


# Weatherization Plus Health:

The  is in the Details

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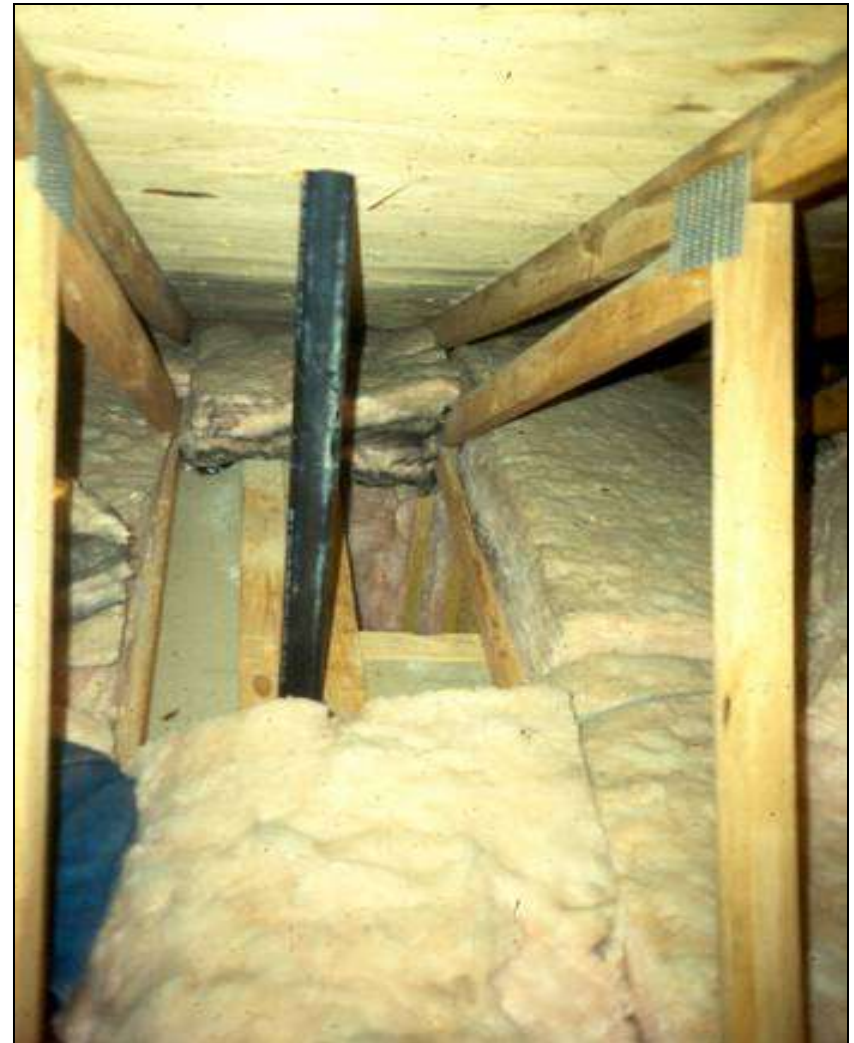
# Weatherization

- Reduce heat loss and heat gain
- Reduce air flow into and out of the house.



# Weatherization = Making House Tighter

- Tighter houses = More comfort for less energy
- Tighter houses = Reducing some health risks, possibly increasing others.



# Tighter Houses: Reduced Health Risk

- Reduction of air-borne contaminants (e.g., pollens)
- Exclusion of critters
- Reduction of air-transported moisture

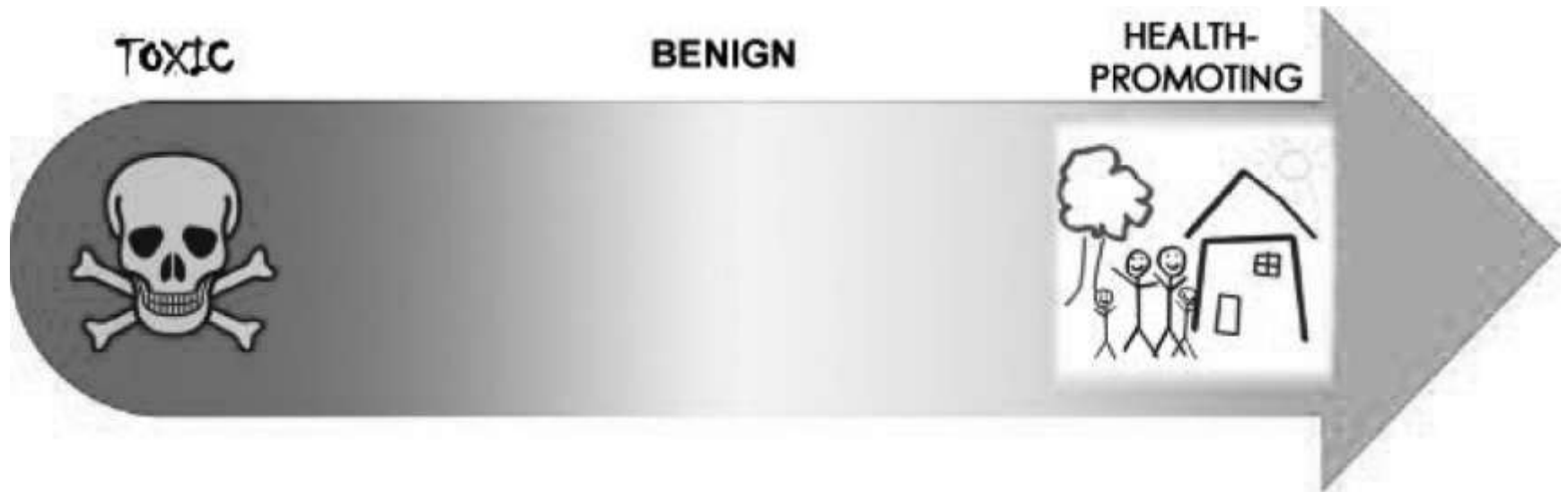


## Tighter Houses: Increased Health Risk

- Concentration of contaminants
- Concentration of moisture
- Pressure imbalance: Randy



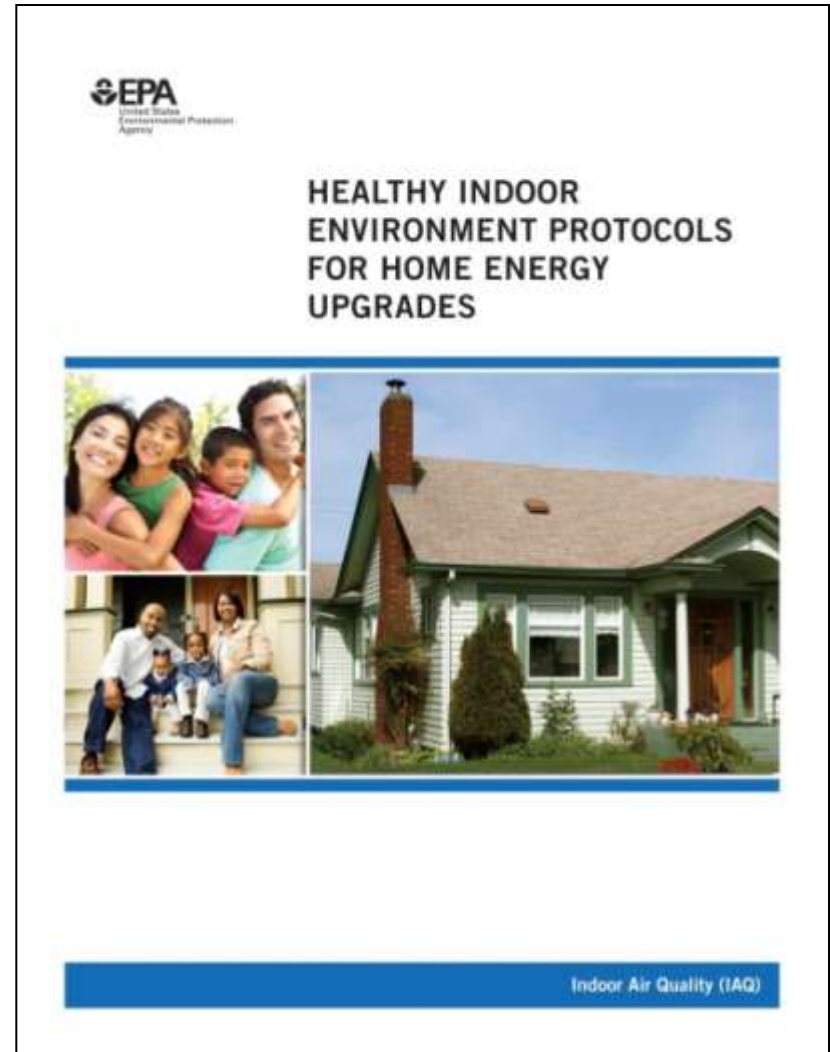
# First, DO NO HARM



DRAFT available now



Final coming soon



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

## HEALTHY INDOOR ENVIRONMENTS

## PRIORITY ISSUES

## ASSESSMENT PROTOCOL

## Minimum Actions

## Expanded Actions

## RADON

Test homes for radon to help ensure home energy retrofit actions do not increase radon exposure. Tests, and follow-up action if needed, may be conducted using either of the options described in the Minimum Actions column at right.

Perform radon testing in accordance with state and federal guidance, as appropriate. Some states regulate the activities of radon services providers through registration, certification, or licensing programs. Individuals conducting radon tests should be trained/certified through either:

- The National Environmental Health Association (NEHA) National Radon Proficiency Program, or
- The National Radon Safety Board (NRSB) certification program.

**Note:**

*An optional second pre-work radon test may be taken and averaged with the initial pre-work test, to increase confidence that the short term test better reflects the annual average radon level in the home.*

Determine whether the home has a radon mitigation system. Most mitigation systems use active soil depressurization and include a radon vent fan, usually located in an attic, attached garage or on the exterior of the home.

The options described below are intended to minimize the potential for increased occupant exposure to radon that may be caused by home energy retrofit work, while minimizing additional costs.

Perform radon testing and mitigation in accordance with state and federal guidance, as appropriate (see Assessment Protocol at left).

**Note:**

*An optional second post-work radon test may be taken and averaged with the initial post-work radon test to increase confidence that the short term test better reflects the annual average radon level. DO NOT average the pre-work and post-work test results.*

**Test-In/Test-Out Option:** Test for radon before and after energy retrofit work.

*If pre-work radon level is 4 pCi/L or greater, take appropriate limited radon reduction actions during retrofit work (see Expanded Actions column at right), AND*

- IF post-work radon level is less than 4 pCi/L, no further action is required.
- IF post-work radon level is 4 pCi/L or greater, but NOT greater than pre-work radon level, inform client about radon and provide client with EPA Citizen's Guide to Radon.
- IF post-work radon level is greater than pre-work radon level, mitigate per ASTM E2121 OR take further radon reduction actions (see Expanded Actions) to reduce radon to pre-work conditions or below, then re-test. Repeat this step until post-work radon level is at or below pre-work radon level.

EPA recommends radon mitigation in all homes that test at 4 pCi/L or greater. Radon levels less than 4 pCi/L still can pose a health risk, and in many cases may be reduced.

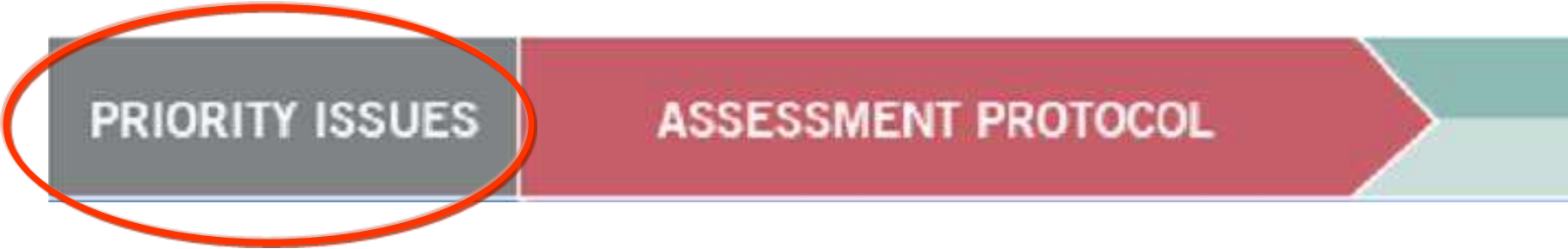
The following recommended lower cost, limited actions may help reduce the radon level in a home or aid more advanced mitigation if necessary:

- Air seal sumps (e.g., install airtight sump cover) in such a way that water can drain from above and below the sump cover.
- Install air-tight drain fittings (e.g., trap or flange system) in foundation floor drains.
- Seal and caulk penetrations, openings, or cracks in floors and below grade walls that contact the ground, per ASTM C920.
- Cover exposed earth floors in basements and crawlspaces per Section 1.2 of EPA Indoor airPLUS Construction Specifications or ASTM E2121.

**Note:**

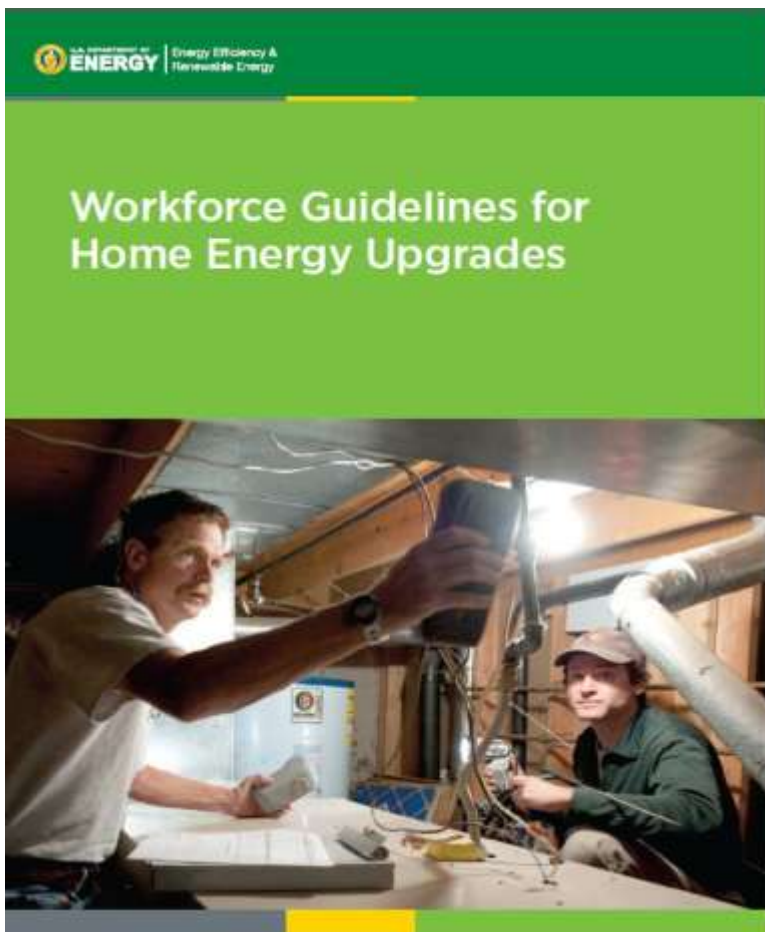
*Only active soil depressurization (ASD) systems installed per ASTM E2121 have been shown to reliably reduce radon below 4 pCi/L. If all the above limited radon reduction actions are attempted and radon remains high, EPA recommends full compliance with ASTM E2121.*

**Homes with an active radon mitigation system:** If the existing radon mitigation system does not reduce radon below 4 pCi/L or is not working as designed, troubleshoot the system. Follow state residential radon regulations where applicable.



Priority health issues related to Home Energy Retrofits

# DOE Guidelines



## Topic: Combustion Appliances

Subtopic: Vented Gas Appliances

### 9) Detail Name: Combustion Flue Gas – Orphaned Water Heater

**Desired Outcome:**

- Flue gasses successfully removed from the house

Row	Title	Specification(s)	Objective(s)
1	Combustion Appliance Zone (CAZ) pressure testing	The Building Performance Institute (BPI) protocol or equivalent for CAZ combustion safety testing will be administered <sup>23</sup>	Determine if applicable appliance is drafting properly and CAZ is safe to work in
2	Flue gas removal (chimney liner or approved methods)	A chimney liner will be installed according to NFPA 54 fuel code or other approved methods [e.g. power vented, sealed non-power vented combustion] <sup>24</sup>	Allow water heater to vent properly and prevent damage to the chimney
3	Retesting CAZ pressure	The BPI protocol or equivalent for CAZ combustion safety testing will be administered <sup>23</sup>	Determine if additional combustion air is needed
4	Required combustion air <sup>25</sup>	Volume of air required for complete combustion of the fuel and air mixture will be calculated in cubic feet per minute (CFM) according to ANSI and NFPA guidelines	Determine if existing conditions meet the combustion air calculation

<sup>23</sup> ASTM E1996 - 02(2007)  
<sup>24</sup> NFPA 54 or NFPA 54/ANSI/AGA Z223.1  
<sup>25</sup> ASTM E1996 - 02(2007)  
<sup>26</sup> NFPA 54/ANSI/AGA Z223.1

# Technical Standards

- BPI (Building Performance Institute)
- RESNET
- ASHRAE
- NFPA
- Etc.



# Primary Opportunities for Harm

- Concentrating Outdoor Contaminants
  - Moisture
  - Particulates
  - Pollens
  - Radon
  - Ozone
  - Molds
  - VOCs

# Primary Opportunities for Harm

- Trapping Internally-generated Contaminants
  - Moisture
  - Combustion By-Products
  - VOCs
  - Tobacco Smoke





# Primary Opportunities for Harm

- Disturbing Existing Contaminants
  - Lead
  - Asbestos
  - Other fibers
  - Dust, dirt, camel cricket caca, bat guano....



# Primary Opportunities for Harm

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- Introducing new contaminants
  - Insulation Fibers
  - VOCs (Caulks, Sealants, Other Materials)
  - Spray Polyurethane Foams

# Rules for Avoiding Harm

1. Do not tighten a house without ensuring proper venting of combustion by-products.
  - No unvented combustion

Vent-free  
gas fireplaces with the  
Catalytic Filter System

As seen at the  
1997 HPA show.



# Rules for Avoiding Harm

1. Do not tighten a house without ensuring proper venting of combustion by-products.
  - No unvented combustion
  - No backdrafting, spillage, or flame roll-out
  - No excessive negative pressure in the Combustion Appliance Zone



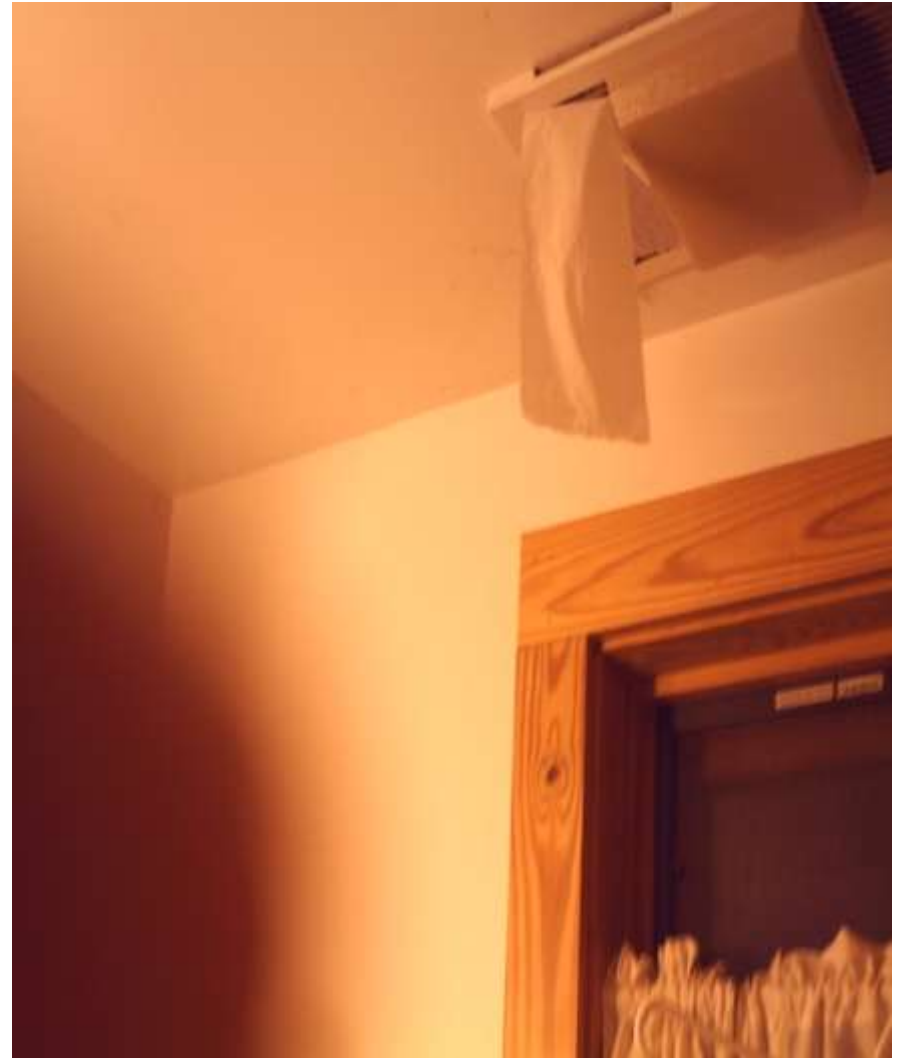
# Rules for Avoiding Harm

- Do not tighten a house without ensuring proper moisture management
  - No unvented combustion appliances
  - Foundation drainage/site grading/gutters & downspouts
  - Proper AC sizing
  - Consider moisture load if replacing atmospherically vented with sealed combustion



# Moisture Management

- Performance test exhaust fan in bath & kitchen



# Why Doesn't My Bath Fan Work?

1. What's it rated?
2. Is it turned the right way?
3. Did you take the tape off?
4. Can the door open?
5. How long is your duct?
6. Too many curves?
7. Stuffing instead of cutting?
8. Where's the plastic?
9. How restrictive is your termination?
10. Is it outside?
11. Holes to the house?

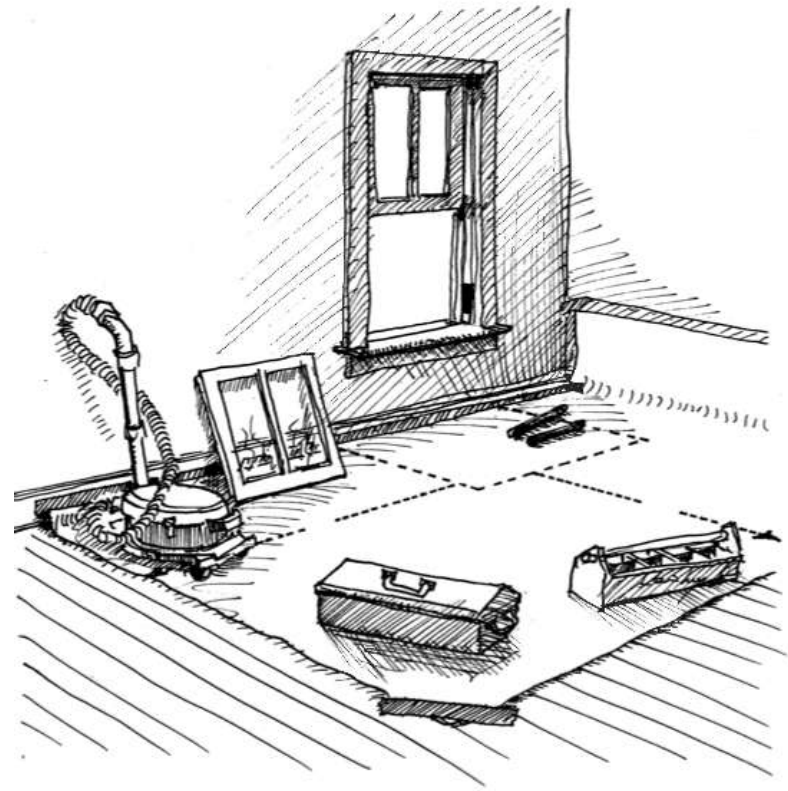


# Crawlspace moisture management



# Do No Harm: Lead Safe Work

- Set up work area
- Contain dust  
avoiding unsafe  
tools, use poly  
sheeting, cover  
belongings etc
- Don't spread lead  
dust outside work  
area



# Clean Up – HEPA Vacuum

4 vacuum cleaners styles

3 container system for washing above floor surfaces

- mister for detergent to use
- One side of bucket for rinsing out

Back packs are best for working above floor

An upright with a beater bar is best for cleaning carpets

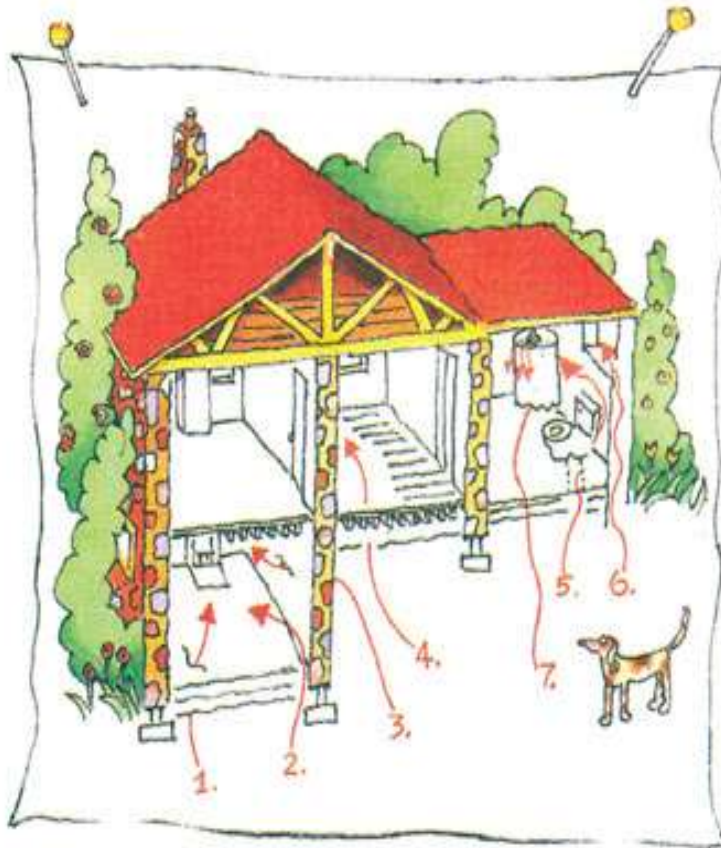
Use micro bag

Have a cheap hose vac at each work site



# Do No Harm: Radon

## How Radon Gets into a Home



- Cracks in solid floors
- Construction joints
- Cracks in walls
- Gaps in suspended floors
- Gaps around service pipes
- Cavities inside walls
- Water supply

# Do No Harm: Radon

- Test radon pre and post work
  - 48-72 hours
  - \$15-25
  - Consider side by side samples
- Radon mitigation if radon increases from  $< 4$  pCi/L to  $> 4$  pCi/L



## Trip/Fall Prevention

- Grab bars
- Lighting
- Handrails
- Safe steps
- Remove throw rugs and trip hazards
- Key areas: bath, steps



# Added Resources



- Arnie Katz, Advanced Energy  
[AKATZ@advancedenergy.org](mailto:AKATZ@advancedenergy.org)
- Ellen Tohn, Tohn Environmental Strategies  
[etohn@tohnenvironmental.com](mailto:etohn@tohnenvironmental.com)

# Room Pressures and Pressure Balancing

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# Definition:

**Pressure Balancing:** The process of neutralizing pressure differentials in the home. It involves changing building and/or mechanical systems so that strong pressure differences are eliminated or at least reduced.

(Florida Solar Energy Center)

Why are we concerned about pressure imbalances in homes?

Pressure imbalances in a house create areas of high and low pressure which can cause:

- Health & safety hazards.
- Create building durability issues.
- Reduce energy efficiency.

# Pressure Imbalances:

- Draw in warm humid air, soil gases, water vapor, mold spores, radon, and anything else that resides in the crawlspace, garage, soil, or ground water.
- Pressures drive moist air into building cavities where condensation occurs promoting mold growth and building decay.

# RADON

- One in 15 American homes contains high levels of radon.

(source: EPA 1/3/2011)

- Radon typically moves up through the ground and into the home through holes, gaps, cracks and pores in the floor or in through the basement walls and slab.

# Water Vapor

Water vapor increases the relative humidity that can then support the growth of mold, dust mites, bacteria, etc.

Strategies that keep soil gases out of a home can also significantly reduce indoor humidity levels.

# Mold





# Mold Is A Health Concern

- Individual responses to mold vary.
- Young children & elderly are the most susceptible, especially those with compromised immune systems.
- Reactions to mold have a cumulative effect.

Indoor growth of molds can lead to the production of a variety of VOCs.

(Bush and Portnoy 2001)

All indoor molds present a potential health risk and should be treated with caution.

(Center for Disease Control)

Occupants of moldy buildings are at increased risk of respiratory symptoms, respiratory infections and exacerbation of asthma.

(WHO 2009)



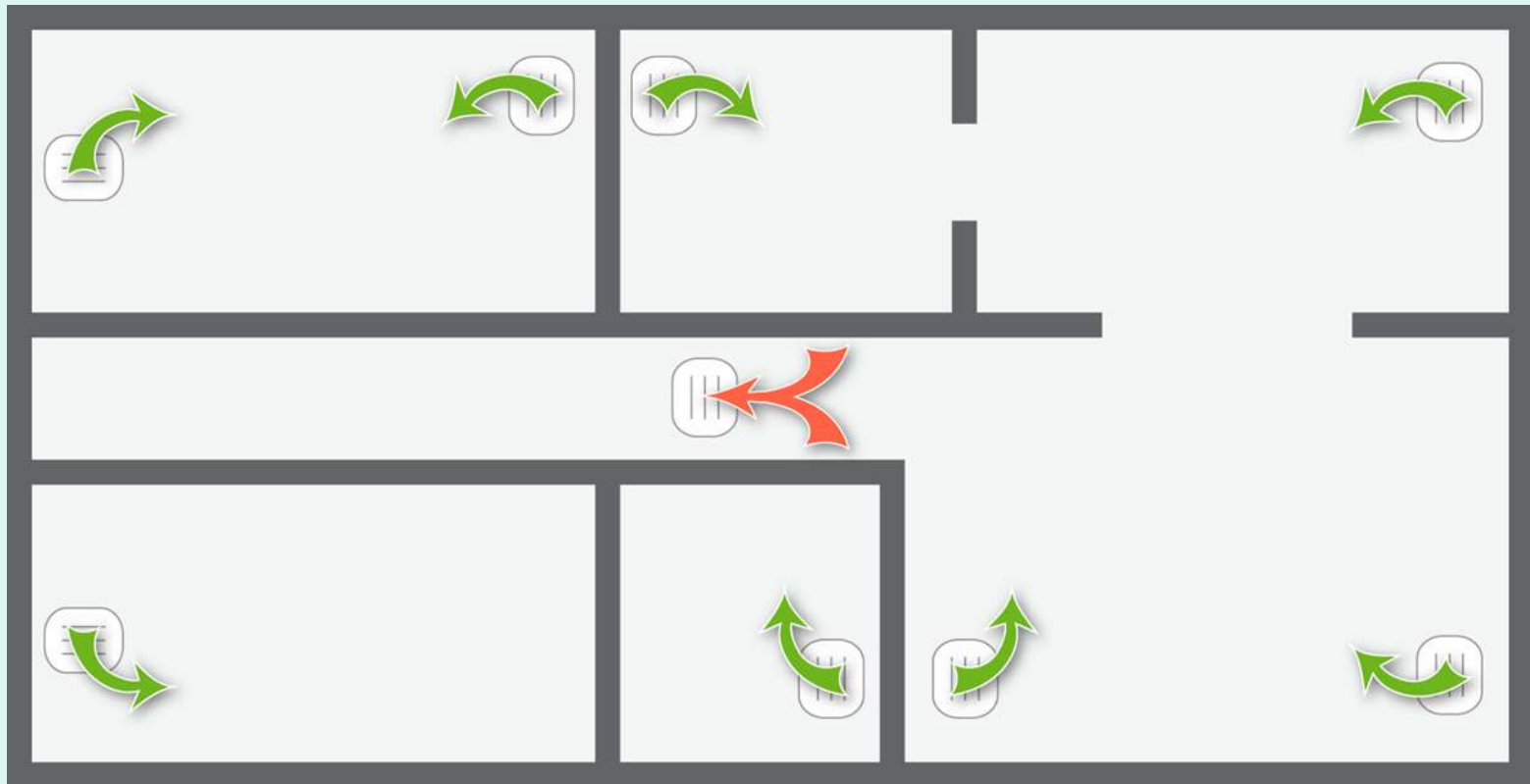
**High humidity air leaking around an electrical outlet condensing and causing mold growth.**



# The Amount of Pressurization in a Room Depends on:

- How much air is delivered to the room;
- How well the room is connected to the rest of the house;
- How well the room is connected to the outside.

# SYSTEM AND DOOR CLOSURE EFFECTS:



# Some basic physics:

For air to move it requires a pressure difference and a pathway (pores, holes, cracks and gaps).

High pressure always goes to low pressure.

249.1 pascals = 1 IWC

# Why Do We Test?

- Pre testing may indicate that pressure balancing may be required.
- Post testing verifies that the work corrected the problem, or at least it did no harm.
- If we are not testing, we are just guessing!

What Should The Room  
Pressures Be???

- Ideally, the pressure differences should be almost zero.
- The proposed DOE National Retrofit Guideline: No room shall exceed  $\pm 3$  pascals wrt outside.

# Recent Test Results:



# Test Procedure:

- Open all registers and install a clean furnace filter.
- Close all windows and doors.
- Turn the air handler on.
- Using a pressure gauge, measure the pressure in each room.
- Record the test results.

# Room Pressure Balancing

(measure pressure in each room WRT the main body, clockwise)

	<b>Room</b>	<b>Suggested repair</b>	<b>pre</b>	<b>mid</b>	<b>post</b>
1					
2					
3					
4					
5					
6					
7					

# Before Attempting Pressure Balancing:

- Complete all air sealing measures.
- Perform duct sealing and repairs.
- Discuss with the homeowner the pressure balancing problems, plans and options.

# Rules of Thumb For Calculating The Area Needed For Pressure Relief:

- Measure: amount of door opening in inches needed to relieve the pressure.

(Multiply: door opening in inches x the height of the door x 1.1 = amount of inch<sup>2</sup> needed for pressure relief.

or

- 1 inch<sup>2</sup> per CFM supply air delivered to the room.

# Pressure Balancing Options:

- The best (and most expensive) solution is a ducted return in each room.
- Rule Of thumb: Don't install returns in the bathroom or kitchen – the return duct would pull moisture and odors to the rest of the house.

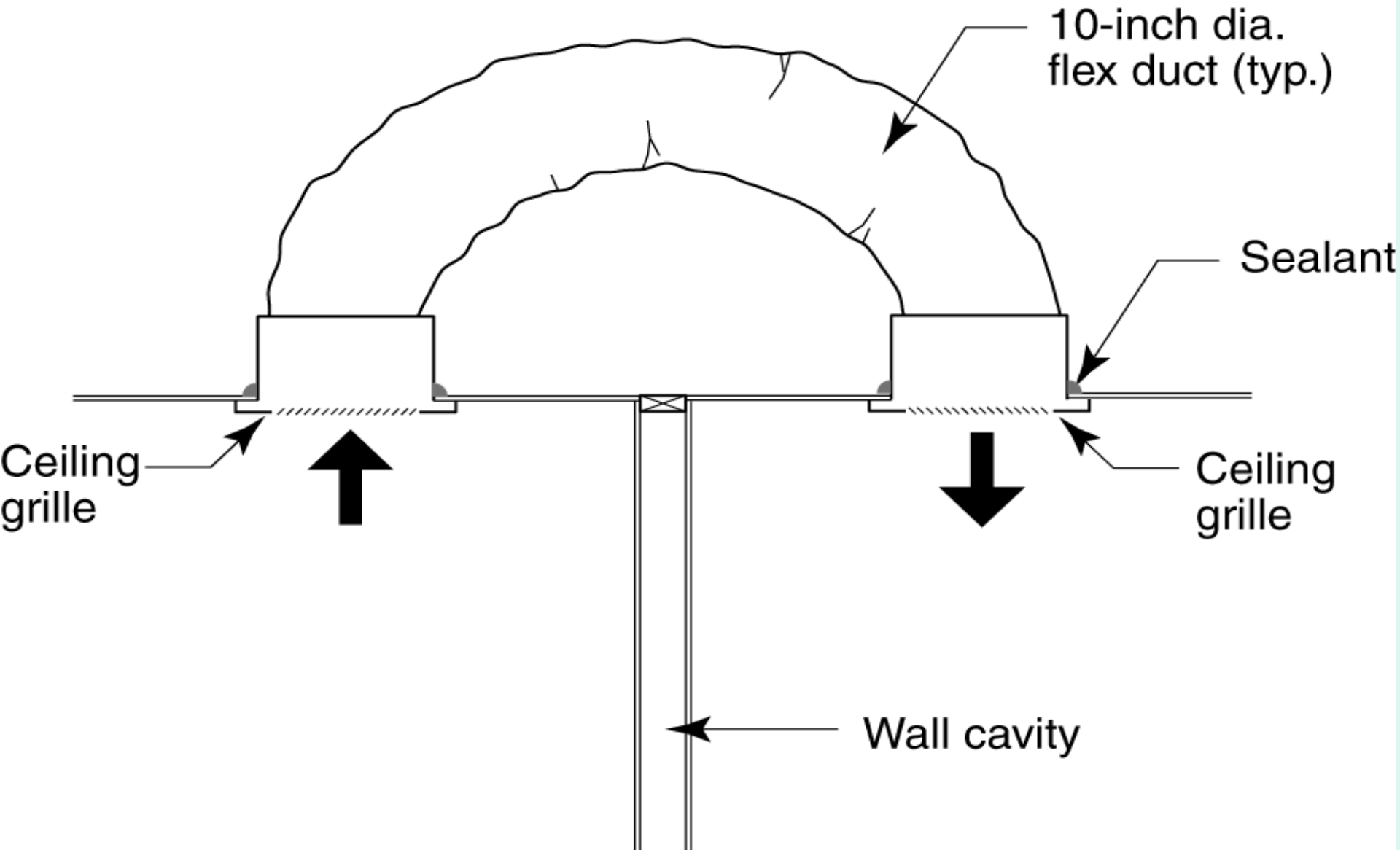
# Ducted Return Duct



# Jump Over Ducts

- Jump over (or under) ducts are passive ducts that connect the room with the main body.
- Flex ducts work best because of their cost, ease of installation, and reduced noise and light transmission (privacy).
- Rule of thumb: Install at least one size larger than the supply duct to the room.

# Jump Over Duct



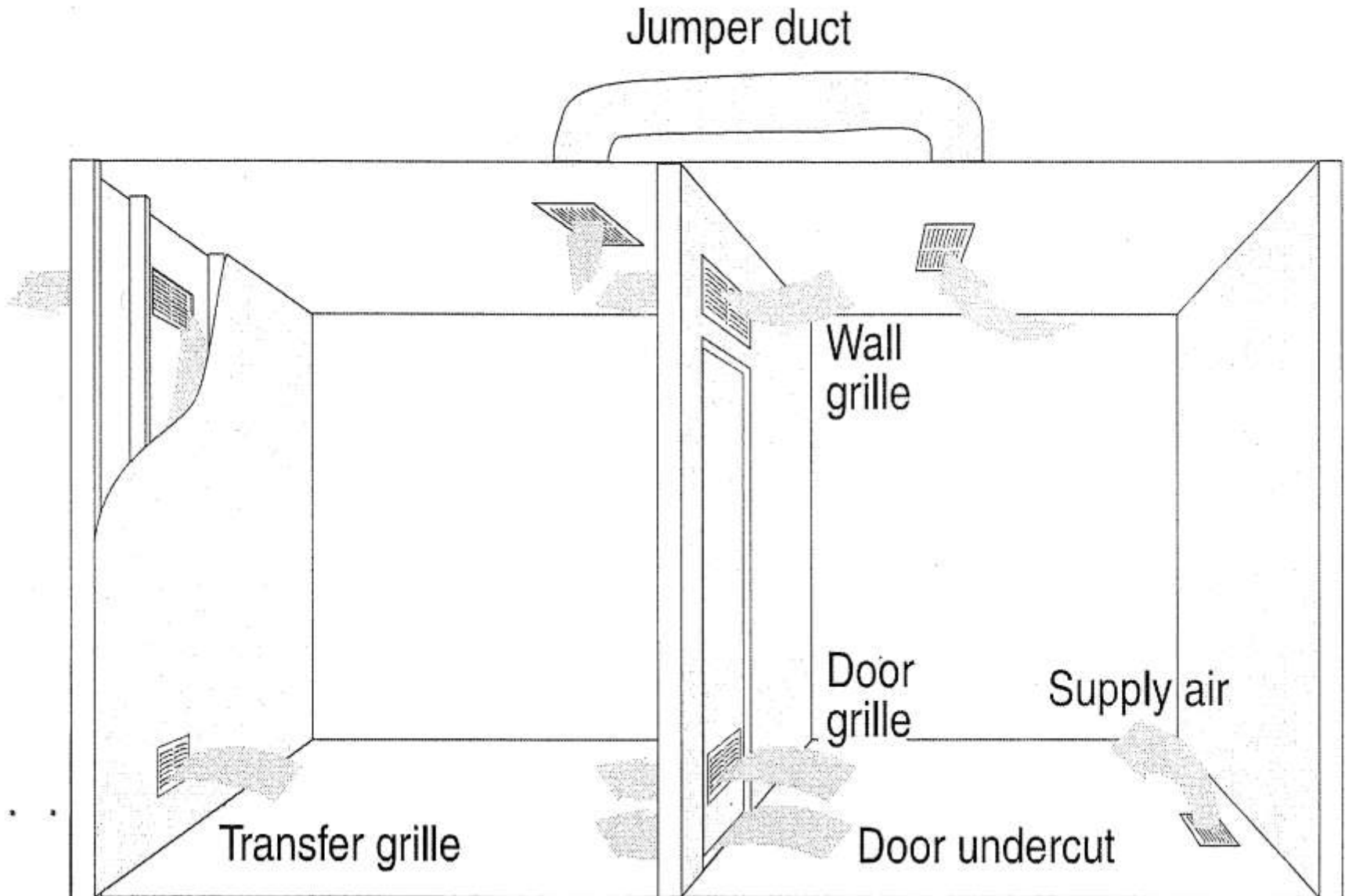
Jump over duct utilizing the ceiling joists as a duct



# Jump Over Duct



# Multiple pressure balancing options:



# Transfer Grills

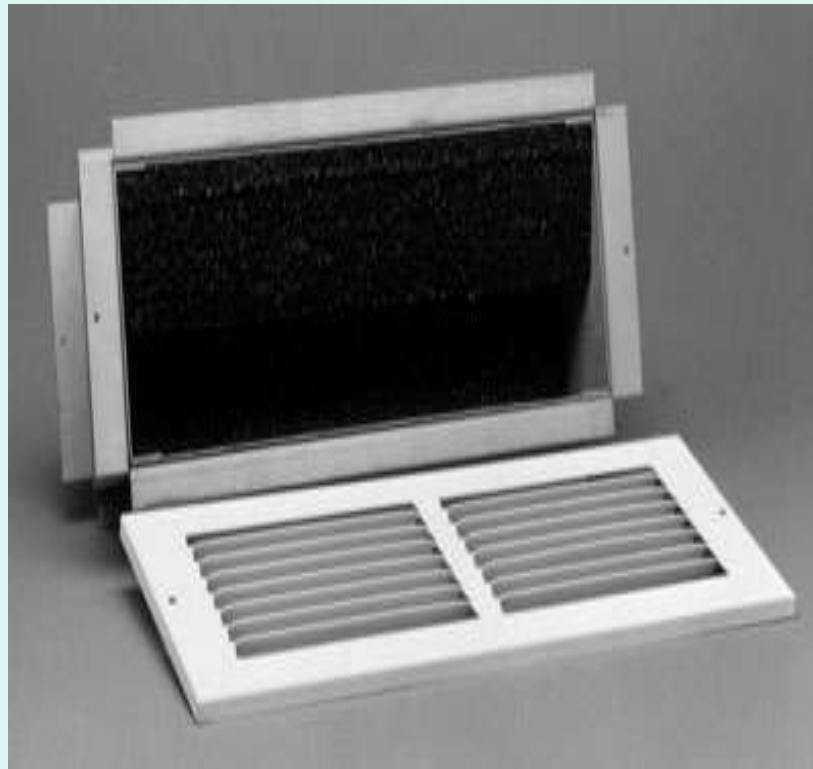
- Install grills in walls. (Best to offset the grills and utilize the interior wall cavity as a duct to reduce noise and light transmission).
- Above the doors (aka a transom).
- Grills can be installed in the doors (less desirable because of privacy issues).

# Transfer Grills



# A Better Grill

- Uses two pieces of black foam to greatly reduce sound and light transmission.



# Door grill with baffles



# Under Cutting The Door

- Doors should not rub on the carpet.
- Not always sufficient (A 32" wide door requires @ 2¼" undercut to alleviate 70 CFM supply to the room).
- Pressure balancing remedies are additive  
- can undercut the door and utilize an additional pressure relief remedy.

# Other considerations:

- Can the fan speed on the air handler be reduced? (reducing air flow)
- If replacing the HVAC system, can a smaller unit be installed? (Bigger is not better!!)
- Don't forget to properly size exhaust fans, especially kitchen fans (again, bigger is not necessarily better!)
- Air seal the floor and the house/garage wall.

Room pressure testing and pressure balancing make homes healthier, safer, more durable, comfortable and energy efficient.

# Thank You!

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