



SUCCESS WITH WEATHERIZATION ARIZONA





SUCCESS WITH WEATHERIZATION

Contents

Critical Details Field Guide List.....	2
Non Critical Details - Quick Links.....	3
Health & Safety Info Sheet.....	4
Duct Repair.....	6
Ventilation.....	36
Air Sealing.....	59
Prep + Insulation.....	82
Appendix.....	137



SUCCESS WITH WEATHERIZATION

Critical Details Field Guide List

Accessing Duct Leakage Sites [N/A](#)

Bar faced Grille [*5.3003.3](#)

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”



SUCCESS WITH WEATHERIZATION

Health & Safety Information Sheet

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.

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 multifamily 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/iag/pdfs/epa_retrofit_protocols.pdf



SUCCESS WITH WEATHERIZATION

Health & Safety Information Sheet

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 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.

OSHA Regulations

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

1. Work site operations are 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.

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 environments during home energy upgrades and retrofits. It addresses these measures:

1. Contaminants
2. Critical Building Systems
3. Safety



Duct Repair

What every contractor needs to know



SUCCESS WITH WEATHERIZATION

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
Critical Detail: Installing Flex Ducts	16
Critical Detail: Installing Duct Support for flex Ducts	18
Critical Detail: Installing Duct Straps	20
Information Sheet: Accessing Duct leakage Sites	22
Tech Tips: Accessing Duct leakage Sites	23
Critical Detail: Sealing Small, medium + large Holes	26
Critical Detail: Installing bar-faced Return grilles	33



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:

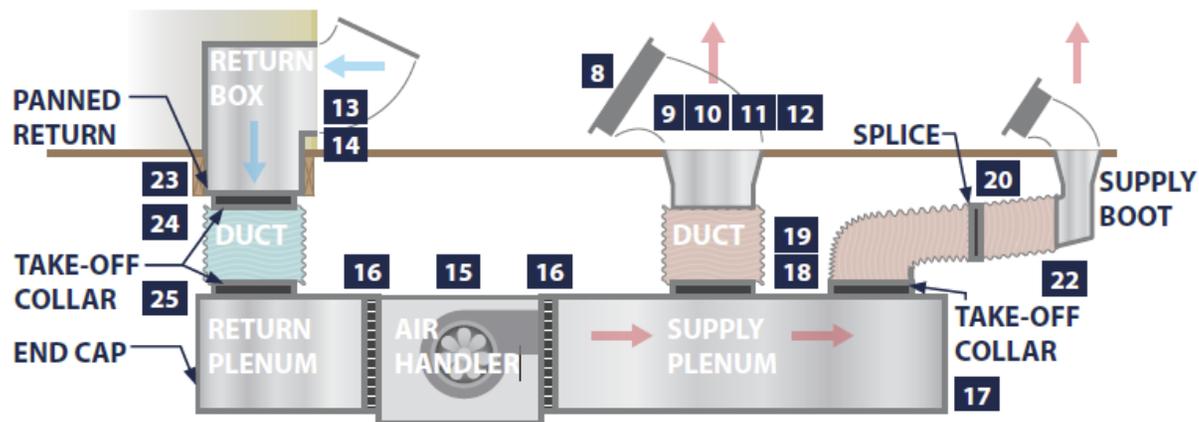
- Sewer gases, fuel oil, chemicals and other pollutants in crawl spaces or attics
- Mold-like growth in attics and crawl spaces
- Presence of pest/rodents in crawl spaces or attics
- lack of CO alarm in all houses
- Unvented combustion appliances
- Duct tapes and wrappings that are likely to contain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

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



SUCCESS WITH WEATHERIZATION

Duct Sealing Checklist



✓ 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 & durability issues before starting work & 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 & feel for air flowing out of each supply with your hand. Note any lines not providing air. Turn the fan off
- 8. Remove all supply registers and return grills
- 9. Fasten all supply boots to subfloor with screws
- 10. Seal all duct inner liners to each supply boot



SUCCESS WITH WEATHERIZATION

- 11. Seal all seams of each supply boot
- 12. Seal all gaps between the subfloor or ceiling and the supply boot
- 13. Seal all seams of each return box
- 14. Seal all gaps between the subfloor, wall/ceiling, and the return box

✓ N/A Outside the Living Space

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

✓ N/A Close Out

- 26. Clean the work area
- 27. Complete a combustion safety test and record the results
- 28. Educate occupants on the work completed

Job Information

Name:

Initials:



SUCCESS WITH WEATHERIZATION

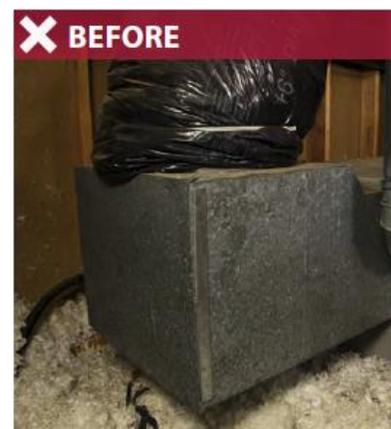
Sealing Ducts

Critical Detail: [SWS 3.1602.1c](#)

Desired Outcome: Ducts and plenums sealed to prevent leakage.

Materials	Tools
Mastic	Utility Knife or Scissors
Fiberglass Mesh Tape	Mastic Brush
Duct Tape	Tin Snips
Sheet Metal	Flashlight/Headlamp
Support Material	Drill
Screws	

Duct and plenum not sealed



Duct and plenum sealed



Safety & Notes

Materials & tools listed are only recommendations & may not include everything needed to complete the job

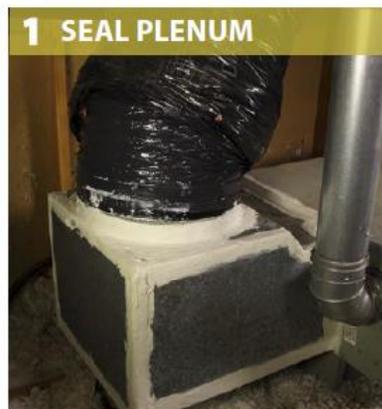


SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1602.1c](#)

Sealing Ducts

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.



Replace outer liner and insulation.



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



Safety & Notes
<i>Gloves, appropriate respirator, safety glasses</i>



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1602.1a](#)

Installing Metal Ducts

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.

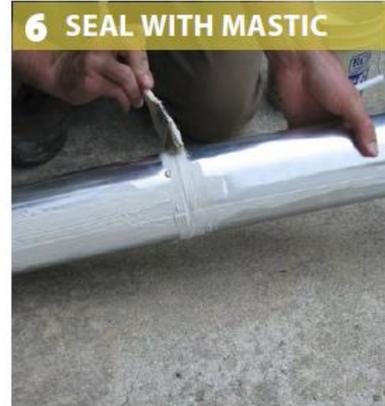
For the connection between the duct and the termination, install the termination cap adaptor.



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.



Safety & Notes
Gloves, appropriate respirator, safety glasses



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1601.1c](#)

Installing Flex Ducts

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.



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



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



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



Seal each flex duct connection with mastic.



Pull flex duct insulation into place and seal with mastic.



Support the duct at least every 4 ft.





SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1601.3a](#)

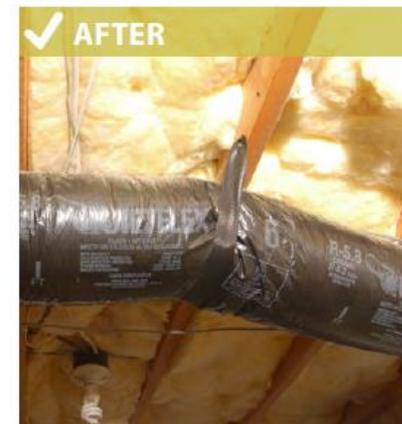
Installing Duct Support for Flex Ducts

Desired Outcome: Ducts & plenums properly supported.

Materials	Tools
Screws	Utility Knife/Scissors
Washers	Flashlight/headlamp
1 1/2" wide support material	

Flex duct need support straps

Flex duct supported every 4' using a minimum of 1.5" wide material, creating no crimps or interior dimension reduction



Safety & Notes
Gloves, appropriate respirator, safety glasses

Materials & tools listed are only recommendations & may not include everything needed to complete the job



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1601.3a](#)

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:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1601.3](#)

Installing Duct Straps

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.



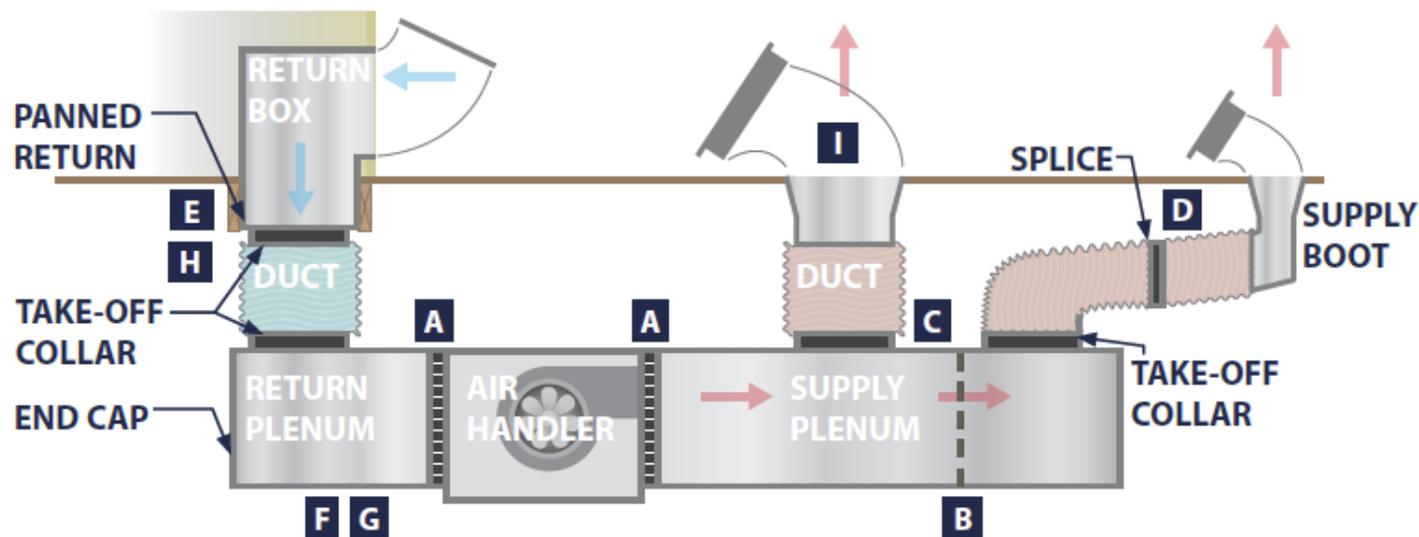
Notes:

Notes:



SUCCESS WITH WEATHERIZATION

Accessing Duct Leakage Sites



Duct Leakage Sites

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

1. Air handler to plenum
2. S & Drive connections
3. Take off collar to plenum
4. Splices
5. Return Platform
6. Metal Plenums
7. Duct Board Plenums
8. Panned Returns
9. Inner Liner to Boot Connections
10. 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 minimum, these tools:

1. Utility knife or scissors
2. Screwdrivers
3. Drill
4. Flashlight
5. Cutter
6. 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.

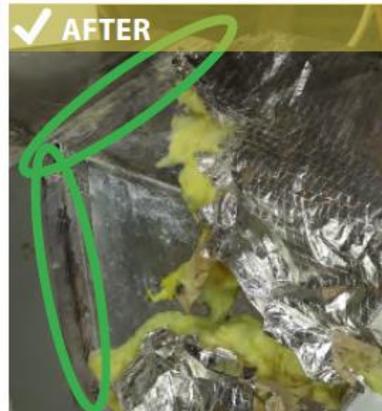
For more information about how to seal these locations please reference our Sealing Duct Leakage Sites CRITICAL DETAILS.



SUCCESS WITH WEATHERIZATION

Tech Tips: Accessing Duct Leakage Sites

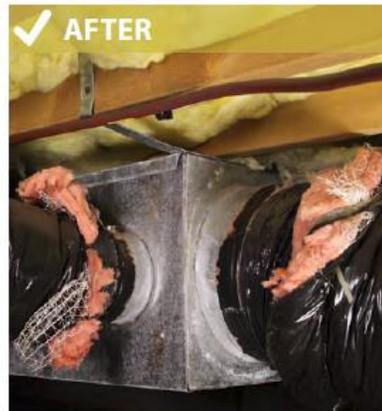
A. Air Handler to Plenum (Externally insulated metal): Gain access to joint by peeling back plenum insulation.



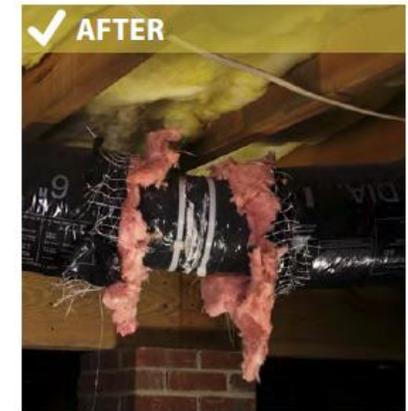
B. S and Drive Connections in Plenum (Externally insulated metal): Gain access to joint by peeling back plenum insulation.



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.

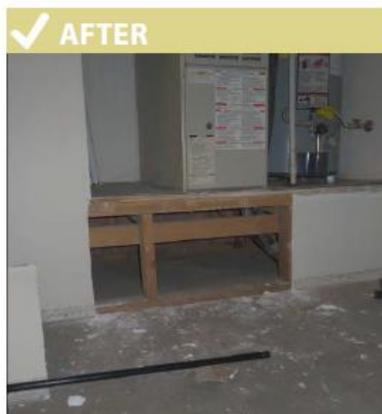
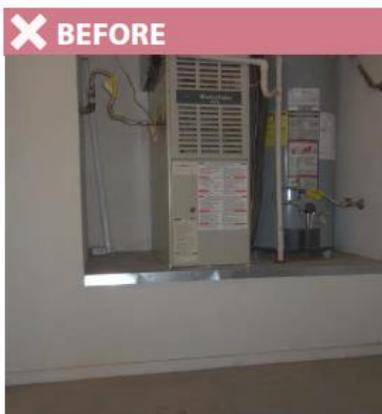




SUCCESS WITH WEATHERIZATION

Tech Tips: Accessing Duct Leakage Sites

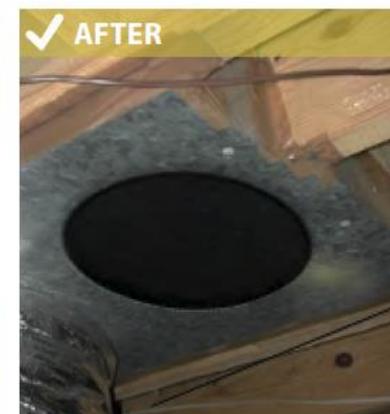
- E. Return Platform: Create temporary access hole by removing or cutting cladding of return platform.



- 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.



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

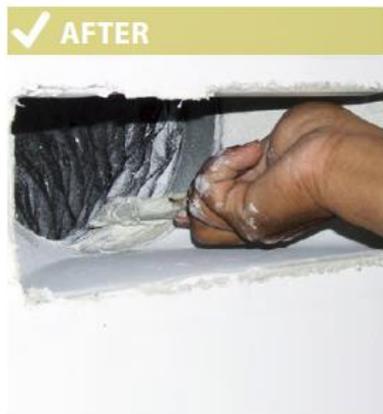




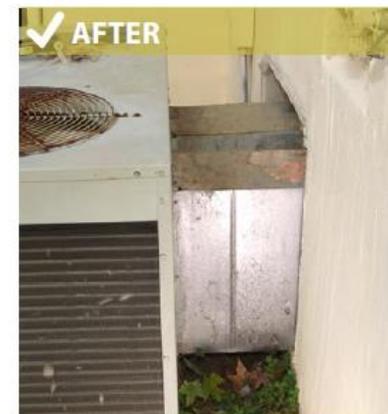
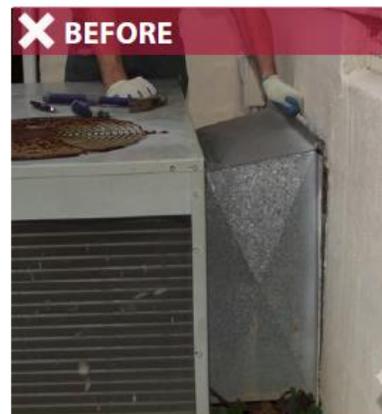
SUCCESS WITH WEATHERIZATION

Tech Tips: Accessing Duct Leakage Sites

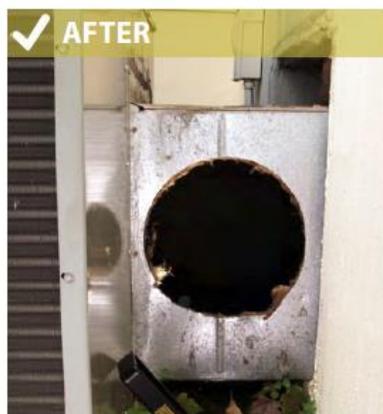
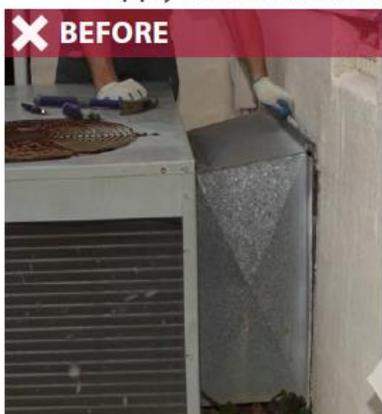
- I. Inner Liner to Boot: Gain access to connection from inside home by removing supply grill.



- 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.



Safety & Notes

Gloves, appropriate respirator, safety glasses



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 3.1602.1](#)

Sealing Small, Medium, & Large Holes

Desired Outcome: Ducts & plenums properly supported.

Materials	Tools
Mastic	Utility Knife/scissors
Fiberglass Mesh Tape	Mastic Brush
Duct Tape	Tin Snips
Sheet Metal	Flashlight/headlamp
Support Material	Drill
Screws	

After gaining access to the leakage site, choose the appropriate sealing technique from below. Each of these step-by-step groupings illustrate a specific sealing technique based on the hole size. Please reference the vertical gray text boxes and first step of each series to ensure the correct step-by-step process is being followed. There are 3 sets to choose from:

(SMALL Holes) - MASTIC ONLY:

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

(Medium Holes) - TEMPORARY TAPE + MASTIC + MESH TAPE:

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

(Large Holes) - RIGID SUPPORT + MASTIC + MESH TAPE:

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

Safety & Notes
Gloves, appropriate respirator, safety glasses

Materials & tools listed are only recommendations & may not include everything needed to complete the job



Critical Details: [SWS 3.1602.1](#)

Sealing Small Holes

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

Seal with mastic.

1 SMALL HOLE



2 MASTIC



Notes:



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 3.1602.1](#)

Sealing Medium Holes

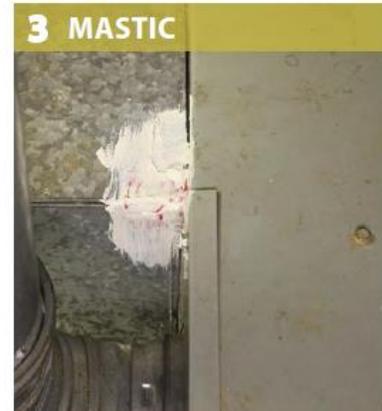
Seams, cracks, joints, holes and penetrations that are 1/4-inch to 3/4-inch.



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.



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



Notes	
<i>Temporary tape can be a variety of different tapes. It is used to prevent mastic from falling into the hole & should only be used if also using mesh tape for reinforcement.</i>	

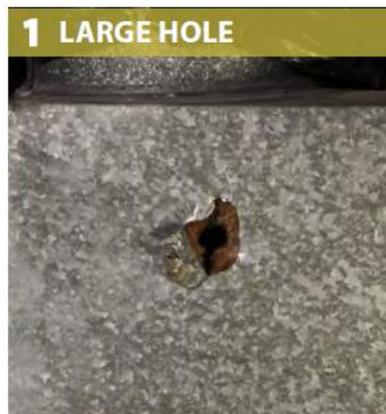


SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 3.1602.1](#)

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.



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



Notes



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 3.1602.1](#)

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.



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



Notes



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 3.1602.1](#)

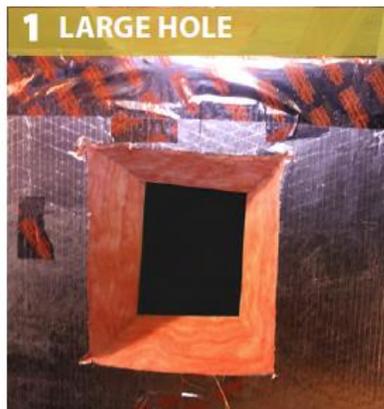
Sealing Large Holes

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.



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



Notes



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 5.3003.3](#)

Bar-Faced Grille Installation

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

1 SCORE



Remove filter and grill.

2 REMOVE FILTER



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

3 REMOVE FASTENERS



Remove frame.

4 REMOVE FRAME



Seal return to sheetrock connection.

5 SEAL



Install new grille and filter.

6 INSTALL GRILLE



Notes

Notes



SUCCESS WITH WEATHERIZATION

Sealing Framed Return Platforms

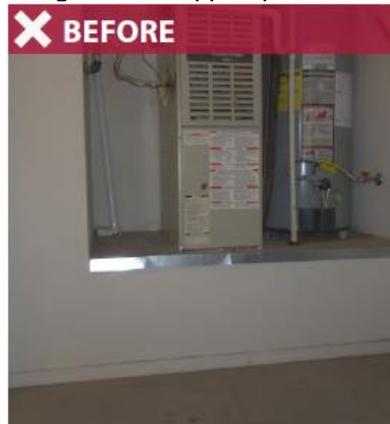
Critical Details: [SWS 3.1602.5](#)

Desired Outcome: Return air sealed to minimize air leakage.

Materials	Tools
Duct Board	

Materials & tools listed are only recommendations & may not include everything needed to complete the job

Rough frame support platform



Platform lined and air sealed



Safety & Notes
Gloves, appropriate respirator, safety glasses



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 3.1602.5](#)

Sealing Framed Return Platforms

Remove grille or cut access hole into framed platform.

1 ACCESS RETURN



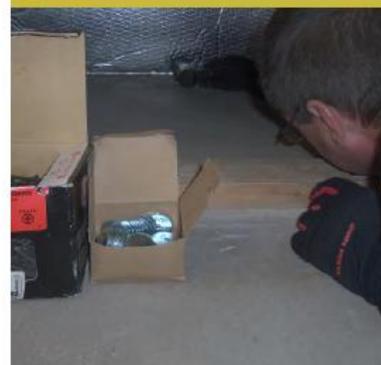
Clean out debris and dirt from return platform.

2 PREP RETURN



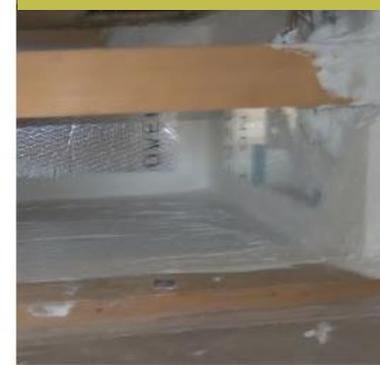
Line plenum with duct board. Mechanically fasten duct board to framing.

3 INSTALL DUCT BOARD



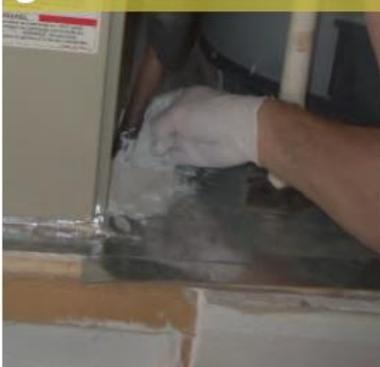
Seal the inside of the return. Choose the appropriate sealing technique based on hole size.

4 DUCT BOARD SEALED



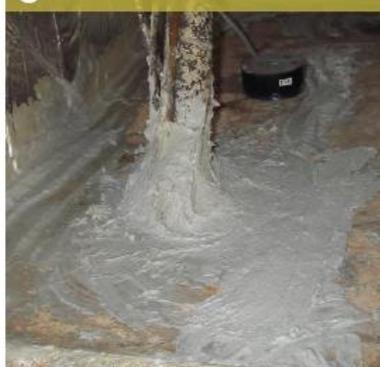
If refrigerant and condensate lines penetrate the platform return, provide infill and seal as needed.

5 SEAL PENETRATIONS



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

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

What every contractor needs to know



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

Health + Safety.....	38
Bathroom Exhaust fan Replacement Checklist.....	39
Bathroom Exhaust fan Installation Checklist.....	41

Additional Job Aids

Critical Detail: Replacing bathroom Exhaust fans.....	42
Critical Detail: Installing bathroom Exhaust fans.....	45
Critical Detail: Installing Roof Terminations for Exhaust fans.....	49
Critical Detail: Installing Wall Terminations for Exhaust fans.....	52
Critical Detail: Installing Transfer grilles.....	55
Critical Detail: Installing Jump Ducts.....	57



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 implementing Home Performance Work.

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.



SUCCESS WITH WEATHERIZATION

Existing Bathroom Exhaust Fan Replacement

- N/A Prep
- 1. Verify current fan does not meet program requirements
- 2. Complete a combustion safety test & record the results
- 3. Verify the selected fan will exhaust the required amount of air & has a back-draft damper
- 4. Verify the selected fan can be properly installed in the selected location
- 5. Put on all personal protection equipment (PPE)
- 6. Identify all worker and occupant safety hazards
- 7. Identify all potential durability issues
- 8. Address all combustion safety, worker safety, occupant safety & durability issues before starting work & notify the occupant. **Do not complete work if a life safety hazard is identified.**
- N/A Work
- 9. Turn off power to the existing fan at the electrical panel
- 10. Remove the existing fan and install the new fan. **Notice:** All electrical work must be completed by a licensed electrician
- 11. Install duct work with appropriate fittings by following the **Duct Repair Critical Details**
- 12. Install a termination to the outside
- 13. Set the ventilation rate on the fan or fan switch to the required airflow
- 14. Verify the airflow matches the program requirement by completing an air flow test
- 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. **Notice:** it is important to inform them that the fan may run after switch has been turned off.



SUCCESS WITH WEATHERIZATION

Job Information

Name:

Initials:

Address:

Date:



SUCCESS WITH WEATHERIZATION

New Bathroom Exhaust Fan Installation

- N/A Prep
 - 1. Complete a combustion safety test & record the results
 - 2. If the fan is the primary ventilation strategy, select a centrally-located bathroom for installation
 - 3. Verify the selected fan will exhaust the required amount of air & has a back-draft damper
 - 4. Verify the selected fan can be properly installed in the selected location
 - 5. Verify that the exterior termination for the selected fan can be properly installed in the selected location
 - 6. Put on all personal protection equipment (PPE)
 - 7. Identify all worker and occupant safety hazards
 - 8. Identify all potential durability issues
 - 9. Address all combustion safety, worker safety, occupant safety & durability issues before starting work & notify the occupant. **Do not complete work if a life safety hazard is identified.**
- N/A Work
 - 10. Install the fan. **Notice:** All electrical work must be completed by a licensed electrician
 - 11. Install duct work with appropriate fittings by following the **Duct Repair Critical Details**
 - 12. Install a termination to the outside
 - 13. Set the ventilation rate on the fan or fan switch to the required airflow
 - 14. Verify the airflow matches the program requirement by completing an air flow test
- 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.



SUCCESS WITH WEATHERIZATION

Job Information

Name:

Initials:

Address:

Date:



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 6.6003.1](#)

Replacing Bathroom Exhaust Fans

Turn off power to the fan at electrical panel.



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.



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



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



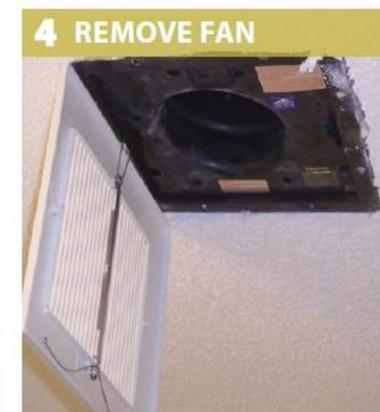
Disconnect the wires and remove from housing. Notice: Licensed electrician only.



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



Remove the fan and housing.



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





SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 6.6003.1](#)

Replacing Bathroom Exhaust Fans

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

9 AIR SEAL



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

10 INSTALL DUCT



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

11 TEST AIR FLOW



Notes:



SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 6.6003.1](#)

Installing Bathroom Exhaust Fans

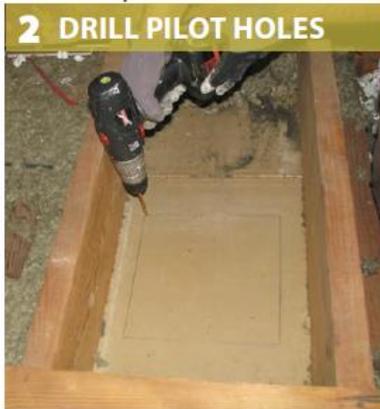
Select the bath fan location close to the tub or shower. Trace the outline of the fan onto the drywall.

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 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





SUCCESS WITH WEATHERIZATION

Critical Details: [SWS 6.6003.1](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Details: SWS [6.6002.2](#)

Installing Roof Terminations Exhaust Fans

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

1 TRACE OUTLINE



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

2 DRILL PILOT HOLES



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

3 TRACE OUTLINE



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

4 CUT HOLE



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

5 PRY SHINGLES



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

6 NOTICE: COLLAR



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

7 INSTALL VENT CAP



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

8 SEAL VENT CAP





SUCCESS WITH WEATHERIZATION

Installing Roof Terminations Exhaust Fans

Critical Details: SWS [6.6002.2](#)

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

Install screen material with no less than 1/4" and no greater than 1/2" hole size in any direction.

9 NOTICE: LOCATION



10 INSTALL SCREEN



Notes:

Notes:

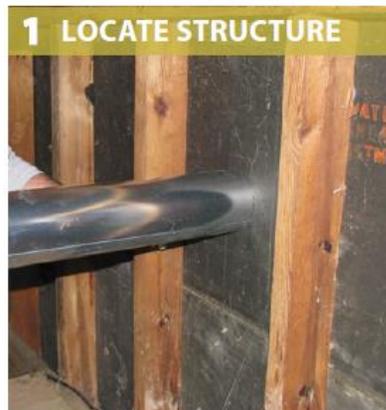


SUCCESS WITH WEATHERIZATION

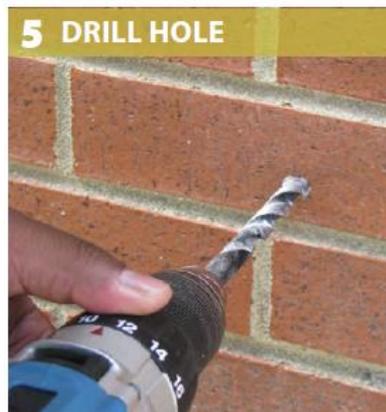
Critical Details: SWS [6.6002.2](#)

Installing Wall Terminations Exhaust Fans

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



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



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



Notice: Install proper flashing around termination hole.



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



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



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



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





SUCCESS WITH WEATHERIZATION

Installing Wall Terminations Exhaust Fans

Critical Details: SWS [6.6002.2](#)

Install screen material with no less than 1/4" and no greater than 1/2" 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:



SUCCESS WITH WEATHERIZATION

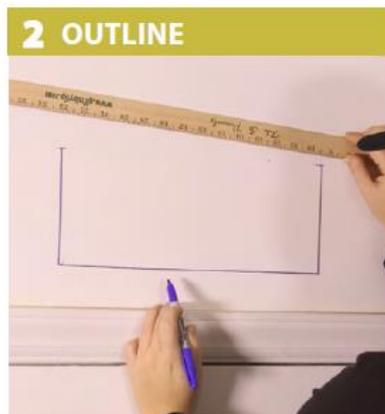
Critical Details: SWS [6.6201.2](#)

Installing Wall Transfers

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.



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.



SUCCESS WITH WEATHERIZATION

Critical Details: SWS [6.6201.2](#)

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.



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.





Air Sealing

What every contractor needs to know



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:

Health + Safety.....	61
Air Sealing Survey Checklist.....	63
Air Sealing Checklist.....	65

Additional Job Aids

Critical Detail: Sealing Cathedral Ceiling Skylights.....	66
Critical Detail: Sealing Penetrations.....	68
Critical Detail: Sealing knee Walls.....	70
Critical Detail: Sealing Tongue + Groove Ceilings.....	72
Critical Detail: Sealing Balloon Framing.....	74
Critical Detail: Capping Chases.....	76
Critical Detail: Capping Soffits.....	78
Critical Detail: Capping Stairwells.....	80



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 implementing Home Performance Work.

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.



House Floor Plan

Create a diagram of the house below:



SUCCESS WITH WEATHERIZATION

Air Sealing Survey

✓	N/A	Assessment
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety testing before starting work & 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 & soffits that are adjacent to the attic
<input type="checkbox"/>	<input type="checkbox"/>	4. Draw conditioned & unconditioned spaces on 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 upon that interior assessment

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
Bottom plates of knee walls	Missing wall cavity top plates	CMU Hollow cones
Floor		
Chases	Electrical	
Plumbing	Blocking of all floor cavities	
Job Information		

Assessor Name:

Initials:

Address:

Date:



SUCCESS WITH WEATHERIZATION

<input checked="" type="checkbox"/>	N/A	Prep
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety test & record the results
<input type="checkbox"/>	<input type="checkbox"/>	2. Verify that 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 & durability issues before starting work & notify the occupant. Do not complete work if a life safety hazard is identified.
<input type="checkbox"/>	<input type="checkbox"/>	7. Create diagram of the attic walls and/or floor, identifying areas that need sealing
<input checked="" type="checkbox"/>	N/A	Air Sealing
<input type="checkbox"/>	<input type="checkbox"/>	8. Remove existing insulation at air selling locations
<input type="checkbox"/>	<input type="checkbox"/>	9. For homes with vented exterior soffits, install protective baffling
<input type="checkbox"/>	<input type="checkbox"/>	10. Install installation dams
<input type="checkbox"/>	<input type="checkbox"/>	11. Verify that all wall cavities have six sides. Install additional blocking where necessary
<input type="checkbox"/>	<input type="checkbox"/>	12. Install infill material in all extra large holes
<input type="checkbox"/>	<input type="checkbox"/>	13. Seal all small, medium, and large holes between the unconditioned and conditioned space
<input type="checkbox"/>	<input type="checkbox"/>	14. Reinstall removed insulation and install new insulation to align with the air barrier and according to the manufacturer's specification. Verify that all insulation has no gaps, voids, compression, or misalignment
<input checked="" type="checkbox"/>	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.

Job Information

Name:

Initials:

Address:

Date:



Air Sealing Guidelines

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

¼ inch or less (small)		¼ inch – 2 inches (medium)		2 – 3 inches (large)		3 inches or more
Seal with Caulking		Seal w/ 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, and 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
Bottom plates of knee walls	Missing wall cavity top plates	CMU Hollow cones
Floor		
Chases	Electrical	
Plumbing	Blocking of all floor cavities	



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1001.3](#)

Sealing 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.



Notes:

Notes:



SUCCESS WITH WEATHERIZATION

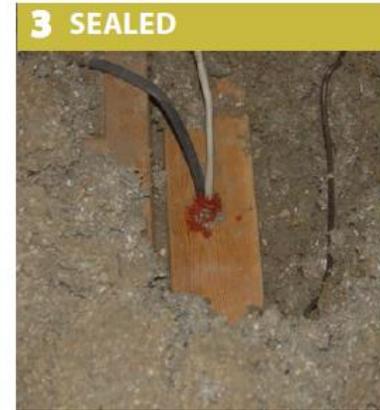
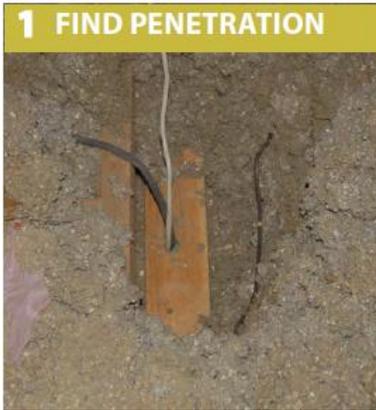
Critical Detail: [SWS 3.1001.4](#)

Sealing Penetrations

Leaking wiring penetration.

Seal penetration with caulk or foam.

Penetration air sealed.



Notes:

Select a sealant that meets local code requirements regarding flammability.



SUCCESS WITH WEATHERIZATION

Sealing Knee Walls

Critical Detail: [SWS 3.1001.3](#)

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.



Notes:

Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1005.1](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1001.3](#)

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.



Notes:

Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1001.2](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1003.6](#)

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).



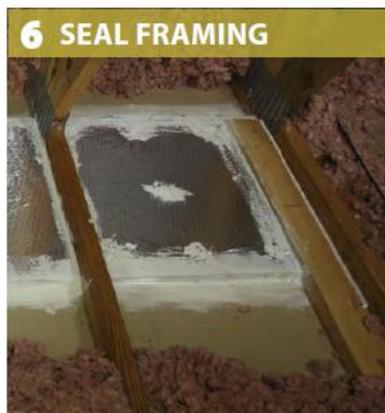
Install and fasten rigid sheathing over soffit/dropped ceiling.



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 materials since excessive hammering may crack interior surfaces (e.g. drywall).



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1002.1](#)

Capping Stairwells

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



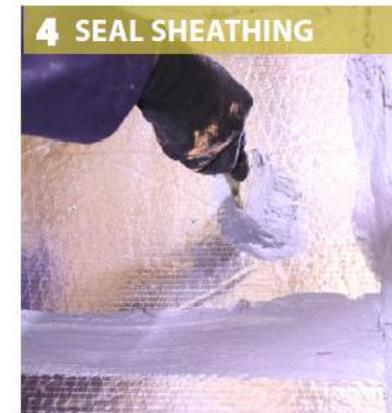
IMPORTANT: Rigid sheathing must have 15-minute fire rating if interior walls are not fire rated.



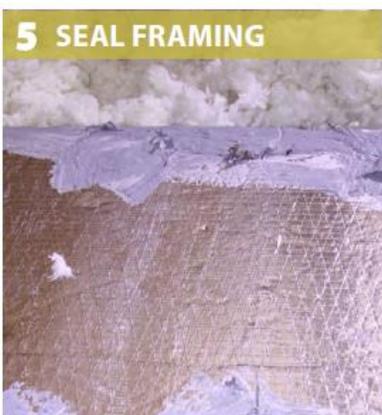
Install and fasten rigid sheathing over stairwell.



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



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



Notes	
	Be cautious when installing support materials since excessive hammering may crack interior surfaces (e.g. drywall).



Prep & Insulation

What every contractor needs to know



SUCCESS WITH WEATHERIZATION

Prep & Insulation Contents

Prep and Insulation 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:

Health + Safety.....	85
Roof Deck Insulation Checklist.....	86
Attic Insulation Checklist.....	87
Crawlspace and/or basement Insulation Checklist.....	88
Open Wall Cavity Insulation Checklist.....	89
Closed Wall Cavity Insulation (Dense Pack) Checklist.....	90
Information Sheet: 2015 IECC Insulation levels.....	91
Information Sheet: Installing Insulation.....	92
Tech Tips: Installing Insulation.....	93
Additional Job Aids	
Critical Detail: Replacing knob + Tube Wiring.....	95
Critical Detail: Enclosing Uninsulated (Non-IC Rated) Recessed lights.....	97



SUCCESS WITH WEATHERIZATION

Prep & Insulation Contents

Critical Detail: Installing Dams Around Chimneys + flues.....	98
Critical Detail: Installing Ventilation baffles.....	100
Critical Detail: Insulating Attic Access Hatches.....	103
Critical Detail: Insulating Attic Pull-Down Stairs.....	105
Critical Detail: Insulating Access Doors.....	107
Critical Detail: Treating Soffit Perimeters.....	109
Critical Detail: Treating Stairwell Perimeters.....	111
Critical Detail: Enclosing knee Walls with Rigid backing.....	113
Critical Detail: Enclosing knee Walls with flexible backing.....	115
Critical Detail: Enclosing knee Walls with Strapping.....	117
Critical Detail: Insulating manufactured knee Walls.....	119
Critical Detail: Enclosing knee Walls with Rigid backing and blowing Insulation.....	121
Critical Detail: Enclosing knee Walls with flexible backing and blowing Insulation.....	123
Critical Detail: Enclosing Skylight Shafts.....	125
Critical Detail: Insulating Attic Platforms.....	127
Critical Detail: Insulating floor Cavities above garages with Dense Pack Insulation.....	129
Critical Detail: Insulating Attics with blow-In Insulation.....	131
Critical Detail: Insulating Attics with blow-In Insulation over Existing batts.....	133



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 implementing Home Performance Work.

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

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.



SUCCESS WITH WEATHERIZATION

Roof Deck Insulation

<input checked="" type="checkbox"/>	N/A	Prep
<input type="checkbox"/>	<input type="checkbox"/>	1. Complete a combustion safety test & record the results
<input type="checkbox"/>	<input type="checkbox"/>	2. Verify that 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 & durability issues before starting work & notify the occupant. Do not complete work if a life safety hazard is identified.
<input checked="" type="checkbox"/>	N/A	Air Sealing
<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. If the removal of insulation exposes combustion safety, worker safety, occupation safety, and durability issues, they MUST be addressed prior to starting work. 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 (knob & tube wiring, or other hazards)
<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 specification. Verify that all insulation has no gaps, voids, compression, or misalignment
<input checked="" type="checkbox"/>	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:



SUCCESS WITH WEATHERIZATION

Attic Insulation

- N/A Prep
- 1. Complete a combustion safety test & record the results
- 2. Verify that 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 & durability issues before starting work & notify the occupant. **Do not complete work if a life safety hazard is identified.**
- N/A Air Sealing
- 7. Identify areas where insulation will not be installed (knob & tube wiring, or other hazards)
- 8. Seal all holes between the interior of the house and the attic.
- 9. For homes with vented exterior soffits, install protective baffling
- 10. Install insulation dams
- 11. Install insulation according to the manufacturer's specification. 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:



SUCCESS WITH WEATHERIZATION

Crawlspace and/or Basement Insulation

- N/A Prep
- 1. Complete a combustion safety test & record the results
- 2. Verify that 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 & durability issues before starting work & notify the occupant. **Do not complete work if a life safety hazard is identified.**
- N/A Air Sealing
- 7. Remove existing damaged insulation from the crawlspace/basement
- 8. If the removal of insulation exposes combustion safety, worker safety, occupation safety, and durability issues, they **MUST** be addressed prior to starting work. Notify the occupant. **Do not complete work if a life safety hazard is identified.**
- 9. Identify areas where insulation must not be installed (knob & tube wiring, or other hazards)
- 10. Seal all holes between the crawlspace/basement & the interior & exterior of the house
- 11. Install insulation according to the manufacturer's specification. 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:



SUCCESS WITH WEATHERIZATION

Open Wall Cavity Insulation

- N/A Prep
 - 1. Complete a combustion safety test & record the results
 - 2. Verify that 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 & durability issues before starting work & notify the occupant. **Do not complete work if a life safety hazard is identified.**
- N/A Air Sealing
 - 7. Remove existing damaged insulation. If the removal of insulation exposes combustion safety, worker safety, occupation safety, and durability issues, they **MUST** be addressed prior to starting work. Notify the occupant. **Do not complete work if a life safety hazard is identified.**
 - 8. Identify wall cavities without top and bottom plates and install blocking
 - 9. Seal all holes in the wall
 - 10. Install insulation according to the manufacturer's specification. Verify that all insulation has no gaps, voids, compression, or misalignment
 - 11. Install a backing material to enclose insulation
 - 12. Seal all holes in the backing material
- N/A Close Out
 - 13. Clean the work area
 - 14. Complete a combustion safety test and record the results
 - 15. Educate occupants on the work completed.

Job Information

Name:

Initials:

Address:

Date:



SUCCESS WITH WEATHERIZATION

Enclosed Wall Cavity Insulation (Dense Pack)

- N/A Prep
- 1. Complete a combustion safety test & record the results
- 2. Verify that 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 & durability issues before starting work & notify the occupant. **Do not complete work if a life safety hazard is identified.**
- N/A Air Sealing
- 7. Gain access to all wall cavities & probe for obstructions and/or hazards
- 8. Install insulation according to the manufacturer's specification
- 9. View completed sections using an IR camera with a blower door operating. Drill & repack any voids/low density areas
- 10. Seal access points of all wall cavities. Patch exterior holes with a weather barrier. Patch & 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:



SUCCESS WITH WEATHERIZATION

2015 IECC Insulation Levels

TABLE N1102.1.2 (R402.1.2) INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT^a

CLIMATE ZONE	FENESTRATION U-FACTOR(b)	SKYLIGHT(b) U-FACTOR	GLAZED FENESTRATION SHGC(b,e)	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT(c) WALL R-VALUE	SLAB(d) R-VALUE & DEPTH	CRAWL SPACE(c) WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13+5(h)	8/13	19	5/13	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5(h)	8/13	19	10/13	10, 2ft	10/13
5 & Marine 4	0.32	0.55	NR	49	20 or 13+5(h)	13/17	30(g)	15/19	10, 2ft	15/19
6	0.32	0.55	NR	49	20+5 or 13+10 (h)	15/20	30(g)	15/19	10, 4ft	15/19
7 & 8	0.32	0.55	NR	49	20+5 or 13+10 (h)	19/21	38(g)	15/19	10, 4ft	15/19



For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

c. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. 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 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure N1101.10 and Table N1101.10.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

h. The first value is cavity insulation, the second value is continuous insulation, so "13+5" means R-13 cavity insulation plus R-5 continuous insulation.

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.



SUCCESS WITH WEATHERIZATION

Insulation Information Sheet

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

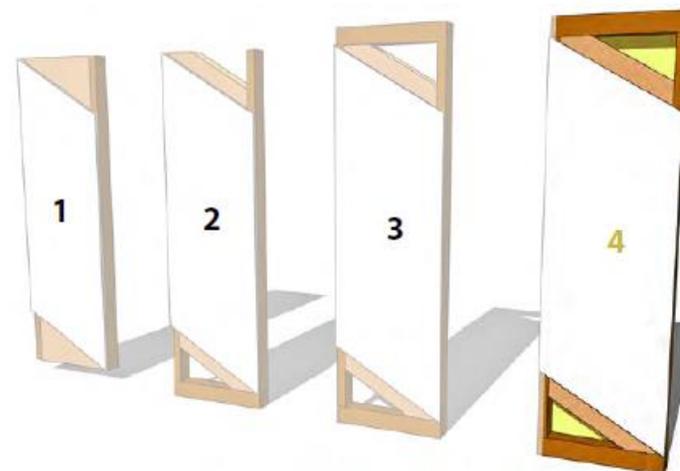
Properly installed insulation consists of insulation framed on all six sides, including top and bottom plates, rigid backing and sheathing. Ensure that framing is correctly installed prior to the start of insulation. By verifying that the framer has created six-sided wall cavities, insulators will save 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.

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.

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.

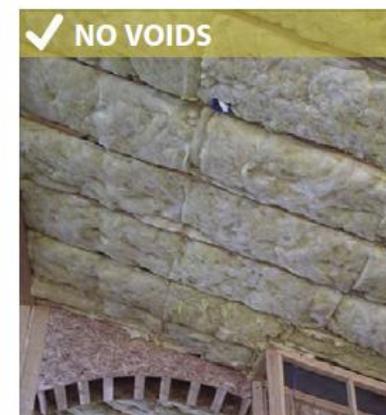
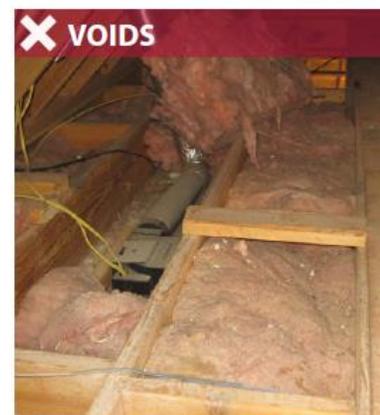


SUCCESS WITH WEATHERIZATION

Tech Tips: Installing Insulation

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.



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.



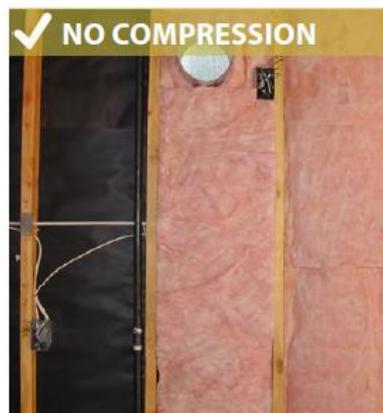


SUCCESS WITH WEATHERIZATION

Tech Tips: Installing Insulation

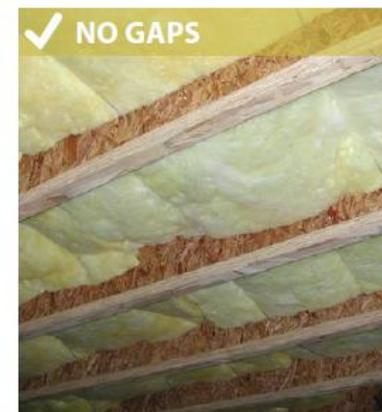
Cut and split insulation around blocking, plumbing, HVAC and electrical components.

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.





SUCCESS WITH WEATHERIZATION

Replacing Knob & Tube Wiring

Critical Detail: [SWS 4.1001.2](#)

Desired Outcome: Insulation kept away from contact w/live wiring

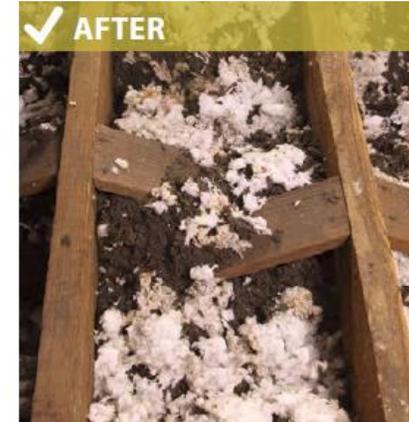
Materials	Tools
Non-Contact voltage tester	

Materials & tools listed are only recommendations & may not include everything needed to complete the job

House visually inspected to identify knob & tube wiring



Documented Inspection



Safety & Notes
Gloves, appropriate respirator, safety glasses
Notice: Use a non-contact voltage tester (clamp style or surface style).
Opinion: If wiring must remain, install insulation dams around the wiring to prevent contact.



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1001.2](#)

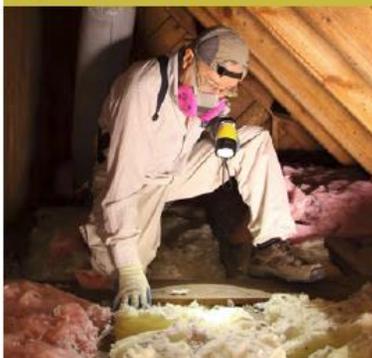
Replacing Knob & Tube Wiring

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.

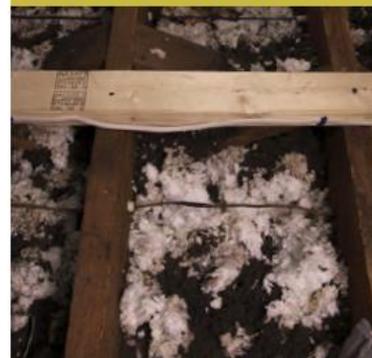
1 INSPECT WIRING



2 TEST WIRING



3 REPLACE WIRING



Notes:



SUCCESS WITH WEATHERIZATION

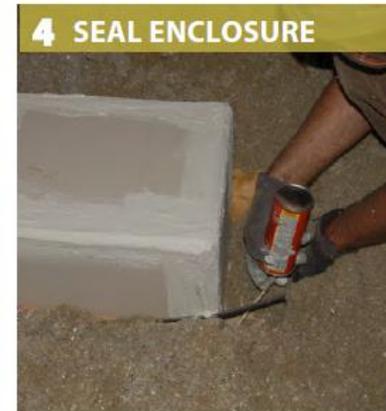
Critical Detail: [SWS 3.1001.10](#) Enclosing Uninsulated (non-IC rated) Recessed Lights

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.



Finished air tight enclosure. No insulation on top.



Notes



SUCCESS WITH WEATHERIZATION

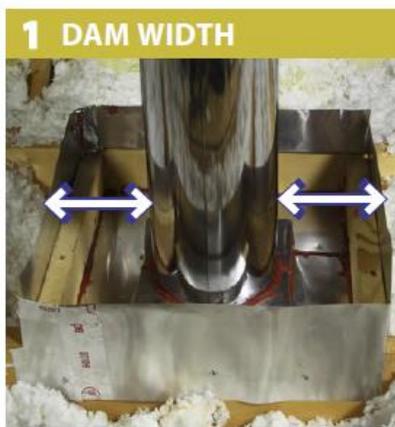
Critical Detail: [SWS 4.1001.3](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1001.4](#)

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:



SUCCESS WITH WEATHERIZATION

Installing Attic Access Hatches

Critical Detail: [SWS 4.1006.2](#)

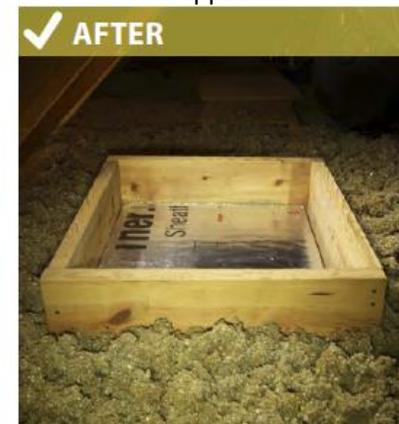
Desired Outcome: Attic access door or hatches properly sealed and insulated to minimize heat loss or gain

Materials	Tools
Dam materials, see note	

Attic hatches that are uninsulated and undammed



Attic hatch insulated, dammed, and weatherstripped



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 & tools listed are only recommendations & may not include everything needed to complete the job



SUCCESS WITH WEATHERIZATION

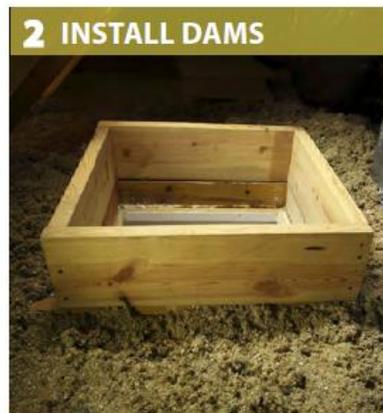
Critical Detail: [SWS 4.1006.2](#)

Installing Attic Access Hatches

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



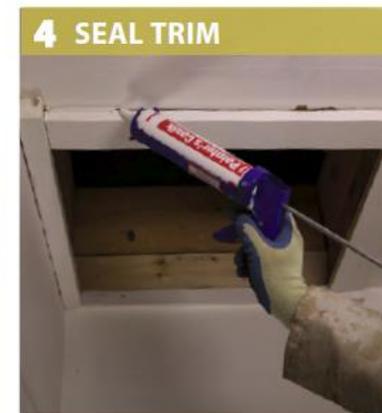
Install dams to prevent insulation from falling out of attic.



Install and weatherstrip access hatch or trim. Verify seal.



Air seal trim in place.



Notes:

Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1006.1](#)

Installing Attic Pull-Down Stairs

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

1 INSULATE STAIRS



Install dams to prevent insulation from falling out of attic.

2 INSTALL DAMS



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

3 SEAL FRAMING



Install and weatherstrip stair or trim. Verify seal.

4 WEATHERSTRIP



Air seal trim in place.

5 SEAL TRIM



Notes

Notes



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1006.2](#)

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:

Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1003.6](#)

Treating Soffit Perimeters

Prepare work area and remove debris.



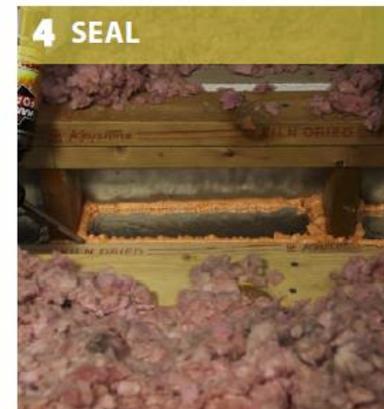
If insulation is on exterior wall, cut at ceiling level.



Install blocking in each wall cavity.



Air seal all gaps, holes and seams.



Notes:

Notes:



SUCCESS WITH WEATHERIZATION

Treating Stairwell Perimeters

Critical Detail: [SWS 3.1002.2](#)

Desired Outcome: Stairwells sealed to prevent air leakage and Moisture between the attic & conditioned space

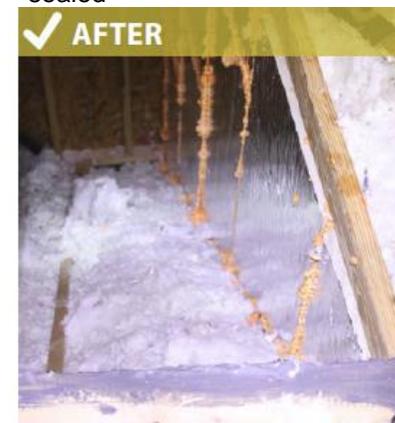
Materials	Tools
Blocking	

Materials & tools listed are only recommendations & may not include everything needed to complete the job

Wall Cavities within the Stairwell Open to the attic



Wall cavities insulated and air sealed



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.



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 3.1002.2](#)

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.



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



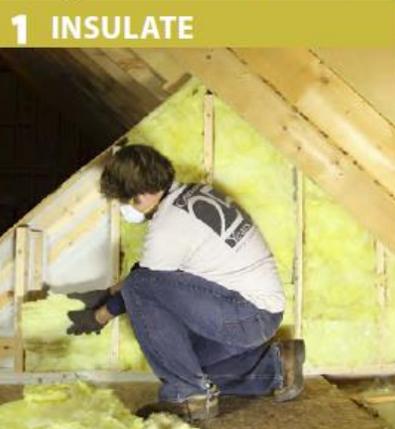
SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1004.1](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Enclosing Knee Walls with Flexible Backing

Critical Detail: [SWS 4.1004.1](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1004.3](#)

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:

Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1004.4](#)

Insulating 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.



Notes:

Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1004.1](#)

Enclosing Knee Walls w/Rigid Backing & Blowing

Insulation

Fasten rigid material to ensure blown insulation stays in place.

Blown insulation installed to manufacturers' specified density.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1004.1](#) Insulation

Enclosing Knee Walls w/Flexible Backing & Blowing

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.



Notes:



SUCCESS WITH WEATHERIZATION

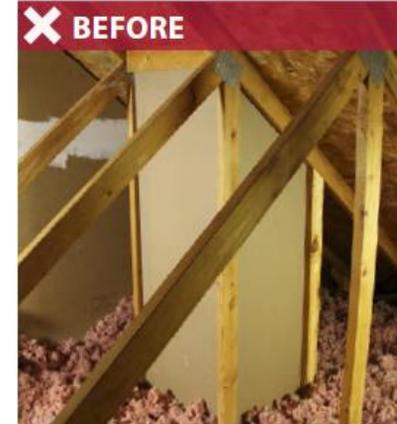
Enclosing Skylight Shafts

Critical Detail: [SWS 4.1088.3](#)

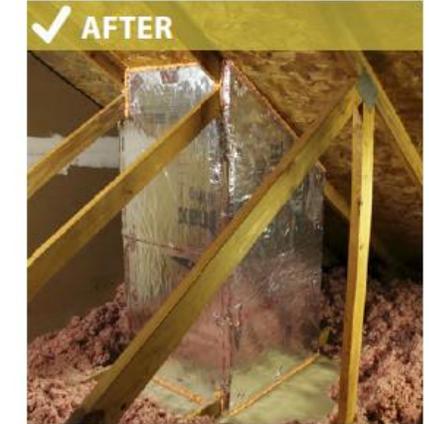
Desired Outcome: Consistent, uniform thermal boundary between the conditioned space & unconditioned space to prescribed R-value

Materials	Tools

Skylight shaft not air sealed or insulated



Skylight fully air sealed and insulated



Safety & Notes
<i>Gloves, appropriate respirator, safety glasses</i>
<i>Any evidence of roof leak must be fixed prior to air sealing</i>

Materials & tools listed are only recommendations & may not include everything needed to complete the job



SUCCESS WITH WEATHERIZATION

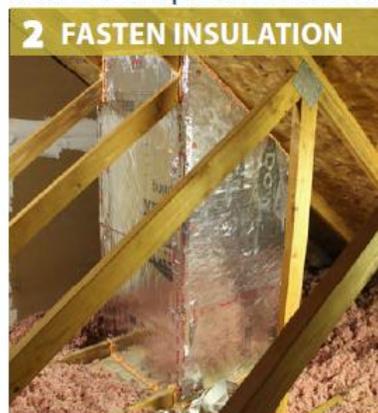
Critical Detail: [SWS 4.1088.3](#)

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.



Notes:



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1005.6](#)

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.



Insulate cavities.



Replace or restore insulation along sides of platform.



Notes



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1005.5](#) Insulating Floor Cavities Above Garages w/Dense Pack Insulation

Insulating Floor Cavities Above Garages w/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.



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

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



Notes



SUCCESS WITH WEATHERIZATION

Insulating Attics with Blow-In Insulation

Critical Detail: [SWS 4.1005.2](#)

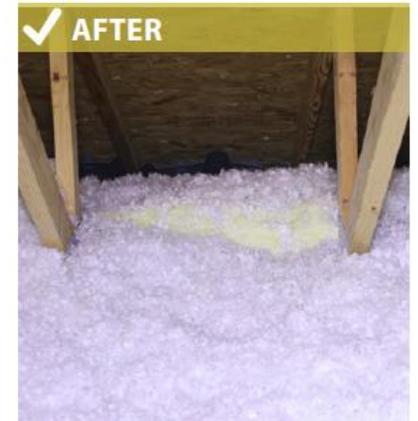
Desired Outcome: Consistent thermal boundary between conditioned and unconditioned space

Materials	Tools

Attic without insulation



Finished attic adequately marked for insulation depth



Safety & Notes
<i>Gloves, appropriate respirator, safety glasses</i>
<i>Do not loose fill when pitch exceeds 3/12</i>

Materials & tools listed are only recommendations & may not include everything needed to complete the job



SUCCESS WITH WEATHERIZATION

Critical Detail: [SWS 4.1005.2](#)

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)



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



SUCCESS WITH WEATHERIZATION

Insulating Attics with Blow-In Insulation Over Existing Batts

Critical Detail: [SWS 4.1005.4](#) Existing Batts

Option 1: Realign batts with air barrier.

1 OPTION 1: REALIGN



Install insulation dams and enclosures as required.

5 INSTALL DAMS



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

2 OPTION 2: MOVE



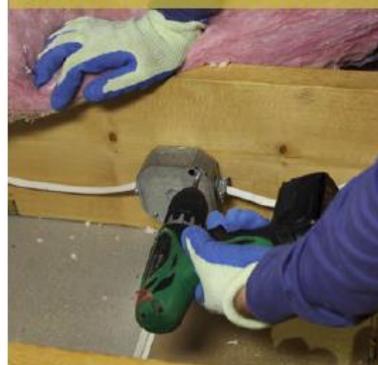
Install insulation depth markers beginning at the air barrier (1 every 300 square feet).

6 INSTALL MARKERS



Install covers on opened electrical junction boxes.

3 SAFETY HAZARDS



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

7 BLOW INSULATION



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

4 FLAG JUNCTIONS



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

8 INSULATION CARD





SUCCESS WITH WEATHERIZATION

Insulating Attics with Blow-In Insulation Over Existing Batts

Critical Detail: [SWS 4.1005.4](#) Existing Batts

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



Notes:

Notes:



Appendix

EPA Healthy Indoor Environment Protocols for Home Energy Upgrades

What every contractor needs to know

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.

Contents

PURPOSE AND SCOPE	i
HOW THE PROTOCOLS ARE ORGANIZED	ii
CONTAMINANTS	1
ASBESTOS	1
BELOWGROUND CONTAMINANTS (EXCEPT RADON).....	3
BUILDING PRODUCTS/MATERIALS EMISSIONS	4
CARBON MONOXIDE (CO) AND OTHER COMBUSTION APPLIANCE EMISSIONS (NITROGEN OXIDES, VOLATILE ORGANIC COMPOUNDS [VOCs] AND PARTICULATES)	6
ENVIRONMENTAL TOBACCO SMOKE (ETS).....	7
GARAGE AIR POLLUTANTS (CO, BENZENE AND OTHER VOCs)	8
LEAD.....	9
MOISTURE (MOLD AND OTHER BIOLOGICALS)	9
OZONE	11
PESTS.....	11
POLYCHLORINATED BIPHENYLS (PCBs).....	12
RADON.....	12
WOOD SMOKE AND OTHER SOLID FUEL EMISSIONS	16
CRITICAL BUILDING SYSTEMS FOR HEALTHY INDOOR ENVIRONMENTS.....	17
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) EQUIPMENT	17
COMBUSTION SAFETY	18
Vented Combustion Appliances.....	18
Unvented Combustion Appliances.....	20
SOURCE VENTILATION.....	21
WHOLE-HOUSE VENTILATION FOR DISTRIBUTED CONTAMINANT SOURCES	22
MULTI-FAMILY VENTILATION.....	22
SAFETY	23
HOME SAFETY	23
JOB SITE SAFETY	24
REFERENCES	26
STANDARDS AND OTHER REQUIREMENTS	26
GUIDANCE	27
ADDITIONAL RESOURCES.....	31
APPENDICES	32
APPENDIX A: WORKER PROTECTION	32
APPENDIX B: CLIENT EDUCATION	38
APPENDIX C: ABBREVIATIONS	43

HEALTHY INDOOR ENVIRONMENT PROTOCOLS FOR HOME ENERGY UPGRADES

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
	<p>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.</p>	<p>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.</p>	<p>Additional actions to promote healthy indoor environments that can be taken during energy-efficiency retrofit projects. EPA recommends considering these improvements when feasible.</p>
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
<p>ASBESTOS <i>(continued)</i></p>	<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. EPA Asbestos: Asbestos in Your Home. EPA Asbestos: Regional and State Asbestos Contacts. 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. DOL, OSHA, Asbestos. DOL, OSHA, Asbestos – Construction. EPA Asbestos: Asbestos in Your Home. EPA Vermiculite.</p>	

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
	<p>BELOWGROUND CONTAMINANTS (except radon)</p> <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>

(Continued on next page)

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
		<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
<p data-bbox="96 118 598 154">ENVIRONMENTAL TOBACCO SMOKE (ETS)</p> 	<p data-bbox="359 167 905 224">Single Family Dwelling: Look for signs of smoking indoors (e.g., ashtrays, cigarette packs, odors).</p> <p data-bbox="359 253 905 367">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 data-bbox="909 167 1451 224">Single-Family Dwelling: See Appendix B: Client Education. </p> <p data-bbox="909 253 1451 394">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 data-bbox="940 402 1451 1068" 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 data-bbox="961 719 1451 1068" 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 data-bbox="940 1084 1451 1255">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 data-bbox="909 1287 1451 1469">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 data-bbox="1455 167 1999 191">This cell is intentionally blank.</p>

(Continued on next page)

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
<p>LEAD</p> 	<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>
<p>MOISTURE (MOLD AND OTHER BIOLOGICALS)</p> 	<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>

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 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>

(Continued on next page)

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
MOISTURE (MOLD AND OTHER BIOLOGICALS) (continued)			
	<p>Relevant Guidance/Standards DOE: Workforce Guidelines for Home Energy Upgrades (under development).</p>	<p>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></p> <p>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.</p>	
OZONE			
	<p>Determine if there is any air-cleaning equipment designed to intentionally produce ozone (i.e., ozone generators) in the house.</p> <p>Relevant Guidance/Standards CARB: Ozone.</p>	<p>Do not install air-cleaning equipment designed to intentionally produce ozone (i.e., ozone generators).</p> <p>Recommend removal of air-cleaning equipment designed to intentionally produce ozone, if present.</p> <p>Relevant Guidance/Standards EPA Indoor airPLUS Specification 4.7. EPA IAQ: Ozone Generators that are Sold as Air Cleaners.</p>	This cell is intentionally blank.
PESTS			
	<p>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.</p> <p>Remove pest-infested materials OR determine if professional assistance is needed to do so before conducting energy retrofit work in pest-infested areas.</p>	<p>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).</p> <p>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.</p>	<p>Protect air intakes from potential bird and pest entry (e.g., cover openings with ½-inch screen or galvanized mesh).</p> <p>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.</p>

(Continued on next page)

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.

(Continued on next page)

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
<p>RADON <i>(continued)</i></p>	<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>

(Continued on next page)

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
<p><2 pCi/L</p> <p><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></p>	<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.	
<p>>2 and <4 pCi/L</p> <p><i>Take precautionary radon-reduction actions: complete foundation air sealing strategies as part of energy upgrade work.</i></p>	<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.	
<p>≥4 pCi/L</p> <p><i>Complete all foundation air sealing strategies as part of energy upgrade work.</i></p>	<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.	
<p>No Pre-Work Test</p> <p><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></p>	<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 CSIA. EPA Burn Wise Guides: Burn Wise Guide for Best Burn Practices for Wood Stoves. EPA Burn Wise Tips. NESCAUM Regulations. 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 EPA Burn Wise Lists.</p>

(Continued on next page)

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>

(Continued on next page)

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>

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
<p data-bbox="113 123 548 147">UNVENTED COMBUSTION APPLIANCES</p> <p data-bbox="369 164 869 277">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 data-bbox="369 310 869 367">Determine whether any state or local regulations prohibiting these devices apply.</p> <p data-bbox="369 399 869 480">Relevant Guidance/Standards Carbon Monoxide (CO) and Other Combustion Appliance Emissions (page 6).</p> <p data-bbox="369 496 625 521">State or local regulations.</p>		<p data-bbox="915 164 1423 245">Verify that the kitchen exhaust fan vents to the outdoors. If not, see Source Ventilation (page 21) for recommended actions.</p> <p data-bbox="915 269 1436 448">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 data-bbox="936 464 1430 578">Note: <i>All equipment removals should include proper disposal so that hazardous units are not reinstalled or used elsewhere.</i></p> <p data-bbox="915 602 1436 837">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 data-bbox="915 854 1436 878">If the occupant objects to these recommendations:</p> <ul data-bbox="936 886 1436 1471" 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 data-bbox="1472 164 1787 188">This cell is intentionally blank.</p>

(Continued on next page)

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 vented 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>

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
<p data-bbox="96 118 590 1521">MULTI-FAMILY VENTILATION <i>(continued)</i></p>		<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			
<p data-bbox="96 971 354 1521">HOME SAFETY</p> <p data-bbox="96 1019 354 1063"></p> <p data-bbox="359 1019 919 1521">Determine whether there are working smoke alarms and CO alarms.</p> <p data-bbox="359 1101 919 1128">Identify knob and tube electrical wiring.</p> <p data-bbox="359 1149 919 1177">Identify harmful chemicals in accessible locations.</p> <p data-bbox="359 1203 919 1258">Check whether there is a fire extinguisher in the home.</p> <p data-bbox="359 1284 919 1372">Determine whether the hot water heater temperature setting is within the allowable limits of the local and state codes.</p> <p data-bbox="359 1398 919 1521">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 data-bbox="924 1019 1451 1193">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 data-bbox="924 1219 1451 1323">Correct life-threatening safety risks (i.e., fall hazards) and provide client education on safety concerns. </p> <p data-bbox="924 1333 1451 1372">Do not bury unsafe wiring in attic insulation.</p> <p>Relevant Guidance/Standards CPSC Document #466. NFPA 720.</p>	<p data-bbox="1455 1019 1999 1079">Install CO alarms that can detect and store peak CO levels of less than 30 ppm.</p> <p data-bbox="1455 1105 1999 1193">Have qualified personnel replace knob and tube wiring in accordance with applicable electrical codes.</p> <p data-bbox="1455 1219 1999 1339">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 data-bbox="1455 1365 1999 1421">In homes with elderly persons, install grab bars, handrails and lighting as appropriate.</p>

PRIORITY ISSUES	ASSESSMENT PROTOCOLS	Minimum Actions	Expanded Actions
HOME SAFETY <i>(continued)</i>			
	<p>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>		<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>	

REFERENCES

Standards and Other Requirements

- ACCA 4 QM-2007:** ANSI/ACCA Standard 4: Maintenance of HVAC Systems. 2007. Air Conditioning Contractors of America.
- ACCA 5 QI-2010:** ANSI/ACCA Standard 5: HVAC Quality Installation Specification. 2010. Air Conditioning Contractors of America.
- ACCA 6 QR-2007:** ANSI/ACCA Standard 6: Restoring the Cleanliness of HVAC Systems. 2007. Air Conditioning Contractors of America.
- ACCA 9 QIVP-2008:** ANSI/ACCA Standard 9: HVAC Quality Installation Verification Protocols. 2008. Air Conditioning Contractors of America.
- ANSI/UL 2034:** ANSI Standard/UL 2034-2005: Single and Multiple Station Carbon Monoxide Alarms. 2005. American National Standards Institute.
- ANSI Z21 Series:** Standards for Residential Gas-Fired Appliances. American National Standards Institute/Canadian Standards Association.
- ANSI Z21.11.2/CSA:** ANSI Standard Z21.11.2-2007. Gas-Fired Room Heaters – Volume II, Unvented Room Heaters. 2007. American National Standards Institute/Canadian Standards Association.
- ANSI Z223.1/NFPA 54:** ANSI Standard Z223.1/NFPA 54: National Fuel Gas Code. 2009. American National Standards Institute/American Gas Association and National Fire Protection Association.
- ASHRAE 52.2-2007:** ANSI/ASHRAE Standard 52.2-2007: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. 2007. American Society of Heating, Refrigeration and Air-Conditioning Engineers.
- ASHRAE 62.1-2010:** ANSI/ASHRAE Standard 62.2-2010: Ventilation for Acceptable Indoor Air Quality. 2010. American Society of Heating, Refrigeration and Air-Conditioning Engineers.
- ASHRAE 62.2-2010:** ANSI/ASHRAE Standard 62.2-2010: Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings including Normative Appendix A – Existing Buildings and Including Informative Appendix B – Addenda Description Information. 2010. American Society of Heating, Refrigeration and Air-Conditioning Engineers.
- ASTM C920:** ASTM Standard C920: Standard Specification for Elastomeric Joint Sealants, Class 25. American Society for Testing and Materials.
- ASTM E2121:** ASTM Standard E2121: Standard Practice for Installing Radon Mitigation Systems in Existing Low-Rise Residential Buildings. 2009. American Society for Testing and Materials.

ASTM E2600: ASTM Standard E2600-10: Standard Guide for Vapor Encroachment Screening on Property Involved in Real Estate Transactions. 2010. American Society for Testing and Materials.

BPI-1100-T-2010: BPI-1100-T-2010: Home Energy Auditing Standard (under development; formerly BPI-101). Building Performance Institute.

http://www.bpi.org/Web%20Download/BPI%20Standards/BPI-101_Home_Energy_Auditing_Standard_Aug_3_2010.pdf

BPI Technical Standards: Technical Standards for the Heating Professional, Blower Door Testing. 2007. Building Performance Institute.

http://www.bpi.org/tools_downloads.aspx?selectedTypeID=1&selectedID=4

BPI Technical Standards: Technical Standards for the Building Analyst Professional, CAZ Depressurization Limits Table. 2005. Building Performance Institute.

http://www.bpi.org/Web%20Download/BPI%20Standards/Building%20Analyst%20Professional_2-28-05nNC-newCO.pdf

California Department of Public Health, Emission Testing Method for California Specification 01350: 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-iag.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.

<http://arb.ca.gov/toxics/compwood/compwood.htm>

<http://www.arb.ca.gov/regact/2007/compwood07/fro-final.pdf>

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/>

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/oshweb/owadisp.show_document?table=STANDARD&p_id=10614

DOL, OSHA, 29 CFR Part 1926.62, subpart D: Lead, 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/oshweb/owadisp.show_document?table=STANDARD&p_id=10641

DOL, OSHA, 29 CFR Part 1926, subpart K: Electrical. Standards for Construction. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oshweb/owadisp.show_document?table=FEDERAL_REGISTER&p_id=16956

DOL, OSHA, 29 CFR Part 1926.501, subpart M: Fall Protection. Safety and Health Regulations for Construction. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10757&p_table=STANDARDS

DOL, OSHA, 29 CFR Part 1926.1053, subpart X: Ladders. Safety and Health Regulations for Construction.

U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=108329

DOL, OSHA, 29 CFR Part 1926.1101, subpart Z: Asbestos. Safety and Health Regulations for Construction: Toxic and Hazardous Substances; Sampling and Analysis: Non-mandatory. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=108664

DOL, OSHA, 29 CFR Part 1926.21 (b)(6)(i), subpart C: Safety and Health Regulations for Construction: General Safety and Health Provisions: Safety Training and Education. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10607&p_table=STANDARDS

DOL, OSHA, 29 CFR Part 1926.59, subpart D: Hazard Communication. Safety and Health Regulations for Construction: Occupational Health and Environmental Controls: Hazard Communication. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10633&p_table=STANDARDS

EPA Indoor airPLUS Specifications: Indoor airPLUS Construction Specifications 1.2, 1.4, 1.5, 1.6, 4.1, 4.2, 4.7, 5.1, 5.6, 6.1, 6.2 and 6.3. U.S. Environmental Protection Agency. http://epa.gov/indoorairplus/construction_specifications.html

EPA Renovation, Repair and Painting (RRP) Program Rule: 24 CFR Part 25, subpart J: Methods and Standards for Lead-Paint Hazard Evaluation and Hazard Rehabilitation, and relevant elements of Subpart R (e.g., 24 CFR 35. 1340; 24 CFR 35.1350). U.S. Environmental Protection Agency. <http://efr.gpoaccess.gov/cgi/text/text-idx?c=ecfr&rgn=div5&view=text&node=24:1.1.1.25&idno=24>

EPA Renovation, Repair and Painting (RRP) Program Rule: 40 CFR Part 745: Lead; Clearance and Clearance Testing Requirements for the Renovation, Repair and Painting Program, Proposed Rule, FR Vol. 75, No. 87, pages 25038-25073. 2010. U.S. Environmental Protection Agency. <http://edocket.access.gpo.gov/2010/pdf/2010-10102.pdf>

Green Seal Standard GS-11: GS-11: Green Seal Environmental Standard for Paints and Coatings. 2008. Green Seal, Inc. http://www.greenseal.org/Portals/0/Documents/Standards/GS-11/GS-11_Paints_and_Coatings_Standard.pdf

Greenguard Children and Schools Certification Program: Greenguard Environmental Institute. <http://www.greenguard.org/en/manufacturers/manufacturer-childrenschools.aspx>

HUD Title 24: U.S. HUD Title 24 subparts J and R: Lead-Based Paint Poisoning Prevention in Certain Residential Structures. 2004. U.S. Department of Housing and Urban Development.

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

International Mechanical Code, 2009: International Code Council, Inc.

MPI 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.paintinfo.com/GPS/gps.pdf>

NESCAUM Regulations: Outdoor Hydronic Heater Model Regulations, including installation of new technology and EPA Phase 2 units, pages 4-5. 2007. Clean Air Association of the Northeast States. <http://www.nescaum.org/documents/modelregulationoudoorhydronicheaterfinalB.pdf>

NFPA 31: Standard for the Installation of Oil-Burning Equipment. 2006. National Fire Protection Association.

NFPA 211: Standard for Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances. 2010. National Fire Protection Association.

NFPA 720: Standard for the Installation of Household Carbon Monoxide (CO) Warning Equipment. 2009. National Fire Protection Association.

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>

Guidance

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

AFHH: Community Environmental Health Resource Center Protocols. Alliance for Healthy Homes. http://www.afhh.org/res/res_celrhc.htm

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

AIIHA: Recognition, Evaluation, and Control of Indoor Mold. 2008. American Industrial Hygiene Association. <https://webportal.aaha.org/Purchase/ProductDetail.aspx?ProductCode=3f9e0a5a-4778-de11-96bb-0050568361fd>

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

ASHI Radon Mitigation System Inspection Checklist: Radon Mitigation System Inspection Checklist. 2000. American Society of Home Inspectors.
http://www.ashi.org/members/ashdocs/pdf/ASHI_Radon_Checklist_PDF

ASHRAE Handbooks: ASHRAE Handbook Series. American Society of Heating, Refrigeration and Air-Conditioning Engineers.

ASPE Data Book: A Plumbing Engineer's Guide to System Design and Specifications, Volume 2: Plumbing Systems, p. 10. 2000. American Society of Plumbing Engineers.

CARB: Formaldehyde, Formaldehyde in the Home. California Environmental Protection Agency, Air Resources Board.
<http://www.arb.ca.gov/research/indoor/formaldehyde08-04.pdf>

CARB: Ozone, Resources on Ozone Producing Air Cleaners. California Environmental Protection Agency, Air Resources Board.
<http://www.arb.ca.gov/research/indoor/ozone.htm>

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>

CDC Home Safety Checklists: Home Safety Checklists. U.S. Centers for Disease Control and Prevention.
<http://www.cdc.gov/hcipc/falls/FallPrev4.pdf>

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, The National Institute for Occupational Safety and Health.
<http://www.cdc.gov/niosh/nas/rdrp/appendices/chapter10/a10-14.pdf>

CDC, NIOSH, Protective Clothing and Ensembles, Safety and Health Topics. 2010. U.S. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health.
<http://www.cdc.gov/niosh/topics/protclothing>

CDC, NIOSH, Respirators, Safety and Health Topics. 2011. U.S. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health.
<http://www.cdc.gov/niosh/topics/respirators>

CDC Resource on Rodents: Resource on Rodents. 2010. U.S. Centers for Disease Control and Prevention.
<http://www.cdc.gov/rodents>

CHPS: High Performance Products Database. Collaborative for High Performance Schools.
<http://www.chps.net/dev/Drupal/node/445>

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

CSIA: Top-Down Method of Stove Loading. Chimney Safety Institute of America.
<http://www.csia.org/HomeownerResources/ChimneySafetyInfo/HOWTOBuildaTopDownBurn/tabid/2229/Default.aspx>

DOE: Workforce Guidelines for Home Energy Upgrades (under development): 2011. U.S. Department of Energy.
http://www1.eere.energy.gov/wip/retrofit_guidelines.html

DOL, OSHA, Asbestos: Asbestos. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SLTC/asbestos/>

DOL, OSHA, Asbestos - Construction: Asbestos - Construction. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SLTC/asbestos/construction.html>

DOL, OSHA, Carbon Monoxide Poisoning Quick Card: Protecting Yourself from Carbon Monoxide Poisoning Quick Card. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/Publications/3282-10N-05-English-07-18-2007.html>

DOL, OSHA, Combustible Dust: Combustible Dust. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/dsg/combustibledust/index.html>

DOL, OSHA, Confined Spaces: Confined Spaces. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SLTC/confinedspaces/index.html>

DOL, OSHA, Confined Spaces E-Tool: Confined Spaces E-Tool. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.dol.gov/elaws/confined.htm>

DOL, OSHA, Electrical Incidents E-Tool: U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/SLTC/eetools/construction/electrical_incidents/mainpage.html

DOL, OSHA, Falls: Falls. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SLTC/fallprotection/index.html>

DOL, OSHA, Falls E-Tool: Falls E-Tool. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SLTC/eetools/construction/falls/mainpage.html>

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/dept/greenjobs/weather_spl.html

DOL, OSHA, Hazard Communication: Hazard Communication. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/dsg/hazcom/index.html>

DOL, OSHA, Lead: Lead. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/lead/index.html>

DOL, OSHA, Lead – Construction: Lead – Construction. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/lead/construction.html>

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>

DOL, OSHA, OSH ACT: Section 5 (a)(1). U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=OSHA&p_id=3359

DOL, OSHA, Permissible Exposure Limits (PELs): Permissible Exposure Limits (PELs). U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/pel/>

DOL, OSHA, Stairways and Ladders: Stairways and Ladders: A Guide to OSHA Rules. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/Publications/osh3124.pdf>

DOL, OSHA, Wood Dust: Wood Dust. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/wooddust/index.html>

Energy Conservatory: Blower Door. Automated Blower Door Systems and Accessories. The Energy Conservatory.
<http://www.energyconservatory.com/products/products1.htm>

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

EPA Asbestos: Regional and State Asbestos Contracts. 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/asbestos/pubs/regioncontract.html>

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

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>

EPA Burn Wise Guides: Burn Wise Guide for Identifying Cleaner-Burning Appliances. 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/burnwise/appliances.html>

EPA Burn Wise Lists: Burn Wise List of Cleaner Burning, More Energy Efficient Hydronic Heaters. 2011. U.S. Environmental Protection Agency.
<http://www.epa.gov/burnwise/owhlist.html>

EPA Burn Wise Tips: Burn Wise Tips. U.S. Environmental Protection Agency.
<http://www.epa.gov/burnwise/pdfs/BurnWiseTips.pdf>

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

EPA Design for the Environment: Safer Product Labeling Program. 2011. U.S. Environmental Protection Agency.
<http://epa.gov/dfe/pubs/projects/formular/formpart.htm>

EPA Environmental Tobacco Smoke: Smoke-free Homes and Cars Program. U.S. Environmental Protection Agency. 2010.
<http://www.epa.gov/smokefree/>

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

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>

EPA IAQ: Ozone Generators that are Sold as Air Cleaners. 2010. U.S. Environmental Protection Agency, Indoor Air Quality.
<http://www.epa.gov/iaq/pubs/ozongen.html>

EPA IAQ: Residential Air Cleaners. 2009. U.S. Environmental Protection Agency, Indoor Air Quality.
<http://www.epa.gov/iaq/pubs/residair.html>

EPA IPM: Integrated Pest Management Principles. 2011. U.S. Environmental Protection Agency, Integrated Pest Management.
<http://www.epa.gov/pesticides/factsheets/ipm.htm>

EPA Lead: EPA Recognized Lead Test Kits. 2010. U.S. Environmental Protection Agency.
<http://www.epa.gov/lead/pubs/testkit.htm>

EPA Lead Accredited Training Programs. Locate Accredited Renovation Training Programs. U.S. Environmental Protection Agency.
http://cfpub.epa.gov/hpp/searchrhp_training.htm

EPA Lead-Based Paint Renovation, Repair, and Painting Program: Small Entry Compliance Guide to Renovate Right. 2010. U.S. Environmental Protection Agency.
<http://www.epa.gov/lead/pubs/sbcomplianceguide.pdf>

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>

EPA Mold: A Brief Guide to Mold, Moisture, and Your Home. 2010. U.S. Environmental Protection Agency. <http://www.epa.gov/redmold1/moldguide.html>

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

EPA Mold: Mold Remediation in Schools and Commercial Buildings. 2010. U.S. Environmental Protection Agency. http://www.epa.gov/redmold1/mold_remediation.html

EPA OSWER Draft Guidance for Evaluating Vapor Intrusion: Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). U.S. Environmental Protection Agency. <http://www.epa.gov/waste/hazard/correctiveaction/eis/vapor.htm>

EPA PCB: Polychlorinated Biphenyls. 2011. U.S. Environmental Protection Agency. <http://www.epa.gov/epawaste/hazard/tsd/pcbs/index.htm>

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: PCBs in Caulk in Older Buildings. 2011. U.S. Environmental Protection Agency. <http://www.epa.gov/pcbbsincaulk>

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

EPA Pests: Pesticides: Controlling Pests. U.S. Environmental Protection Agency. 2011. <http://www.epa.gov/pesticides/controlling/index.htm>

EPA Radon: State Radon Contact Information. U.S. Environmental Protection Agency. <http://www.epa.gov/radon/wherexoulive.html>

EPA Radon Guidance: Citizen's Guide to Radon. 2009. U.S. Environmental Protection Agency. <http://www.epa.gov/radon/pubs/citguide.html>

EPA Radon Guidance: Guidance for Radon Testing and Mitigation. 2011. U.S. Environmental Protection Agency. <http://www.epa.gov/radon/pubs/index.html>

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

EPA Vapor Intrusion Mitigation Approaches: Indoor Air Vapor Intrusion Mitigation Approaches. 2008. U.S. Environmental Protection Agency. <http://www.epa.gov/nrmrl/pubs/600r08115/600r08115.pdf>

EPA Vermiculite: Vermiculite. 2011. U.S. Environmental Protection Agency. <http://www.epa.gov/asbestos/pubs/verm.html>

Home Energy, Advanced Blower Door Techniques: David Bohac, “Zone Pressure Diagnostic.” 2002. Home Energy. <http://www.homeenergy.org/show/article/nav/diagnostics/page/77/id/267>

HUD Lead Safe Work Practices: Lead Safe Work Practices. U.S. Department of Housing and Urban Development. <http://www.hud.gov/offices/cpdf/affordablehousing/training/web/leadsafe/keyrequirements/safepactices.cfm>

HUD Notice: Public Housing Assessment System Physical Condition Scoring Process Interim Scoring, Corrections and Replication. FR Vol. 66, No. 117, pages 59084-59124. 2001. U.S. Department of Housing and Urban Development. <http://www.huduser.org/portal/datasets/pis/66FR59084.pdf>

MNCEE: Reduction of Environmental Tobacco Smoke Transfer in Minnesota Multifamily Buildings Using Air Sealing and Ventilation Treatments. Minnesota Center for Energy and Environment. <http://www.mncee.org/Innovation-Exchange/Reports-and-Technical-Documents/Reduction-of-Environmental-Tobacco-Smoke-Transfer-/>

NAHB Research Center: ToolBase Resources. Search “whole house ventilation” and “HRV” for additional resources. <http://www.toolbase.org/>

NCHH Fact Sheet: Improving Ventilation in Existing or New Buildings with Central Roof Exhaust. 2009. National Center for Healthy Housing. http://www.nchh.org/Portals/0/Contents/Green_ventilation2.pdf

NCHH Fact Sheet: Improving Ventilation in Multi-Family Buildings That Do Not Have Fan-Powered Ventilation Systems. 2009. National Center for Healthy Housing. National Center for Healthy Housing. http://www.nchh.org/Portals/0/Contents/Factsheet_Ventilation%201.pdf

NCHH Fact Sheet: Improving Ventilation in New and Existing Multi-Family Buildings with Individual Unit Ventilation Systems. 2009. National Center for Healthy Housing. <http://www.nchh.org/LinkClick.aspx?fileticket=g%2f9%2fqIHh1wA%3d&tabid=370>

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

NCHH Fact Sheet: Testing for Lead-Contaminated Dust. 2001. National Center for Healthy Housing. http://www.nchh.org/Portals/0/Contents/factsheet_lead_dust.pdf

NCHH IPM: Integrated Pest Management in Affordable Housing, 2010. National Center for Healthy Housing. <http://www.healthyhomestraining.org/ipm>

NIST/NVLAP: Accredited Laboratories for the Polarized Light Microscopy (PLM) Test Method. National Institute of Standards and Technology/National Voluntary Laboratory Accreditation Program.

<http://ts.nist.gov/Standards/scopes/plmtm.htm>

NIST/NVLAP: Accredited Laboratories for the Transmission Electron Microscopy (TEM) Test Method. 2011. National Institute of Standards and Technology/National Voluntary Laboratory Accreditation Program.

<http://ts.nist.gov/Standards/scopes/temtm.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.healthyhomestraining.org/IPM/IPM_MPH_Ref_4_NYC_Pest_Control_9-11-08.pdf

Additional Resources

CDC, NIOSH: U.S. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health.

<http://www.cdc.gov/niosh>

DOL, OSHA: U.S. Department of Labor, Occupational Safety and Health Administration.

<http://www.osha.gov/>

EPA IAQ: An Introduction to Indoor Air Quality, Formaldehyde. 2011. U.S. Environmental Protection Agency.

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

EPA IAQ: Care for Your Air: A Guide to Indoor Air Quality. 2008. U.S. Environmental Protection Agency.

<http://www.epa.gov/iaq/pdfs/careforyourair.pdf>

White House, Recovery Through Retrofit: Recovery Through Retrofit by Middle Class Task Force and Council on Environmental Quality. 2009. White House.

http://www.whitehouse.gov/assets/documents/Recovery_Through_Retrofit_Final_Report.pdf

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

Asbestos

Assessment: Determine whether workers will be exposed to asbestos-containing material (ACM).

Actions:

- 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.

Chemical Hazards

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

Actions:

- 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.

Confined Space

Assessment: Determine whether workers will be exposed to confined-space hazards.

Actions:

- 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.

Dust

Assessment: Determine if the work will create dust.

Actions:

- 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 [ICRC'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

CDC, NIOSH, U.S. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health.

<http://www.cdc.gov/niosh>

CDC, NIOSH, Protective Clothing and Ensembles, Safety and Health Topics. 2010. U.S. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health.

<http://www.cdc.gov/niosh/topics/protclothing>

CDC, NIOSH, Respirators, Safety and Health Topics. 2011. U.S. Centers for Disease Control and Prevention, The National Institute for Occupational Safety and Health.

<http://www.cdc.gov/niosh/topics/respirators>

DOL, OSHA, U.S. Department of Labor, Occupational Safety and Health Administration.

<http://www.osha.gov>

Asbestos

DOL, OSHA, Asbestos: Asbestos. U.S. Department of Labor, Occupational Safety and Health Administration.

<http://www.osha.gov/SLTC/asbestos/>

DOL, OSHA, 29 CFR Part 1926.1101, subpart Z: Asbestos. Safety and Health Regulations for Construction: Toxic and Hazardous Substances; Sampling and Analysis: Non-mandatory. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oslaweb/owadisp.show_document?p_id=10862&p_table=STANDARDS

Chemical Hazards

DOL, OSHA, 29 CFR Part 1926.59, subpart D: Hazard Communication. Safety and Health Regulations for Construction: Occupational Health and Environmental Controls: Hazard Communication. U.S. Department of Labor, Occupational Safety and Health Administration.

http://www.osha.gov/pls/oslaweb/owadisp.show_document?p_id=10633&p_table=STANDARDS

DOL, OSHA, Hazard Communication: Hazard Communication. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/dsg/hazcom/index.html>

Confined Space

DOL, OSHA, 29 CFR Part 1926.21 (b)(6)(i), subpart C: Safety and Health Regulations for Construction: General Safety and Health Provisions: Safety Training and Education. U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10607&p_table=STANDARDS

DOL, OSHA, Carbon Monoxide Poisoning Quick Card: Protecting Yourself from Carbon Monoxide Poisoning Quick Card. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/Publications/3282-10N-05-English-07-18-2007.html>

DOL, OSHA, Confined Spaces E-Tool: Confined Spaces E-Tool. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/dts/ostal/oshasoft/index.html>

DOL, OSHA, Confined Spaces: Confined Spaces. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/confinedspaces/index.html>

DOL, OSHA, OSH ACT: Section 5 (a)(1). U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=OSHACT&p_id=3359

EPA Design for the Environment: Safer Product Labeling Program. 2011. U.S. Environmental Protection Agency.
<http://epa.gov/dte/pubs/projects/formulat/formpart.htm>

Dust

DOL, OSHA, Combustible Dust: Combustible Dust. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/dsg/combustible dust/index.html>

DOL, OSHA, Permissible Exposure Limits (PELs): Permissible Exposure Limits (PELs). U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/pe/>

DOL, OSHA, Wood Dust: Wood Dust. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/wooddust/index.html>

EPA Renovation, Repair and Painting (RRP) Program Rule: 40 CFR Part 745: Lead: Clearance and Clearance Testing Requirements for the Renovation, Repair and Painting Program, Proposed Rule, FR Vol. 75, No. 87, pages 25038-25073. 2010. U.S. Environmental Protection Agency.
<http://edocket.access.gpo.gov/2010/pdf/2010-10102.pdf>
<http://www.epa.gov/lead/pubs/renovation.htm>

Electrical

DOL, OSHA, 29 CFR Part 1926, subpart K: Electrical Standards for Construction. U.S. Department of Labor, Occupational Safety and Health Administration
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=16956

DOL, OSHA, Electrical Incidents E-Tool: U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/SITC/eetools/construction/electrical_incidents/mainpage.html

Falls

DOL, OSHA, 29 CFR Part 1926.501, subpart M: Fall Protection. Safety and Health Regulations for Construction. U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10757&p_table=STANDARDS

DOL, OSHA, Falls: Falls. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/fallprotection/index.html>

DOL, OSHA, Falls E-Tool: Falls E-Tool. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/SITC/eetools/construction/falls/mainpage.html>

Ladders

DOL, OSHA, 29 CFR Part 1926.1053, subpart X: Ladders. Safety and Health Regulations for Construction. U.S. Department of Labor, Occupational Safety and Health Administration.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10839

DOL, OSHA, Stairways and Ladders: Stairways and Ladders: A Guide to OSHA Rules. U.S. Department of Labor, Occupational Safety and Health Administration.
<http://www.osha.gov/Publications/osha3124.pdf>

Lead

DOI, OSHA, 29 CFR Part 1926.62, subpart D: Lead. 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=10641

DOI, OSHA, Lead - Construction: Lead - Construction. U.S. Department of Labor, Occupational Safety and Health Administration. <http://www.osha.gov/SITC/lead/construction.html>

EPA Renovation, Repair and Painting (RRP) Program Rule: 40 CFR Part 745; Lead: Clearance and Clearance Testing Requirements for the Renovation, Repair and Painting Program, Proposed Rule, FR Vol. 75, No. 87, pages 25038-25073. 2010. U.S. Environmental Protection Agency.

<http://edocket.access.gpo.gov/2010/pdf/2010-10102.pdf>

<http://www.epa.gov/lead/pubs/renovation.htm>

Mold

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

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

https://webportal.aiiha.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/r5508a1.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>

DOI, 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/redmold1/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/pbcsincaulk/guide/guide-sect2.htm>

DOI 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>

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

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

EPA SPF: Spray Polyurethane Foam. 2011. U.S. Environmental Protection Agency.

http://www.epa.gov/dfe/pubs/projects/spffspray_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/dfe/pubs/projects/spffspray_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, caulks, 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.
<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

AHRI: 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.healthyonemestraining.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/tsdl/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/GreenBusinessStandards.aspx?vid=ViewStandardDetail&cid=0&sid=6>

MPI 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.speccifygreen.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>

APPENDIX C

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
HPS – 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	



Office of Air and Radiation (6609J)
EPA 402/K-11/003 | October 2011

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

