consult manufacturer installation and operating instructions for proper operation and maintenance of gas appliances. If manufacturer instructions are not available, contact manufacturer to obtain replacement instructions or contact the Air-Conditioning, Heating and Refrigeration Institute (AHRI) for information on obtaining these instructions for gas appliances.
<p>Environmental Tobacco Smoke (ETS) – Exposure to ETS, also known as “secondhand smoke,” can occur if someone smokes in a home or apartment building. Exposure to secondhand smoke increases the risk of lung cancer in adults. Children are at increased risk of ear infections, bronchitis and pneumonia, Sudden Infant Death Syndrome (SIDS) and asthma symptoms. Secondhand smoke triggers symptoms in people who have asthma or chronic obstructive pulmonary disease (COPD).</p>	<ul style="list-style-type: none"> • Secondhand smoke poses health risks to non-smokers (e.g., cancer in adults, SIDS, breathing problems in children). • Do not allow smoking in the home. Smoke outside to reduce the risk to others in the home. • Provide access to information on local smoking cessation programs for those who want to quit. • Explore smoke-free housing policies for multi-family properties. Explain financial and reduced liability benefits to owners. See the National Center for Healthy Housing’s fact sheet Reasons to Explore Smoke Free Housing for additional information.

Priority Health Concerns	Recommended Occupant Health Messages
<p>Lead – Housing-related lead sources include flaking or peeling lead-based paint, leaded dust, lead in soil and lead in drinking water. Exposure can cause learning difficulties, behavior problems, hearing damage and in extreme cases seizures or death. Children under six years of age and pregnant women are at greatest risk.</p>	<ul style="list-style-type: none"> • Pregnant women and children under six years are at greatest risk. • In homes built before 1978: 1) If repainting, remodeling or disturbing paint, use lead safe-work practices; 2) Repair peeling paint using lead safe work practices in homes where young children or pregnant women live. • Consider testing blood lead levels in children younger than six years of age, if living in a pre-1978 home. • For pre-1978 homes with chipping exterior paint: Test soil for lead content and remove or cover lead-contaminated soil.
<p>Mold and Moisture – Mold can grow almost anywhere there is moisture in a house. Asthma symptoms, allergic reactions, and other respiratory symptoms can be triggered by damp indoor environments and mold. Inhaling mold spores can trigger asthma attacks in people sensitive to molds.</p>	<ul style="list-style-type: none"> • If you see mold on hard surfaces, clean it up with soap and water. Let the area dry completely. • Repair moisture problems to avoid dampness or mold. • Dry water-damaged areas and items within 24-48 hours after a leak or spill to prevent mold growth. • Avoid installing carpet in areas prone to wetting or moisture problems. • Run bathroom and kitchen fans when showering, cooking, etc., and run whole-house ventilation system according to manufacturer's instructions to help minimize moisture and contaminant buildup.
<p>Pests – Rodents, cockroaches, termites, birds, bats and other pests can be found in homes. Exposure to some pest droppings and body parts (e.g., from mice and cockroaches) can trigger asthma attacks. Rodents can also carry diseases such as hantavirus, which can result in a deadly condition called hantavirus pulmonary syndrome (HPS). Misusing pesticides to address pest problems can sometimes result in harmful exposures to carcinogens or chemicals that result in respiratory problems or allergic reactions.</p>	<ul style="list-style-type: none"> • Follow integrated pest management (IPM) strategies to reduce pest infestations and to avoid the overuse of pesticides: 1) Reduce pest access to water and food by properly storing food and trash and by using effective housekeeping techniques; 2) Limit pest entry by sealing holes and cracks; 3) Use targeted and least toxic pesticides. • Clean up pest droppings and body parts to reduce allergens. • Safely store pesticides out of reach of children.
<p>Polychlorinated Biphenyls (PCBs) – PCBs were manufactured domestically from 1929 until their manufacture was banned in 1979. PCBs have been shown to cause a variety of adverse health effects, including effects on the immune system, reproductive system, nervous system and endocrine system in animals. PCBs have also been shown to cause cancer in animals. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs.</p>	<ul style="list-style-type: none"> • Although no longer commercially produced in the U.S., PCBs may be present in products and materials produced before the 1979 PCB ban (e.g., transformers and capacitors, cable insulation, oil-based paint, caulk, plastics, floor finish). • Materials suspected of PCB contamination should be sampled, tested and safely abated by a professional.
<p>Radon – Radon is the #1 cause of lung cancer for non-smokers. It is the 2nd leading cause of lung cancer overall (after smoking), accounting for 21,000 deaths annually. A radioactive gas that comes from the natural decay of uranium in soil and water, radon can enter homes through openings in walls and floors where they come into contact with the ground. An estimated one in every 15 U.S. homes has radon levels at or above EPA's action level of 4 pCi/L.</p>	<ul style="list-style-type: none"> • The only way to know the radon level in your home is to test for it. • EPA and the Surgeon General recommend testing all homes below the third floor for radon. • Mitigate radon in homes if levels are greater than or equal to 4 pCi/L. Strongly consider mitigating homes with levels between 2 and 4 pCi/L. <ul style="list-style-type: none"> ◦ Radon levels below 4 pCi/L still pose a health risk and in many cases may be reduced. See EPA's A Citizen's Guide to Radon. • Make sure any existing radon mitigation system is functioning properly. If a vent fan is installed, check its condition first.

Priority Health Concerns	Recommended Occupant Health Messages
<p>Safety – Trips and falls, poisoning and burns are significant injury risks in homes. Poor lighting, lack of handrails, unstable stairs and other housing hazards increase the risk of falls. Improperly stored chemicals increase the risk of poisoning.</p>	<ul style="list-style-type: none"> • Smoke alarms and CO alarms should be installed in all homes and tested regularly. Replace batteries annually. Replace smoke alarms every 10 years and CO alarms every five to seven years. • Set hot water heater thermostats to 120 degrees Fahrenheit to reduce burns and scalds. • In homes where elderly persons live, reduce trip hazards, provide sufficient lighting on stairs, ensure handrails and grab bars are in key locations, and follow CDC's guide Check for Safety: A Home Fall Prevention Checklist for Older Adults. • In homes with young children, install gates at the tops of stairs and securely store chemicals and pesticides.
<p>Volatile Organic Compounds (VOCs) in Household Products and Materials – VOCs are found in many household products and materials including paints, carpets and pads, pressed wood, composite wood, cleaning supplies, air fresheners and furniture. Exposures can cause eye, nose and throat irritation, liver damage and cancer.</p>	<ul style="list-style-type: none"> • Select low-VOC products when possible (e.g., paint, carpet, furniture, cabinets, adhesives and cleaning products). Green testing and rating programs that assess products for VOCs and other health hazards include: <ul style="list-style-type: none"> ◦ California Department of Public Health, Emission Testing Method for California Specification 01350. ◦ Carpet and Rug Institute (CRI) Green Label or Green Label Plus program criteria or equivalent standards for carpet. ◦ Collaborative for High Performance Schools (CHPS) High Performance Products Database. ◦ Green Seal Standard GS-11. ◦ GreenGuard Children and Schools Certification Program. ◦ Master Painters Institute (MPI) Green Performance Standards GPS-1 or GPS-2. ◦ Scientific Certification Systems (SCS) Standard EC-10.2-2007 (Indoor Advantage Gold). • If using pressed or composite wood products, avoid products containing urea formaldehyde. Select products compliant with California Title 17. • Local ventilation can be used when strong sources of VOCs or other airborne contaminants are isolated to a specific room or area. Whole-house ventilation will also help reduce VOCs and other airborne contaminants in most homes. • Safely store chemicals out of reach of children. • Ensure fireplace chimney or wood stove flue is working properly (i.e., there is no wood smoke in the home). • Clean chimney once a year. • Follow EPA's Guide for Best Burn Practices for Wood Stoves. • If purchasing a new stove, ensure it is EPA-certified.
<p>Wood Smoke and Solid Fuel Emissions – Wood stoves and fireplaces can create emissions, and exposures can cause breathing problems.</p>	<ul style="list-style-type: none"> • Ensure fireplace chimney or wood stove flue is working properly (i.e., there is no wood smoke in the home). • Clean chimney once a year. • Follow EPA's Guide for Best Burn Practices for Wood Stoves. • If purchasing a new stove, ensure it is EPA-certified.

Client Education Resources:

Asbestos

EPA Asbestos: Asbestos in Your Home. 1990. U.S. Environmental Protection Agency.
<http://www.epa.gov/asbestos/pubs/ashome.html>
<http://www.epa.gov/asbestos/>

Asthma Triggers

EPA Asthma: Indoor Environmental Asthma Triggers. 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/asthma/triggers.html>

Carbon Monoxide

AHRF: Air-Conditioning, Heating and Refrigeration Institute.
<http://www.ahrinet.org/default.aspx>

CPSC Document #466: Carbon Monoxide Questions and Answers. 2008. U.S. Consumer Product Safety Commission.
<http://www.cpsc.gov/cpscpub/pubs/466.html>

EPA IAQ: An Introduction to Indoor Air Quality (IAQ), Carbon Monoxide. U.S. Environmental Protection Agency. 2011.
<http://www.epa.gov/iaq/co.html>

Environmental Tobacco Smoke

EPA Smoke-free Homes and Cars Program: U.S. Environmental Protection Agency. 2010.

<http://www.epa.gov/smokefree/>

NCHH Fact Sheet: Reasons to Explore Smoke-Free Housing. 2009. National Center for Healthy Housing.
http://www.nchh.org/Portals/0/Contents/Green%20FactSheet_Smokefree.pdf

Lead

EPA Lead-Based Paint Renovation, Repair, and Painting Program: Lead Safe Certified Guide to Renovate Right Brochure. 2010. U.S. Environmental Protection Agency.

<http://www.epa.gov/lead/pubs/renovaterightbrochure.pdf>

Mold and Moisture

EPA Mold: A Brief Guide to Mold, Moisture, and Your Home. 2010. U.S. Environmental Protection Agency.

<http://www.epa.gov/iedmold1/moldguide.html>

Pests

EPA Pests: Controlling Pests. U.S. Environmental Protection Agency. 2011.

<http://www.epa.gov/pesticides/controlling/index.htm>

New York City Department of Health and Mental Hygiene: How to Control Pests Safely. 2008. New York City Department of Health and Mental Hygiene.

http://www.healthylhomestraining.org/IPM/IPM_MPH_Ref_4_NYC_Pest_Control_9-11-08.pdf

Polychlorinated Biphenyls (PCBs)

EPA PCB: Polychlorinated Biphenyls. 2011. U.S. Environmental Protection Agency.

<http://www.epa.gov/epawaste/hazard/tsd/pcbs/index.htm>

Radon

EPA Radon Guidance: Citizen's Guide to Radon. 2009. U.S. Environmental Protection Agency.

<http://www.epa.gov/radon/pubs/citguide.html>

Safety

CDC Fall Prevention Checklist: Check for Safety: A Home Fall Prevention Checklist for Older Adults. 2009. U.S. Centers for Disease Control and Prevention.

<http://www.cdc.gov/HomeandRecreationalSafety/Falls/ChecklistForSafety.html>

Volatile Organic Compounds in Household Products and Materials

California Department of Public Health CAL-IAQ Program Standard: Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers. Version 1.1. 2010. California Department of Public Health.

<http://www.cal-iaq.org/vocs/standard-method-for-voc-emissions-testing-and-evaluation>

California Title 17: California Code of Regulations, Title 17, sections 93120 - 93120.12. 2008. State of California.

CRI: Green Label, Green Label Plus. The Carpet and Rug Institute.

<http://www.carpet-rug.org/commercial-customers/green-building-and-the-environment/green-label-plus/>

EPA IAQ: An Introduction to Indoor Air Quality (IAQ), Volatile Organic Compounds (VOCs). 2011. U.S. Environmental Protection Agency.

<http://www.epa.gov/iaq/voc.html>

Greenguard Children and Schools Certification Program: Greenguard Environmental Institute.

<http://www.greenguard.org/en/QuickSearch.aspx>

Green Seal Standard GS-11: GS-11: Green Seal Environmental Standard for Paints and Coatings. 2008. Green Seal, Inc.
<http://www.greenseal.org/GreenBusiness/Standards.aspx?vid=ViewStandardDetail&cid=0&sid=6>

MP1 GPS-1 and GPS-2: Master Painters Institute (MPI) Green Performance Standards for Paints and Coatings [GPS-1 and GPS-2]. 2008. Master Painters Institute, Inc.

<http://www.specifygreen.com/EvrPerf/EnvironmentalPerformance.html>

SCS Standard EC-10.2-2007: Standard EC-10.2-2007, Indoor Air Quality Performance. 2007. Scientific Certification Systems.
<http://www.scs-certified.com/docs/SCS-EC10.2-2007.pdf>

Wood Smoke and Solid Fuel Emissions

CSIA: Top-Down Method of Stove Loading. Chimney Safety Institute of America.

<http://www.csia.org/HomeownerResources/ChimneySafetyInfo/HOWTOBuildaTopDownBurn/tabid/229/Default.aspx>

EPA Burn Wise Guides: Burn Wise Guide for Best Burn Practices for Wood Stoves. 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/burnwise/bestburn.html>

ABBREVIATIONS

AC – Air Conditioning	IAQ – Indoor Air Quality
ACCA – Air Conditioning Contractors of America	IPM – Integrated Pest Management
ACM – Asbestos-Containing Material	LED – Light-Emitting Diode
AFHH – Alliance for Healthy Homes	MDI – Methylene Diphenyl Diisocyanate
AHRI – Air-Conditioning, Heating and Refrigeration Institute	MERV – Minimum Efficiency Reporting Value
ANSI – American National Standards Institute	MNCEE – Minnesota Center for Energy and Environment
ASHI – American Society of Home Inspectors	MPI – Master Painters Institute
ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers	MPI GPS – Master Painters Institute Green Performance Standard
ASPE – American Society of Plumbing Engineers	N/A – Not Applicable
ASTM – American Society for Testing and Materials	NAHB – National Association of Home Builders
BPI – Building Performance Institute	NCHH – National Center for Healthy Housing
CA – California	NEHA – National Environmental Health Association
CAZ – Combustion Appliance Zone	NESCAUM – The Clean Air Association of the Northeast States
CDC – Centers for Disease Control and Prevention	NFI – National Fireplace Institute
CEQ – White House Council on Environmental Quality	NFPA – National Fire Protection Association
cfm – Cubic feet per minute	NIOSH – National Institute for Occupational Safety and Health
CFR – Code of Federal Regulations	NIST – National Institute of Standards and Technology
CHPS – Collaborative for High Performance Schools	NRSB – National Radon Safety Board
CO – Carbon Monoxide	NVLAP – National Voluntary Laboratory Accreditation Program
CO₂ – Carbon Dioxide	ODS – Oxygen Depletion Sensor
COPD – Chronic Obstructive Pulmonary Disease	OSHA – Occupational Safety and Health Administration
CPSC – Consumer Product Safety Commission	PCBs – Polychlorinated Biphenyls
CRI – Carpet and Rug Institute	pCi/L – picocuries per liter
CSA – Canadian Standards Association	PELs – Permissible Exposure Limits
CSIA – Chimney Safety Institute of America	PLM – Polarized Light Microscopy
DOE – U.S. Department of Energy	ppm – Parts per million
DOL – U.S. Department of Labor	RRP – Renovation, Repair and Painting
EPA – U.S. Environmental Protection Agency	SCS – Scientific Certification Systems
EPA OSWER – U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response	SIDS – Sudden Infant Death Syndrome
ETS – Environmental Tobacco Smoke	SPF – Spray Polyurethane Foam
ft² – Square feet	TEM – Transmission Electron Microscopy
GS – Green Seal	U.S. – United States
HPIS – Hantavirus Pulmonary Syndrome	VOCs – Volatile Organic Compounds
HRV – Heat Recovery Ventilator	W.C. – Water Column
HUD – U.S. Department of Housing and Urban Development	XRF – X-Ray Fluorescence
HVAC – Heating, Ventilating and Air Conditioning	



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<http://www.epa.gov/iaq/homes/retrofits.html>

Pressure Pan/ Duct Sealing Potential Chart

The updated Pressure Pan/ Duct Sealing Potential process incorporates the total airflow of a distribution system into the calculation.

Use the spreadsheet below (double click on the spreadsheet) to establish the home's CFM50 and CFM25 Duct Sealing Potential.

Process:

1. Determine the **average** of a home's pressure pan results from all registers (both supply and return) tested. Repeat process for each individual distribution system. Each individual distribution system should have a leakage value.
2. Determine the airflow of each system. A default of 400 CFM per ton can be used.
3. Enter system airflow in yellow box.
4. Enter the average pressure pan reading in the blue box.
5. Duct leakage is capped at 70% entered flow. CFM reading output will be red if 70% limit is exceeded. In cases where the 70% limit is reached, use the 70% value in the green box.

	System Air Flow	Average Pressure Pan Reading				
	1200	13				
Not to Exceed 70%	840	2607	CFM50 leakage			
		1560	CFM25 leakage			

Navajo Nation

Priority List for Hogan Housing

The *Navajo Nation Priority List for Hogan Housing* lists the weatherization measures that shall be installed in Navajo hogan homes. The measures should be installed in order, as conditions dictate and funding allows. The most cost-effective measures are listed first. When no electric service is present, a more restrictive list of measures must be followed (see note on Electric Service below). Site-specific audits should be completed for unusual hogan homes or when measures not listed below appear suitable for a particular house.

An analysis of typical homes identified the following weatherization measures to be cost effective based on Navajo housing stock, energy costs, and climatic conditions.

Ensuring the health and safety of clients, contractors, and local agency personnel is an important component of the Weatherization Assistance Program. Health and safety inspection and testing should be conducted before delivery of weatherization services and after completion of work.



Wood Stoves:

- For wood stoves, DOE analysis indicates that **\$1,150 of total replacement costs can be financed through program operations funds**. The remaining installed cost should be financed from alternate non-federal funding sources.
- If total installed cost (including chimney kit) is under \$1,150, charge to program operations
- If total installed cost is over \$1,150, the chimney kit can be charged as health and safety to bring down the total installed cost.
- All wood stoves not being replaced should be checked for draft and CO to ensure they are safe.

Health and Safety Measures:

- The Navajo budget for health and safety measures is not to exceed 15% of program funding.
- DOE Health & Safety Notices (Weatherization Program Notice [WPN] 11-6 and subsequent versions) contain the guidance on allowable costs.
 - Excludes items such as windows, doors, ramps, and handrails
 - Costs are reasonable as determined by DOE in accordance with the Navajo Nation's approved Annual Plan; **AND**
 - The actions must be taken to effectively perform weatherization work; **OR**
 - The actions are necessary as a result of weatherization work.

Electric Service: Homes with no electric service must not install electricity-based priority list measures, including:

- Duct Sealing
- Lighting Retrofits
- Refrigerator Replacement

General Heat Waste Measures: (Items must only be performed on homes with hot water service)

- Set back water heater temperature to 120° F (with client approval)
- Install low-flow showerheads if existing showerhead has a flow rate greater than 2.5 gallons per minute. (with client approval)
- Install faucet aerators.
- Install insulating blanket on water heater tank if none exists. Follow unit labeling and safety guidelines detailed in the *Energy OutWest Field Guide*.
- Install pipe insulation on the first six feet of hot water pipe exiting the water heater.
- Install new furnace filter and air conditioner filter.

1. Air Sealing:

- Use the blower door and digital manometer to guide air sealing.
- Determine the closure target.
- Seal plumbing, electrical, and HVAC penetrations through ceiling, flooring, and exterior walls. Use proper materials for high-temperature surfaces.

Primary Space Heating Fuel	Cost limit per 100 CFM50 of reduction:
Wood	\$25.00
All other	\$50.00



2. Attic Insulation: The amount of attic insulation that can be cost-effectively added depends on the heating fuel used.

In hogans with vaulted un-insulated ceilings, NWAP personnel shall consult with the client to discuss adding a drop ceiling to improve efficiency and comfort with insulation.

NWAP must obtain written client approval to convert vaulted ceiling into a flat ceiling in order to add R-38 insulation. Use the insulation guidelines below. Ensure the ceiling can bear the weight of insulation. Consider using fiberglass if necessary.

- Air seal the attic, including wire and plumbing penetrations, recessed light fixtures, and other bypasses, prior to the installation of attic insulation.
- Check electrical circuits. Enclose exposed wires and connections in junction boxes and mark with flags for subsequent access.
- Use caution and consider building an enclosure around active knob-and-tube wiring before insulating.
- Check attic ventilation. There should be 1 square foot (ft²) of attic net free vent area for every 150 ft² of ceiling area if there is no vapor barrier¹. The ratio is 1:300 if a vapor barrier is present, or if 50% to 80% of the vents are placed at least 3 feet above the lower vents. Generally, half of the vent area should be located low and half should be located high to induce good ventilation.



Table 1 –Post-Weatherization Attic Insulation R-Values (No Existing Insulation)

Primary Space Heating Fuel	Add Insulation to:
Propane	R-49
All other	R-38

3. Lighting Retrofits: (Skip measure if home is without electric service)

- Install compact fluorescent lamps (CFLs) in sockets used more than two hours per day.
- Tip: Use ENERGY STAR-qualified CFLs with a correlated color temperature between 2,700 – 3,000K (warm white).
- Educate client on proper disposal.



¹ A sound, painted ceiling counts as a vapor barrier.

4. **Replace Refrigerator: (Skip measure if home is without electric service)**

- Determine annual energy consumption of existing unit by metering it for at least two hours. **Note: DOE requires grantees to meter at least 10% of units that are replaced.** Electricity usage of older refrigerators can also be found in the database http://www.waptac.org/sp.asp?mc=techaids_refrigerator.

Table 1 – Refrigerator Replacement: Maximum Cost for a Cost-Effective Refrigerator Replacement

Annual kWh/yr Existing Unit	Annual kWh/yr of New Refrigerator		
	400 kWh/yr	500 kWh/yr	600 kWh/yr
900	\$442	\$353	\$265
1,000	\$530	\$442	\$353
1,100	\$618	\$530	\$442
1,200	\$707	\$618	\$530
1,300	\$795	\$707	\$618
1,400	\$795	\$795	\$707
1,500	\$795	\$795	\$795
1,600	\$795	\$795	\$795

- Replacement refrigerators *may not* have through-the-door ice or water service.
- Original units must be removed and decommissioned

Incidental Repairs:

- Cost is limited to **\$400.00**
- Incidental repairs should only be undertaken after other priority list measures have been performed
- Incidental repairs must be energy related or installed to protect an energy related measure. Some examples include window or door repair.

Navajo Nation

Priority List for Mobile Home Housing

The *Navajo Nation Priority List for Mobile Home Housing* lists the weatherization measures that shall be installed in Navajo mobile homes. The measures should be installed in order, as conditions dictate and funding allows. The most cost-effective measures are listed first. When no electric service is present, a more restrictive list of measures must be followed (see note on Electric Service below). Site-specific audits should be completed for unusual mobile homes, those with additions or when measures not listed below appear suitable for a particular house.

An analysis of typical homes identified the following weatherization measures to be cost effective based on Navajo housing stock, energy costs, and climatic conditions.

Wood Stoves:

- For wood stoves, DOE analysis indicates that **\$2,400 of total replacement costs can be financed through program operations funds**. The remaining installed cost should be financed from alternate non-federal funding sources.
- If total installed cost (including chimney kit) is under \$2,400, charge to program operations
- If total installed cost is over \$2,400, the chimney kit can be charged as health and safety to bring down the total installed cost.
- All wood stoves not being replaced should be checked for draft and CO to ensure they are safe.

Health and Safety Measures:

- DOE Health & Safety Notices (Weatherization Program Notice WPN 11-6 and subsequent versions) contain the guidance on allowable costs.
 - Excludes items such as windows, doors, ramps, and handrails
 - Costs are reasonable as determined by DOE in accordance with the Navajo Nation's approved Annual Plan; **AND**
 - The actions must be taken to effectively perform weatherization work; **OR**
 - The actions are necessary as a result of weatherization work.

Electric Service: Homes with no electric service must not install electricity-based priority list measures, including:

- Duct Sealing
- Lighting Retrofits
- Refrigerator Replacement
- Heating System Replacement



General Heat Waste Measures: (Items must only be performed on homes with hot water service)

- Set back water heater temperature to 120° F (with client approval)
- Install low-flow shower heads if existing shower head has a flow rate greater than 2.5 gallons per minute (with client approval)
- Install faucet aerators.
- Install insulating blanket on water heater tank if none exists. Follow safety guidelines labeled on the unit and detailed in the *Energy OutWest Field Guide*.
- Install pipe insulation on the first six feet of hot water pipe exiting the water heater.

1. Duct Sealing: (Skip measure if home is without electric service)

- Seal accessible ducts, connections, and boots with mastic.
- Pressure pan test all registers with blower door running to determine relative air leakage of tested sites. The goal is a cumulative reading of 1 Pascal or less.



2. Air Sealing:

- Use the blower door and digital manometer to guide air sealing.
- Determine the closure target.
- Seal plumbing, electrical, and HVAC penetrations through ceiling, flooring, and exterior walls. Use proper materials for high-temperature surfaces.

Primary Space Heating Fuel	Cost limit per 100 CFM50 of reduction:
Wood	\$20.00
All other	\$35.00



3. Roof Insulation:

- Add blown fiberglass roof insulation to mobile home roofs without existing effective insulation.
- Air seal penetrations, including wire and plumbing penetrations, around furnace flues, and other bypasses, prior to insulating the roof.
- Check attic ventilation. There should be 1 square foot (ft²) of attic net free vent area for every 150 ft² of ceiling area if there is no vapor barrier¹. The ratio is 1:300 if a vapor barrier is present, or if 50% to 80% of the vents are placed at least 3 feet above the lower vents.



4. Belly Insulation:

- Repair holes and tears in belly fabric and blow loose-fill fiberglass insulation to uninsulated or poorly insulated belly cavities.
- Cost should not exceed **\$1.50** per square foot.



5. Lighting Retrofits: (Skip measure if home is without electric service)

- Install compact fluorescent lamps (CFLs) in sockets used more than two hours per day.
- Tip: Use ENERGY STAR-qualified CFLs with a correlated color temperature between 2,700 – 3,000K (warm white).
- Educate client on proper disposal.

¹ A sound, painted ceiling counts as a vapor barrier.

6. **Replace Refrigerator: (Skip measure if home is without electric service)**

- Determine annual energy consumption of existing unit by metering it for at least two hours. **Note: DOE requires grantees to meter at least 10% of units that are replaced.** Electricity usage of refrigerators can also be found in the database http://www.waptac.org/sp.asp?mc=techaids_refrigerator.

Table 1 – Refrigerator Replacement: Maximum Measure Cost for a Cost-Effective Refrigerator Replacement

Annual kWh/yr Existing Unit	Annual kWh/yr of New Refrigerator		
	400 kWh/yr	500 kWh/yr	600 kWh/yr
900	\$442	\$353	\$265
1,000	\$530	\$442	\$353
1,100	\$618	\$530	\$442
1,200	\$707	\$618	\$530
1,300	\$795	\$707	\$618
1,400	\$795	\$795	\$707
1,500	\$795	\$795	\$795
1,600	\$795	\$795	\$795

- Replacement refrigerators *may not* have through-the-door ice or water service.
- Original units must be removed and decommissioned.

7. **Heating and Cooling Systems: (Skip measure if home is without electric service)**

- Heating system replacements are cost-effective under the circumstances displayed in Table 2.
- Manual J calculations must be completed to appropriately size the heat pump with higher order weatherization measures included.
- A clean and tune not to exceed \$150 total cost is appropriate if the existing system does not need to be replaced. Install new furnace filter or air conditioning filter.
- If measured CO level of the heating system is 100ppm or greater the clean and tune is an allowable health and safety cost.
- Inoperable furnaces being replaced with a wood stove is a fuel switch and must be approved on a case by case basis. They must also be replaced with health and safety funds.



Table 2 – Heating System Replacement Maximum Installed Costs

Existing Unit	Replacement Unit	Maximum Installed Cost
Electric Furnace – Ducts in place	Heat Pump	\$4,400
Propane Furnace – 75% SSE or less	Propane Furnace – 90 AFUE or better	\$3,500

8. **Storm Windows:**

- Installations can occur to existing single pane windows
- Maximum installed cost of **\$4.80** per square foot.

Incidental Repairs:

- Cost is limited to **\$400.00** in total.
- Incidental repairs should only be undertaken after other priority list measures have been performed
- Incidental repairs must be energy related or installed to protect and energy related measure. Some examples include window or door repair.

Navajo Nation

Priority List for Single-Family Housing

The *Navajo Nation Priority List for Single-Family Housing* lists the weatherization measures that shall be installed in Navajo single-family homes. The measures should be installed in order, as conditions dictate and funding allows. The most cost-effective measures are listed first. When no electric service is present, a more restrictive list of measures must be followed (see note on Electric Service below). Site-specific audits should be completed for unusual single-family homes or when measures not listed below appear suitable for a particular house.

An analysis of typical homes identified the following weatherization measures to be cost effective based on Navajo housing stock, energy costs, and climatic conditions.



Wood Stoves:

- For wood stoves, DOE analysis indicates that **\$2,300 of total replacement costs can be financed through program operations funds**. The remaining installed cost should be financed from alternate non-federal funding sources.
- If total installed cost (including chimney kit) is under \$2,300, charge to program operations
- If total installed cost is over \$2,300, the chimney kit can be charged as health and safety to bring down the total installed cost.
- All wood stoves not being replaced should be checked for draft and CO to ensure they are safe.

Health and Safety Measures:

- DOE Health & Safety Notices (Weatherization Program Notice [WPN] 11-6 and subsequent versions) contain the guidance on allowable costs.
 - Excludes items such as windows, doors, ramps, and handrails
 - Costs are reasonable as determined by DOE in accordance with the Navajo Nation's approved Annual Plan; **AND**
 - The actions must be taken to effectively perform weatherization work; **OR**
 - The actions are necessary as a result of weatherization work.

Electric Service: Homes with no electric service must not install electricity-based priority list measures, including:

- Duct Sealing
- Lighting Retrofits
- Refrigerator Replacement
- Heat Pump Installation

General Heat Waste Measures: (Items must only be performed on homes with hot water service)

- Set back water heater temperature to 120° F (with client approval)
- Install low-flow showerheads if existing showerhead has a flow rate greater than 2.5 gallons per minute. (with client approval)
- Install faucet aerators.
- Install insulating water heater tank blanket if none exists. Follow safety guidelines detailed in the *Energy OutWest Field Guide*.
- Install pipe insulation on the first six feet of hot water pipe exiting the water heater.
- Install new furnace filter or air conditioner filters.

1. Duct Sealing: (Skip measure if home is without electric service)

- Seal accessible ducts, connections, and boots with mastic.
- Insulate ducts located outside the conditioned space with R-4, foil-faced duct insulation.
- Pressure pan test all registers with blower door running to determine relative air leakage of tested sites. The goal is a reading of 1 Pascal or less.



2. Air Sealing:

- Use the blower door and digital manometer to guide air sealing.
- Determine the closure target.
- Seal plumbing, electrical, and HVAC penetrations through ceiling, flooring, and exterior walls. Use proper materials for high-temperature surfaces.

Primary Space Heating Fuel	Cost limit per 100 CFM50 of reduction:
Wood	\$25.00
All other	\$50.00



3. Attic Insulation: The amount of attic insulation that can be cost-effectively added depends on existing levels of insulation and HVAC type. If existing insulation is R-19 or less, add insulation until the R-value in **Table 1** is reached.

- Air seal the attic, including wire and plumbing penetrations, recessed light fixtures, and other bypasses, prior to insulating the attic.
- Check electrical circuits. Enclose exposed wires and connections in junction boxes.
- Check attic ventilation. There should be 1 square foot (ft²) of attic net free vent area for every 150 ft² of ceiling area if there is no vapor barrier¹. The ratio is 1:300 if a vapor barrier is present, or if 50% to 80% of the vents are placed at least 3 ft. above the lower vents. Generally, half of the vent area should be located low and half should be located high to induce good ventilation.



Table 1 – Post-Weatherization Attic Insulation R-Values

Primary Space Heating Fuel	If existing insulation is R-19 or less, add to reach these levels:
Propane	R-49
All other	R-38

¹ A sound, painted ceiling counts as a vapor barrier.

4. **Side Wall Insulation:** See the *Dense-Pack Sidewall Insulation* technical brief for installation procedures.

- Drill test holes to determine existing insulation.
- If there is no existing wall insulation, dense-pack all sidewall cavities with insulation at the recommended density.
- If all test holes indicate existing wall insulation, skip sidewall insulation measure.
- If some wall cavities have existing insulation and some do not, drill additional test holes to determine if sidewall dense-packing is warranted. If at least half of the wall cavities have no existing insulation, dense-pack all sidewalls with insulation.
- Wall insulation should only be installed in walls that can withstand the additional insulation.
- There is an additional allowance of up to \$2.00/sf to insulate a wall that needs to be substantially rebuilt before it can be insulated.



5. **Floor Insulation:**

- Before adding floor insulation, establish an effective air barrier at the floor.
- Add insulation to R-11 or maximum amount that joist dimensions will allow to all uninsulated floors.
- Install vapor barrier in crawl spaces.



6. **Lighting Retrofits: (Skip measure if home is without electric service)**

- Install compact fluorescent lamps (CFLs) in sockets used more than two hours per day.
- Tip: Use ENERGY STAR-qualified CFLs with a correlated color temperature between 2,700 – 3,000K (warm white).
- Educate client on proper disposal.

7. **Replace Refrigerator: (Skip measure if home is without electric service)**

- Determine annual energy consumption of existing unit by metering it for at least two hours. **Note:** DOE requires grantees to meter at least 10% of units that are replaced. Electricity usage of refrigerators can also be found in the database http://www.waptac.org/sp.asp?mc=techaids_refrigerator.

Table 2 – Refrigerator Replacement: Maximum Measure Cost for a Cost-Effective Refrigerator Replacement

Annual kWh/yr Existing Unit	Annual kWh/yr of New Refrigerator		
	400 kWh/yr	500 kWh/yr	600 kWh/yr
900	\$442	\$353	\$265
1,000	\$530	\$442	\$353
1,100	\$618	\$530	\$442
1,200	\$707	\$618	\$530
1,300	\$795	\$707	\$618
1,400	\$795	\$795	\$707
1,500	\$795	\$795	\$795
1,600	\$795	\$795	\$795

- Replacement refrigerators **may not** have through-the-door ice or water service.
- Original units must be removed and decommissioned.

8. **Heating and Cooling System: (Skip measure if home is without electric service)**

- Installing a **Heat Pump Replacement** can **only** occur in a home heated by a forced air electric furnace **and** a central air conditioner (existing equipment in place).
- Home must already have ducts.
- Manual J calculations must be completed to appropriately size the heat pump with higher order weatherization measures included.
- Maximum installed cost: **\$2,500**.
- Inoperable furnace replacements must use health and safety funds.
- A clean and tune not to exceed \$150 total cost is appropriate if the existing system does not need to be replaced. Install new furnace filter or air conditioning filter.
- If measured CO level of the heating system is 100ppm or greater the clean and tune is an allowable health and safety cost.
- Switching from furnaces to wood stoves is a fuel switch and must be approved on a case by case basis.

Incidental Repairs:

- Cost is limited to **\$400.00** in total
 - Incidental repairs should only be undertaken after other priority list measures have been performed
 - Incidental repairs must be energy related or installed to protect an energy related measure.
- | • Some examples include window or door repair

ASHRAE 62.2-2013 Whole Building Ventilation Calculations

New and Existing Homes

[Clear Entries](#)

Basic Building Data

Select State or Province

Select City

Enter Square footage

Enter # of Bedrooms

Select # of Floors

Infiltration Credit

Start

Finish

Enter Blower Door CFM₅₀

--	--

Appendix A Existing Building Calculations

Kitchen

Start

Finish

Window?

Enter Fan CFM

Bath 1

Window?

Enter Fan CFM

Bath 2

Is there a 2nd Bath?

Window

Enter Fan CFM

Bath 3

Is there a 3rd Bath?

Window

Enter Fan CFM

Ventilation "Deficit" CFM

--	--

Start

Finish

Exist. Adjusted Whole Bldg CFM

#N/A

#N/A

New Bldg Whole Bldg CFM

#N/A

#N/A

(Note for new homes Local Exhaust ventilation must be added)

ACH₅₀

No CFM50

No CFM50

ACH_{Natural}

No CFM50

No CFM50

Target CFM₅₀ (0.35 ACH)

#N/A

About this sheet

This sheet is designed to determine the volume of airflow required to meet the ASHRAE 62.2-2013 whole building ventilation requirement.

There is a tab at the bottom of the page that links to a Report Sheet that can be completed and signed to document the system.

The "Exist. Adjusted Whole Bldg CFM" cells display the ventilation requirements for existing buildings adjusted for existing fans, windows and infiltration credit.

The "Whole Bldg CFM (New Bldg)" displays the CFM required for new buildings, adjusted with the infiltration credit. Note that for new buildings, local exhaust ventilation must also be installed.

It displays required ventilation when the building is tightened, calculates the ACH_{50} , $ACH_{natural}$ and the Target CFM50 for .35 $ACH_{natural}$.

Ceiling height assumed to be 8 feet.

Note that the calculations are based on ASHRAE's TMY 3 weather data, and the number of stories of the building.

If Macros are active, select "Clear Entries" to clear all the entry fields.

Using the Sheet

Select the closest State or Province.

Select the closest Weather Station.

Enter the square footage of the house.

Enter the number of bedrooms.

Select the number of floors.

Enter the Blower Door CFM_{50} (if it is known) in the "Start" cell.

Existing Building Adjustment

NOTE: Calculations assume that if there is no entry for a window or fan in the kitchen, the Existing building calculations are not being used.

The "Finish" column allows you to adjust the fan sizes to achieve a '0' cfm deficit.

Select "Yes" or "No" for a window in the kitchen.

Enter the measured fan CFM in the kitchen.

Select "Yes" or "No" for a window in the bathroom.

Enter the measured fan CFM in the bathroom.

Select "Yes" or "No" for second bathroom, etc.

Note that for intermittent control, click the Intermittent Control tab.

Click on the Report Control tab for a printable report version of the data.

Whole Building Ventilation Intermittent Control

All information with PINK fill is generated automatically.

Enter the total cycle time (total On plus Off time).

Enter the cfm fan to be used, sheet will calculate required ON time

or

Enter the desired fractional on time (half time would be .5)

and the sheet will calculate the cfm of the fan required.

Clear
Entries

House is in: , 0
Square feet: 0
of Bedrooms: 0
of Stories: 0

Continuous Whole Building Ventilation Required

	Start	Finish
Existing Bldg	#N/A	#N/A
New Building	#N/A	#N/A

For Intermittent Operation

Enter Total cycle Time Time On + Time Off: 2 Hour(s)

Existing House	Start	Finish
Enter installed fan CFM:		
Minutes on:	#N/A	#N/A
Minutes off:	#N/A	#N/A
OR	Start	Finish
Enter desired fractional on-time:		
Fan cfm Required:	#N/A	#N/A
Minutes on:	0	0
Minutes off:	120	120

New House	Start	Finish
Enter installed fan CFM:	80	
Minutes on:	#N/A	#N/A
Minutes off:	#N/A	#N/A
OR	Start	Finish
Enter desired fractional on-time:		
Fan cfm Required:	#N/A	#N/A
Minutes on:	0	0
Minutes off:	120	120

#N/A

Project Name:	
Project Address:	
Project City:	
Project State:	0
Project Zip:	

Floor area:	0	Square feet
# of Bedrooms:	0	
Combustion CFM Threshold:	0	cfm

If the sum of highest flow rate of the two largest fans exceeds this number, make-up air must be supplied to any atmospherically vented appliance.

Whole Building Ventilation Type:	
----------------------------------	--

	Continuous	Intermittent
Control (check):		
Closest Weather Station:	0	
Target CFM ₅₀ (0.35 ACH)	#N/A	

Blower Door (CFM ₅₀):	Start	Finish
	0	0
ACH ₅₀	No CFM50	No CFM50
ACH _n	No CFM50	No CFM50
Whole Building CFM Required		
New	#N/A	#N/A
Existing	#N/A	#N/A
Measured Flow (enter):		

These calculations were made to determine the correct ventilation flow rate based on the ASHRAE 62.2-2013 Standard. I attest that the results are correct and accurate to the best of my knowledge and ability.

Signed:	
For:	
Date:	



NEW: FREE Combustion Safety App

Advanced Energy is proud to announce the release of the new Combustion Safety App. With support from the Southwest Building Science Training Center and Foundation for Senior Living, this new tool is available for FREE. The app assists with the combustion safety testing process - typically a home performance contractor as part of an energy assessment or in combination with any additional home energy upgrades such as air sealing, insulating, HVAC upgrades, etc.

HOW TO USE THIS APP:

- Enter the data for each step. This data will give feedback during testing and be stored for a final report.
- Use the arrow beside each step for further instruction and illustration.
- Enter information in all input fields to complete testing.
- Select an appliance from the drop-down menu. The Combustion Appliance Zones will be auto-populated from the appliance section.
- When completed, enter your email address and click save to save a completed report to your phone or email to have a completed report sent to your email address.

The Combustion Safety App can be downloaded through the Google Android Marketplace or iTunes, depending on your device. Click the link to below to download, or launch your phone store through the QR Code.



If you have any questions about this app or would like additional information program, you can visit the following sites:

- Advanced Energy: www.AdvancedEnergy.org
- Foundation for Senior Living: www.FSL.org
- Southwest Building Science Training Center: www.swbstc.org