# INDOOR ENVIRONMENTAL QUALITY OVERVIEW

## PowerPoint Presentation with Notes

**June 2004**
**Version 1.0**

**Florida Building Commission**
**2555 Shumard Oak Boulevard**
**Tallahassee, Florida 32399-2100**
**(850) 487-1824**

# Preface

This document supports the *2004 Florida Building Code*. The book describes products and conditions that contribute to Indoor Environmental Quality (IEQ) problems and associated health issues. It also covers techniques designed to minimize IEQ problems. Although the module is intended for a 2-hour continuing education program, its contents are designed to also serve as a reference resource.

Formative reviews by:

- Dr. Rajiv R. Sahay, PureAir Control Services – U.S. Energy Services, Inc.
- Timothy E. Wallace, R.S., Florida Department of Health, Environmental Health

Products referenced in this course are for illustration only and are not an endorsement, warrant, or representation by the author or instructor that the product meets the requirements of the *2004 Florida Building Code*. Use of all products requires the approval of the local jurisdictional authority.

For more information regarding the Florida Building Code contact:

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To obtain a complete copy of the 2004 Florida Building Code contact The Florida Department of Community Affairs Building Code Information System web site:

http://www.floridabuilding.org

The Florida Energy Extension Service worked with Building A Safer Florida, Inc. under contract to the Florida Building Commission through the Florida Department of Community Affairs to develop version 1.0 of this program. Dr. Kathleen C. Ruppert coordinated development of the program and Ms. Barbara Haldeman provided layout and design services.

Version 1.0 Printed June 2004

# Table of Contents

# Pre-test

**Course Title: Indoor Environmental Quality Overview**

**Course #:** _____

**Date:** _____ **Location:** _____

1. Which of the following building materials may contain VOCs?
   a. carpets
   b. cabinets
   c. paints and sealers
   d. all of the above
   e. a and c only

2. True or false? Building-related illnesses can be fatal.
   a. true
   b. false

3. True or false? Lead and asbestos were commonly used in building until the late 1980s and should be removed as soon as detected.
   a. true
   b. false

4. True or false? In most homes, particle board and medium density fiberboard (MDF) are by far the major sources of formaldehyde in the indoor environment.
   a. true
   b. false

5. Formaldehyde emissions and concentration levels are increased by
   a. high humidity
   b. low humidity
   c. the presence of oxygen
   d. the presence of carbon monoxide

6. True or false? Elevated indoor concentrations of radon can be found in every state.
   a. true
   b. false

7. Five major indoor triggers of asthma are:
   a. secondhand smoke, mold, formaldehyde, lead, and pests
   b. dust mites, formaldehyde, pests, mold, and secondhand smoke
   c. dust mites, lead, pet dander, mold, and secondhand smoke
   d. dust mites, pet dander, pests, mold, and secondhand smoke

8. The optimum zone of relative humidity, where the presence of many pollutants is minimized, is:
   a. 50% to 70%
   b. 40% to 60%
   c. 35% to 70%
   d. 35% to 55%

9. Backdrafting occurs when:
   a. there is positive pressure in the area where the combustion device is operating
   b. there is negative pressure in the area where the combustion device is operating
   c. the air pressure inside is greater than the air pressure outside
   d. a combustion device is turned off

10. Building-related bacteria usually are associated with the presence of:
    a. high humidity
    b. high temperature
    c. moldy building materials
    d. stagnant water

# Introduction 3

Sick building syndrome, building-related illnesses, and multiple chemical sensitivity have recently received much media attention. Billions of dollars are lost each year due to decreased productivity and lawsuits. Consequently, construction industry professionals now take the issue of Indoor Environmental Quality very seriously. You can protect the health of your clients *and* your reputation by following a few simple guidelines. After completing this module, participants will be able to:

- Identify potential indoor air pollutants and why they may be problematic.
- Understand the difference between sick building syndrome, building-related illnesses, and multiple chemical sensitivity.
- Design and construct buildings that eliminate potential pollution problems at the source.

# Indoor Environmental Quality Overview

**Version 1.0 / June 2004**

Florida Building Commission
Department of Community Affairs, Codes and Standards
2555 Shumard Oak Boulevard
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(850) 487-1824
http://www.floridabuilding.org

Primary sources of information:

Healthy Indoor Air for America's Homes (Montana State University, U.S. Environmental Protection Agency, and the United States Department of Agriculture)

Florida Department of Health

U.S. Environmental Protection Agency

John C. Hanner, CIE, Indoor Environment & Air Quality Consultants, St. Petersburg, FL

Formative reviews by:

Dr. Rajiv R. Sahay, PureAir Control Services - U.S. Energy Services, Inc.

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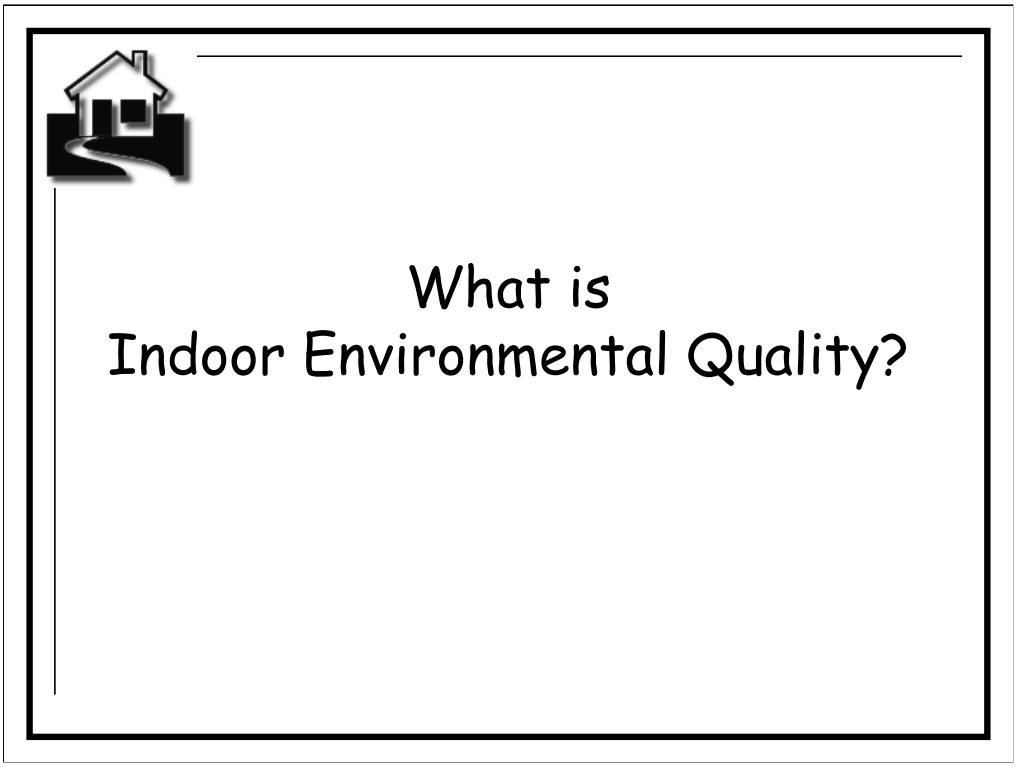
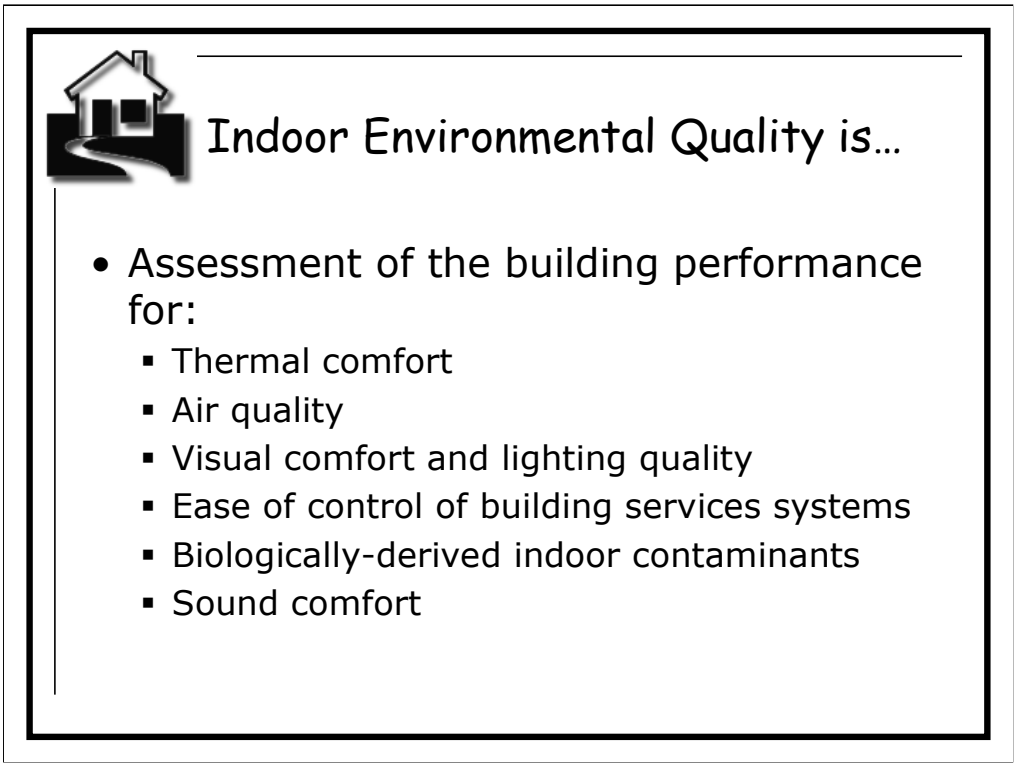



**Indoor Environmental Quality: What is it?**

There is no universally accepted definition. The general feeling is that since the identification of what became known as "Sick Building Syndrome" the issues that in combination are called "Indoor Environmental Quality" have been dominated by discussions about indoor air quality (IAQ). Various authors writing on the subject of IAQ have offered their versions of a definition. Similarly, some agencies dealing with the problem of IAQ (e.g., U.S. Environmental Protection Agency and the World Health Organization) have advanced various definitions.

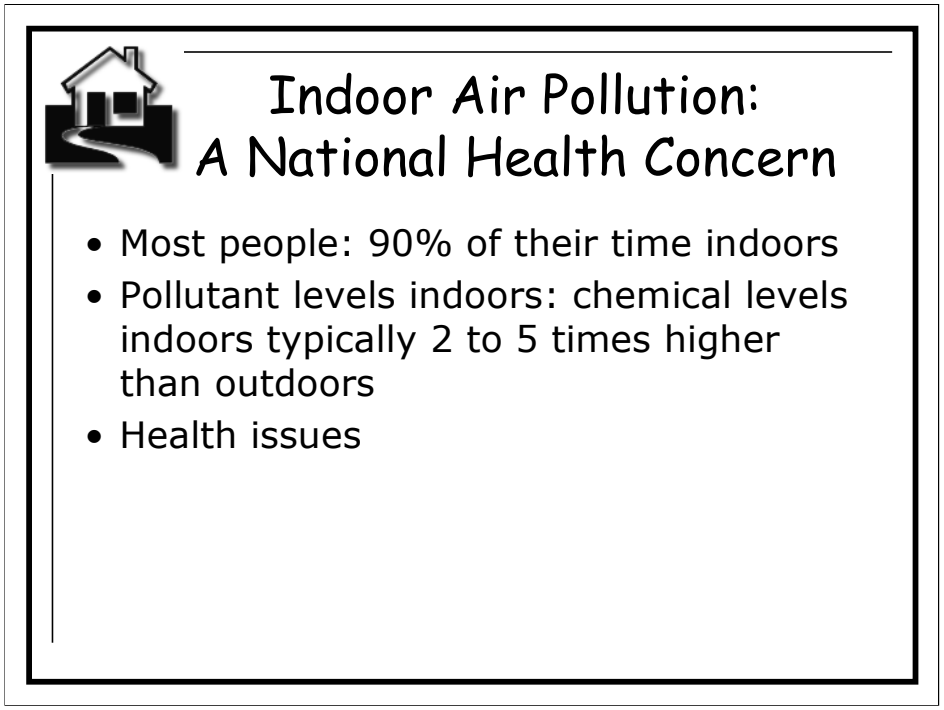
IAQ can be defined as the degree of contamination of air inside a habitable structure. However, IEQ is much more…




The broader topic of indoor environmental quality generally involves the assessment of the building performance for:

- thermal comfort
- air quality
- visual comfort and lighting quality
- ease of control of building services systems
- biologically derived indoor contaminants, and
- sound comfort.

Therefore, a reasonable lay definition for Indoor Environmental Quality is that it is the quality of the components of the indoor environment that affect the health and well-being of the occupants.



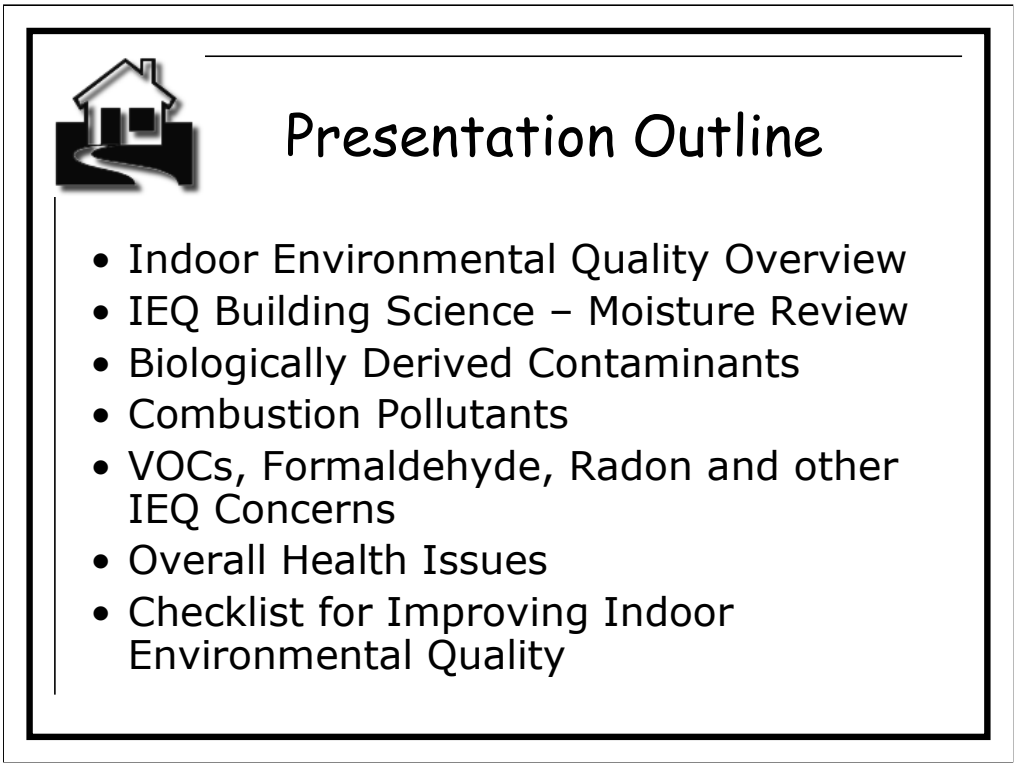

In recent years, a growing body of scientific evidence has indicated the air people breathe inside their homes can be more seriously polluted with dangerous pollutants than outdoor air in even the largest and most industrialized cities. The growing awareness of this issue is causing indoor air pollution to become a national health concern.

The issue is important because most people spend about 90% of their time indoors. For infants, the elderly, persons with chronic diseases, and most urban residents of any age, the proportion is probably higher. The matter is serious when you consider that chemical levels indoors are typically two to five times greater than chemical levels outdoors.

Infants (less than 12 months old), persons recovering from recent surgery, or people with immune suppression, asthma, hypersensitivity pneumonitis, severe allergies, sinusitis, or other chronic inflammatory lung diseases may be at greater risk for developing health problems associated with indoor air pollution. However, medical evaluation is necessary apart from indoor environmental assessment to correlate persistent health problems by indoor air quality pollution, if any.

**Note:**

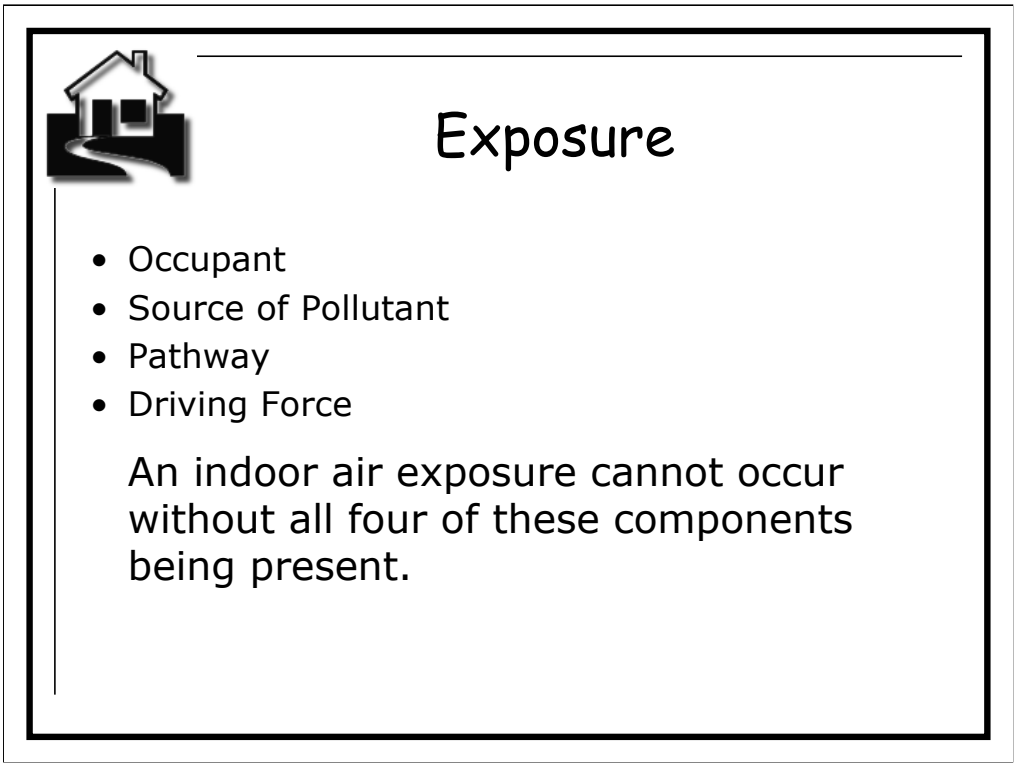
From 1992 through 1994, the U.S. EPA conducted the probability-based National Human Activity Pattern Survey (NHAPS). Telephone interviews were conducted with over 9,000 respondents across the ten EPA regions in 48 states. The national results were generally consistent with a California study conducted in 1987 and 1988 by the California Air Resources Board, which conducted a statewide survey of activity patterns of individuals over 11 years of age. Both studies resulted in a mean percentage of time spent indoors of 87%. The EPA study was broken down into 69% of time spent in a residence and 18% of the time spent in other indoor locations. Source: Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division.




**Presentation Outline**

This course is designed to cover the following:

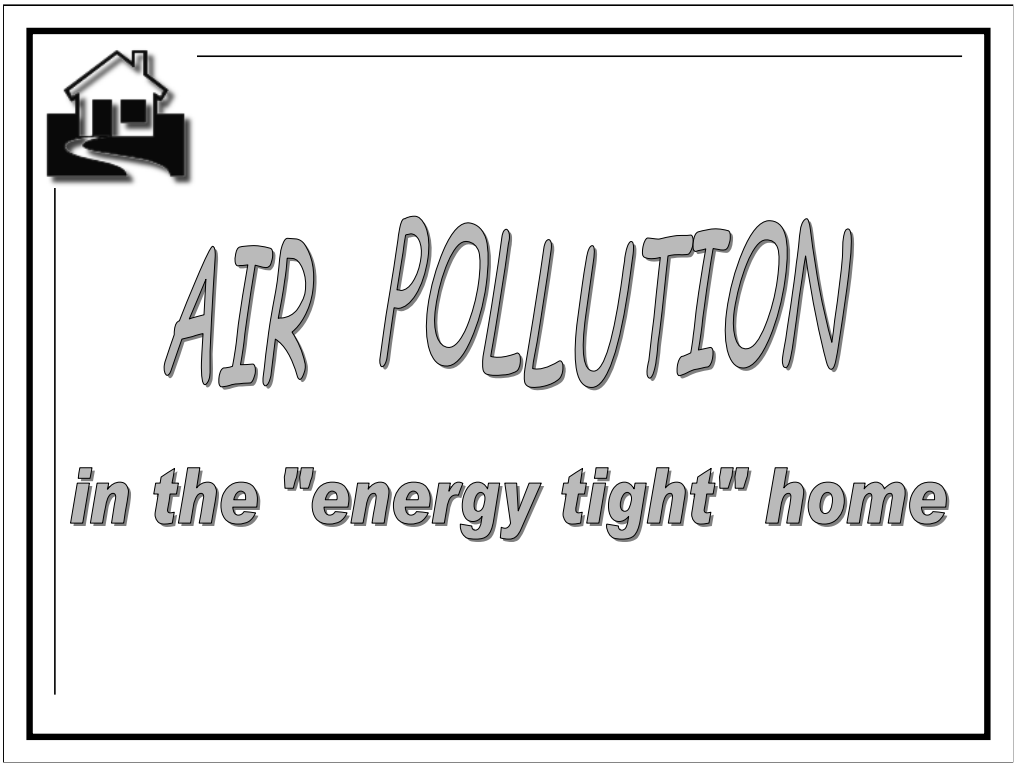
- Indoor Environmental Quality Overview: reviews sources of different pollutants and substances that affect indoor environmental quality
- IEQ Building Science – Moisture Review: emphasis is on moisture sources in a hot, humid climate
- Biologically Derived Contaminants: where they are found and what environmental conditions support their growth
- Combustion Pollutants: covers combustion pollutant sources from cooking, space heating, hot water generation, and attached garages as well as methods on how to minimize or prevent these problems
- VOCs, Formaldehyde, Radon, Lead and other IEQ Concerns: presents recommendations and methods to minimize or eliminate these potential hazards in the home
- Overall Health Issues: reviews relationships between indoor environmental quality and increased rates of asthma, allergies, and other illnesses
- Tips for construction professionals on methods to decrease the possibility of indoor environmental quality problems, primarily in new construction (in the section titled "Checklist for Improving Indoor Environmental Quality")




For an actual exposure to an indoor air pollutant to occur, four components must be present:

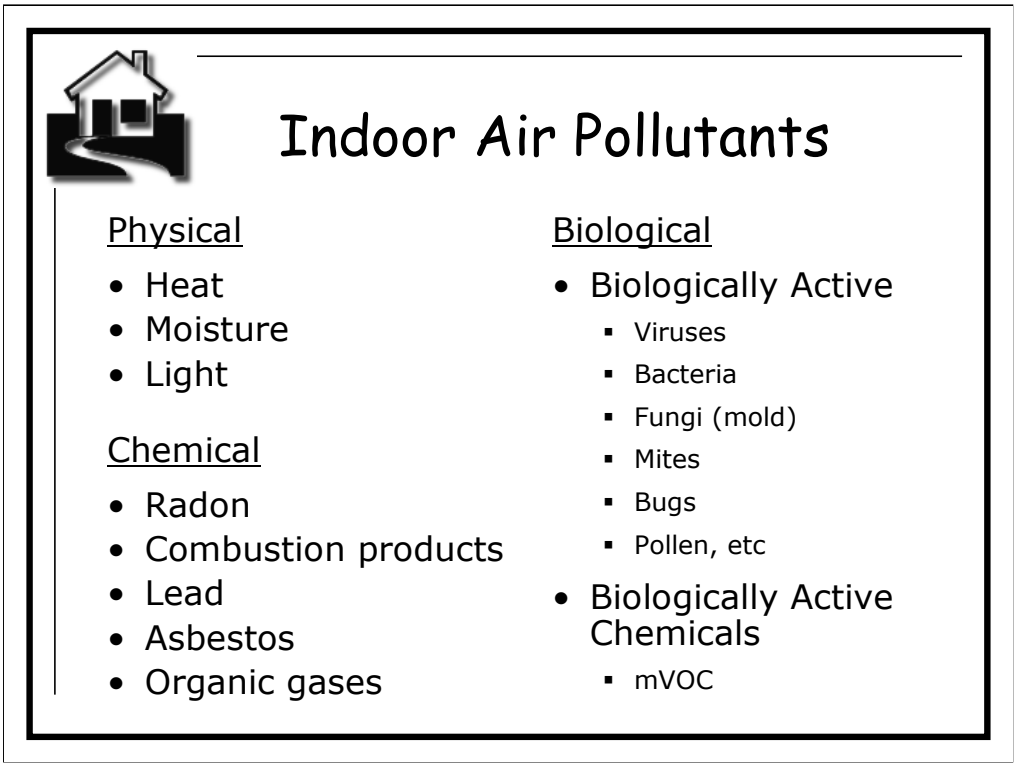
1. The occupant
2. Source of pollutant (where did it come from?—e.g., a mold colony, urea-formaldehyde binder in a pressed wood product, a contaminated humidifier, etc.)
3. Pathway (how did it get to where it caused the problem?—a physical route from source to occupant)
4. Driving force (a physical energy to drive the pollutant from source through pathway to occupant—such as gravity, air pressure, capillarity, diffusion, etc.)

Without any one of these factors, an indoor air exposure cannot occur.



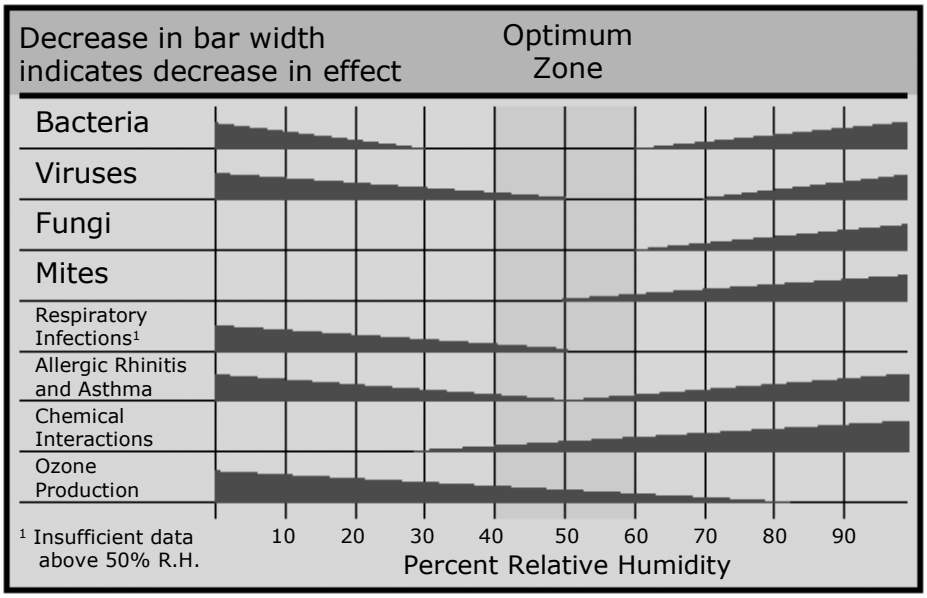

Many people incorrectly assume that energy conserving or "energy tight" homes are more susceptible to indoor air pollution than homes kept deliberately leaky. These people may be surprised to learn that properly designed and maintained energy efficient homes can have a better quality of indoor air than leaky, drafty homes.

This is because in new, energy efficient homes, and in older homes that have had energy conservation features correctly installed, many pollutants are less likely to enter the homes, and those that do can be removed with controlled ventilation. Remember, in a home that is left intentionally leaky, there is no way to control the air that enters through cracks and other openings. That air flow is affected by wind speed, topography, vegetation, and many other factors. On the other hand, energy efficient homes using properly designed HVAC systems, exhaust fans to remove excessive moisture and cooking odors, and a tight building shell can ensure that potential toxins do not enter the home.




What are the pollutants that can be found in the air of a home? This slide shows that these pollutants can be included under three broad categories: physical, chemical, and biological. Some pollutants can be in several categories. For instance, one could argue that radon (radioactivity) and asbestos (toxicity related to physical/mechanical properties) belong in the physical pollutant category and all biologically derived pollutants involve reactive chemistry interactions. The categorizing of indoor air pollutants, therefore, is in part a matter of preference.

Note that mVOC stands for microbial Volatile Organic Compounds—chemicals released by molds that are responsible for the musty smell associated with mold growth. (Noted as mVOC to indicate it is a microbial volatile organic compound.)




**Optimum relative humidity ranges for minimizing adverse health effects.**

*Source: Theodore D. Sterling and Associates, Ltd., Vancouver, B.C.*

Now, let's look at how relative humidity might influence some of these indoor pollutants.

This chart summarizes research conducted on what happens at different levels of relative humidity (RH). Note that humidity levels from 0% to 100% are shown on the horizontal line. If we go down the list on the vertical line, we can see that bacteria populations are high at low levels of RH, drop off at 30% RH, then begin to increase again at 60% RH.

Levels of viruses are high at low RH levels till about 50% RH, then begin to increase again at 70% RH. Fungi and dust mites need moisture to survive. We begin to see fungal growth at 60% RH and mites at 50% RH.

Research on respiratory infections and RH is limited, but suggests that more infections occur at lower levels of RH. Allergy problems and asthma occur at both low and high RH levels. Chemical interactions (here the main interaction is formaldehyde emission) begin at about 30% RH and increase as RH increases. Ozone is a respiratory irritant that is produced by some appliances. Its levels are highest at low levels of RH.

The main feature of this chart is that there is an optimum zone of RH between 40% and 60%, where the presence of all these pollutants is minimized. However, be aware that in very cold weather, moisture levels in the home over about 50% RH can cause condensation problems, leading to the growth of mold and mildew.

**Note:**

This chart is for comparison only. For example, among the tens of thousands of bacterial species, some grow at every level of relative humidity. So, think of this chart in terms of comparisons and not absolutes. Also, ASHRAE recommends 30–60% RH for our comfort.

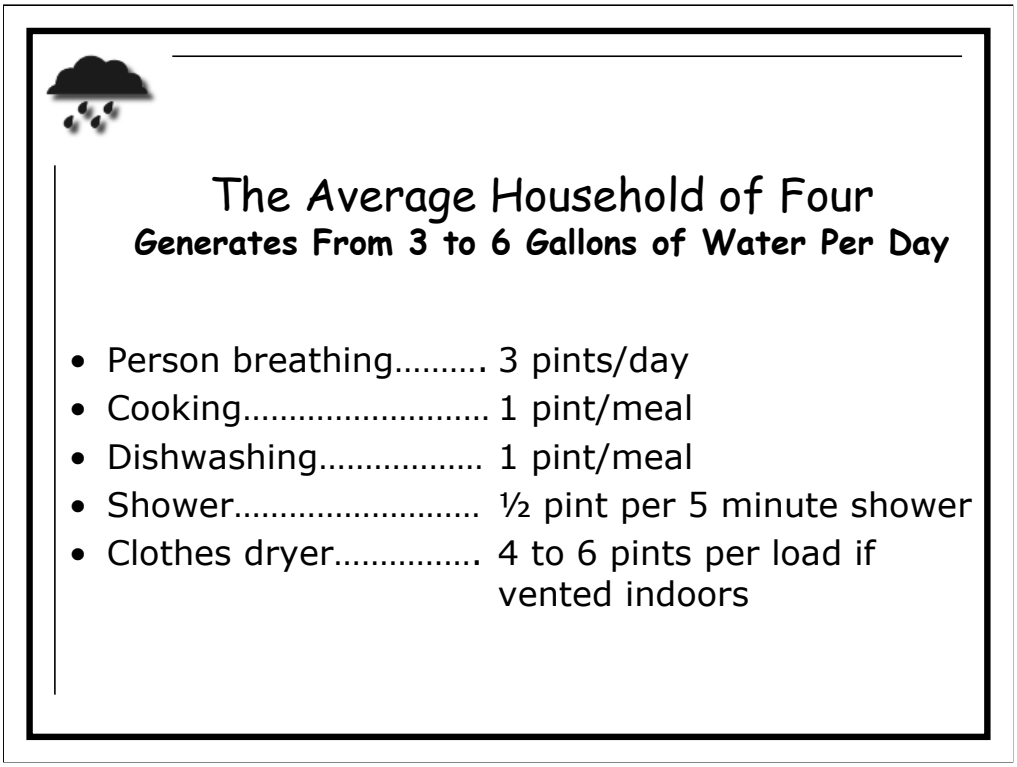

**What are some sources of moisture (humidity) in a home?**

Moisture is produced by common household activities such as cooking, cleaning, and taking showers. People, plants, and pets also produce moisture. These are items the homeowner controls.

But major moisture sources include:

- Leaking roofs
- Unvented heaters
- Improperly installed windows
- Open windows
- Exhaust fans (which can pull humid air into wall cavities)
- Hidden problems, such as a broken ice maker line which drips behind the refrigerator

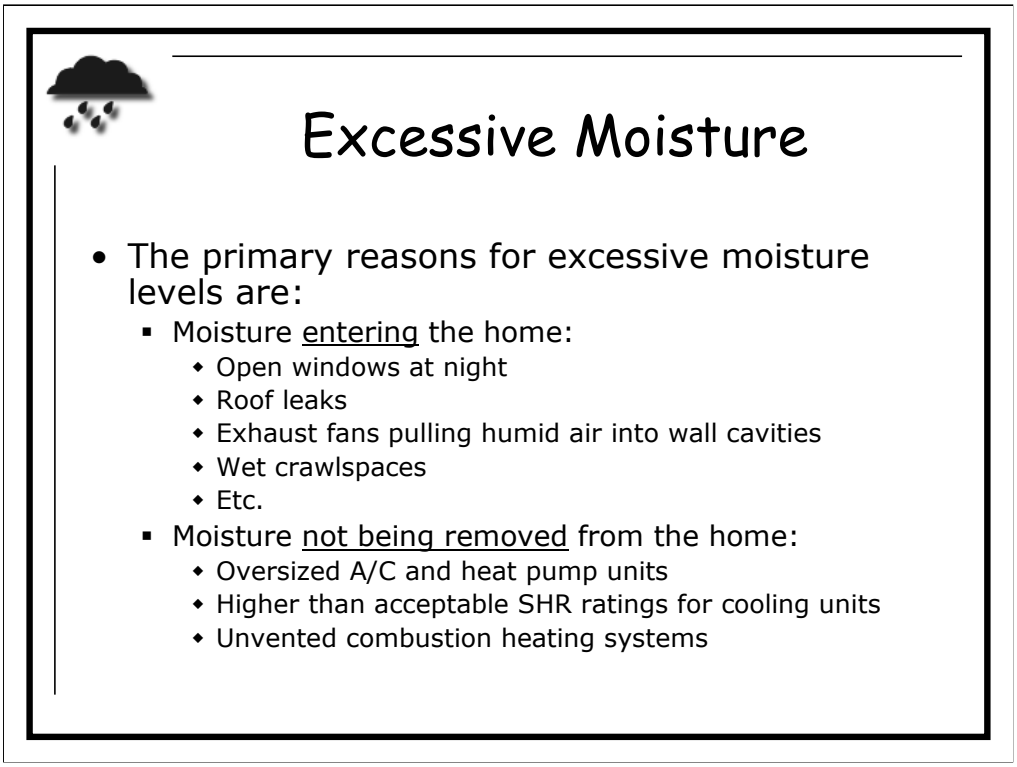
…many of which the construction professional can help prevent.




The average household of four adds between three and six gallons of water in a day to the air. A person gives off three pints of moisture a day by breathing. Cooking and dishwashing each produce about one pint of water per meal (plus 1.6 pints if gas cooking). About one-half pint of moisture is released into the air from taking a 5-minute shower. And a clothes dryer will produce 4 to 6 pints per load if vented indoors.

In addition…houseplants are estimated at providing about 1 pint per six plants.

As a construction professional, you need to consider these moisture sources in your design and construction of the structure.



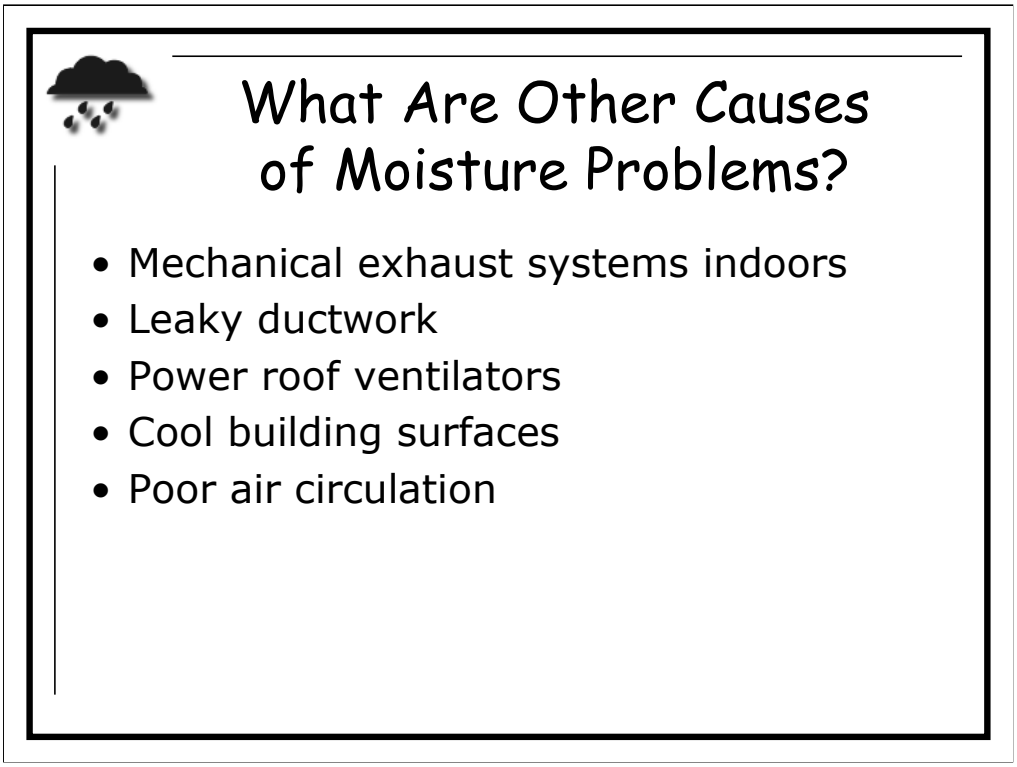

### Excessive Moisture

As discussed earlier, excessive moisture is a major cause of indoor environmental quality problems in warm climates (such as Florida). This can be caused by:

- high outdoor moisture brought in with open windows at night
- roof leaks
- exhaust fans pulling humid air into wall cavities
- wet crawlspaces (or basements) that connect to the living space

It can also be cause by moisture *not being removed* from the home, because of:

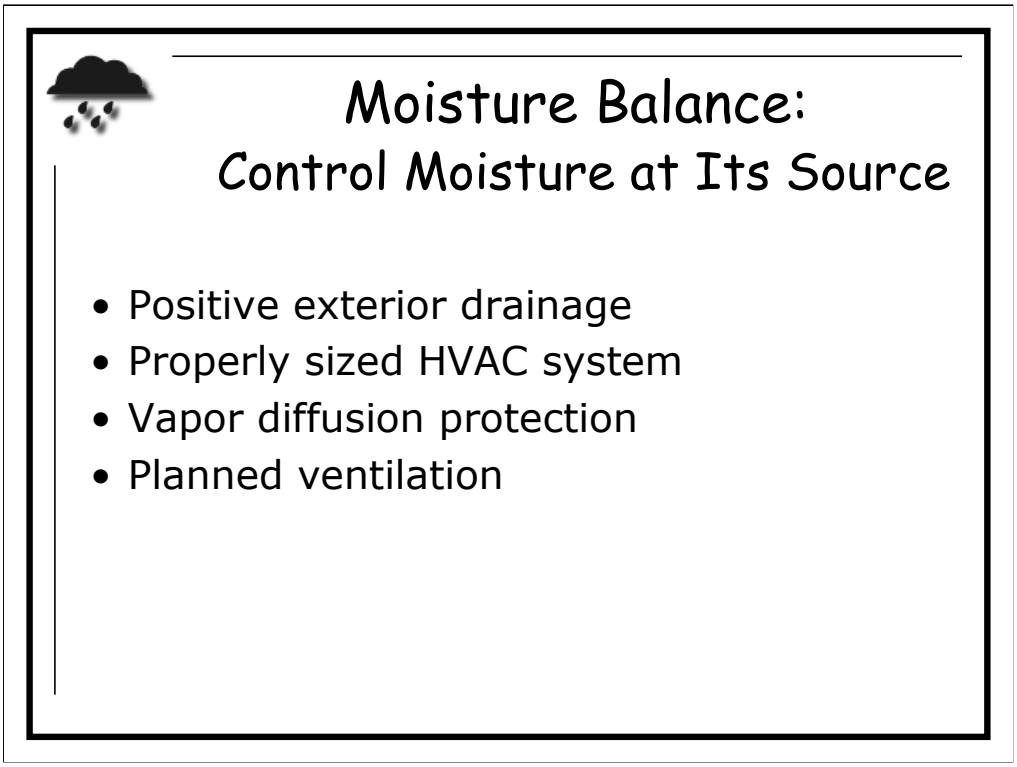
- poor dehumidification by oversized A/C and heat pump units
- higher than acceptable Sensible Heat Ratio (SHR) ratings on cooling equipment (SHR describes the moisture-removing capability of air conditioning systems)
- unvented combustion heating systems.




**Other Causes of Moisture Problems**

Many homes have a variety of exhaust appliances, such as clothes dryers, range hoods, and bath vents. Leaky ductwork can also cause moisture problems. Even power roof vents can depressurize the living space if there is an inadequate vent area in the attic.

High moisture levels can be made even worse when there are cool surfaces present, which permit mold to grow. Cool surfaces can result from cold walls below grade, metal frames around windows or even from poor air circulation behind furniture or cabinets against outside walls.

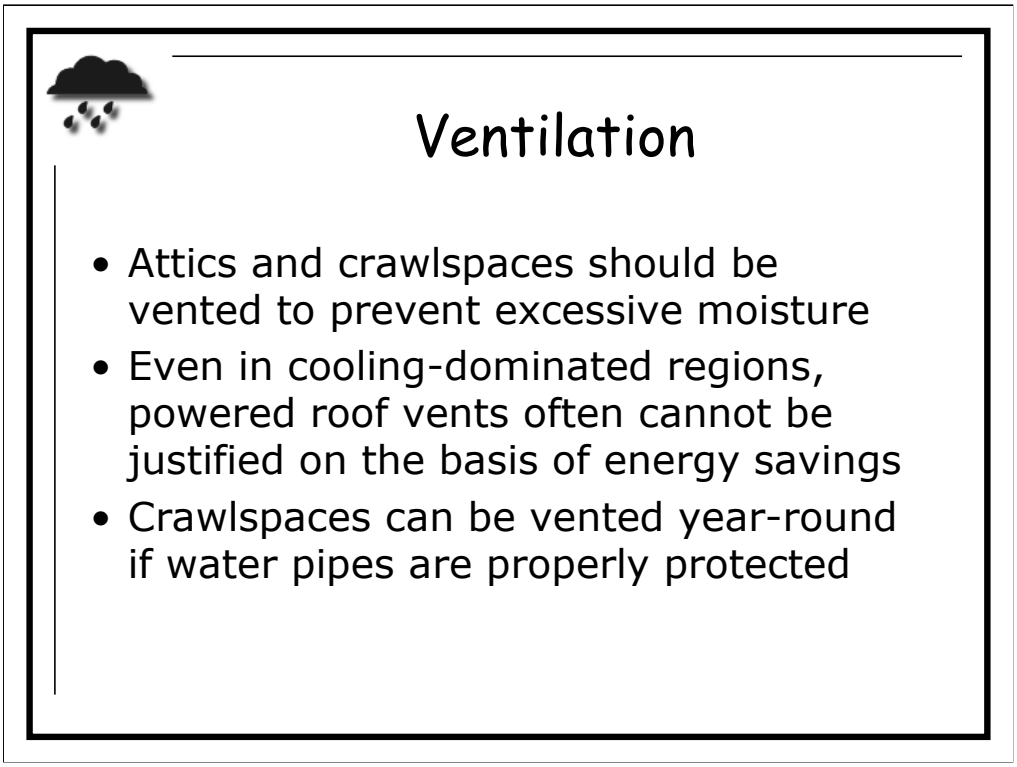



The key to controlling relative humidity levels in a home is to maintain a moisture balance. Remember, some moisture in the air is necessary for human health and comfort, but too much moisture can cause problems.

A moisture balance is maintained by making sure a home has positive exterior drainage away from the house in all directions, a properly sized and operational heating and cooling system, vapor diffusion protection (through the installation of vapor retarders where needed), as well as adequately planned ventilation, especially at points where moisture is produced.


Inside the home, moisture should be vented to the outside from the point at which it is produced. This means that a kitchen stove needs an exhaust fan over it, which should be ducted to the outside. A circulating fan may remove some cooking odors from the air, but it will not remove moisture.

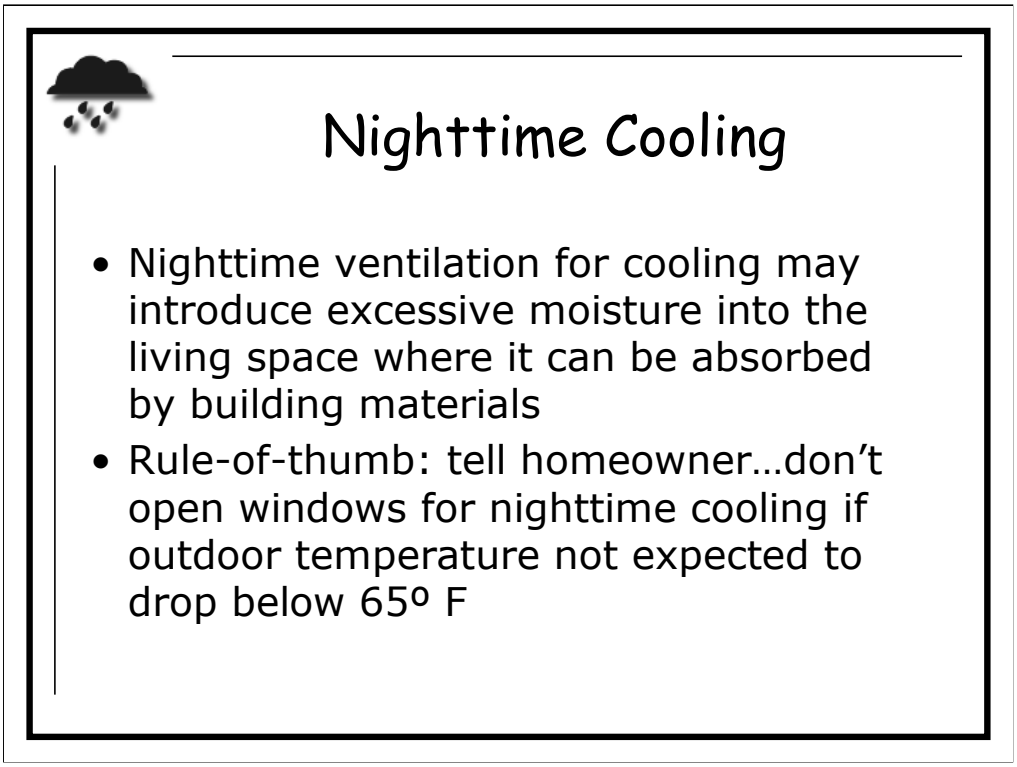
A bathroom also needs an exhaust fan that leads to the outside. This fan should be used when anyone is taking a shower and for a short time afterwards, until moisture levels have decreased to the point that there is no condensation on windows and mirrors. In the laundry room, a clothes dryer should be vented to the outdoors.




**Ventilation**

Ventilation of attics and crawlspaces is still needed primarily for moisture problems, even in cooling-dominated climates. Powered roof vents are common in the South, but often cannot be justified based on energy savings when typical attic insulation is present. Powered roof vents can also contribute to house de-pressurization. Conditioned air is drawn from the living space to the attic through cracks and crevices. More energy can be wasted in this manner than gained by cooling the attic.

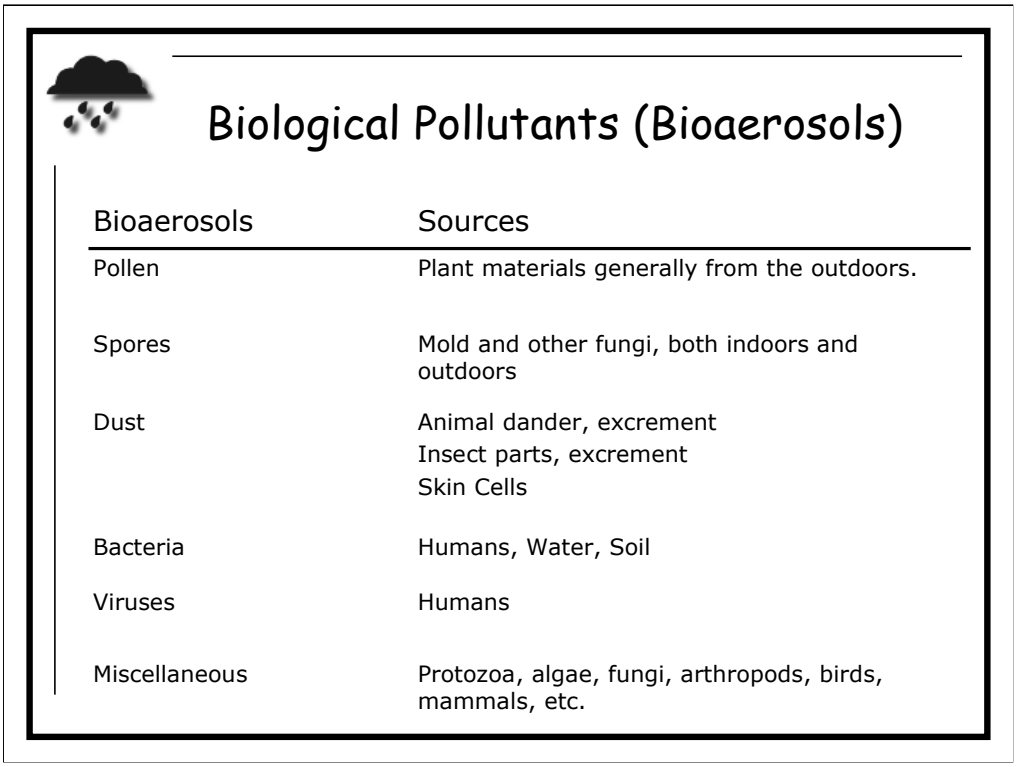
Crawlspace vents that close in cool weather are not needed if the water pipes are properly insulated. Such vents are not desirable if there is any source of water going into the crawlspace, such as from a spring or surface drainage. High humidity air from the crawlspace can be drawn into the living area due to depressurization from venting devices.




**Nighttime Cooling**

Using natural ventilation of houses for nighttime cooling should be done with some measure of caution. The nighttime low temperature is usually near the dew point of the air. If the air allowed into the house has a higher moisture content than the design indoor condition, the use of the air conditioner the next day may not be able to properly remove all the excess moisture from the indoor materials.

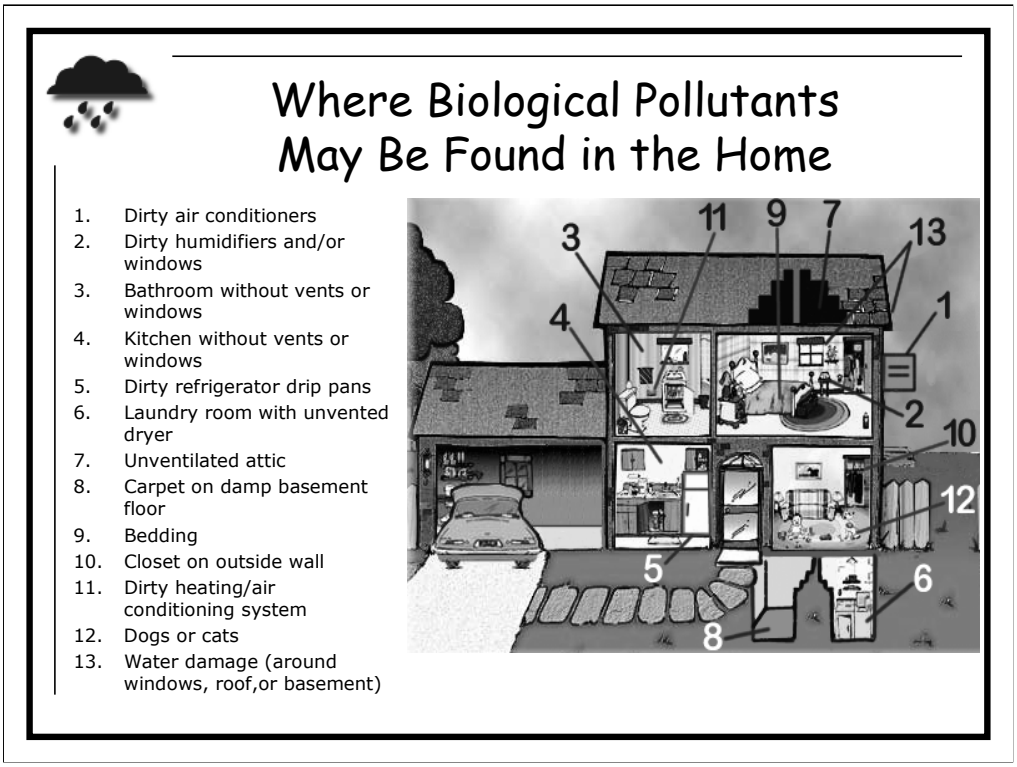
The dew point at standard room conditions is about 58º F. Sensible cooling of the air can compensate somewhat for higher humidities. However, windows should probably not be opened for nighttime cooling if the temperature is not expected to get below about 65º F (this isn't a perfect rule-of-thumb, but it should help).




**What are the sources of biologically-derived contaminants?**

Biologically-derived contaminants (biological pollutants), also called bioaerosols, come from plant, animal, bacterial, fungal, viral, and algal material. Some are generated outside the home, such as pollen, but enter the home through open doors and windows and on people and pets entering the home. Pollen and animal dander do not depend on moisture or nutrients in the home.

Other biological pollutants are generated in the home: mold growth in the home releases spores into the air; animals generate dander and insects generate excrement and body parts that are small enough to become airborne. Bacteria and viruses are infectious agents that are brought into the home in a number of ways. They grow in appropriate hosts, which include people and water and can be spread through indoor ventilating systems. All of these pollutants are particulates – that is, they are particles so small that they "float" in the air. Larger particles settle out onto surfaces, but very small particles stay suspended indefinitely.



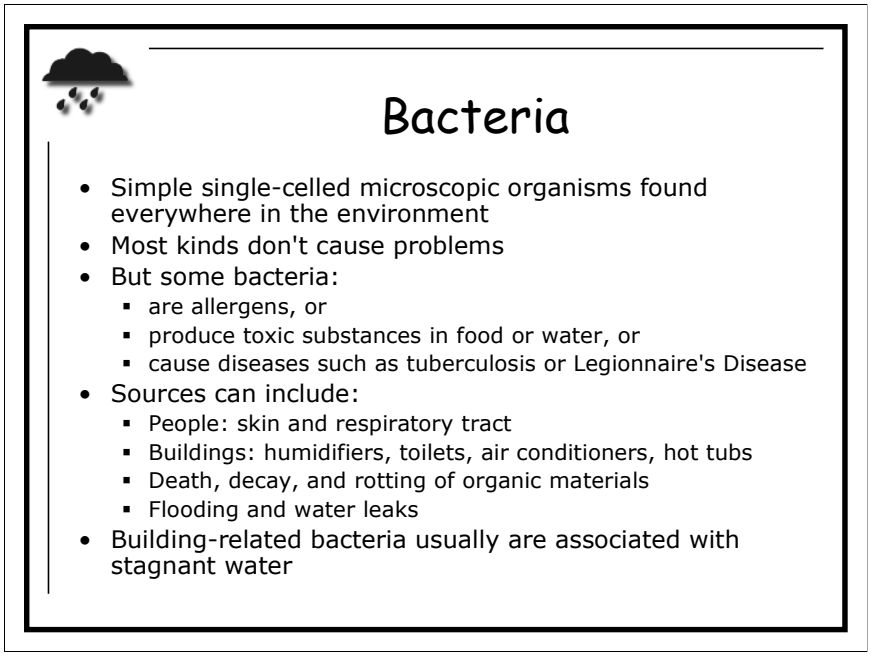

Many places where biological pollutants are found have high humidity levels or moisture associated with them: rooms with humidifiers or unvented combustion space heaters, bathrooms, kitchens, laundry rooms, basements, crawlspaces, and places with water leaks or water damage. Other common sources of moisture include rainwater entry (above or below the ground), groundwater, and insufficient ventilation. Places where water collects, such as dehumidifiers, refrigerator collection pans, and air conditioner drip trays, promote the growth of mold and bacteria.

Areas where there is poor ventilation and cold walls, such as unventilated attics and closets, may have mold growth due to condensation. Moist summer air contacting cool, air-conditioned surfaces also creates condensation problems. Mold-contaminated heating and air conditioning systems can spread biological pollutants throughout the house.

Dogs and cats are the sources of allergens for some people. And dust mites thrive in bedding and upholstery. (Keep in mind that carpets, draperies, and other textiles in the home can act as a "sink" for airborne pollutants. Also, chemicals sprayed or evaporated can collect in the same areas.)

## Environmental Factors

Under the influence of environmental factors (i.e., moisture, temperature, light, nutrients, etc.), all of the biologically active particles pass through different stages (source, release, dispersal, deposition, impaction). The study of all these stages helps in tracking and identification of biological pollutants in a given environment.




**Bacteria**

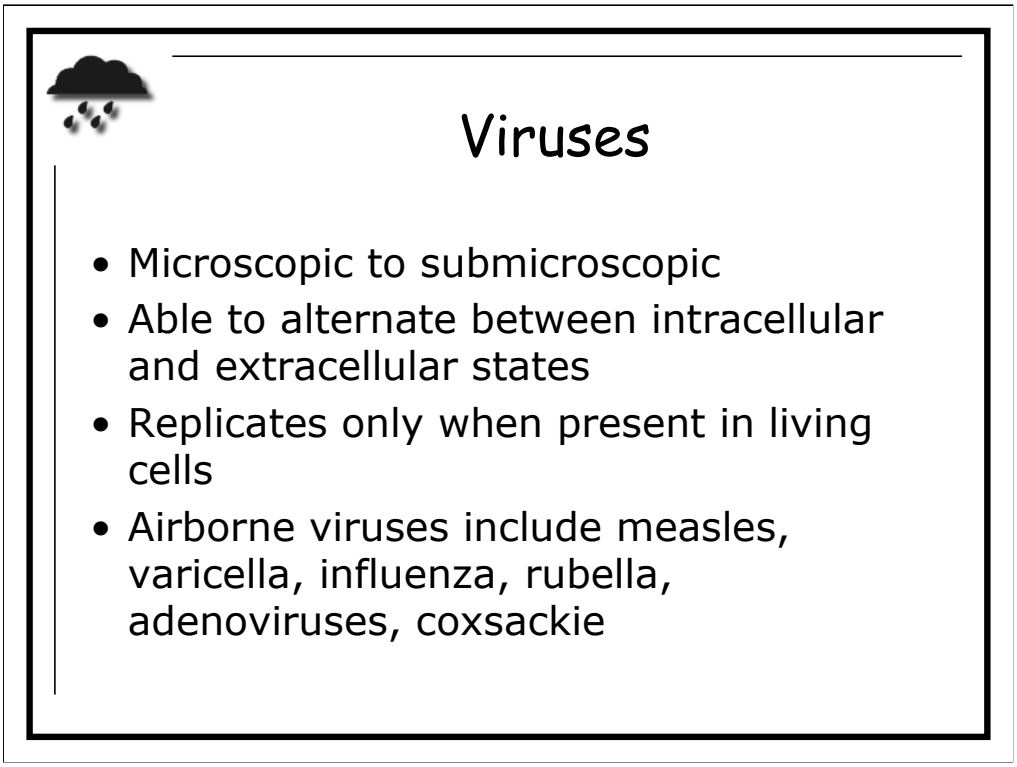
Bacteria are simple unicellular microscopic organisms without a nucleus or organelles. Bacteria are found everywhere in our environment. There are over 400 known genera and thousands of species of bacteria. They can be found in the indoor environment as a whole organism, a spore, a cell fragment, or as a cell metabolic product. While most bacteria do not cause human illnesses, some bacteria act as allergens, some produce toxic agents (endotoxins), and some cause infectious diseases. Diseases or health effects associated with bacteria in indoor air include: Legionnaires' Disease, Pontiac Fever, tuberculosis (TB), and hypersensitivity pneumonitis (interstitial lung disease, also called allergic alveo-litis). Indoor air in occupied buildings typically has higher concentrations and more types of bacteria than outdoor air.

A majority of the bacteria in homes and non-industrial buildings come from human skin and the respiratory tract. Building-related sources such as humidifiers, hot tubs, toilets, showers, fountains, and air conditioners can generate aerosols of bacteria. Building-related bacteria usually are associated with the presence of stagnant water.

The bacteria most commonly associated with building related illnesses are from the genus Legionella. Legionella bacteria are the infectious agents for Legionnaires' Disease and Pontiac Fever (these diseases are different forms of Legionellosis).

Tuberculosis is a disease caused by the pathogen *Mycobacterium tuberculosis*. This bacterium is transmitted from person to person through aerosolized respiratory secretions (coughing, sneezing, speaking). The indoor environment plays a major role in the transmission of this disease. As air moves past a human source, the aerosols are moved from one location in the building to another. While these aerosols would be easily dispersed in outdoor environments, they are concentrated in indoor environments. The CDC has offered guidelines on engineering controls for controlling the transmission of TB bacteria in buildings such as health care facilities.

Bacteria can also generate toxins. These toxins are either part of the cell wall (endotoxins) or are secreted externally (exotoxins) into the environment. While there is considerable information available on the health effects of ingesting certain bacterial toxins (food or waterborne route), the health effects of inhalation or skin contact with bacterial toxins are poorly understood. It is believed that at high levels of exposure, endotoxins act as irritants or cause flu-like symptoms.



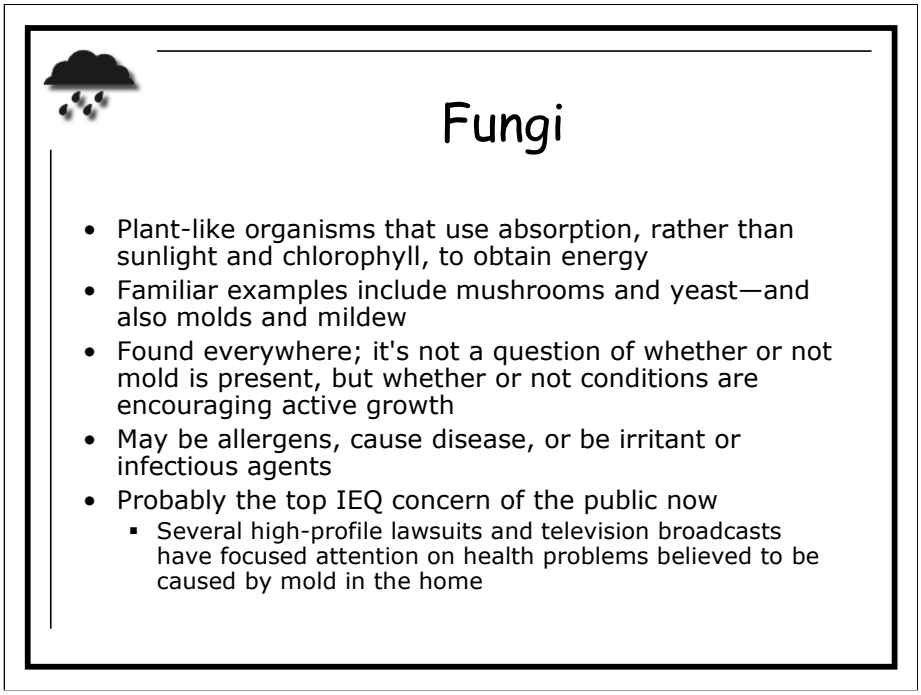

**Viruses**

Viruses are:

- Microscopic to submicroscopic infective agents that essentially consist of a core of RNA or DNA surrounded by a protein coating.
- Able to alternate between intracellular and extracellular states
- Unable to replicate without a host cell

Airborne viruses include measles, varicella (chicken pox), influenza, rubella, adenoviruses (causes of influenza-like upper respiratory infection), and the coxsackie (hand-foot-mouth) viruses. In contrast, the common cold (caused by rhinoviruses) is much more commonly transmitted by direct contact.

Viruses and bacteria grow in appropriate hosts, which include people and water. They can be spread through indoor ventilating systems. Humidifiers that are not cleaned and disinfected regularly can have bacteria, as well as mold, growing in them. The spray from the humidifier causes the contaminants to become airborne.




## Fungi

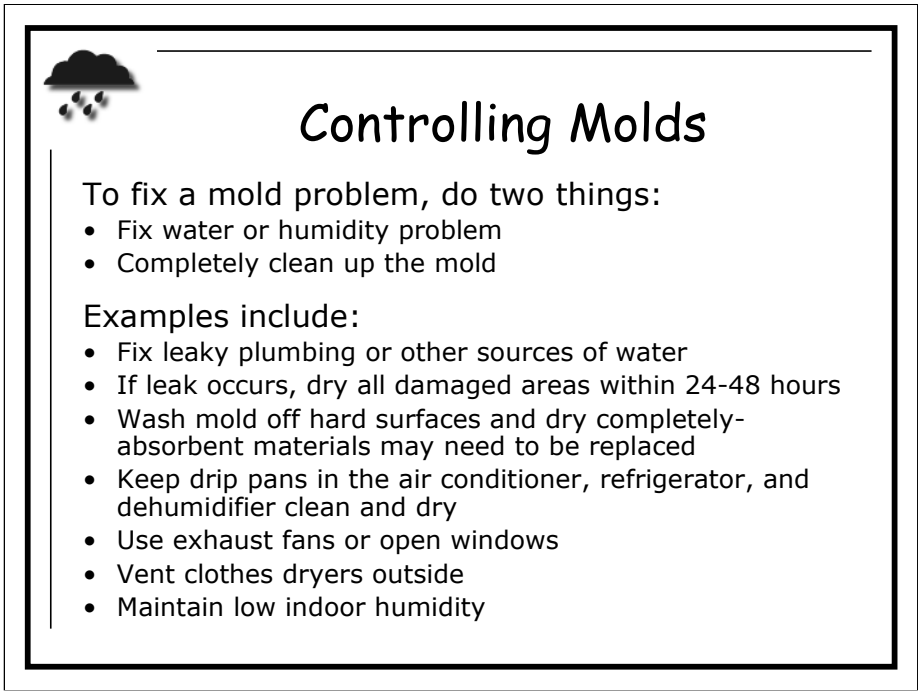
Fungi is a kingdom of unicellular or multicellular organisms that do not use chlorophyll, and primarily use absorption as a means to obtain energy from their environment. Molds, mildews, yeasts, and mushrooms all belong to the kingdom fungi. The term "mold" is a general word for unwanted visible fungal growth. Mildew is sometimes referred to as fungi that grows on fabrics, or fungi that can cause plant disease. Yeast is used to describe fungi that are unicellular when cultured.

Fungi can act as allergens, toxicants (toxic agent), irritants or infectious agents. It is believed that all forms of fungi are potential allergens to man. Some fungi species are known to produce specific metabolic products (mycotoxins) which are toxic to man and animals. Some (if not most) fungal species can produce metabolic products that are irritating to the mucus membranes (eyes and the lining of the nose and throat). Some fungal species are known to be infectious to humans and animals.

Mold can be found everywhere in indoor and outdoor environments. It is not a question of whether or not mold is present; it is a question of active mold growth, amplification conditions and moisture. Currently, indoor mold is probably the top IEQ concern of the public. Several high profile mold lawsuits and television news broadcasts have highlighted the potential hazards and liabilities associated with indoor mold. The Insurance Information Institute reported insurers paid out more than $3 billion nationwide in 2002 for repairs and litigation related to mold.

**Note:**

The Centers for Disease Control states that it is estimated that there are between 50,000 and 250,000 species of fungi, and fewer than 200 have been described as human pathogens that can cause infections. More than 1,000 different kinds of indoor molds have been found in U.S. homes.



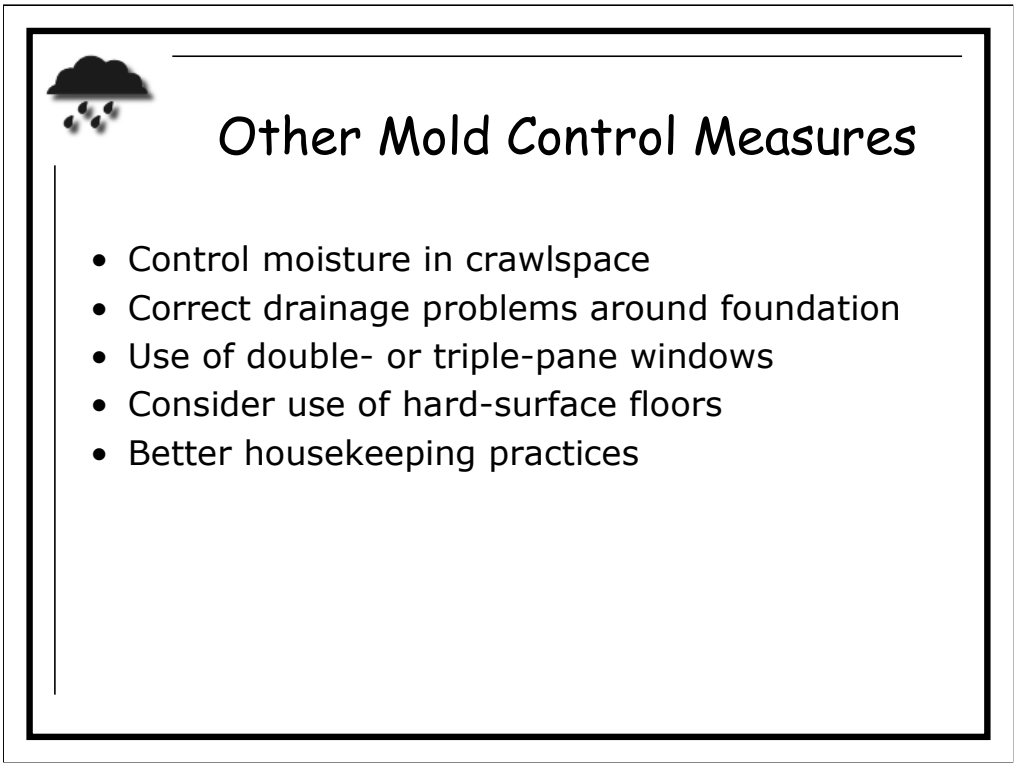

**Controlling Molds**

To fix a mold problem, you should do two things:

1. Fix the water or humidity problem. Mold growth is almost always due to an excess moisture problem in the area. Solving the moisture problem will stop the mold growth, although the existing mold will need to be cleaned up. Solving the moisture problem can involve some detective work and is not always easy. Besides moisture, a number of other environmental factors (both physical and biological), i.e., temperature, light elements, etc., are directly or indirectly responsible for mold growth. This essentially means that, for controlling mold problems, these factors should also be controlled.
2. Completely clean up the mold. Some examples of fixing a water or humidity problem include:
   - Repairing a plumbing leak or raising the temperature of cold surfaces where moisture condenses by adding insulation
   - If a leak or other water damage occurs, drying all water-damaged areas completely within 24 to 48 hours
   - Washing mold off hard surfaces and drying completely – absorbent materials (ceiling tiles and carpet) may need to be replaced
   - Keeping drip pans in the air conditioner, refrigerator, and dehumidifier clean and dry
   - Using exhaust fans or opening windows in kitchens and bathrooms when showering, cooking, or using the dishwasher
   - Venting clothes dryers to the outside
   - Maintaining low indoor humidity (some people recommend between 35–55% relative humidity; others recommend between 40–60%; ASHRAE recommends 30–60% relative humidity.) If the humidity level in the home remains high, there are several methods for lowering it. When outside air is drier than inside air, opening doors and windows can increase ventilation and help dry out the house. In warm, humid climates like ours, outside air is usually more humid than inside air so other strategies must be used.

Note that dehumidifiers can help lower humidity in rooms or certain areas of the house, yet an on-going expense compared to fixing the underlying problem. Room-size air conditioners can also help remove moisture from a room or a limited amount of space. Central air conditioning systems are needed to lower humidity levels throughout the house. As mentioned before, air conditioners must be properly sized (and installed) to lower both temperature and humidity levels.

` As you are building the house, keep in mind that moisture is probably the biggest problem. Imagine where and how water and humidity will attempt to come into the structure, and build them out. Imagine where and how water and humidity will be generated within the structure, and make provisions to get them out. Have you planned to exclude and/or control moisture as much as possible?

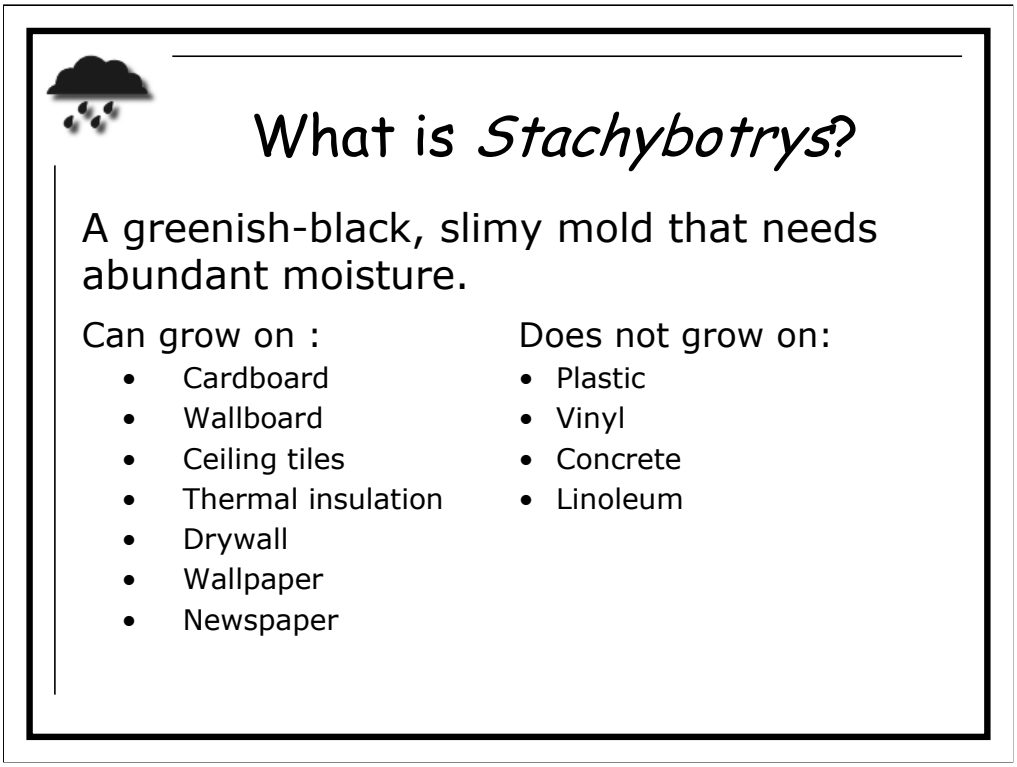



Crawlspaces can have high humidity levels that promote mold growth. Whether crawl spaces are ventilated or not, moisture can still migrate from the soil into the crawlspace, so a moisture barrier must be installed to control humidity. Polyethylene sheeting laid on the ground and extending slightly up the sides of the crawlspace can be an effective control. The sheeting can be anchored with sand, bricks, or other weights. Overlap plastic sheets and seal with caulking or tape to prevent ground moisture from entering the crawlspace.

Other moisture problems in crawlspaces (and basements) can be the result of improper drainage around the foundation. Some problems can be solved with properly functioning gutters and downspouts, and sloping earth away from the house. More severe problems may require installing drain tile systems, sump pumps, or waterproofing basement walls and floors. It cannot be emphasized enough that proper site preparation can make a lot of difference!

Double- or triple-pane windows and storm windows raise the temperature of inside glass and reduce condensation problems in these areas. The use of hard-surface floors, in lieu of wall-to-wall carpet, may also be advisable.

Regular and better housekeeping practices help in maintaining proper sanitation that can prevent mold growth. Keep in mind that mold grows on organic materials such as paper, textiles, grease, dirt, and soap scum. When a mold colony has been established (for example, on a bathroom wall), it generates mold spores that float through the air, land on other surfaces, and if conditions are right, form new colonies.



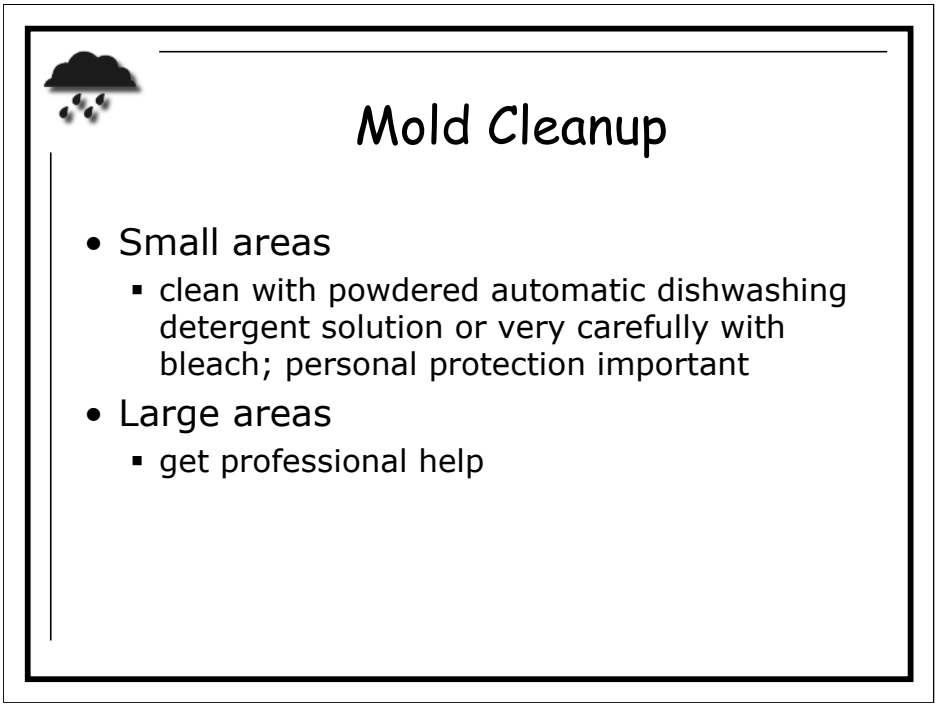

In case you are asked…

**What is *Stachybotrys*?**

*Stachybotrys atra* (also called *S. chartarum*) is a greenish-black, slimy mold that grows on wet materials containing **cellulose**. Such materials include: paper, wood, cardboard, wallboard, ceiling tiles, drywall, wallpaper, newspaper, etc. This particular mold may contain a toxic substance, mycotoxin, named Satratoxin H (a thrichothecene). Again, keep in mind that this is a greenish-black, slimy mold that grows on paper or wood-based products that have been wet for at least several days. There are many other black molds similar in appearance that are not *Stachybotrys*.

**Note:**

In January 1997, press reports told of a number of deaths of young infants in the Cleveland area. These deaths involved bleeding from the lungs and were associated with a specific type of mold called *Stachybotrys atra* (or *S. chartarum*). Although health officials feel that there is not sufficient evidence to absolutely blame this mold for these cases, this mold can nevertheless cause serious health problems in both children and adults. Media reports about this "killer mold" have caused concerns among the public, so this information is provided as an optional resource should questions or requests arise concerning *Stachybotrys* or "killer mold". A good resource for additional information can be found at http://www.cdc.gov/nceh/airpollution/mold/stachy.htm (Air Pollution and Respiratory Health Branch, National Center for Environmental Health, Centers for Disease Control and Prevention.)
All molds are allergenic and potentially harmful, when present in large quantities. It is therefore prudent to avoid exposure to all molds and mold products.



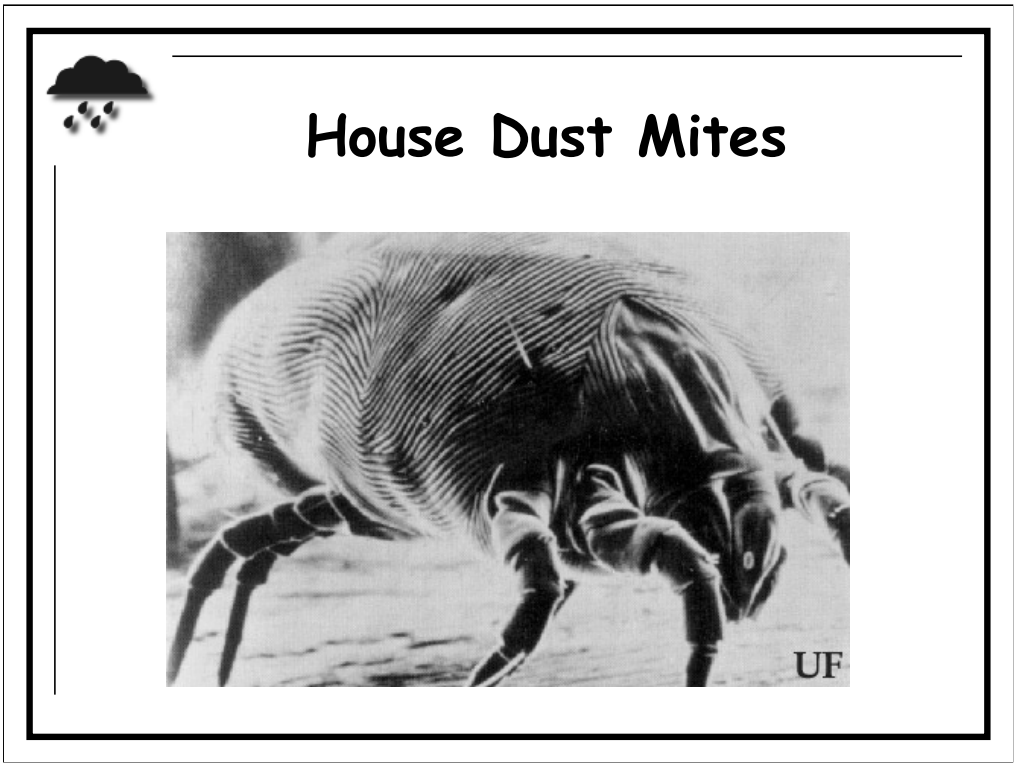

**Mold Cleanup**

Agencies differ on their recommendations for cleaning up mold. Many people just recommend a solution of powdered automatic dishwasher detergent and hot water. Dead mold is still allergenic, and some dead molds are potentially toxic. The use of a biocide, such as chlorine bleach, is not recommended as a routine practice during mold remediation, although there may be instances where professional judgment may indicate its use (for example, when immune-compromised individuals are present.) If chlorine bleach is used on small areas of painted surfaces (less than a couple of square feet), many people mix a solution of ¾ to 1 cup laundry bleach to a gallon of water. This can be applied with a sponge or spray bottle, and rinsed after 15 minutes. Remember, bleach will kill the mold, but does not inactivate the toxin. Be sure to wear a dust mask for protection against mold spores (many recommend a N95 mask), eye protection, and rubber gloves. Provide plenty of ventilation and keep others out of the work area. To get rid of the mold for good, it is necessary to solve the moisture or leakage problem. Extensive contamination should be assessed by an experienced health and safety professional and remediated by personnel with training and experience in handling environmentally contaminated materials.

Call the Florida Department of Health (800-543-8279) or call your local Florida Department of Health contact for more information (list is available at http://www.doh.state.fl.us/environment/facility/iaq/iaqctlst.htm).

**Note:**

The only way to verify mold identity is by laboratory analysis. The New York City Department of Health & Mental Hygiene Bureau of Environmental & Occupational Disease Epidemiology, in their often cited publication *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*, states: "Bulk or surface samples may need to be collected to identify specific fungal contaminants as part of a medical evaluation if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is equivocal (e.g., discoloration, and staining)." The Centers for Disease Control and the Environmental Protection Agency, in general, state that sampling is not recommended and is not required to undertake a remediation. The publication *How to Prevent and Remove Mildew* offers additional information on prevention and clean-up http://edis.ifas.ufl.edu/HE633




**Dust Mites**

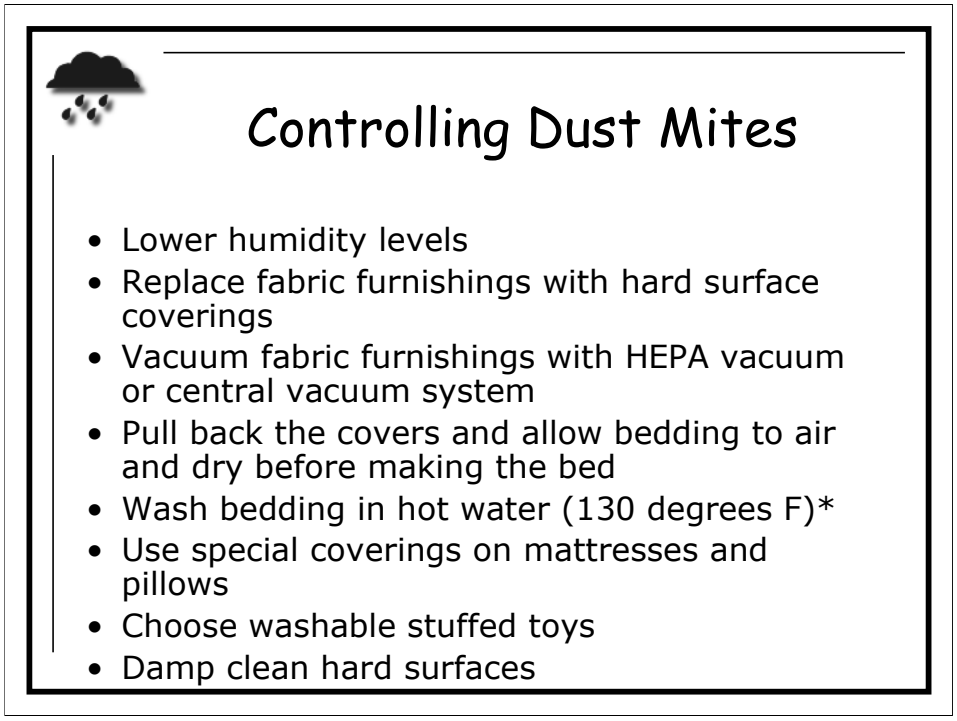
House dust mites are microscopic *arthropods* (which means "jointed foot"). Arthropods are characterized by a segmented body, jointed appendages, and an exoskeleton, meaning their skeleton is on the outside of their bodies. House dust mites are in the class *Arachnida* (spiders and mites) and order *Acarina* (mites). Dust mites may be found in warm, humid places such as carpets, furnishings, bedding, clothing, and stuffed toys. They are most prolific in bedrooms, where an average bed contains 10,000 dust mites. Mites are not visible in dust because they are only between 0.3 and 0.4 mm in length (therefore unable to be seen without magnification).

Optimal growth requirements for mites are very similar to those required for fungi. The levels of mites and mite allergens (primarily mite feces) in homes are closely related to humidity.

There is general agreement that house dust mites in the home feed on human shed skin. The average human sheds 0.5 to 1.0 gram of skin daily. One gram of skin will feed thousands of dust mites for months. Exposure to house dust mites and their droppings can trigger asthma attacks. In fact, house dust mites have been identified as the single most important trigger for asthma attacks. By the way…the age of the dust also appears to be a factor in the degree of allergen activity. Mite allergens are mainly present in feces of house dust mites and may become airborne and inhaled, giving rise (in addition to asthma) to rhinitis and atopic dermatitis. It is presently estimated that four percent of the human population shows a house dust allergy.

**Note:**

One simple method for detecting the presence of house dust mites is to put a small amount of dust on the surface of water and look at it under 20x magnification. Both the live and the dead mites will remain on the surface of the water.

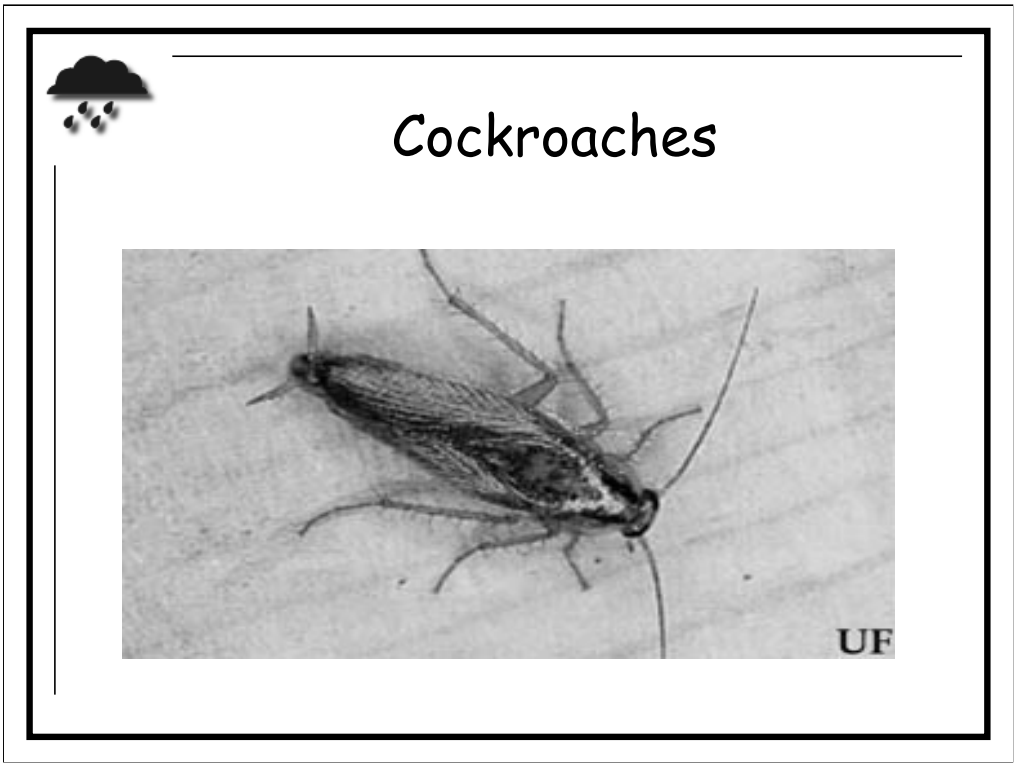



**What can be done to control dust mites?**

Humidity levels can be lowered using the same methods as for controlling mold. People who are sensitive to dust mites may need to replace carpeting in their homes with hard surface flooring and use area rugs that can be removed and cleaned. Although it is important to vacuum often, filter bags allow small particles to go back into the air and may actually raise dust levels in the air—the house dust mites actually become airborne. Vacuums with high efficiency filters and central vacuum systems reduce the airborne dust generated by vacuum cleaning. Allergic people may need to leave the house during vacuum cleaning or may need to wear a dust mask.

Since bedding provides an optimal environment for dust mites to thrive, wash bedding often with hot water (at least 130˚ F*). Pull back the covers and let the bedding air and dry before making the bed. Use plastic coverings on mattresses and pillows. Note that there are also special allergen-reducing covers on the market for bedding. Since stuffed toys are a breeding ground for dust mites, choose toys that can be washed and thoroughly dried, and keep them off beds to reduce the exposure received during long hours of sleep. Some people place stuffed animals in their freezer (in a plastic bag) for 24 to 48 hours and vacuum the "fur" once thawed. As to how the efficacy of this practice compares to washing, we are unsure. However, if washing is out of the question, freezing should be considered. Hard surfaces can be damp cleaned to remove dust without causing it to become airborne.

* Note that, according to the Physicians of Saint Louis University Web site, each year about 112,000 people are treated in hospital emergency rooms with scald burns, and about 6 percent of them are hospitalized. Many of the scaldings are a result of household water heaters being set at temperatures above 120º F. About 80 percent of hot tap water burns are among young children, the elderly, and the physically impaired. So, an alternative to setting your main water heater to 130º F may be to purchase a washing machine with an auxiliary heater or install a separate water heater in your home dedicated to the washing machine. Of course, these are more extreme measures, but possibly needed if dust mites are problematic.



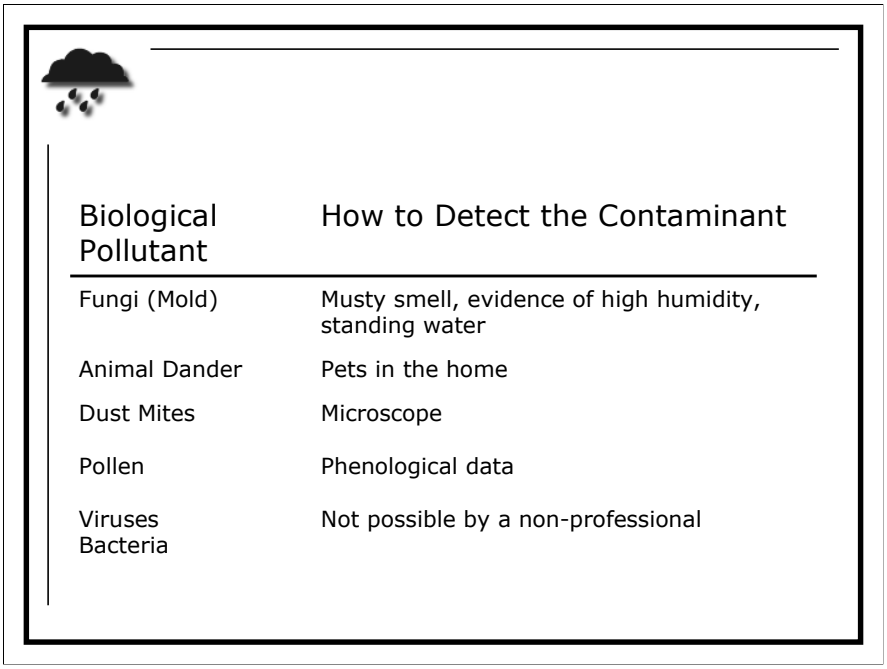

## Cockroaches

Cockroaches and house dust mites are the most common causes of problems associated with indoor environmental quality due to arthropods. Cockroaches are present in many homes and can increase to overwhelming numbers if not controlled aggressively. Cockroach allergens are usually found in the household dust of cockroach infested buildings. Studies show that exposure to cockroach allergens has been linked to the development and exacerbation of asthma in inner city children.

The German cockroach, pictured, occurs in structures throughout Florida, and is the species that typically plagues multifamily dwellings. German cockroaches are found throughout the world and are unable to survive in locations away from humans or human activity. The major factor limiting German cockroach survival, in addition to food, water, and harborage, seems to be cold temperatures. The German cockroach eats table scraps, pet food, and even book bindings.

German cockroaches can cause harm in several ways – they can adulterate food or food products with their feces and defensive secretions, physically transport and often harbor pathogenic organisms, may cause severe allergic responses, and in extremely heavy infestations have been reported to bite humans and feed on food residues on the faces of sleeping humans.

Improving sanitation and utilizing exclusion practices such as sealing cracks and crevices will reduce insect living space and population size. As you are constructing the home, proper sealing of cracks and crevices can help avoid cockroaches and other insects from entering the structure. Many "outdoor" insects wander indoors in search of moisture.




**How can we test for these contaminants?**

It is not practical for a non-professional to test for the presence of biological contaminants. But if contaminants are suspected in the home, an investigation should be conducted to remove and control them because of the health consequences.

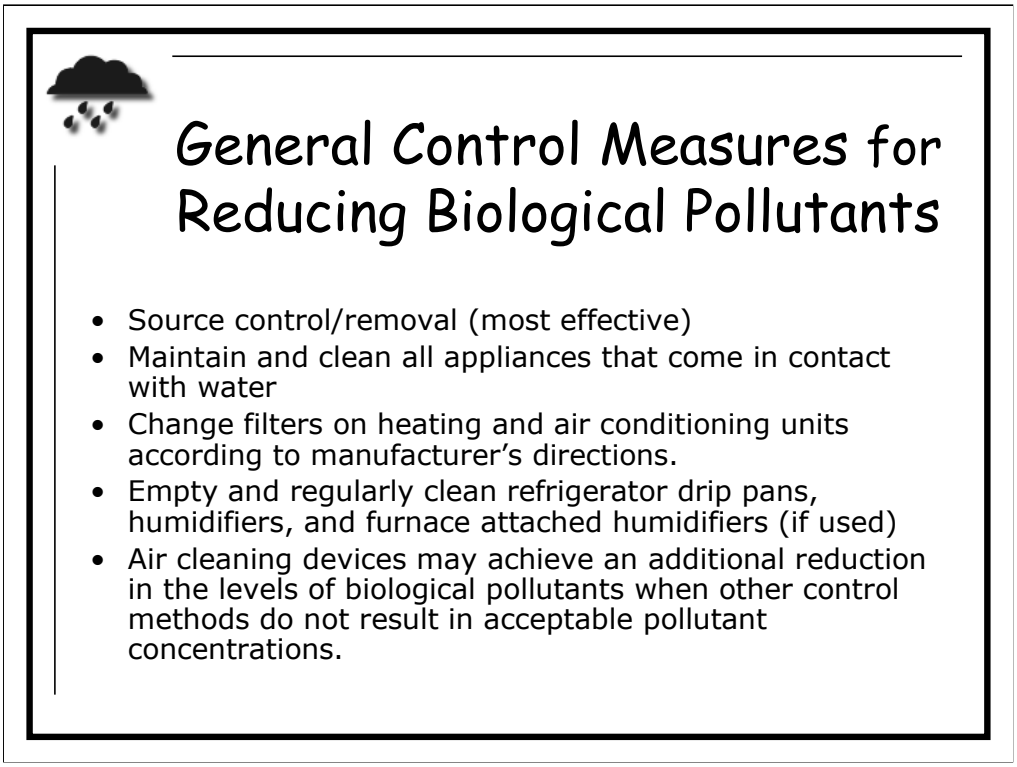
Left unchecked, mold can continue to grow and cause health problems for sensitive people. Because there are no standards for "normal" levels of mold, tests are not usually conducted. When tests are done, however, they compare types and levels of molds in the house with molds in the outside air (and sometimes this comparison doesn't help).

Mold growing on surfaces can occasionally be seen (it is sometimes invisible) or smelled (it has a musty odor). Mold should be suspected wherever there are water stains, standing water, or moist surfaces. Conditions that indicate high humidity levels include condensation on windows or walls, water pooled in the basement or crawlspace, rotting wood or other signs of water damage, use of humidifiers, or use of unvented kerosene and gas heaters. Damp carpet, walls feeling cold to the touch, and areas where there is poor ventilation (such as closets) may have mold growth. Cooking or bathing without using an exhaust fan promotes mold growth. Firewood stored in the home can also promote mold growth.

Refrigerator drip pans, dehumidifiers, and the condensate pans in air conditioning units should all be inspected to ensure they are not dirty and are not harboring biological pollutants. Mold also grows in wall cavities, under carpets, behind wall coverings, above ceilings, and in other places where moisture can accumulate undetected.

Many of these same conditions promote the growth of dust mites. However, dust mites have no smell and cannot be seen. You need a microscope to make an accurate identification. Bedding and other soft textiles are where dust mites thrive. Whenever pets are in the house, there will be animal dander. Rodents and insects (such as cockroaches) can also be the source of allergens for some people.

With regard to pollen, phenology is the knowledge of phenomena. Basically, it's the study of the laws of phases in the development cycle of plants and animals and establishes their dependence on environmental factors. Phenological data therefore can help identify possible sources of pollen by knowing time of year, temperature, humidity, etc. under which certain plants produce and release pollen.




**What are other measures to control these contaminants?**

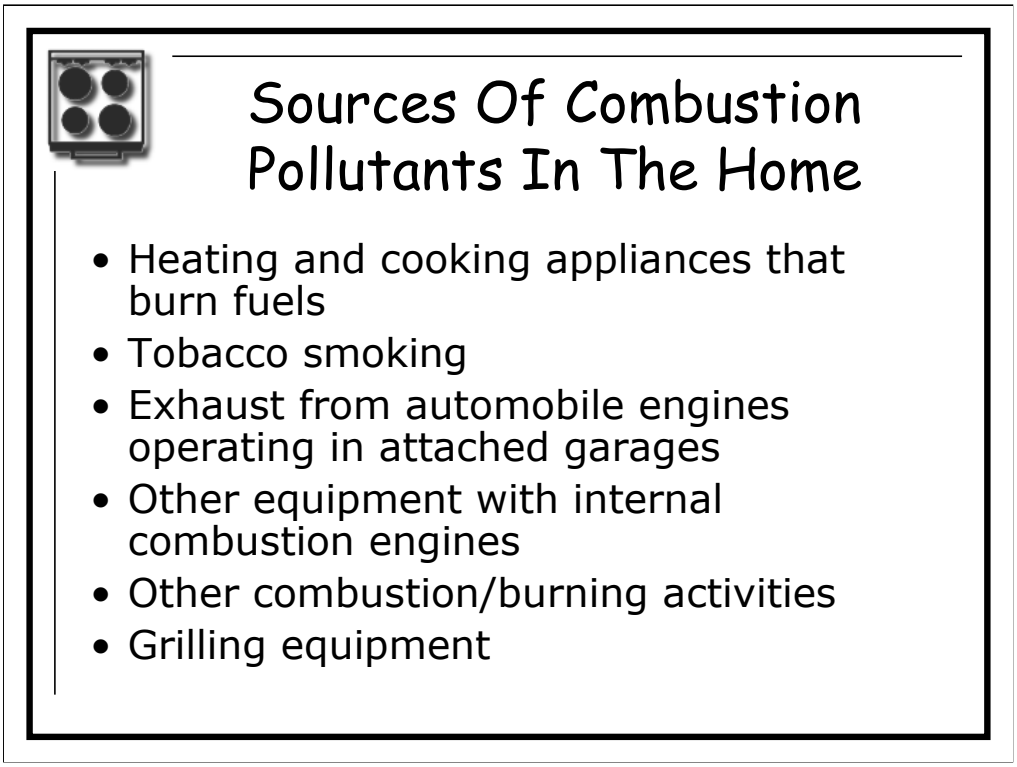
General measures for controlling airborne contaminants, in addition to reducing humidity, include maintaining and cleaning heating and air conditioning units. Ventilating homes by opening doors and windows may be counter-productive in Florida due to high humidity levels most of the year, or for people allergic to pollens. In homes with ductwork, the standard mesh filter should be replaced with one offering improved performance (such as pleated filters).

Allergies to pets may be relieved by removing pets from the home or keeping pets out of sleeping quarters. Cats kept in the home should be washed weekly to reduce the allergen level. Allergen accumulation may be reduced with the use of vinyl or hardwood floors instead of carpets. Vacuum with high efficiency filter vacuums or central vacuum systems to remove dusts which may harbor allergens.

Using air cleaning devices may result in lower levels of biological contaminants. "According to EPA, however, air cleaning alone cannot be expected to adequately remove all of the pollutants present in the typical indoor air environment… The effectiveness of air cleaners in removing pollutants from the air is a function of both the efficiency of the device itself and the amount of air handled by the device." Air cleaners are available in portable tabletop size, room-size consoles, and as part of central heating and air-conditioning systems in the home. No universally accepted standards exist for comparing the effectiveness of air cleaning devices.

**Note:**

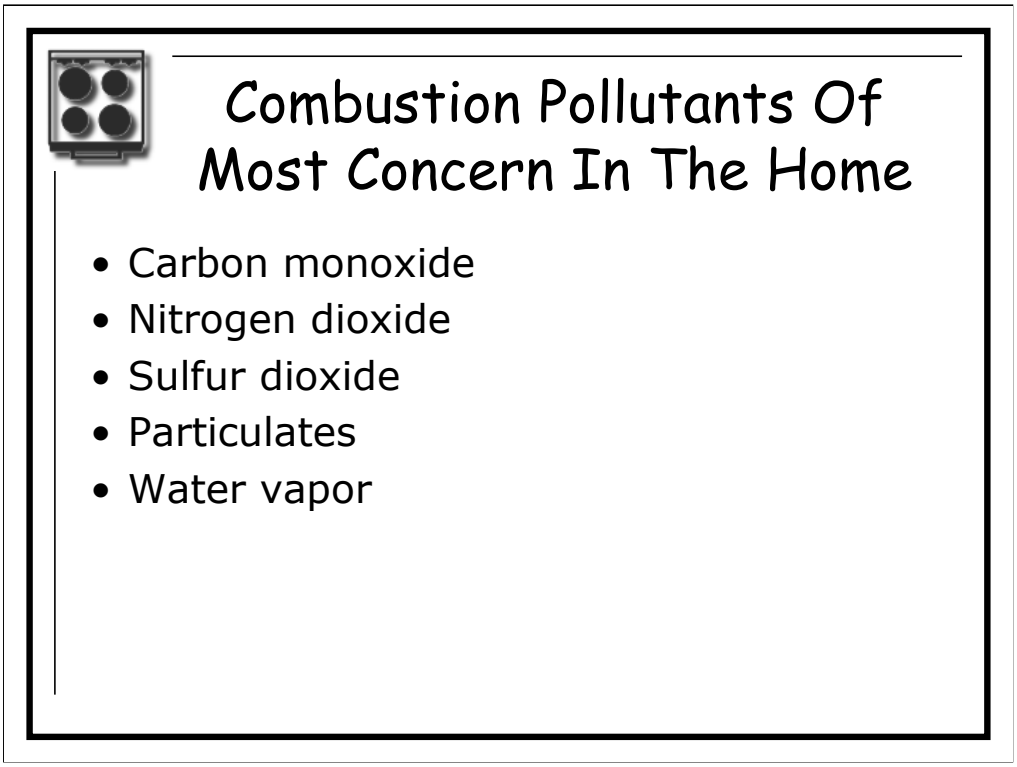
The Association of Home Appliance Manufacturers (AHAM) Room Air Cleaner Certification Seal is a mark issued by AHAM to all manufacturers and private brand sellers of room air cleaners who are licensees in the program. Under the terms of the program, the manufacturer certifies that the clean air delivery rate of all room air cleaners bearing this mark are determined and accurately stated in accordance with the requirements of AHAM Standard AC-1 (latest edition). Only the clean air delivery rates for tobacco smoke, dust and pollen are certified. No implication should ever be made that the seal certifies any other feature or performance factor. Note that ozone generators, marketed as air cleaners, should not be used in occupied buildings.




**Sources of Combustion Pollutants**

Combustion pollutants in the home come from a variety of sources:

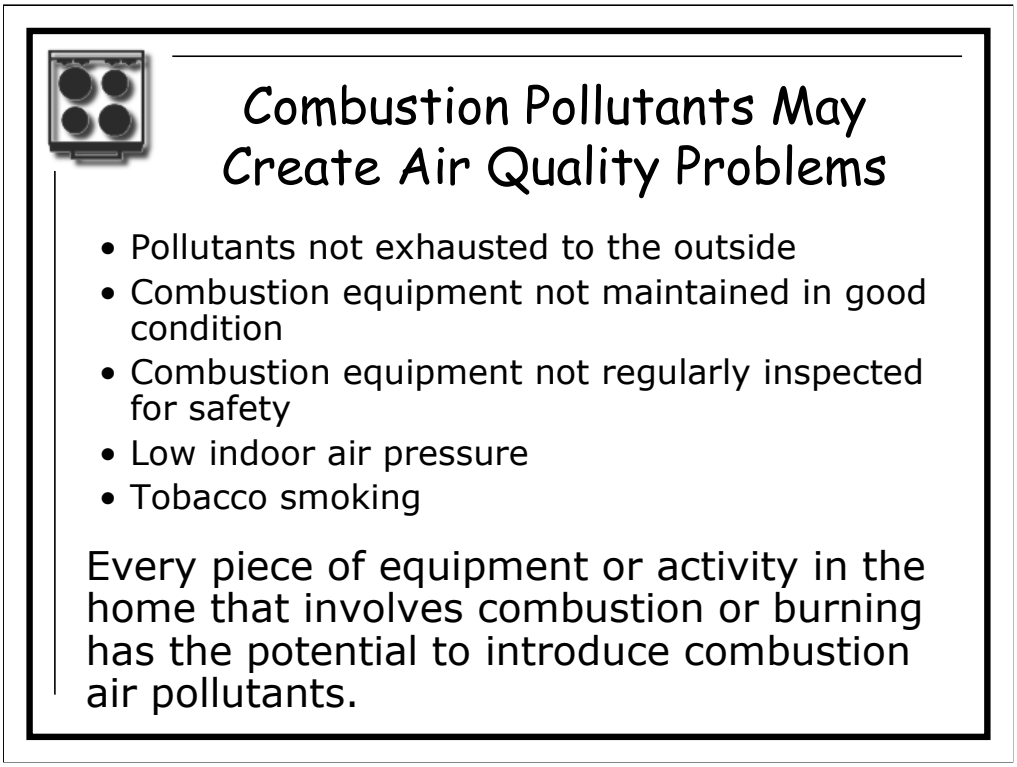
- Heating and cooking appliances that burn fuels
  - Gas, oil, coal, or wood furnaces or boilers
  - Gas or oil water heaters
  - Gas or kerosene space heaters
  - Fireplaces
  - Wood or coal stoves
  - Gas ranges and ovens
  - Gas clothes dryers
- Tobacco smoking
- Exhaust from automobile engines operating in attached garages
- Other equipment with internal combustion engines, such as lawn mowers or generators
- Other combustion burning activities, such as welding or soldering or burning candles
- Gas or charcoal grills and hibachis




**Combustion Pollutants Of Most Concern**

Specific combustion pollutants that are of most concern in the home:

- Carbon monoxide – an odorless gas that can kill
- Nitrogen dioxide – gas that can damage the respiratory tract
- Sulfur dioxide – gas that irritates the eyes, nose, and respiratory tract
- Particulates – tiny particles that make up smoke and irritate the eyes, nose, and throat
- Water vapor – excess moisture that can lead to mold and rot of the house structure

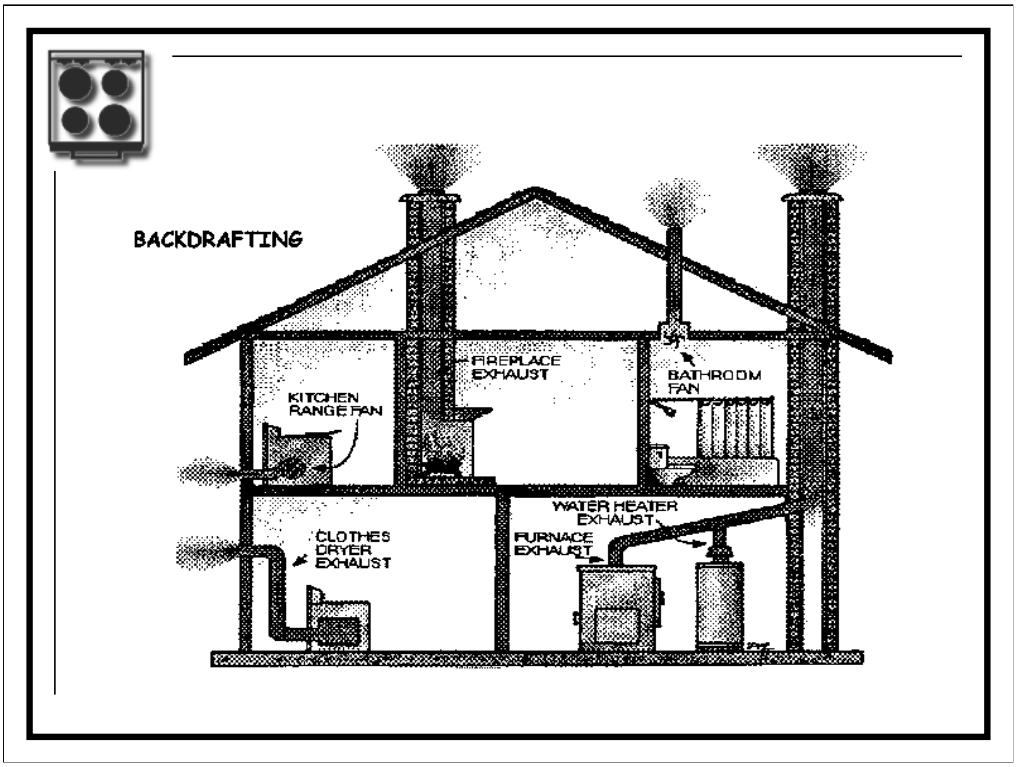



**Combustion Pollutants May Create Air Quality Problems**

Combustion pollutants are more likely to create air quality problems when:

- Pollutants from combustion equipment are not exhausted to the outside of the home
- Combustion equipment is not maintained in good working order
- Combustion equipment is not regularly inspected for safe operation
- Air pressure indoors is lower than outdoors (negative pressure), preventing safe exhaustion of combustion pollutants
- Tobacco smoking is permitted in the home

Every piece of equipment or activity in the home that involves combustion or burning has the potential to introduce combustion air pollutants.

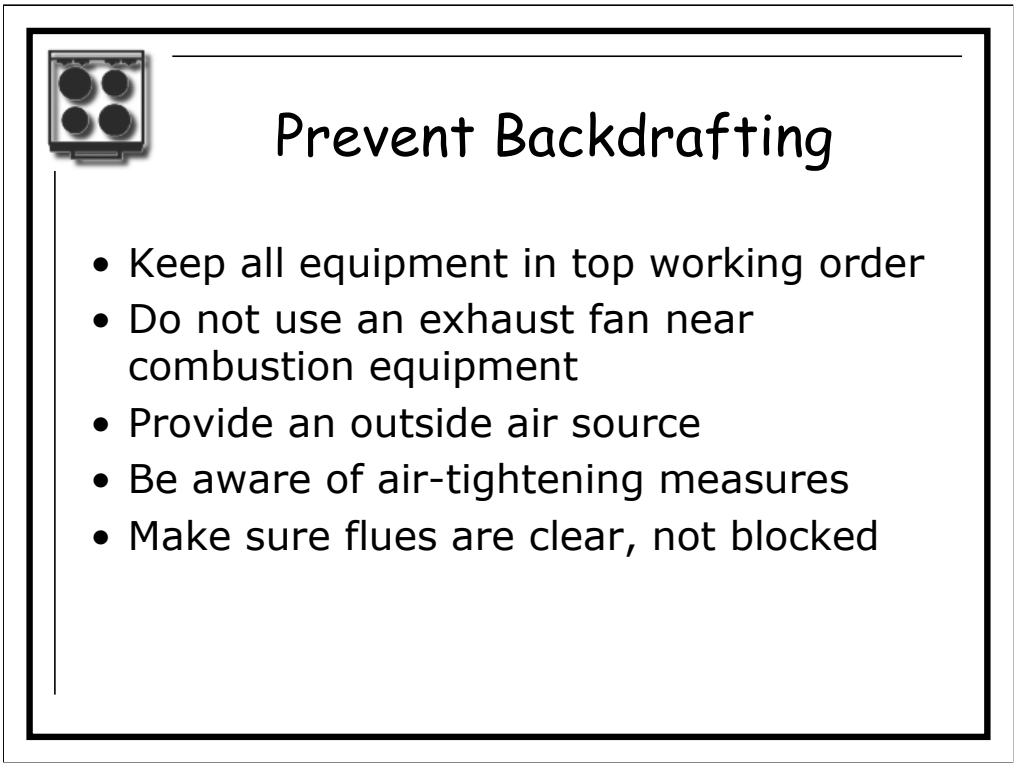



## Backdrafting

Backdrafting occurs when there is negative pressure in the area where the combustion device is located. This means the air pressure inside the area is lower than the air pressure outside.

Negative pressure indoors can occur when there are duct leaks in the heating system, or when exhaust ventilation, such as from a clothes dryer or kitchen or bathroom exhaust fan, is greater than air replacement through infiltration or other means. This scenario is more likely to occur in "tight", well constructed, energy efficient homes that do not have controlled ventilation.

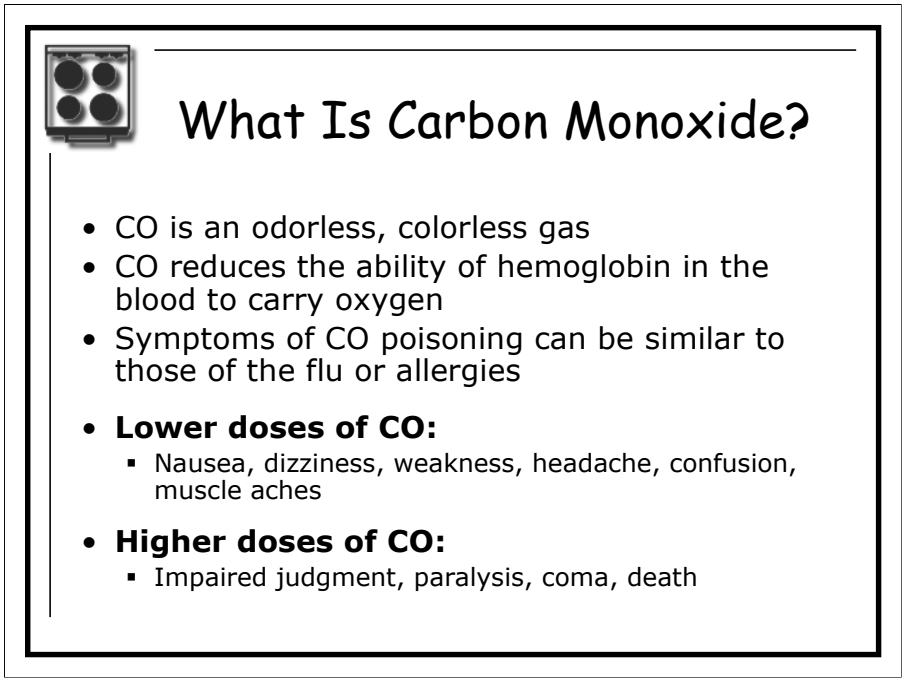
When there is negative pressure indoors, combustion by-products from conventional (natural draft) furnaces, water heaters, fireplaces, or similar equipment tend to spill into the room, or backdraft, rather than exhaust to the outside.




**Prevent Backdrafting**

To prevent backdrafting of carbon monoxide and other combustion pollutants in the home:

- Keep all combustion equipment, flues, and chimneys in top working order
- Do not use an exhaust fan in the same area where a naturally-vented combustion appliance is operating
- Select closed combustion or draft-induced combustion equipment, or provide an outside air source for combustion appliances, especially in tightly constructed homes
- Do not implement air-tightening measures, such as caulking, weather stripping, insulation, or new/improved windows, without investigating potential impacts on the operation of combustion equipment
- Make sure flues are clear, not blocked




**What Is Carbon Monoxide?**

Carbon monoxide (CO) is an odorless, tasteless, colorless gas produced when any carbon-based fuel is burned. The amount of CO produced depends mainly on the quality or efficiency of combustion. A properly functioning natural gas or liquefied petroleum (LP) gas burner produces little CO, while an out-of-adjustment burner can produce life threatening amounts without any visible indications. What really matters, though, is how this deadly gas is disposed of. If CO collects in an enclosed space, or if other conditions result in exposure to it, it can cause illness or death.

Typical sources of CO in homes include gas stoves, hot water heaters, candles, and gas or oil burning furnaces. CO is also a major component of tobacco smoke. Some types of fuel (wood, oil) produce other combustion products (with odors) along with CO, so there can be some warning. These other pollutants can be dangerous as well and may be produced even when CO levels are not harmful.

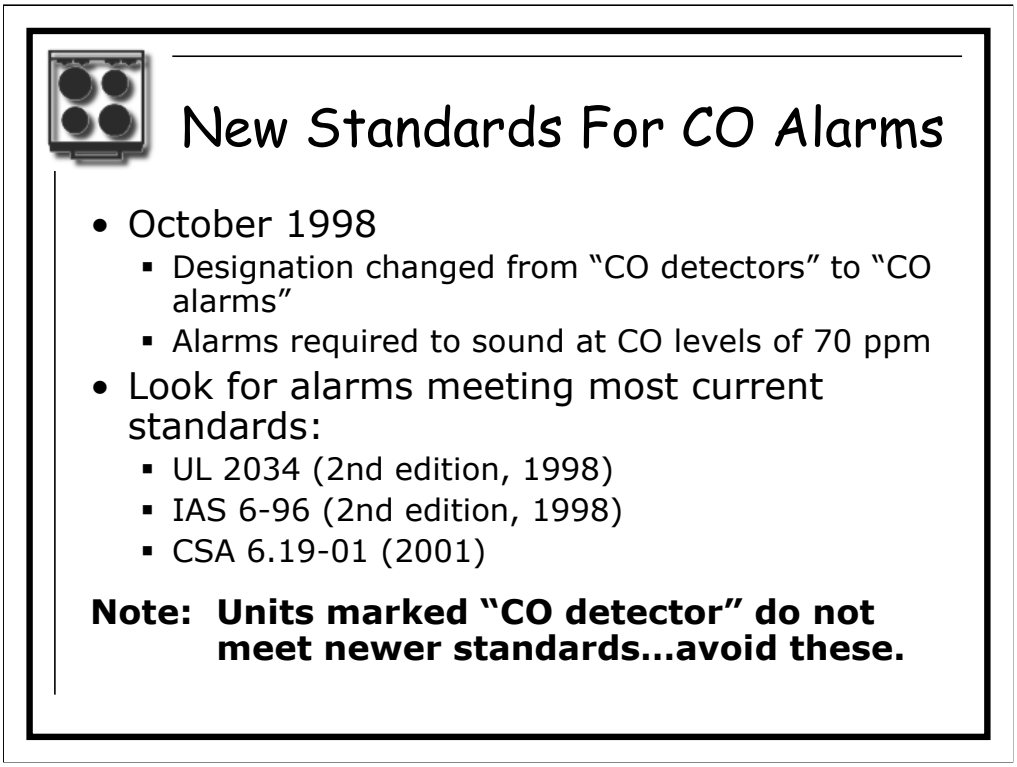
Carbon monoxide reduces the ability of hemoglobin in the blood to carry oxygen. Red blood cells will "pick up" CO quicker than they pick up oxygen. So, if there is a lot of CO in the air, your body may replace the oxygen in your blood with CO. Health effects or symptoms of CO poisoning can be similar to other illnesses, such as the flu or allergies.

Typical symptoms associated with exposure to CO include headaches, confusion, nausea, vomiting, drowsiness, fatigue, fainting, muscle aches, and other flu-like symptoms. Higher doses of CO can result in impaired judgment, paralysis, coma, or death.

**Note:**

An interesting, but not widely known, way of being exposed to CO is through exposure and absorption of methylene chloride, a common industrial and professional solvent. As the methylene chloride is metabolized in the body by the liver, CO is released into the bloodstream.

By the way…carbon dioxide ($CO_2$) is another combustion byproduct. Carbon dioxide is also a major constituent of animal and human respiration. In most cases, $CO_2$ is not considered a toxic gas at levels typically measured in buildings. Typically, $CO_2$ is measured in buildings as an indicator of ventilation. Elevated levels of $CO_2$ usually indicate that a building may not have sufficient ventilation.




**New Standards For Co Alarms**

A new standard for CO alarms took effect in October 1998. The new standard changes the designation of CO units from "CO detectors" to "CO alarms". Alarms are now required to sound at CO levels of 70 parts per million (the old standard was 100 ppm) and are prohibited from sounding or indicating at levels below 30 ppm (some older units were more sensitive).

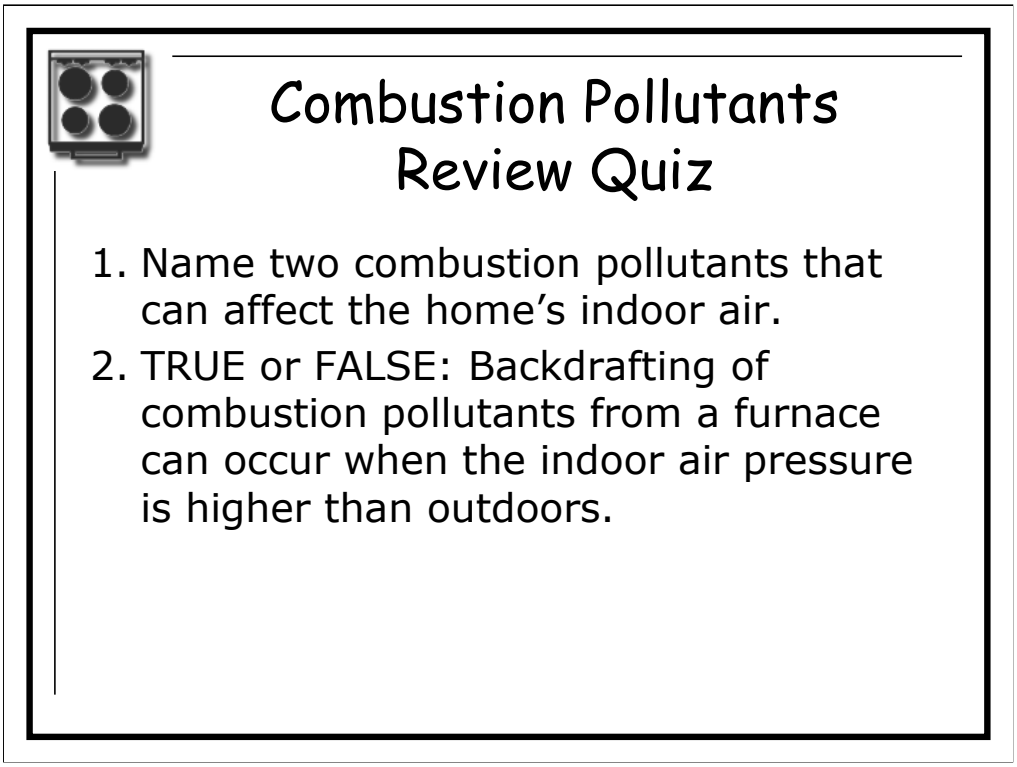
Alarms manufactured to these new UL and IAS standards give additional protection against acute, high levels of CO, but do not protect against CO levels below 30 ppm. When purchasing an alarm, contractors and consumers should look for one meeting the most current standards. Presently, alarms should bear the designation of UL 2034, IAS 6-96 (IAS stands for International Approval Service) or Canadian Standards Association 6.19-01 (2001). Individuals with medical problems might consider using an additional detection device that has lower signaling capabilities.

**Note:**

It is possible there will be future revisions to these standards. Always make sure CO alarms meet current standards. Units marked "CO detector" were manufactured under older standards and do not meet the more stringent October 1998 standard. These older units are often sold at a substantial discount. Installers and consumers should avoid these units.

By the way…According to the National Safety Council and the Centers for Disease Control and Prevention, about 500-1,000 people are killed in their homes each year by CO. It is likely that many more are harmed to some degree by this gas, but the extent is not known.

A research study revealed that heart patients' emergency room admissions had a small but significant correlation with changes in the outdoor levels of carbon monoxide. It was concluded that episodes of elevated outdoor CO can trigger emergencies in some heart patients exposed to this gas. It is possible that elevated indoor CO levels may likewise trigger problems in some heart patients. [Citation: Morris, et. al. *American Journal of Public Health*, Volume 85, p 1361–1365, October 1995.]



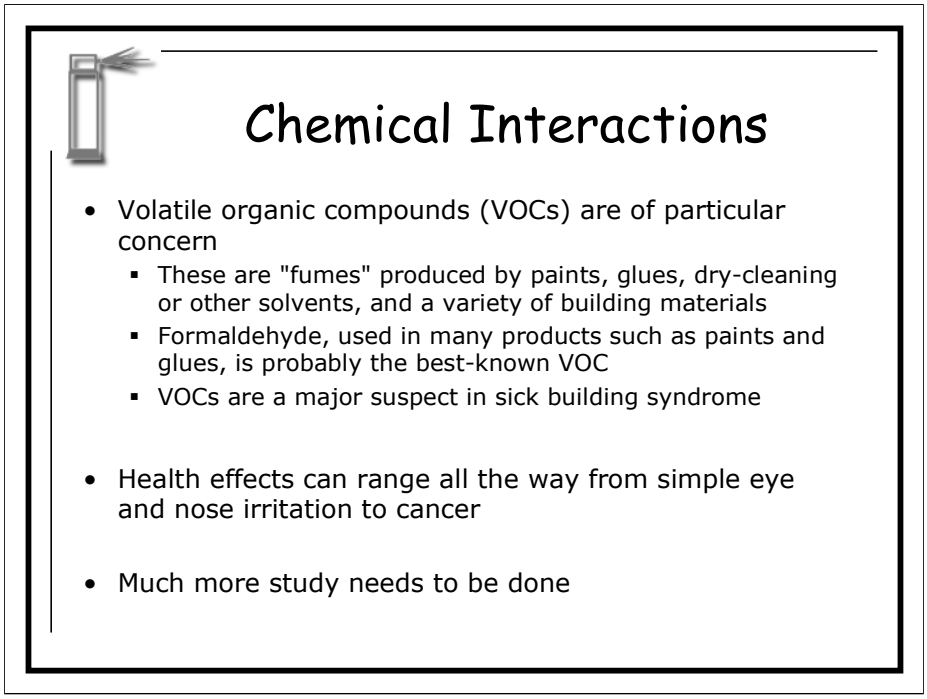

**Combustion Pollutants Teaser Test**

1. Name two combustion pollutants that can affect the home's indoor air.

   Possible answers: carbon monoxide, nitrogen dioxide, sulfur dioxide, particulates, water vapor

2. TRUE or FALSE: Backdrafting of combustion pollutants from a furnace can occur when the indoor air pressure is higher than outdoors.

   Answer: False




**Now let's look at chemical agents.**

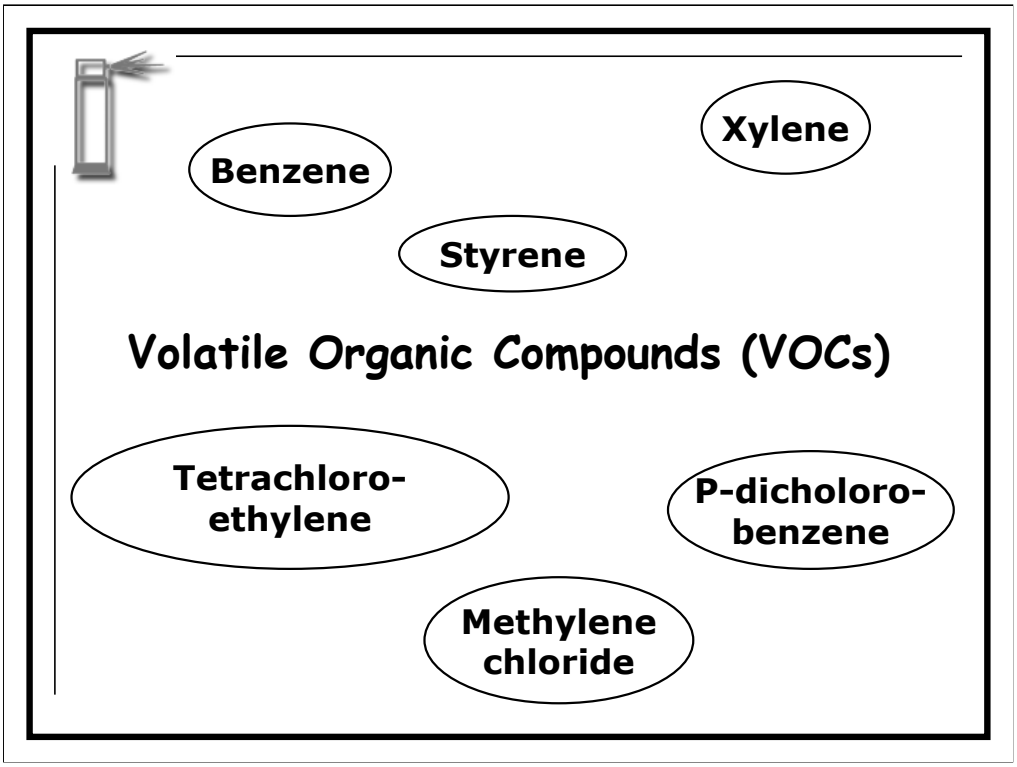
One might define chemical agents as substances that are not of biological origin, and may cause a health effect due to their chemical attributes, such as toxicity. Chemical agents can be solids, liquids, gases, or vapors. People in buildings are exposed to some of these chemicals on a daily basis. Most of the modern cleaning agents, pesticides and some of the personal care products contain chemical agents. Examples of these agents are chlorine vapors, ammonia, formaldehyde, benzene, odorants, deodorizers, perfumes, fuels, etc.

**Volatile Organic Compounds**

Volatile organic compounds (VOCs) are a type of chemical agent or compound that contains carbon and hydrogen. Volatile organic compounds volatilize readily. Several hundred VOCs have been identified in indoor air. VOCs come from building materials, fuels, and household and commercial products such as cleaners, pesticides, adhesives, paints, stains, and solvents. VOCs can result in eye, nose, and throat irritation; headaches; loss of coordination; loss of memory; nausea; and damage to liver, kidney, and nervous system. Some organic gases cause cardiac sensitization reactions and some are also known or suspected of causing cancer in humans. They include aromatic hydrocarbons, halogenated hydrocarbons, alcohols, ketones, aldehydes, ethers, esters and others. Exposure to mixtures of VOCs commonly found in building materials may be an important source of sick building complaints. In general, the health effects of exposure to VOCs through indoor air are not well understood.

Formaldehyde, which is probably the best-known VOC, is often implicated in many IAQ complaints. It is a natural byproduct of human metabolism and is usually present in our bodies in minute amounts. Formaldehyde is also used in many products such as paints (as a preservative) and in pressed wood products that use urea-formaldehyde binding agents. It can be found in elevated levels in newer homes, especially in new manufactured homes. Formaldehyde is also used in textiles and fabrics as a permanent press agent. Formaldehyde is an irritant; eye, nose, and throat irritation, as well as symptoms including headache, wheezing, coughing, fatigue, and skin irritation may be experienced at concentrations encountered in non-occupational environments. Formaldehyde is also a known skin sensitizer. It has been shown to cause cancer and mutations in laboratory animal studies. The U. S. Environmental Protection Agency (EPA) has classified it as a probable human carcinogen.

Some consumers purposely use these VOCs in their homes and businesses. Perchloroethylene (also known as PERC) is a VOC used in large amounts by the dry cleaning industry. It can be found in homes as a result off-gassing from recently dry cleaned clothes. Some VOCs are used as deodorizers or pesticides. Mothballs are made from either paradichlorobenzene or naphthalene. Recently, naphthalene was identified as a probable human carcinogen.

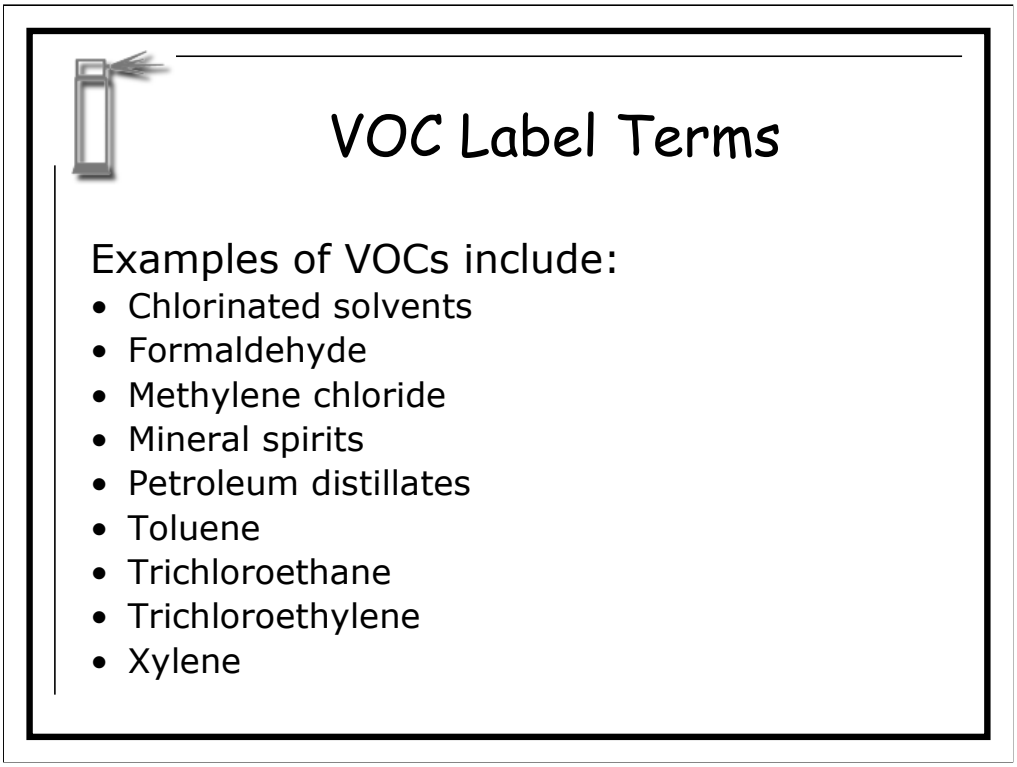



### Organic Gases

In the field of chemistry, the term "organic" refers to carbon-based compounds. Life on earth is based on organic molecules—those that contain carbon, hydrogen, and oxygen. How those atoms are arranged affects many things, including: interactions with other molecules, freezing and boiling temperatures, smell, and living things, including people.

Volatility means that a compound tends to exist as a vapor or gas at normal indoor conditions. Therefore, volatile organic compounds volatilize readily. There are hundreds of volatile organic compounds (VOCs) in indoor and outdoor air, many of which have adverse impacts on human health. Many VOCs are present in household products, and many are known or suspected carcinogens. Benzene, for example, is a carcinogen, and Xylene may injure the heart, liver, kidney, or nervous system at high concentrations.

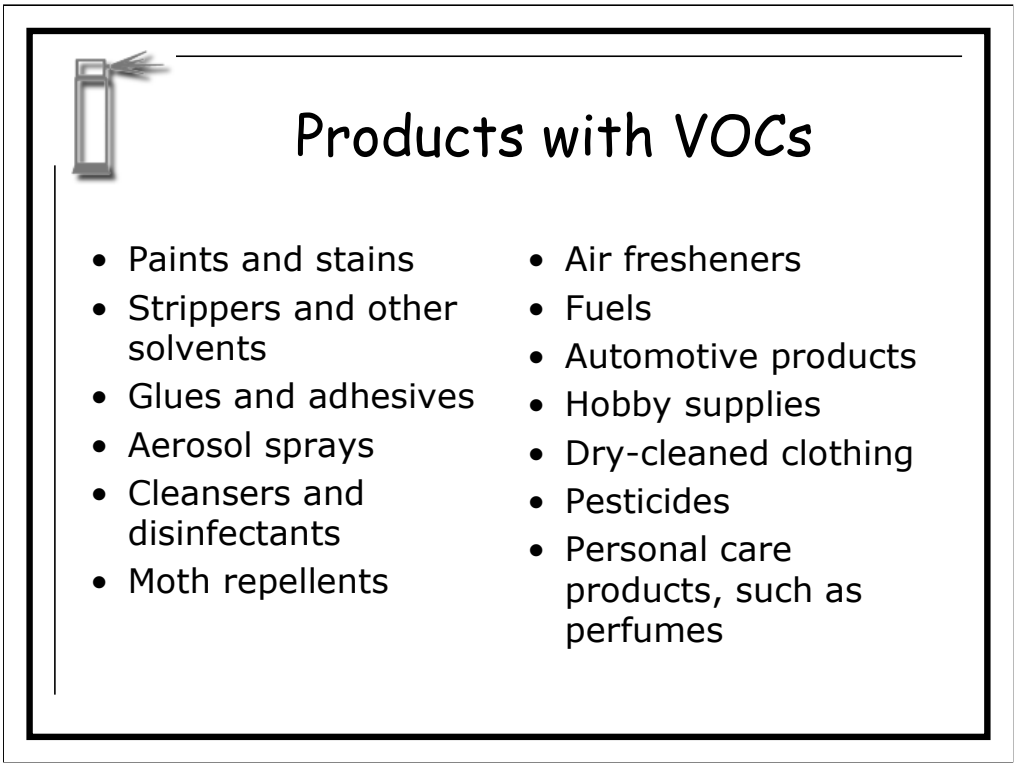
Keep in mind that fungi and bacteria may also produce microbial volatile organic compounds (mVOCs).




**VOC Label Terms**

Examples of product label terms that identify VOCs include:

- Chlorinated solvents
- Formaldehyde
- Methylene chloride
- Mineral spirits
- Petroleum distillates
- Toluene
- Trichloroethane
- Trichloroethylene
- Xylene




**Products With VOCs**

Examples of products that usually contain VOCs include:

- Paints and stains
- Strippers and other solvents
- Glues and adhesives
- Aerosol sprays
- Cleansers and disinfectants
- Moth repellents
- Air fresheners
- Fuels
- Automotive products
- Hobby supplies
- Dry-cleaned clothing
- Pesticides
- Personal care products, such as perfumes

## Formaldehyde: Sources

- Particle board, MDF – found in countertops, and cabinets, floor, underlayment, shelving, laminated and veneered furniture (major sources)
- Some professionally applied (acid-cured) furniture and floor finishes (major source)
- Hardwood plywood, paneling
- Interior plywood (small amounts)
- Permanent press fabrics, some drapes (small amounts)
- Cosmetics (trace amounts)
- Combustion products (gas flame, cigarette smoke)

### Sources Of Formaldehyde

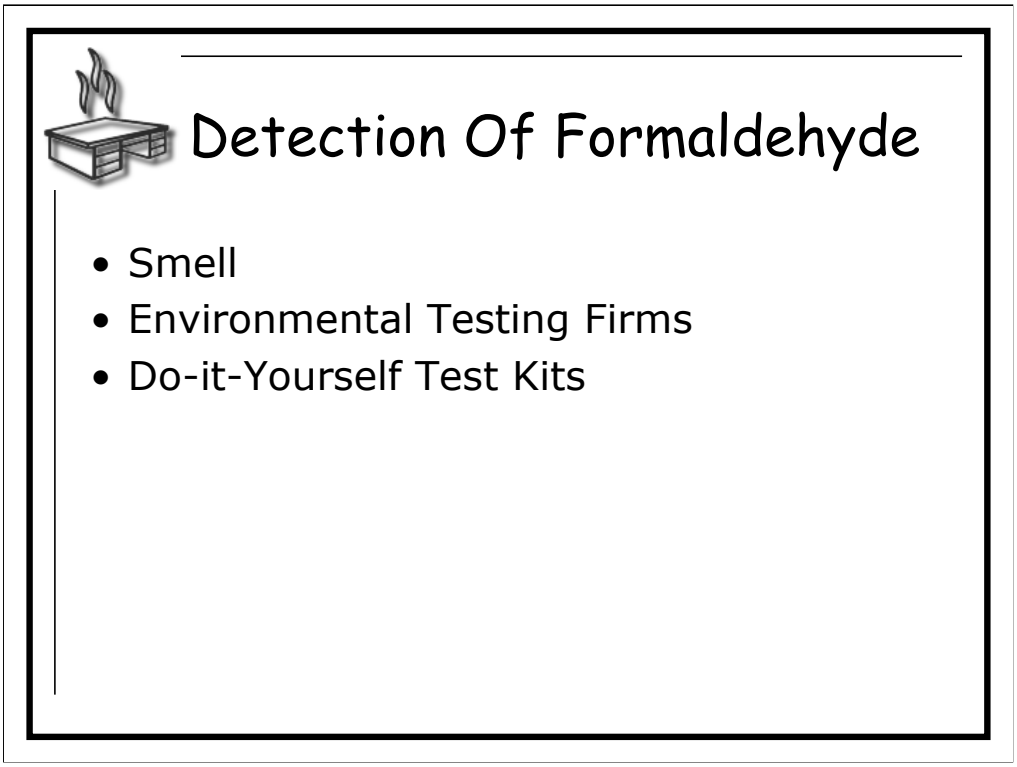
Formaldehyde, which is probably the best known VOC, is often implicated in many IEQ complaints. It is a natural byproduct of human metabolism and is usually present in our bodies in minute amounts. Formaldehyde is a chemical that is released into the air as a pungent vapor; many of us remember this smell from the high school biology lab.

In most homes, particle board and medium density fiberboard (MDF) are by far the major sources of formaldehyde in the environment. Some particle board is now manufactured with reduced formaldehyde, thus helping the problem to some degree. The culprit is the adhesive urea formaldehyde which can break down and release formaldehyde. A related adhesive, called phenol formaldehyde (used in softwood plywood and oriented-strand board) releases little, if any, formaldehyde. Therefore, products with phenol formaldehyde are widely recommended as substitutes for problematic board products. Oriented-strand board is now widely used for flooring and roof decking.

In the mid-1980s, some homes had severe problems due to improperly mixed urea formaldehyde foam insulation (UFFI). This product was taken off the market and is virtually unavailable today. Foams installed back then are unlikely to cause problems today. Other types of foam insulation are not associated with such problems.

Some commercially-applied furniture and floor finishes (acid-cured finishes) can also release formaldehyde. Hardwood plywood, paneling, and interior plywood are sources of formaldehyde as well. Permanent-press fabrics, some other textiles, and cosmetics are sources of trace amounts of formaldehyde. In addition, formaldehyde is produced by combustion processes, including gas flame and cigarette smoke.

Formaldehyde emissions can continue for a long time after original product manufacture; emissions and concentration levels are increased by elevated temperature and humidity.




**Detection Of Formaldehyde**

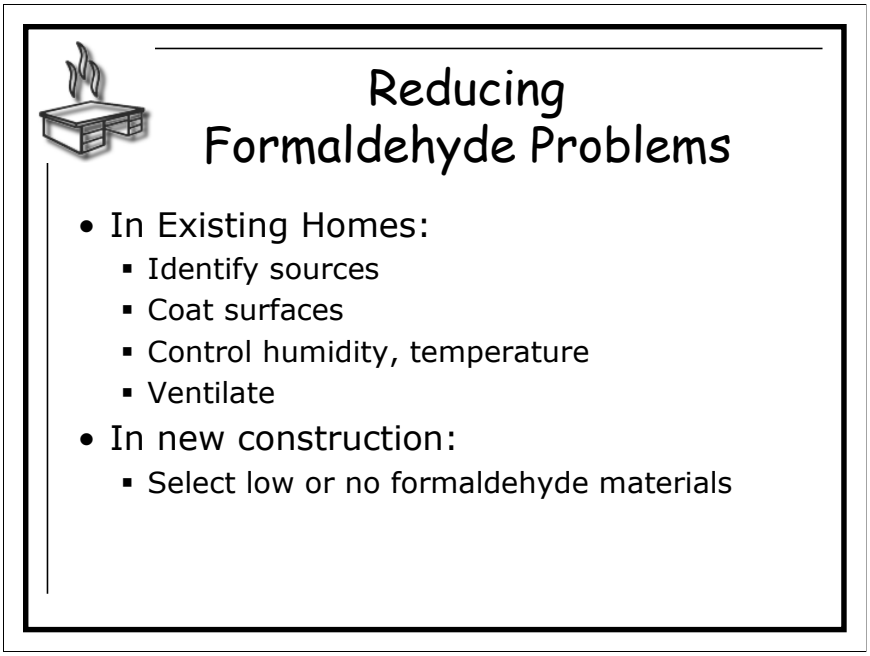
Those who are familiar with the characteristic smell of formaldehyde may be able to identify it by its odor. (The formaldehyde symptoms we have mentioned are not much help in identifying this substance since these symptoms are also produced by a wide array of other irritants.)

Environmental testing firms (listed in the yellow pages of the phone directory) should be able to provide testing for residential formaldehyde levels. Since such tests are costly, it is wise to establish some reasonable suspicion that formaldehyde is present before considering testing. The presence of abundant formaldehyde-containing materials would be one indication of a problem, especially if these materials have been in place in the home for less than one year.

Do-it-yourself test kits are available by mail. However, there are some concerns about the accuracy of test results, especially at the lower levels that might be seen in homes. Moreover, there does not presently exist any certification program or other standard to assure the reliability of these tests.

**Note regarding standards**:

The U.S. does not have any standards for formaldehyde in residential indoor air. A ventilation organization has proposed a voluntary standard of 0.10 parts per million (although this level can still cause problems for sensitive individuals). Some agencies recommend lower levels.




**Reducing Formaldehyde Problems**

Existing homes

The first step in reducing formaldehyde problems in existing homes is to identify possible sources. As mentioned earlier, likely sources include particle board, medium density fiberboard (MDF), acid-cured finishes, paneling and hardwood plywood, and cabinets and furnishings made from these materials. Such furnishings are often covered with plastic laminate, veneer, or a "woodgrain" covering.

Formaldehyde cannot penetrate plastic laminate and is at least partly blocked by coatings. Although special formaldehyde sealants are available, varnishes (polyurethane and nitrocellulose) are also effective in this regard (two coats are preferred). Coatings should be applied to all exposed edges and surfaces (for example, the underside of countertops, and cabinet interiors and drawers).

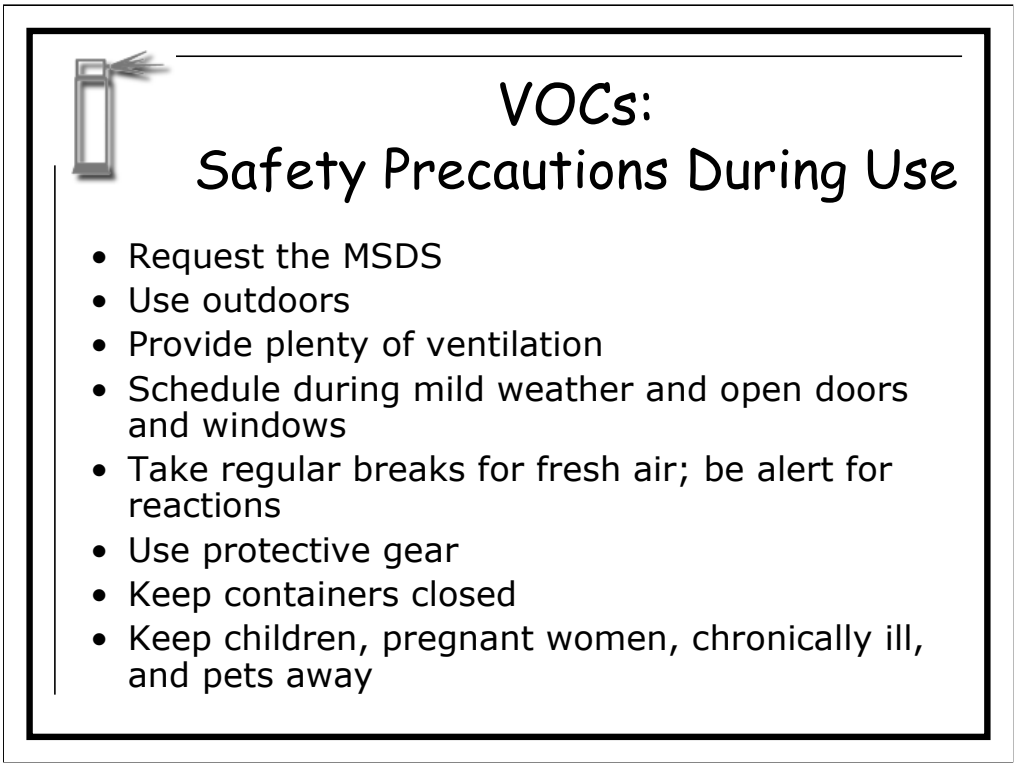
Since high humidity and elevated temperatures increase formaldehyde release, these conditions should be controlled when possible. Air conditioning, dehumidifiers, and other moisture control measures should be explored, as appropriate. Additionally, ventilation can help lower indoor formaldehyde levels when outdoor weather conditions permit.

New construction

In new construction, use low-emitting or formaldehyde-free materials. To reduce exposure to formaldehyde, use exterior grade plywood instead of interior grade plywood, because it is formulated differently and emits the gas at lower rates. Some research has indicated that coating pressed wood products with polyurethane (including all surfaces and edges) may reduce formaldehyde emissions. Veneered furniture can be replaced by solid wood furniture or old furniture, and particle board can be replaced by exterior softwood plywood or a similar product – wafer board (not associated with formaldehyde problems). Some particle board is now manufactured to have "lower" formaldehyde emissions. (These products are identified by a stamp indicating compliance with HUD standards for formaldehyde emissions.) While this is an improvement, there is still no guarantee that indoor formaldehyde levels will be acceptable. Now there are also formaldehyde-free fiber glass insulation products available for residential installation (formaldehyde is often used as a binder; formaldehyde-free insulation products often use an acrylic binder in the place of formaldehyde).

**Note:**

Although there have been press reports about research showing certain plants (such as spider plants) can absorb formaldehyde and other indoor pollutants, other studies show such effects are limited and it would be impractical (or impossible) to have enough plants to counteract continuous formaldehyde emissions (Resource: *An Update on Formaldehyde*, CPSC).



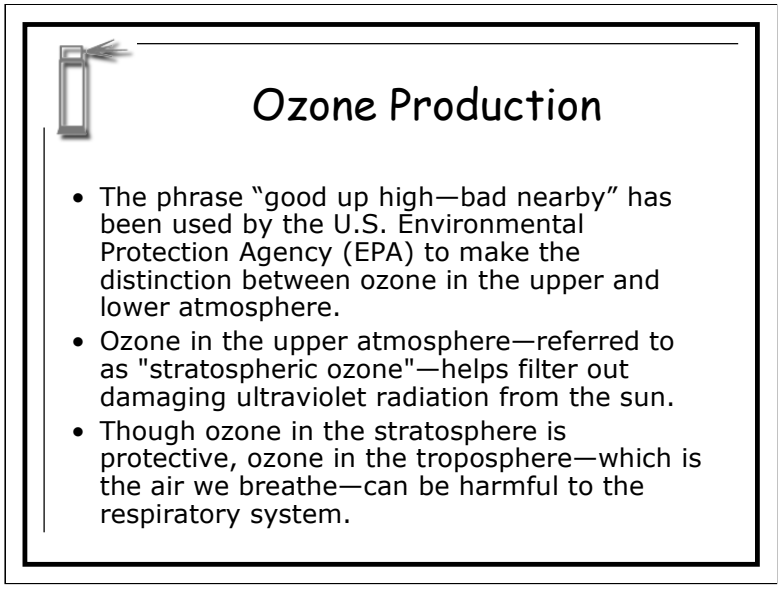

### VOCs—Safety Precautions During Use

You can learn more information about a potentially hazardous product by requesting a copy of the Material Safety Data Sheet (MSDS). The MSDS contains complete information about a product, including all safety precautions. Request the MSDS by calling the manufacturer (check the product label for a telephone number). Also, a MSDS might be available by looking up the manufacturer on the Internet.

When possible, use VOC products outdoors where compounds are more widely dispersed. Provide plenty of ventilation and fresh air if VOC products must be used indoors. If indoor use of VOC products is required, schedule activities for a time when the weather is mild so doors and windows can be opened for ventilation.

When using VOC products, take regular breaks for fresh air and be alert for possible reactions to the chemicals. Use protective gloves and glasses when using VOC products. A respirator with an appropriate cartridge is recommended for prolonged use of VOC products, especially when working indoors. Keep VOC product containers tightly closed to minimize evaporation.

Keep children and pets away from VOC products. Also, pregnant women and those who are chronically ill should avoid VOC products.




**What is Ozone?**

Ozone is a molecule composed of three atoms of oxygen. Two atoms of oxygen form the basic oxygen molecule—the oxygen we breathe that is essential to life. The third oxygen atom can detach from the ozone molecule, and re-attach to molecules of other substances, thereby altering their chemical composition. The same chemical properties that allow high concentrations of ozone to react with organic material outside the body give it the ability to react with similar organic material that makes up the body, and potentially cause harmful health consequences. When inhaled, ozone can damage the lungs. Relatively low amounts can cause chest pain, coughing, shortness of breath, throat irritation, etc. People vary widely in their susceptibility to ozone. Keep in mind that ozone is a toxic gas with vastly different chemical and toxicological properties from oxygen. Several federal agencies have established health standards or recommendations to limit human exposure to ozone.

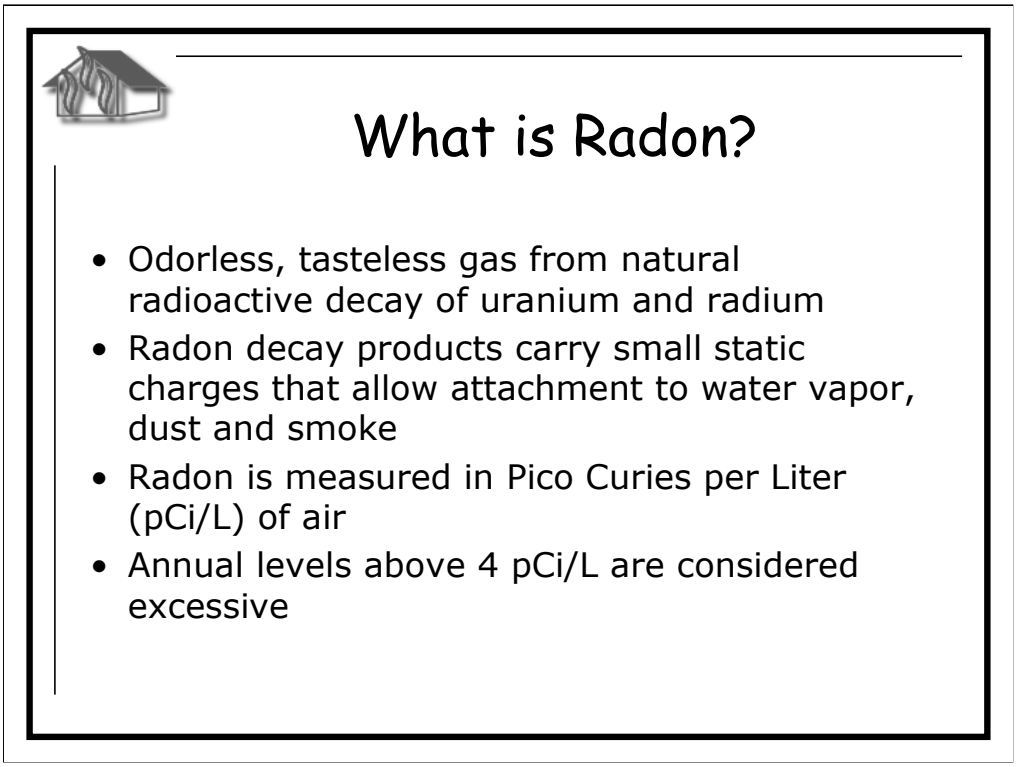
**Ozone Production**

Ozone is a highly unstable molecule. Small concentrations of ozone occur naturally at ground level (from vegetation and soils), formed in the presence of sunlight through reactions between nitrogen oxides and volatile organic compounds. Human activities have increased the amount: VOCs from petroleum, chemical industries, and transportation and nitrogen oxides from combustion in power stations and automobiles. Therefore, ozone is more concentrated and more smog occurs in densely populated and/or industrial regions.

Ozone generators that are sold as air cleaners intentionally produce the gas ozone. Often the vendors of ozone generators make statements and distribute material that lead the public to believe that these devices are always safe and effective in controlling indoor air pollution. Some vendors suggest that these devices have been approved by the federal government for use in occupied spaces. To the contrary, NO agency of the federal government has approved these devices for use in occupied spaces.

The phrase “good up high – bad nearby” has been used by the U.S. Environmental Protection Agency (EPA) to make the distinction between ozone in the upper and lower atmosphere. Ozone in the upper atmosphere—referred to as "stratospheric ozone"—helps filter out damaging ultraviolet radiation from the sun. Though ozone in the stratosphere is protective, ozone in the troposphere—which is the air we breathe—can be harmful to the respiratory system. Harmful levels of ozone can be produced by the interaction of sunlight with certain chemicals emitted to the environment (e.g., automobile emissions and chemical emissions of industrial plants). These harmful concentrations of ozone in the atmosphere are often accompanied by high concentrations of other pollutants, including nitrogen dioxide, fine particles, and hydrocarbons. Whether pure or mixed with other chemicals, ozone can be harmful to health.

Ozone has been extensively used for water purification, but ozone chemistry in water is not the same as ozone chemistry in air. High concentrations of ozone in air, when people are not present, are sometimes used to help decontaminate an unoccupied space from certain chemical or biological contaminants or odors (e.g., fire restoration). However, little is known about the chemical by-products left behind by these processes. While high concentrations of ozone in air may sometimes be appropriate in these circumstances, conditions should be sufficiently controlled to ensure that no person or pet becomes exposed. In the process of reacting with chemicals indoors, ozone can produce other chemicals that themselves can be irritating and corrosive—ozone can adversely affect indoor plants, and damage materials such as rubber, electrical wire coatings, and fabrics and art work containing susceptible dyes and pigments.




**What is radon?**

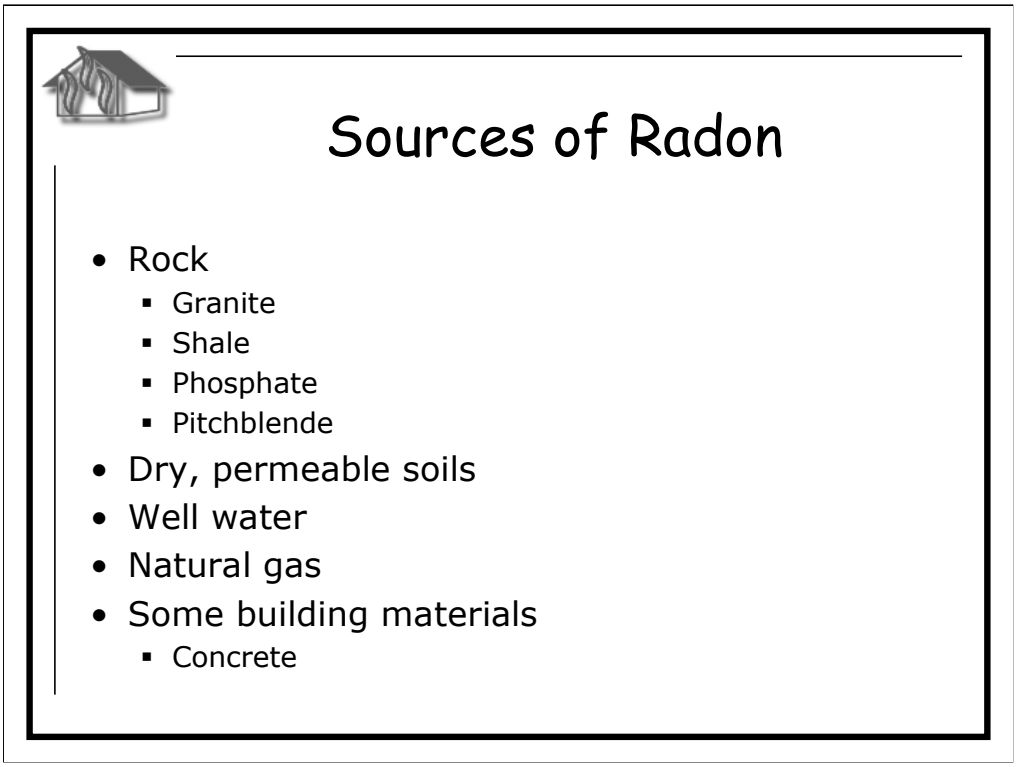
Radon is an odorless, tasteless gas. Radon originates in the soil from Uranium 238. Uranium is radioactive and has a long decay chain in the soil through a series of heavy metals to the precursor of radon, Radium 226. Radium 226 decays into Radon 222. Suddenly what used to be a solid radioactive material now has become a radioactive gas. Because radon is a gas, it can leak into the house with air that is in contact with the soil.

The radioactive decay products of radon are charged ions. The ions have a static charge that enables easy attachment to water vapor, dust, and smoke particles in the air, which can then be inhaled into people's lungs. Radiation released from these particles can then damage lung tissue and can eventually cause lung cancer.

Radon is measured in units called Pico Curies per liter (pCi/L) of air. Any radon exposure carries some risks; EPA recommends that corrective measures be taken to reduce radon levels in residential housing if the annual average radon level is 4 pCi/L or higher.

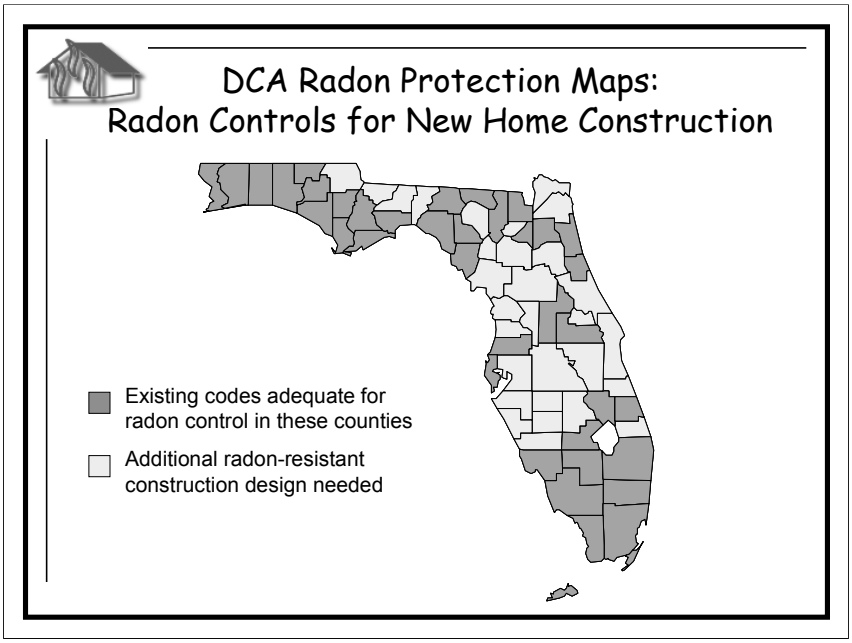
**Note:**

Since the mid-1980s, radon gas in the home environment has been recognized as a significant health hazard. While the presence of elevated levels of the gas in a home is a serious issue, there are proven methods that are in many cases simple to implement that can successfully reduce dangerous concentrations of the gas.




**Sources**

Radon comes from various sources and can be found in nearly all soils—including rock, with four likely rock sources being: granite, shale, phosphate, and pitchblende. Other rocks also have some percentage of uranium naturally occurring in them. Radon moves easily through permeable materials. It can come from well water, natural gas, and, in rare cases, some building materials (such as concrete) that have the potential to contain and emit radon.



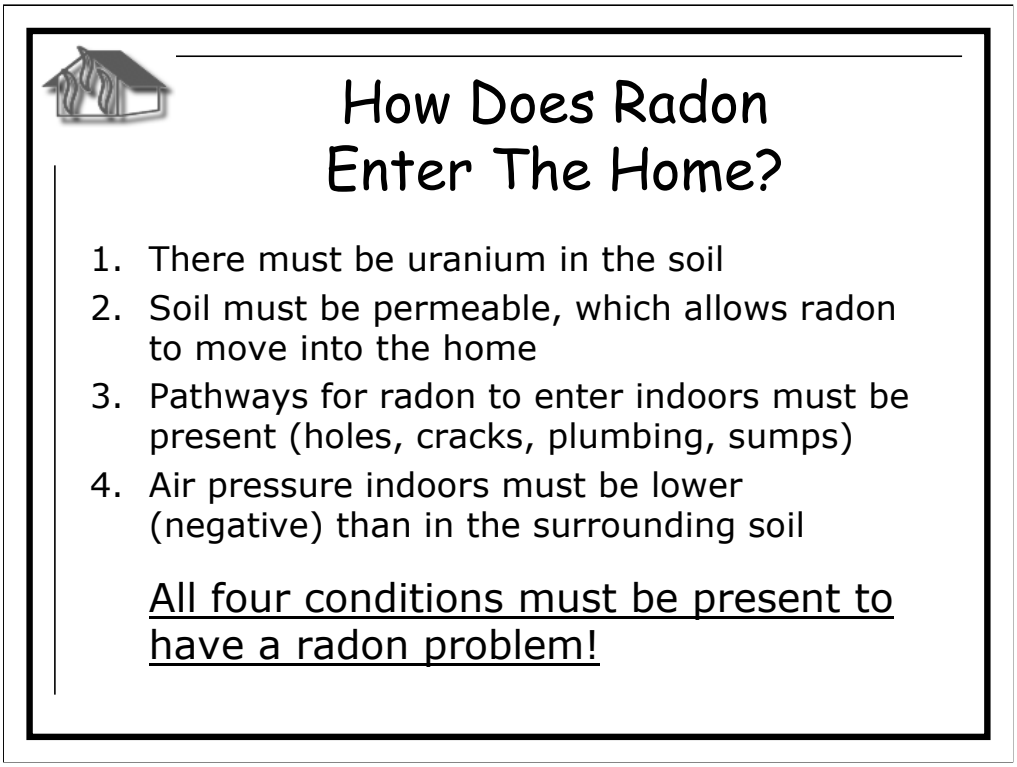

## DCA (Department of Community Affairs) Radon Protection Maps: Radon Controls for New Homes

Elevated indoor concentrations of radon can be found in every state. Uranium is present in most of the soil in the world. However, some places are definitely "hot spots" for radon. Testing is the only way to know for sure if the occupants are at risk. This map depicts counties in Florida and recommendations for radon controls for new home construction. Information about mitigation strategies for existing homes, along with this map, can be found at http://www.doh.state.fl.us/environment/facility/radon/index.html The State's Radon contact is Mike Gilley (1-800-543-8279).

Note that you'll need to visit this Web site and click on the individual county you're interested in to view specific areas of interest. Also, note that some municipalities require radon-resistant construction design techniques. See Appendix B of the *2004 Florida Building Code, Building*…also see *Building Radon Out*... at http://epa.gov/radon/construc

According to surveys conducted by the National Association of Home Builders (NAHB), the total number of homes built with radon resistant new construction (RRNC) features from 1990 through 1999 is estimated to be 1.8 million. Of this 1.8 million, an estimated 1.2 million homes in Zone 1 (areas with high radon potential) were built radon-resistant.

Regarding the DCA map: Note the darker areas (green, if being projected; dark gray in the printed version) on the map. Fewer than 5% of new homes in these counties are expected to have elevated radon levels, so no additional radon resistant construction techniques are recommended to prevent radon problems. The lighter areas of the map (yellow, if being projected; light gray in the printed version) indicate counties with areas where the addition of radon resistant construction features are recommended to prevent radon problems (i.e., more than 5% of new homes are expected to have annual average radon levels above the EPA action level in the identified areas).




**How Does Radon Enter Your Home?**

Four conditions must be present to enable radon to enter the home. The first two conditions are geological:

1. there must be uranium in the soil as a source material, and
2. there must be permeable soil, which allows radon to move into a home.

The other two conditions are determined by the house and its construction:

3. there must be pathways for radon to enter the basement, such as holes, cracks, plumbing penetrations, or sumps, and
4. there must be lower air pressure (negative) in the home than in the surrounding soil.

All four conditions must be present to have a radon problem in the home. If you reduce any one of these conditions, less radon will enter the home. The last two conditions, determined by the house and its construction, are the key ones for mitigation.

Once radon comes in contact with a house, it can be drawn inside through cracks or other openings in foundation walls and concrete floors. Some of these other openings include sump holes, French drains, and utility pipes or wires that penetrate a foundation wall. Radon has been found to contaminate some private water supplies as well. Once in water, radon is released into the air of a house when the water is aerated at dishwashers, clothes washers, faucets, and showers.


**Radon detectors**

### Testing

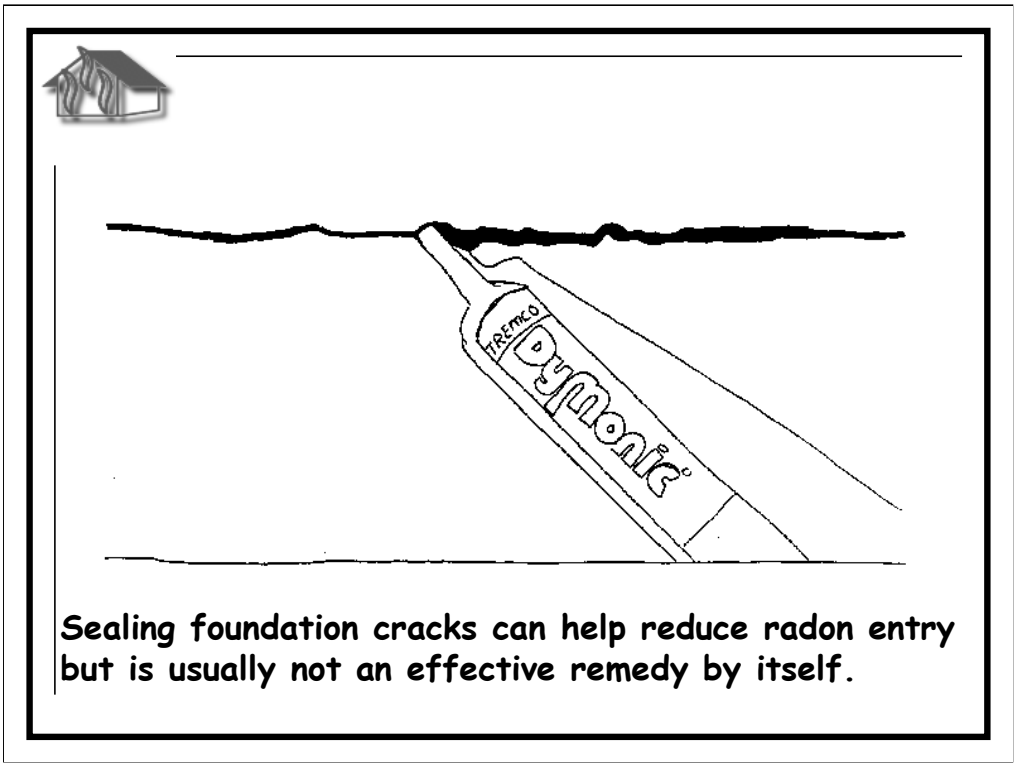
How do you test for radon? One way of detecting its presence is to use a canister of activated charcoal, which costs about $15. Once opened and set in place for a specified period (anywhere from two to seven days), radon in the air is adsorbed, or collected onto the surface of the charcoal granules. The first measurement taken in a house is known as the screening measurement, and it helps to determine whether more measurements should be made.

When the test period is completed, the canister is sealed and sent back to the testing company. After it has been analyzed, you receive a report on the radon level. Because radon concentrations vary with time, the screening measurement from a charcoal canister should only be used as an indicator of a potential problem. A year-long measurement can give a better idea of average radon levels in a house.

Long-term testing usually involves the use of an Alpha Track Detector, which costs about $25 (including postage and test results). Instead of measuring radon gas, this device records radiation damage from radon decay products on a plastic film inside the canister. This type of detector is kept in place for a period of three months to a year. As with the charcoal canister, it is sent to a laboratory for analysis.

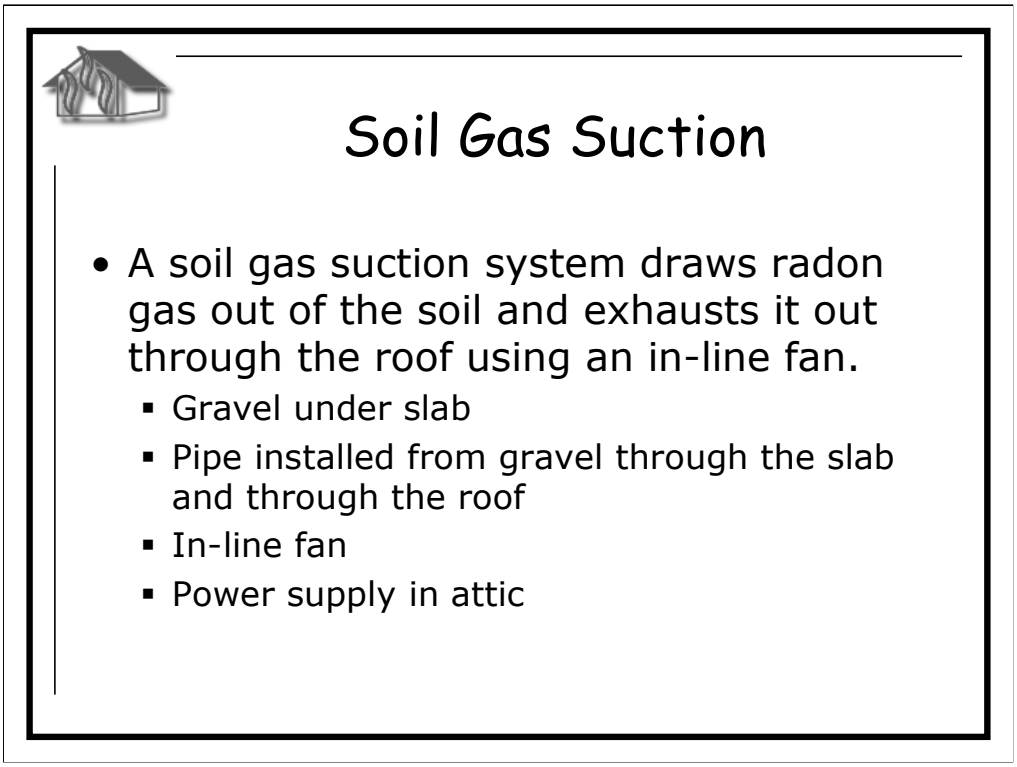
**Note:**

For professional radon monitoring call the Florida Department of Health (FDOH) (1-800-543-8279) or go to the FDOH web site for information (http://www.doh.state.fl.us/environment/facility/radon/blstfrms.htm)




A first step in preventing the entry of radon gas into a home involves sealing all openings to the soil, such as this settling crack in a foundation wall. Settling cracks occur in foundation walls and in concrete floors. These cracks can be filled with cement grout if they are large enough; small cracks can be filled with high quality caulking compounds suitable for concrete. Sole reliance on sealing cracks is usually not an effective radon remedy.

However, proper placement, installation, and sealing of the vapor barrier under the slab can help reduce radon levels in a structure.



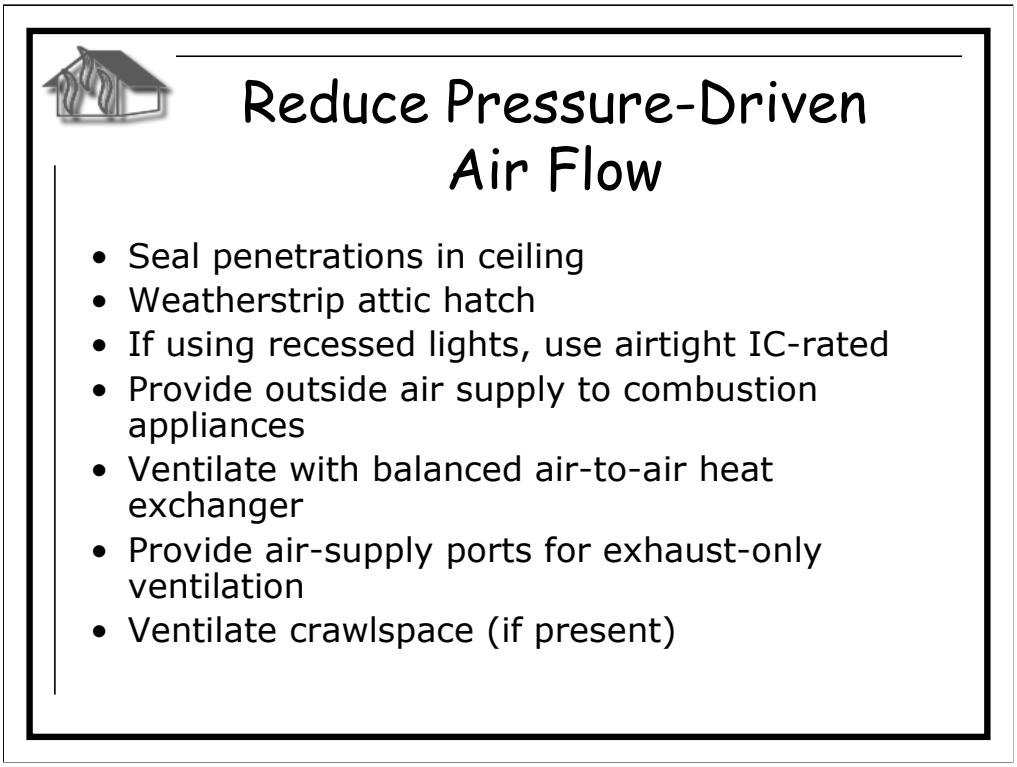

A very effective radon mitigation method diverts radon from a house at its source, through soil gas suction. In this system, a plastic pipe is installed through a concrete floor to gravel beneath the slab. The pipe extends to the attic of the house and through the roof. Here, a special fan (called an in-line fan) draws radon gas out of the soil from beneath the house and pulls it upward through the pipe.

The pipe then exhausts the radon gas to the outside, where it is diluted with outdoor air. This method of radon removal is effective because it addresses the pollutant at its source: the soil. Radon is removed from the soil and sent outside, before it has a chance to enter the house.

**Note:**

At this time, there is no reliable method for testing a building site to determine if radon is going to be a problem in a house to be built there. The best way to avoid a potential radon problem is to take preventive steps during construction.

Many of these steps are similar to those implemented for waterproofing a house, such as treating a foundation wall and installing traps in floor drains. Other steps, such as soil suction, cost very little when a house is first being built. Some construction professionals will install part of a soil gas suction system, such as the pipe and power supply in the attic, without the fan. If radon is determined to be present in the new house, the fan will be installed later.

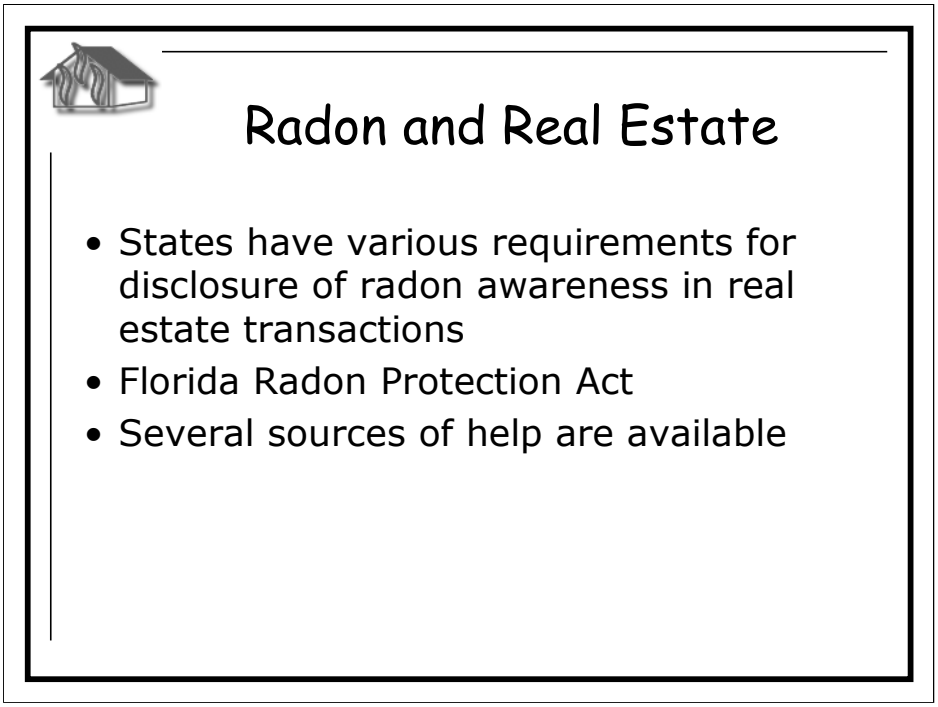



**Reduce Pressure-Driven Air Flow**

The faster the air leaks out of the house, the more it inducts radon by increasing negative pressure in the bottom of the house. Different combustion appliances and exhaust devices produce negative pressure by exhausting air from the house.

There are several methods that can be used to reduce pressure-driven air flow when attempting to control radon. Some of these include:

- sealing penetrations in the ceiling
- weatherstripping the attic hatch
- avoiding the use of recessed lights
  - or, if used, use airtight IC-rated cans
- providing an outside air supply to combustion appliances
- ventilating with a balanced air-to-air heat exchanger
- providing air-supply ports for exhaust-only ventilation
- ventilating the crawlspace (if present)




**Radon and Real Estate**

States have various requirements for disclosure of radon awareness in real estate transactions. In Florida, since January 1, 1989, the Florida Radon Protection Act has required a mandatory disclosure statement in the sales contract or rental agreement if a building is located on the property under contract. The required radon statement reads:

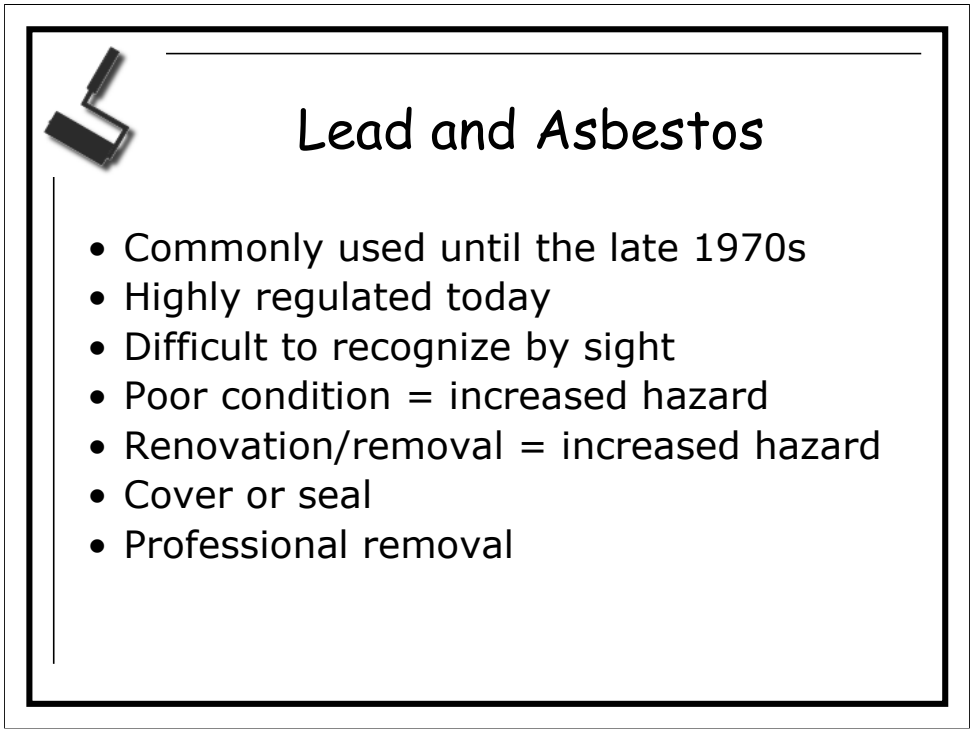
> "RADON GAS: Radon is a naturally occurring radioactive gas that, when it has accumulated in a building in sufficient quantities, may present health risks to persons who are exposed to it over time. Levels of radon gas that exceed federal and state guidelines have been found in buildings in Florida."

The requirements and procedures for mandatory testing can be found in Florida Statute 404.056 and our administrative code 64E-5 Parts X and XII—or check with the Florida Department of Health.

Help is available, often locally, for mitigating radon. Good information resources include your State Department of Health or your State Radon Contact, as mentioned earlier. The EPA's publication, *Building a New Home: Have You Considered Radon?* (http://www.epa.gov/iaq/radon/construc.html) may also be of help. You can also call the EPA's toll-free Indoor Air Quality Information Hotline at (800) 438-4318 to obtain a current listing of State Radon Contacts. EPA also has a national hotline (Safe Drinking Water) if you suspect the drinking water is a source of radon. The toll-free number is (800) 426-4791. This national service will supply phone numbers and local addresses of state-certified water testing laboratories throughout the country. These labs can advise citizens about testing water and also about local conditions where radon in water may be a concern. However, always test the air in the home for radon before testing well water.

**Note:**

The EPA has a free 13:10 minute video on radon in real estate titled *Breathing Easy: What Home Buyers and Sellers Should Know About Radon*. With a bit of light humor, the video covers the basics, including radon science, the lung cancer risk, home inspection, building a new home radon-resistant, testing and fixing a home, disclosure, state radon offices, hotline and web resources, etc. The primary audiences are home buyers and sellers, and real estate sales agents and brokers. Home inspectors, contractors, mortgage lenders, other real estate practitioners, and radon services providers will also find the video helpful. Single copies are free from IAQ-Info (1-800-438-4318 in VHS format [ask for EPA 402-V-02-003]); copies in CD-ROM and DVD formats may also be available.




**Lead And Asbestos**

Lead and asbestos have some similarities:

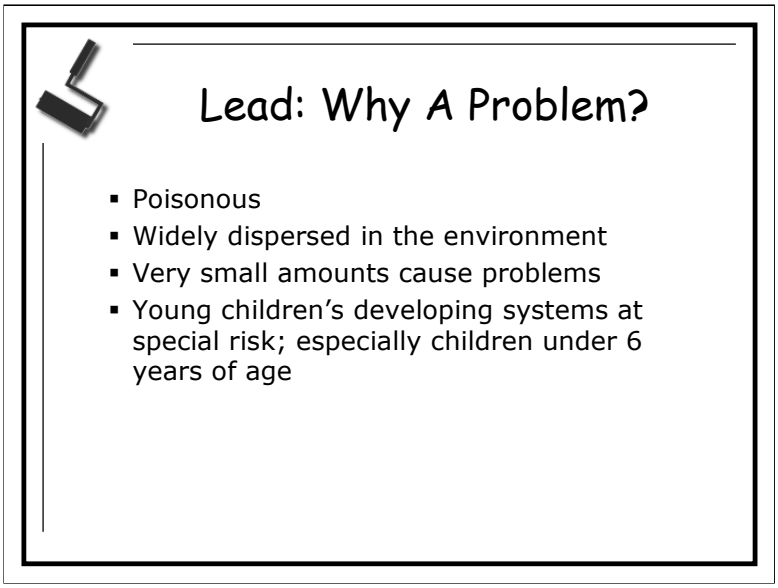
- Commonly used in home building until the late 1970s; present in a large percentage of houses
- Highly regulated, both in removal from existing buildings and in new construction
- Lead- and asbestos-containing materials generally cannot be recognized by sight and identification by special testing is needed
- Lead- (primarily lead-based paint) and asbestos-containing materials, if in good condition and left undisturbed, may pose little health threat; however, small children may chew on painted surfaces in good condition and get lead poisoning
- Deterioration of lead- or asbestos-containing materials increases the likelihood that residents of the home (or those working on the home) will be exposed to the health hazard
- Disturbing lead- or asbestos-containing materials, such as during renovation, increases the likelihood of dangerous exposure
- It is often better to leave the lead- or asbestos-containing materials in place if they are in good condition, but they may need to be covered or sealed to reduce exposure
- Removal of lead- or asbestos-containing materials is hazardous and generally it is best left to a trained professional; professional removal may be expensive

**Note:**

Lead and asbestos hazards are primarily concerned with improperly or poorly done removal, repair, or alteration of existing building materials and features.

Lead and asbestos are two "hot" environmental issues today—why?

1. Both had been commonly used in building materials until the late 1970s, so everyone's potential exposure is high
2. We continue to learn more about the potential health threats, especially to children under 6 years of age
3. Attempting to remove these materials from a building can actually increase the danger and risk of exposure, if done improperly




**Lead: Why A Problem?**

The poisonous properties of lead have been known since antiquity. Benjamin Franklin wrote of illness seen among typesetters and attributed it to their exposure to lead. Since lead is used in a wide variety of materials and products, it is dispersed throughout the environment and there are many opportunities for exposure and poisoning.

In recent years, more and more attention has been directed to "small" doses of lead, once thought harmless. As a result, lead was banned from house paint in 1978 and almost completely removed from gasoline. Other minor sources can contain lead as well, such as older, vinyl mini-blinds.

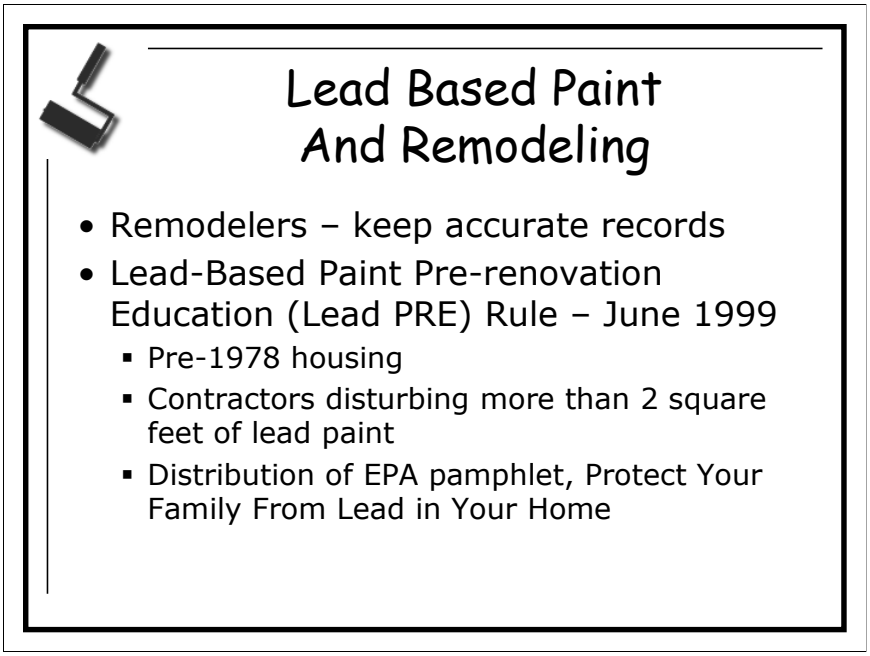
Nationwide health surveys conducted in the late 1970s and the late 1980s show dramatic decreases in blood-lead levels for all segments of the population. However, research also done in the '80s, '90s and this decade show that serious damage can be done by blood-lead levels once thought harmless, without any obvious warning signs.

**Note:**

The CDC 1991 guidelines for preventing lead poisoning considers blood levels greater than 10 micrograms per deciliter of blood hazardous, even though mental and physical problems can occur below this level. A microgram can be thought of as the equivalent of one-millionth of a packet of artificial sweetener. A deciliter amounts to about 3.4 fluid ounces. Keep in mind that, according to the Centers for Disease Control (CDC), there is no minimum standard of safe exposure to lead. A study in The New England Journal of Medicine (April 2003) found that any increase in lead, even under the CDC's 10 microgram limit, harms brain development in children and reduces IQ. According to the EPA, about 900,000 children under the age of 5 have elevated blood-lead levels.

Young children (up to about 6 years old) are especially at risk for these health problems, which include delayed development, reading and learning difficulties, lowered IQ, hyperactivity, and discipline problems. There are several reasons for this. Frequent hand-to-mouth activity of young children provides an important path for ingestion of lead dust. Moreover, children's digestive tracts absorb a significant proportion of lead in comparison to adults. Perhaps most importantly, the period of rapid growth and development in the early years of life leaves the body's systems highly vulnerable to the effects of toxicants. The most important route of exposure is unintentional ingestion of lead dust through teething and other hand-to-mouth activities. It only requires a few grains of lead-contaminated dust, eaten (or inhaled) on a regular basis, to cause these problems. In some places, and in and around some homes, soil and house dust are contaminated with lead. Children's health can be impaired without parents even being aware.

It is estimated that three-quarters of the nation's houses built before 1978 have at least some lead-based paint, with those homes built before the 1950s likely to have high amounts. Properly managed, this paint poses little immediate risk. If allowed to deteriorate or if disturbed, however, lead from the paint or lead dust can cause serious hazards.




**Lead-based Paint And Remodeling**

In 1996, federal regulations were instituted requiring property sellers and landlords to disclose known lead hazards in housing built before 1978. Remodelers should be cautioned to keep accurate records of lead testing or remediation.

As of June 1999, according to the federally regulated Lead-Based Paint Pre-Renovation Education (Lead PRE) Rule, remodeling contractors who will be disturbing more than 2 square feet of lead-based paint in pre-1978 housing are required to disclose the risks of lead to their clients. The main part of the Lead PRE Rule requires remodeling contractors to distribute the lead pamphlet, *Protect Your Family From Lead in Your Home*, to home owners and occupants before starting renovation work. For more information, see the fact sheet, *EPA Releases Final Rule Requiring Distribution of Lead Hazard Information Prior to Renovations*, or you can also contact the National Lead Information Center at 1-800-424-LEAD. Check http://www.epa.gov/opptintr/lead/leadpdfe.pdf to view and print the EPA pamphlet.

**Lead And Real Estate**

Federal legislation affects the sale and rental of nearly all residential properties built before 1978, the year when lead was banned from residential paint. While there are numerous provisions and details to this law, known as Title X, the most important parts involve "disclosure" of lead hazards.

Property sellers or landlords are required to disclose information on known lead hazards in their buildings (e.g., data from prior testing). Buyers are given 10 days to have lead hazard testing conducted at their own expense. Sellers or landlords are also required to provide the buyer/renter with the EPA/CPSC pamphlet *Protect Your Family From Lead in Your Home*, which describes the lead poisoning issue. This is a very brief summary of a few highlights of a detailed piece of legislation. The final regulation is published in the Federal Register of March 6, 1996, pp 9064-9088. For a useful summary of Title X, call the Alliance to End Childhood Lead Poisoning at (202) 543-1147.

**Special note about paints**

As part of an agreement with dozens of attorneys general across the country (including Florida), The National Paint and Coatings Association, Inc. (NPCA) agreed to put "*Lead Exposure Surface Preparation Warning*" labels or stickers on paint cans. This agreement also provides point of sale information (in both English and Spanish), until 2007, and training for painting contractors. This Agreement was made in order to provide timely and meaningful notice to consumers of the potential risks of lead exposure that could arise out of surface preparation during remodeling, renovation or repainting where old lead based paint is present.

## Measures to Reduce Lead Hazards

- Dust Control (damp dusting)
- Duct Tape – for chips
- Good Nutrition
- Hand Washing – to minimize dust ingestion
- Never sand, scrape,or burn old paint (may need qualified workers)
- Component removal (windows, moldings)
- Enclosure (covering walls with drywall)
- Don't use candles with lead-cored wicks

**Measures To Reduce Lead Hazards**

The simplest measures for controlling exposure to lead involve dust control via frequent damp mopping/dusting. Use of a conventional vacuum cleaner disperses finer dust particles back into the room. Therefore, don't vacuum unless you can get access to a special high efficiency particulate air (HEPA) vacuum. (A "commercial" grade HEPA vacuum might be a good investment.) In recent years, high performance and HEPA vacs have appeared in the retail market, targeted toward allergy sufferers. Also, it is possible to buy high performance filters (almost meeting HEPA standards) for shop vacuums.

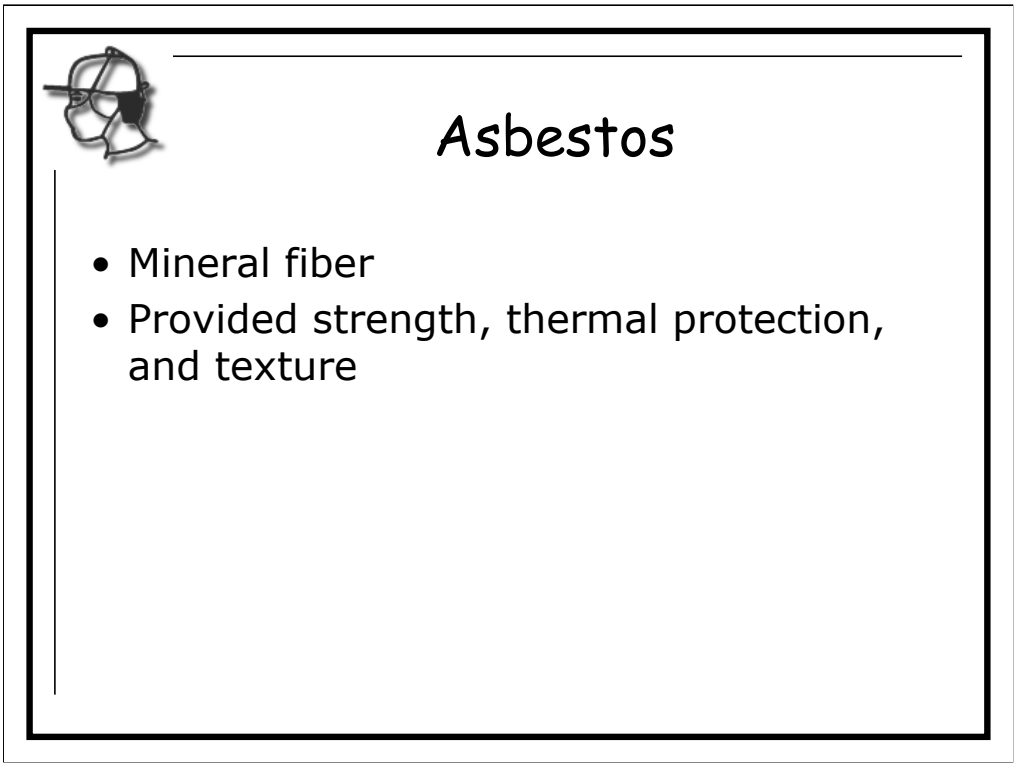
Loose paint chips can be picked up with duct tape. Good nutrition will reduce absorption of lead. Frequent washing of children's hands and toys will reduce exposure as well. It is extremely important to avoid sanding, scraping, or burning lead paint (or any other activities that will generate significant amounts of dust). Small areas (1-2 square feet per room, or within 1 foot of electrical outlets) may be sanded with minimal risk if done properly. Sanding large areas without the proper training, equipment, and precautions can create major problems in the home. Remodeling can create serious contamination if lead paint is disturbed (see *Reducing Lead Hazards When Remodeling Your Home*—http://www.epa.gov/opptintr/lead/rrpamph.pdf); or *Minimizing Lead-Based Paint Hazards During Renovation, Remodeling & Painting* (http://www.epa.gov/lead/coverinstructor.pdf); or contact The National Lead Information Center (1-800-424-5323). You may need qualified personnel to perform complete lead paint removal.

To permanently eliminate lead dust hazards, you may also remove and replace entire building components (windows and moldings, for example) or cover surfaces with materials such as drywall. During substantial remediation activities, children and pregnant or nursing women should live elsewhere until the site passes "clearance" inspection. (In a recent study, lead debris found on the floor after poorly performed window replacements was two hundred times greater than acceptable limits.)

Except for the most elementary measures, dealing with lead is an extremely complex task best left to professionals. Implementation may be affected by local regulations. Finding the money to pay for these measures, especially in low income housing, remains a major problem.

**Note:**

The U.S. Consumer Product Safety Commission (CPSC) banned the manufacturing, importing, or selling of candles with lead wicks effective October 2003. This federal ban applies to all domestic and imported candles. A CPSC investigation found that despite a voluntary industry agreement in the 1970s to remove lead from candle wicks, a small percentage of candles sold over the last several years still contained lead-cored wicks. Some candles tested by the CPSC emitted lead levels in excess of 3,000 micrograms per hour – about seven times the rate that could lead to elevated levels of lead in a child. According to the CPSC, safe alternatives to lead-cored wicks include zinc, synthetic fibers, cotton and paper. Since consumers cannot tell if a metal-cored wick contains lead or an alternative, consumers may wish to contact the retailer for information about the materials used in their candles.




**Asbestos**

- Mineral fiber; asbestos is the name given to a group of six different minerals that occur naturally in the earth—chrysotile, amosite, crocidolite, tremolite, actinolite, and anthophyllite. These minerals are composed of fibers that vary in length and may be straight or curled—they also can be so small as to be invisible to the naked eye.
- Added to products to provide extra strength, increase thermal protection (heat insulation), and to provide texture. Asbestos was a popular commercial product because it is strong, won't burn, resists corrosion, and insulates well.

## Where is Asbestos Found?

- Steam pipes, boilers, and furnace ducts
- Resilient floor tiles and sheet flooring
- Cement sheets, millboard
- Sound proofing and decorative materials sprayed on walls and ceilings
- Textured paints—use was banned in 1977
- Roofing and siding shingles
- Artificial ashes and embers
- Consumer products needing insulation and home insulation

**Where Is Asbestos Found?**

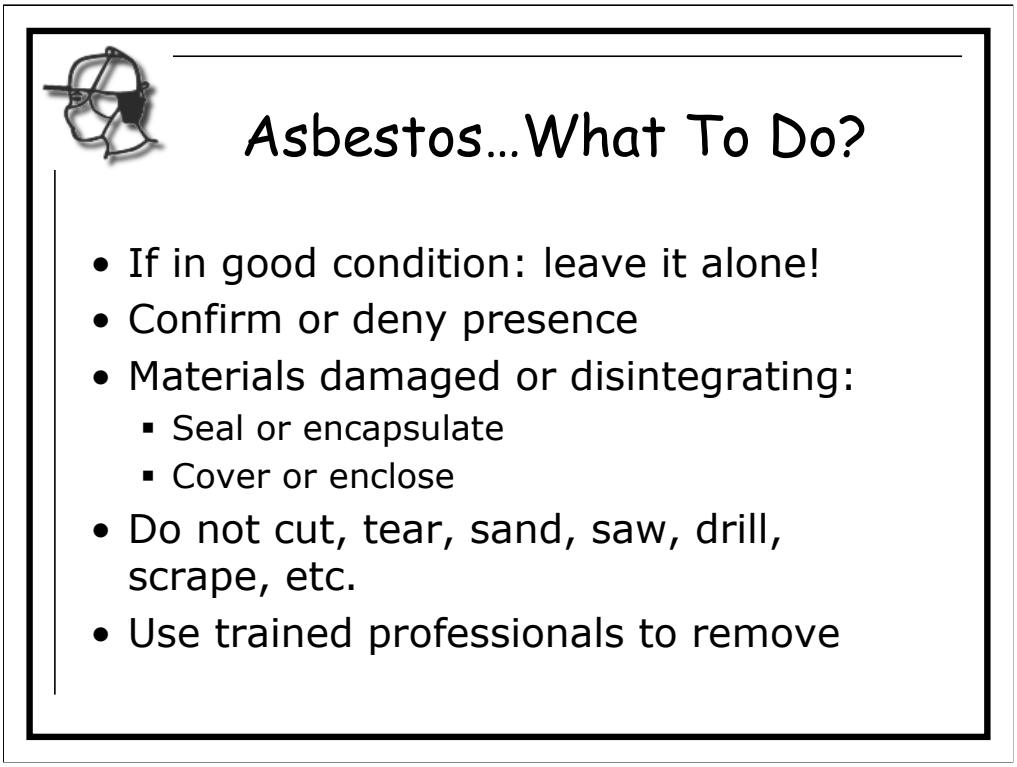
Asbestos can be found in:

- Steam pipes, boilers, and furnace ducts for thermal insulation (may also have asbestos tape)
- Resilient floor tiles and sheet flooring (vinyl asbestos)
- Cement sheets, millboard, and other materials insulating around furnaces, fireplaces, and woodstoves
- Soundproofing and decorative materials sprayed on walls and ceilings
- Textured paints and patching and joint compounds (use was banned in 1977)
- Roofing and siding shingles (asbestos cement)
- Artificial ashes and embers (sold for use in gas-fired fireplaces)
- Consumer products needing insulation (i.e., ironing board covers and stove top pads)
- Also, houses built between 1930 and 1950 may have asbestos as insulation – or contained in vermiculite in more recently-constructed homes

**Note:**

Many household uses of asbestos have been eliminated in recent years. Thus, asbestos is more likely to be found in older (pre-1980) homes and products.

Also, you may have read about asbestos and vermiculite. Vermiculite is a naturally occurring mineral that has the unusual property of expanding into worm-like accordion shaped pieces when heated. The expanded vermiculite is a light-weight, fire-resistant, absorbent, and odorless material—properties that allow its use in a number of products, including insulation. Before its closing in 1990, much of the world's supply of vermiculite came from a mine near Libby, Montana. This large mine had a natural deposit of asbestos, which resulted in the vermiculite being contaminated with asbestos. Attic insulation produced using vermiculite ore, particularly ore that originated from the Libby mine, may contain asbestos fibers. More information is available from the EPA…note that today, vermiculite is mined at three U.S. facilities and in other countries that have low levels of contamination in the finished material. See EPA's web site (*Welcome to EPA's Asbestos and Vermiculite Home Page*) at http://www.epa.gov/asbestos/




**Asbestos...What To Do?**

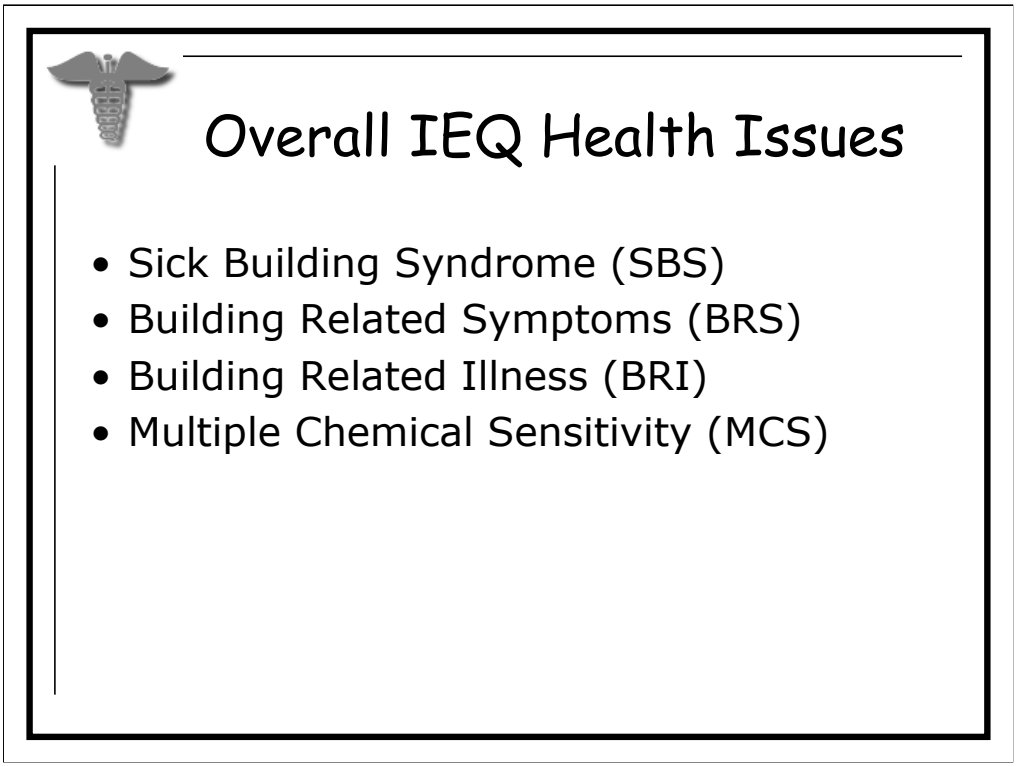
What do you do if you suspect you have asbestos-containing materials? If the material is in good condition: leave it alone!

Before beginning any remodeling work, have a laboratory test done to confirm or deny the presence of asbestos in suspicious materials.

If materials are damaged or disintegrating:

- Seal or encapsulate—use a sealant to bind materials together, or coat the material so fibers cannot be released
- Cover or enclose—cover the asbestos-containing materials so fibers cannot be released
- Do not cut, tear, sand, saw, drill, or scrape asbestos-containing materials unless absolutely necessary, and then only after taking full safety precautions.
- If removal of asbestos-containing materials is necessary, using a trained and certified professional is recommended.

For more information, read sections 105.3.6 and 105.9 of the *2004 Florida Building Code, Building*, 469.003 of the *Florida Statutes*, and http://www.epa.gov/region04/air/asbestos/inform.htm



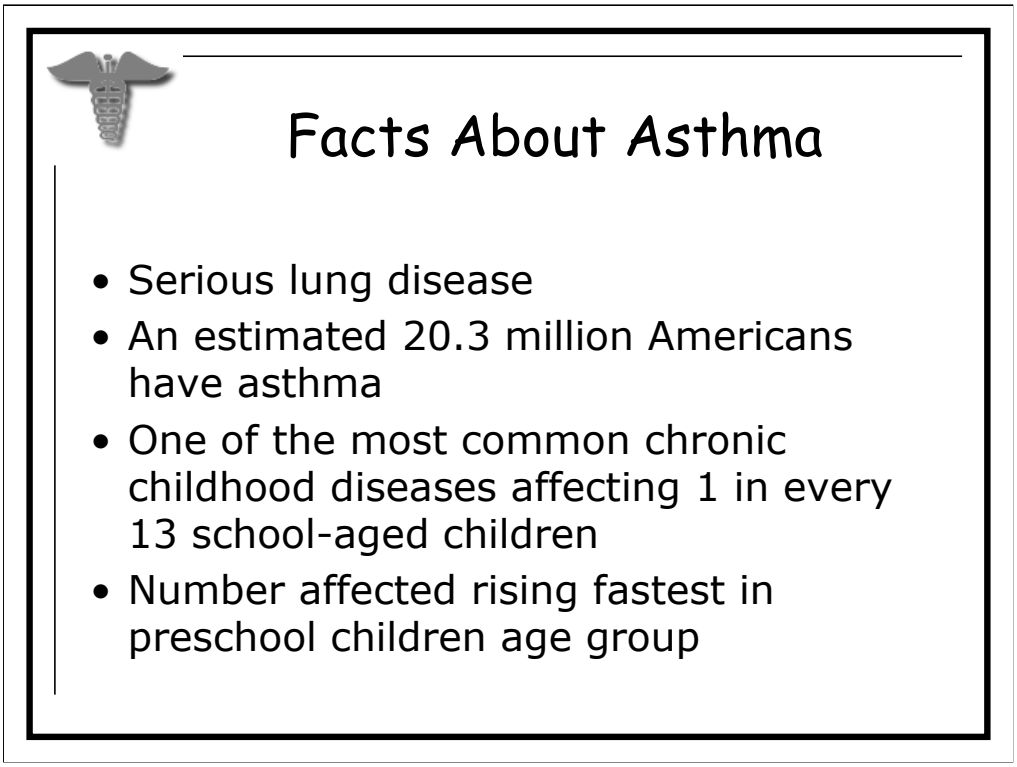

**Overall IEQ Health Issues**

The term "sick building syndrome" (SBS) – sometimes referred to as Building Related Symptoms (BRS), first used in the 1970s, is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building. Indicators of SBS include: building occupants complain of symptoms associated with acute discomfort, e.g., headache, eye, nose, or throat irritation, dry cough, dry or itchy skin, dizziness and nausea, difficulty in concentrating, fatigue, and sensitivity to odors; the cause of the symptoms is not known; and most of the complainants report relief soon after leaving the building. Suspected causes of SBS include inadequate ventilation, chemical contaminants from indoor sources, chemical contaminants from outdoor sources, and biological contaminants.

In contrast, the term "building related illness" (BRI) is used when symptoms of diagnosable illness are identified and can be attributed directly to airborne building contaminants. Indicators of BRI include: building occupants complain of symptoms such as cough, chest tightness, fever, chills, and muscle aches; the symptoms can be clinically defined and have clearly identifiable causes; and complainants may require prolonged recovery times after leaving the building. Legionnaires' Disease and hypersensitivity pneumonitis are examples of BRI.

People who have environmental sensitivities (a disorder otherwise known as environmental illness, 20th Century Disease, Total Allergy Syndrome, Idiopathic Environmental Illness, or multiple chemical sensitivity [MCS]) show a heightened sensitivity when exposed to common environmental agents. MCS is a highly controversial entity. Even low concentrations of indoor air contaminants, which do not illicit serious health problems in the majority of the population, have significant detrimental effects on people who are hypersensitive to them. Individuals afflicted usually display a polysymptomatic disorder that primarily affects one organ, and causes secondary effects in others. This disorder manifests itself through a multitude of often serious and debilitating symptoms, with relief that may be possible by avoidance of the instigating factor(s). MCS appears to affect young women at a proportionally greater rate than men or older women.

Keep in mind that the severity of any health effect depends to a large degree upon the contaminant's toxicity, duration of exposure, and individual sensitivity.

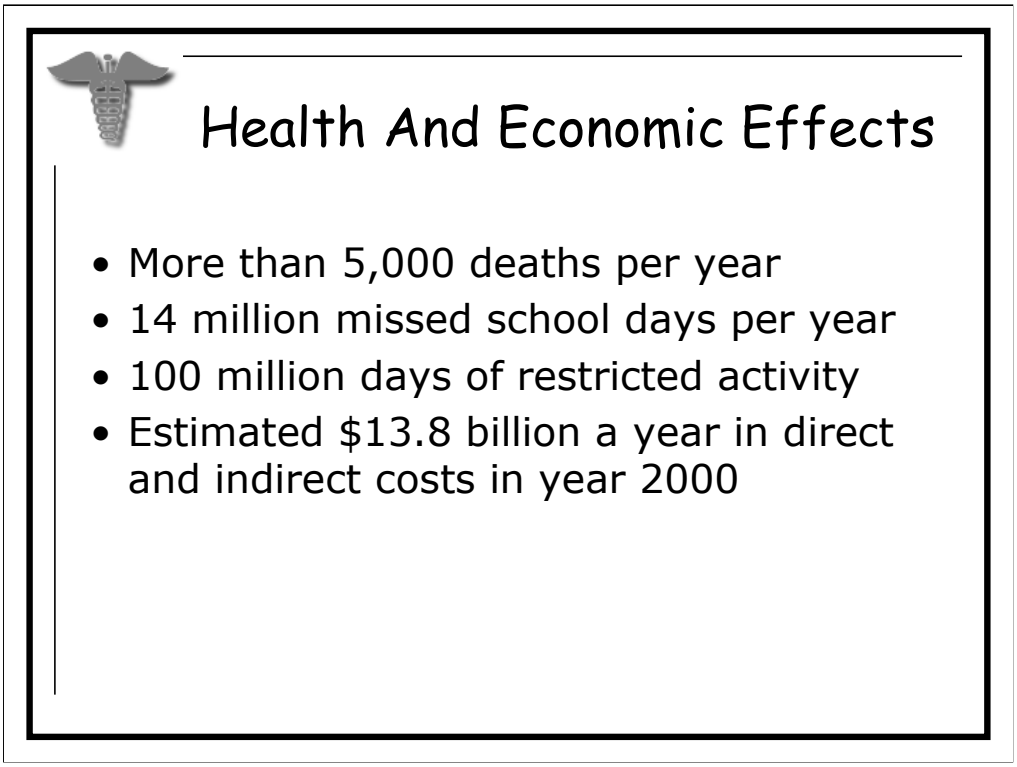



The next few slides concentrate on asthma and the relationship to IEQ.

**Facts About Asthma**

Asthma is a serious lung disease that is an inflammation of the airways that can restrict the flow of air into the lungs. The airways are the passages that carry air to the lungs. As the airways progress through the lungs, they become smaller, like branches of a tree. The inflammation may be present even when a person doesn't outwardly show any symptoms. When asthma is under control, the airways are clear and air flows easily in and out. When not under control, the sides of the airways in the lungs become inflamed and swollen. During an attack, muscles around the airways constrict, and less air passes in and out of the lungs. Excess mucus forms in the airways, clogging them even further. The attack, also called an episode or exacerbation, can include recurrent and distressing episodes of wheezing, breathlessness, chest tightness, and nighttime or early morning coughing. This disease can be difficult to diagnose and to differentiate from other respiratory illnesses.

It affects an estimated 20.3 million Americans and is one of the most common chronic childhood diseases in the country, affecting about one in every 13 school-aged children. The American Lung Association estimates that of the 20.3 million people who have been diagnosed with asthma, more than a third are children. The Environmental Protection Agency reports that the percentage of children with asthma is rising more rapidly in preschool children than in any other age group.

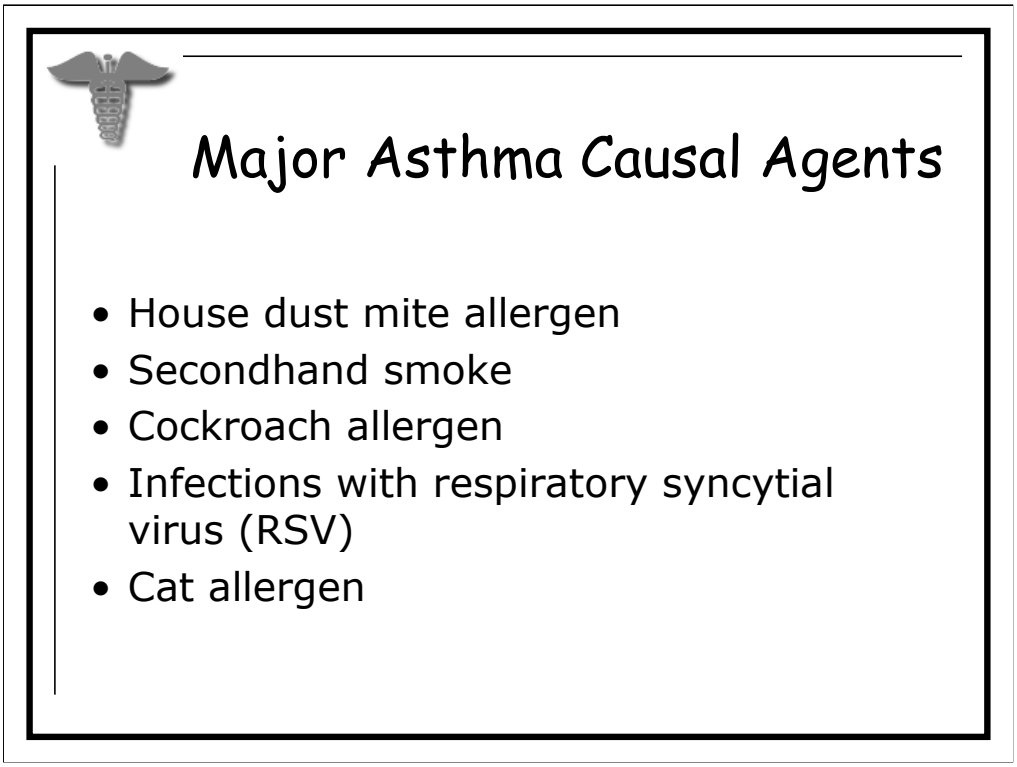



### Health And Economic Effects

Asthma is especially worrisome because the national health and economic consequences are substantial, including:

- More than 5,000 deaths per year
- 14 million missed school days per year
- 100 million days of restricted activity
- $13.8 billion a year in direct and indirect costs. Direct costs of asthma can include the costs of asthma management programs, inpatient and outpatient medical care, physician services, emergency visits, ambulance use, drugs, short-term and long-term treatment complications, devices, nursing services, allergy testing, and research. Some of the indirect costs of asthma include work or school absenteeism, travel, time waiting for care, and death. Costs difficult to measure or put value on include anxiety, pain, suffering and decreased potential resulting from school absenteeism.

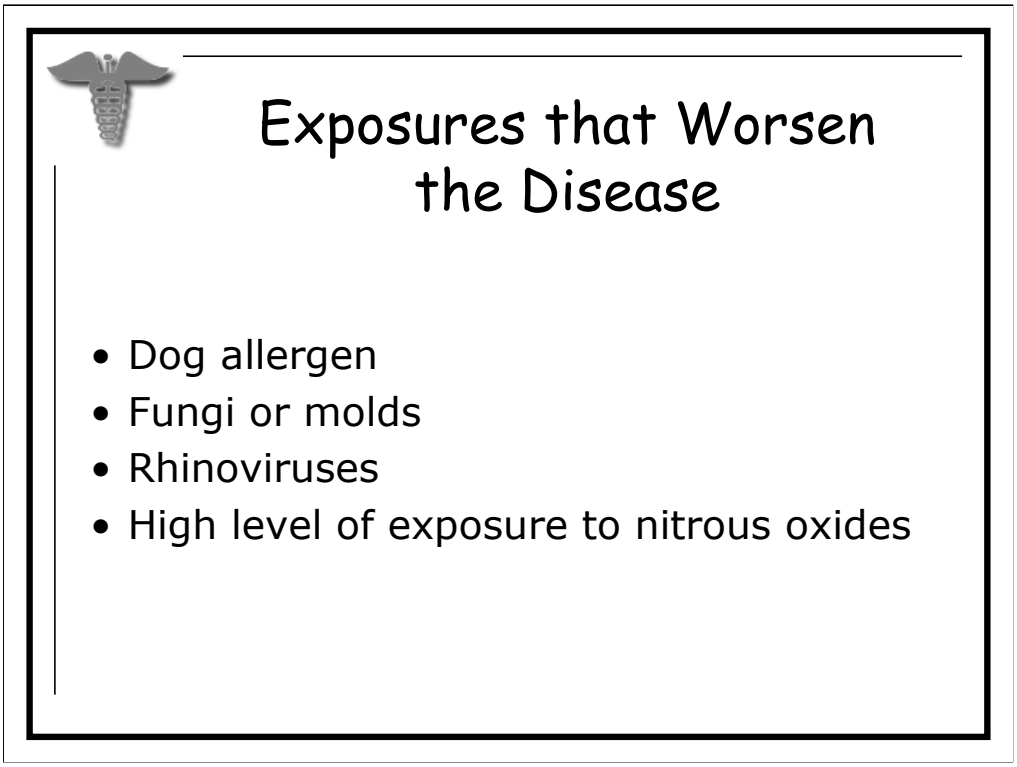
The increase in asthma cases has occurred during a period of reduction in outdoor air pollutants, leading many scientists to consider poor indoor air as a primary factor. The rates of childhood asthma cases in Florida are not being tracked by any coordinated state public health effort although efforts are being made in some municipalities.




**Major Asthma Causal Agents**

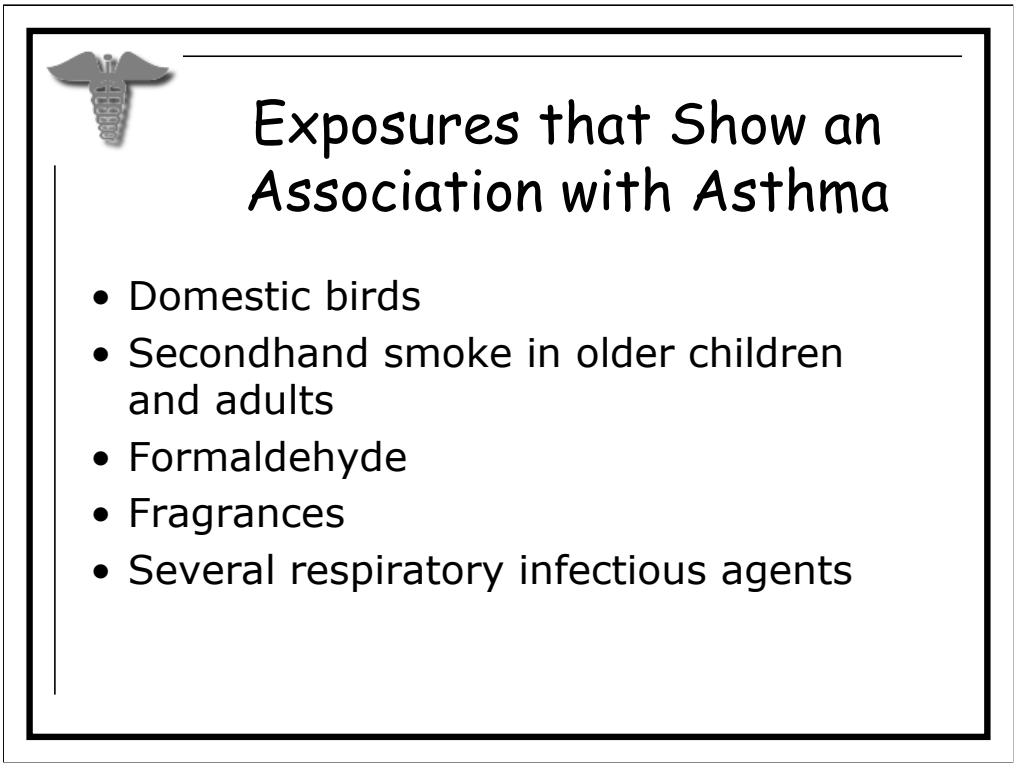
In 2000, the Institute of Medicine published the report *Clearing the Air*. The report reviews the evidence about indoor air exposures and asthma as presented in the scientific literature looking at components that affect both the development of the disease itself and the exacerbation of symptoms in someone who already has the disease. The Institute of Medicine committee concluded evidence was sufficient to suggest a causal relationship between exposure to house dust mite allergen and development of asthma is susceptible children. Also, between exposure to environmental tobacco smoke (ETS) – also known as secondhand smoke, in younger children (preschool-aged) and the development of asthma (both prenatal exposure to active maternal smoking and ETS exposure after birth). They also found some evidence to link asthma's development with exposure to cockroach allergen in preschool-aged children, and with infections with respiratory syncytial virus (RSV). Cat allergen was also considered causes of asthma exacerbations. By the way…causal relationship means that the evidence is strong enough to document that exposure to these substances causes the disease's onset or exacerbation.

An allergen is any foreign substance capable of causing an allergic (hypersensitive) reaction.




**Exposures that Worsen the Disease**

Sufficient evidence of an association means that the evidence is strong enough to document an association between the agent and the outcome has been observed in studies in which chance, bias and confounding factors can be reasonably ruled out. These four additional exposures are associated with worsening the disease: dog allergen, fungi or molds, rhinoviruses, and a high level of exposure to nitrous oxides.



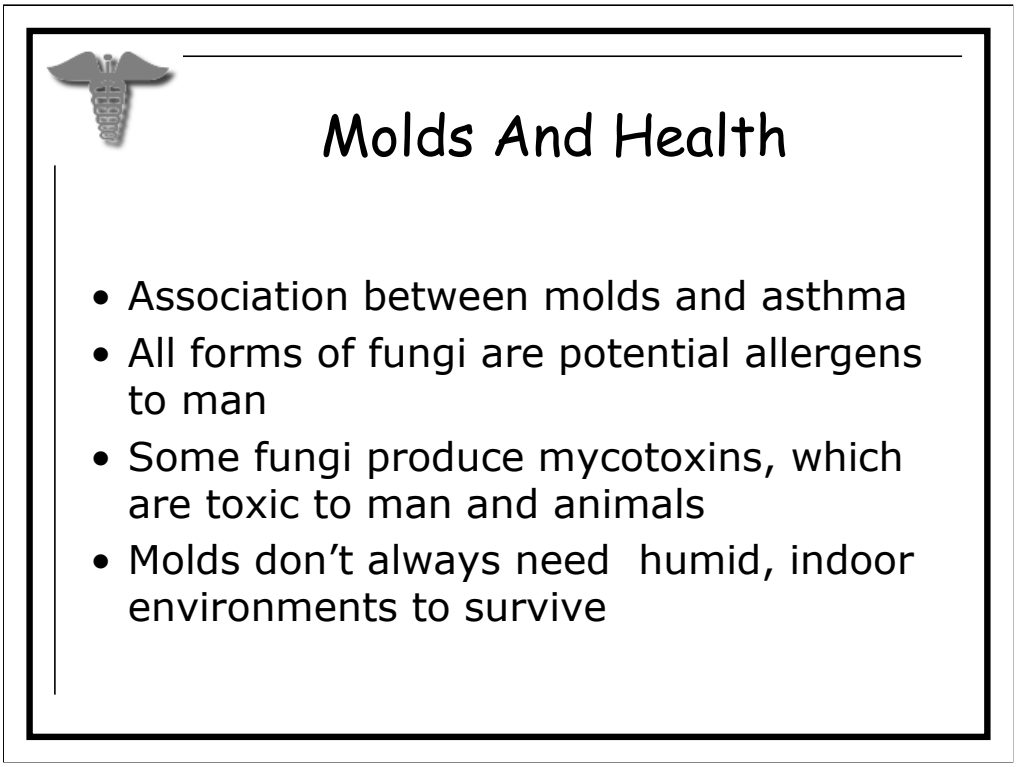

**Exposures that show an Association with Asthma**

Limited or suggestive association means that the evidence suggests an association, but chance, bias, and confounding factors cannot be ruled out with confidence. Evidence suggests an association between asthma exacerbations and exposure to domestic birds, secondhand smoke in older children and adults, formaldehyde, fragrances, and several respiratory infectious agents.

**Note:**

In addition to the indoor agents studied extensively by the Institute of Medicine, there are other possible triggers for asthma that affect some people. These triggers can include strenuous physical exercise; adverse weather conditions like freezing temperatures, high humidity, and thunderstorms; and some foods and food additives and drugs. Strong emotional states, either positive or negative, can lead to hyperventilation and an asthma episode.

Outdoor air pollution, caused by industrial emissions and automobile exhaust, also can cause an asthma episode. The number of emergency department visits in large cities that have air pollution problems like Los Angeles, Houston, and Atlanta, go up during ozone action days when the air quality is especially poor.



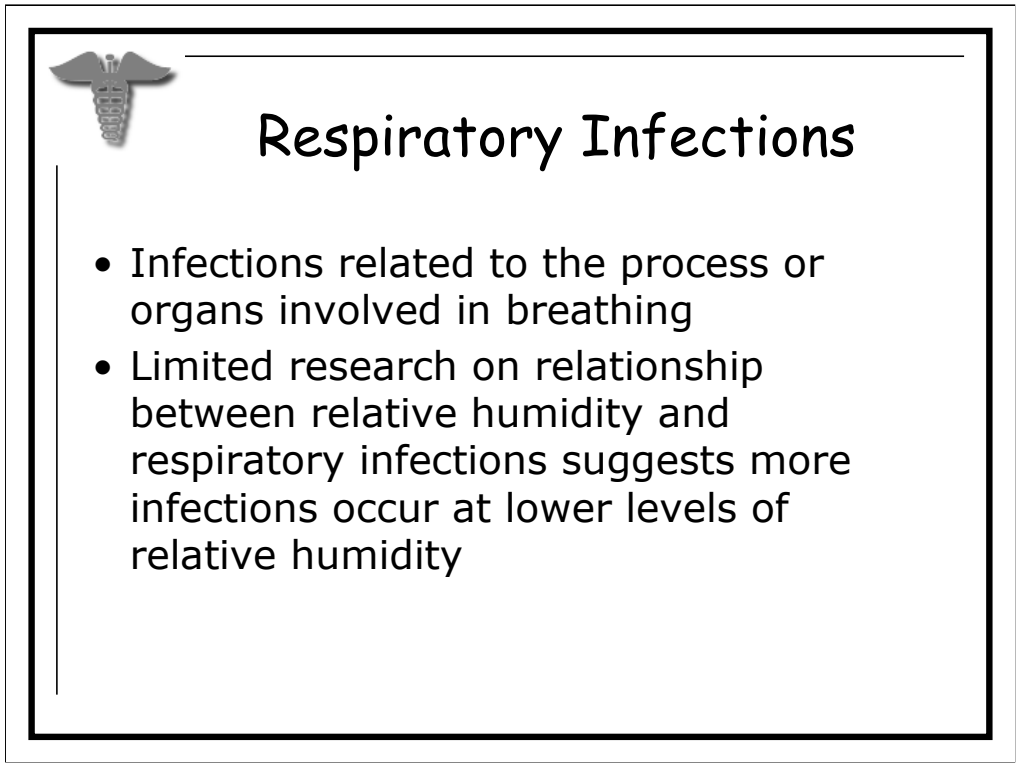

**Molds And Asthma**

As mentioned in an earlier slide, the evidence is strong enough to document an association between molds and asthma. Some people's asthma can be triggered by mold. Fungi can act as allergens, toxicants (toxic agent), irritants or infectious agents. It is believed that all forms of fungi are potential allergens to man. Some fungi species are known to produce specific metabolic products (mycotoxins) which are toxic to man and animals. Some (if not most) fungal species can produce metabolic products that are irritating to the mucus membranes (eyes and the lining of the nose and throat). Some fungal species are known to be infectious to humans and animals.

There is no practical way to eliminate all mold and mold spores in the indoor environment. The best way to control indoor mold growth is to control moisture. Clean up the mold and get rid of excess water or moisture. Lowering moisture also helps reduce other triggers, such as dust mites and cockroaches.

**Note:**

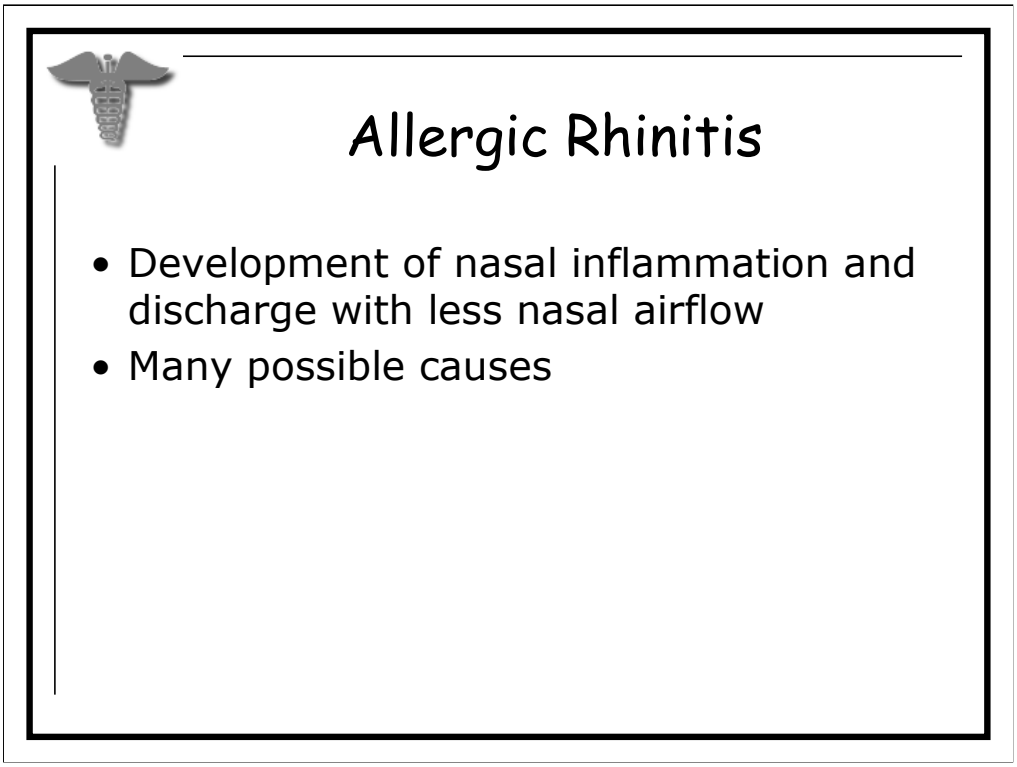
According to the Centers for Disease Control, molds can cause illnesses in situations other than humid indoor environments. They have documented that molds can cause infections in susceptible people, particularly in hospital settings where 9% of hospital-acquired infections are caused by fungi. Respiratory infections due to inhalation of the fungus Aspergillus have been documented mostly in immunocompromised individuals. Molds also have been associated with some cancers. Two mold-produced toxins (aflatoxins and ochratoxin A) have been classified by the National Toxicology Program as human carcinogens (http://ntp-server.niehs.nih.gov). Chronic ingestion of these toxins from eating contaminated foods has been associated with liver and kidney tumors in animals and people. In addition…in industrial and agricultural settings, various forms of hypersensitivity pneumonitis (e.g., farmer's lung, woodworker's lung, malt worker's lung), and other allergic responses and infectious respiratory diseases (e.g, aspergillosis) have been reported.




**Respiratory Infections**

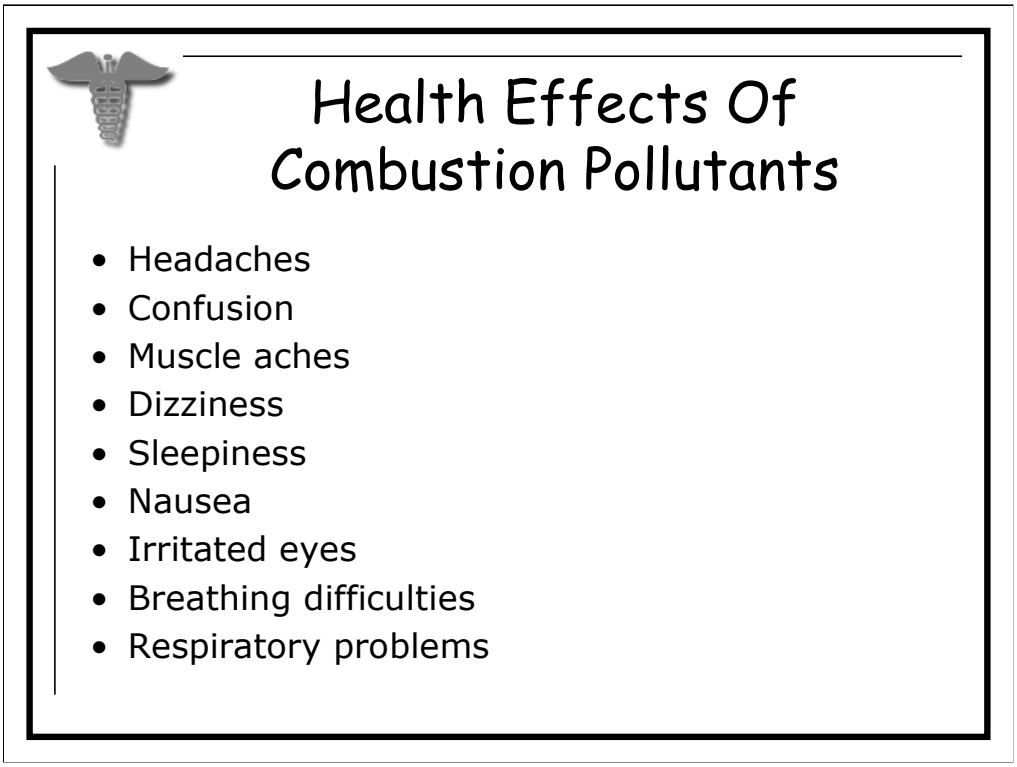
Infections related to the process or organs involved in breathing – including pharyngitis, viral rhinitus (common cold), sinusitis, etc.

Research on the interaction between respiratory infections and relative humidity is limited, but suggests that more infections occur at lower levels of relative humidity.




**Allergic Rhinitis and Asthma**

Allergic rhinitis is the development of nasal inflammation and discharge, with increased nasal resistance to airflow. An individual may have sensitization to airborne allergens in a building, although the specific allergen may be difficult to identify. Mites, dust, and mold or other biological materials in buildings may exacerbate this condition. Off gassing of building materials or other point sources may also cause irritant-induced rhinitis.



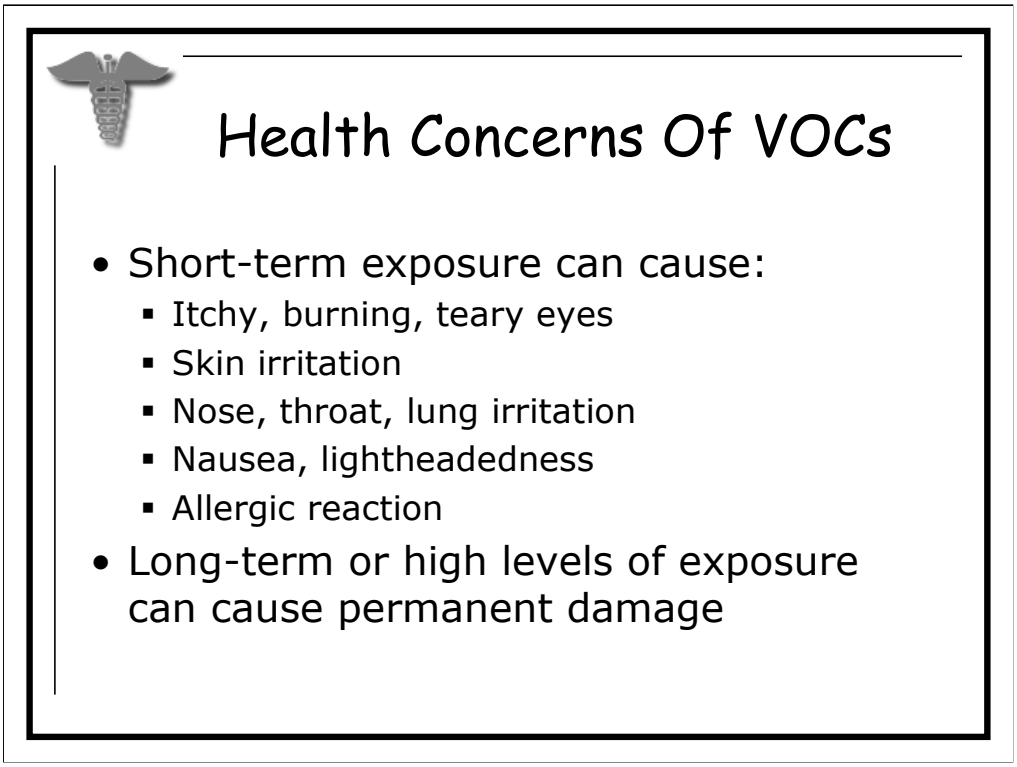

### Health Effects

Health effects from exposure to combustion pollutants vary from very mild to lethal. Typical health effects are:

- Headaches
- Confusion
- Muscle aches
- Dizziness
- Sleepiness
- Nausea
- Irritated eyes
- Breathing difficulties
- Respiratory problems (i.e., coughing)

People with allergies, asthma, or chronic respiratory or heart problems are particularly susceptible to health effects from combustion pollutants. It is important to note, though, that these health effects can have many other causes as well.

For your information…If you suspect you're being poisoned, call the 911 emergency services or the Florida Poison Information Center at 1-800-222-1222.

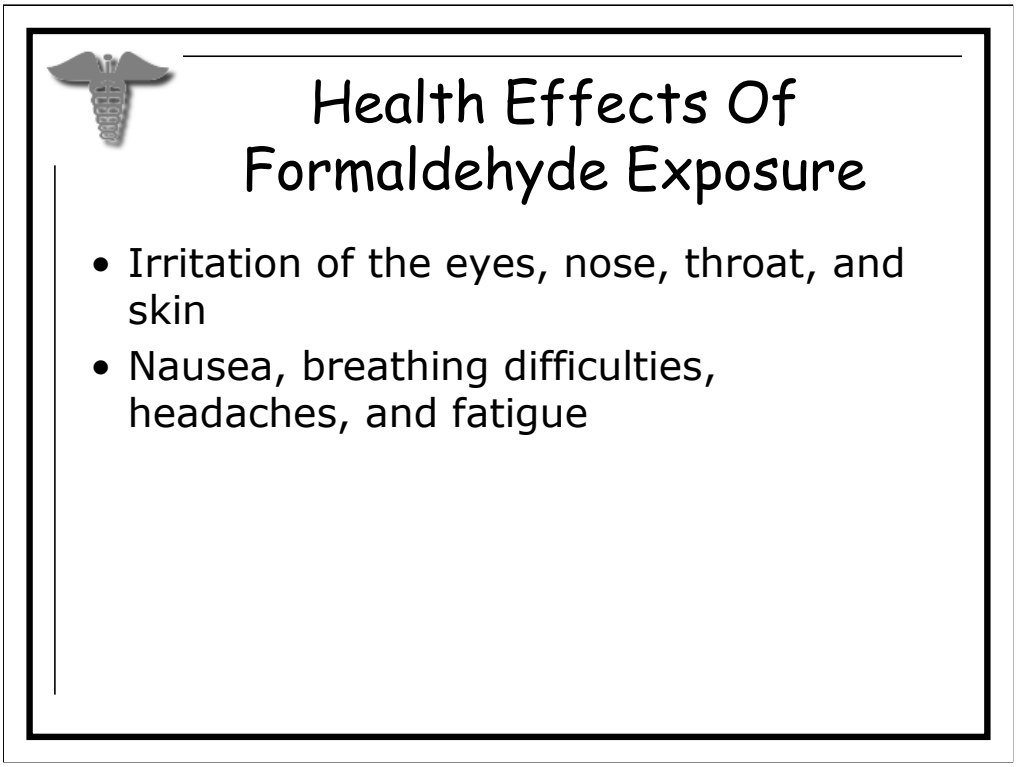



**Health Concerns Of VOCs**

VOCs may be toxic products under certain conditions! Short-term exposure can cause:

- Itchy, burning, or teary eyes
- Skin irritation
- Nose, throat, or lung irritation
- Nausea or headache
- Dizziness or lightheadedness
- Allergic reaction

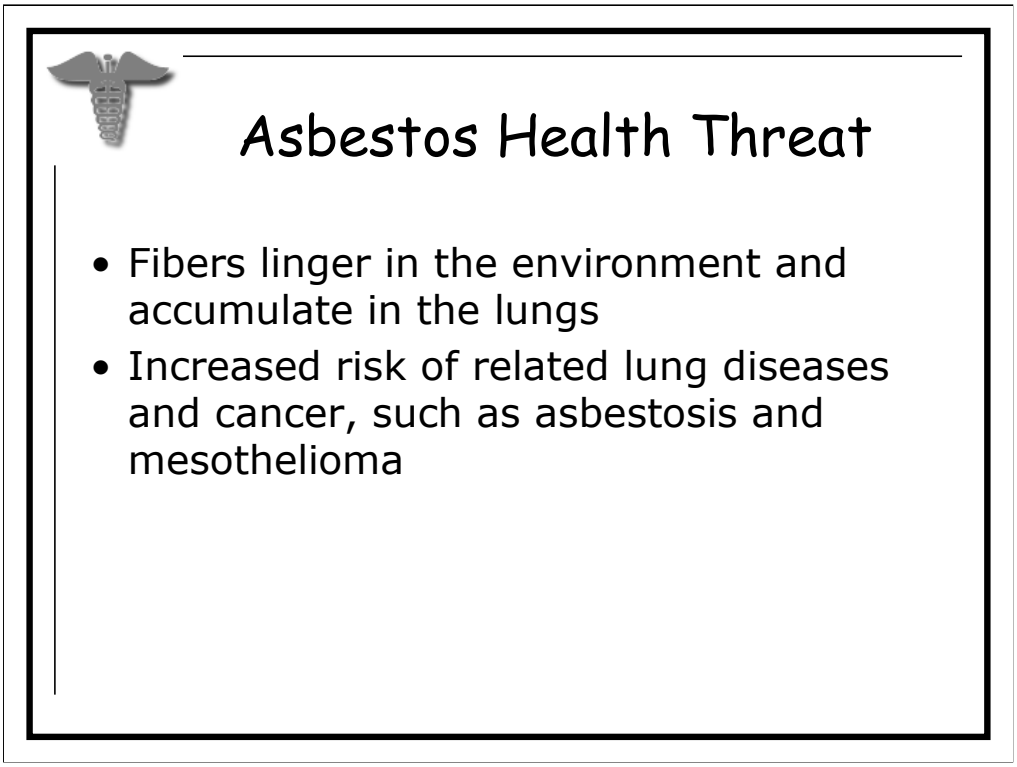
Long-term or high levels of VOC exposure can cause permanent damage to various parts of the body, such as the lungs, kidneys, liver, and nervous system.




**Health Effects Of Formaldehyde Exposure**

Low doses cause watery eyes or burning sensations in the eyes, nose, and throat. Larger doses can cause nausea, breathing difficulties, headaches, and fatigue. High doses can cause asthma attacks. Some people are highly sensitive to formaldehyde and react to concentrations that would not bother other people.

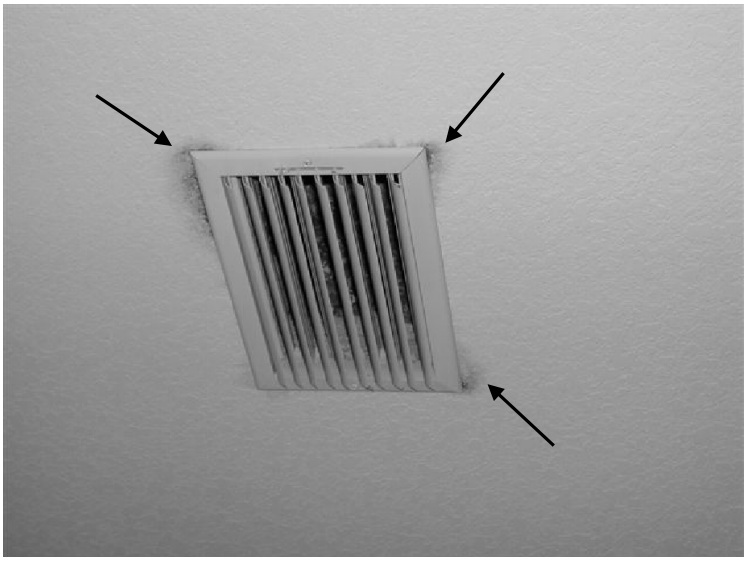
Formaldehyde has been shown to cause cancer in laboratory animals, but to date there is limited evidence it has caused increased incidence of cancer in humans. Nevertheless, it is classified as a "probable human carcinogen" by the EPA and the National Institute for Occupational Safety and Health (NIOSH).




**Asbestos Health Threat**

- Asbestos fibers break down into very fine fibers that are easily inhaled into the lungs. The small fibers and fiber-containing particles may be carried long distances by wind or water currents before settling. These fibers do not break down to other compounds in the environment…in fact, they can remain in the environment indefinitely.
- Fibers tend to accumulate in the lungs
- Increased risk of related lung diseases such as asbestosis, which is a chronic lung disease—the signs and symptoms result from permanent changes in lung tissue (asbestos fibers lodge in the lungs causing irritation of the lung tissues and inflaming the small air tubes and sacs in the lungs) due to asbestos exposure. Generally, the symptoms don't become apparent until approximately ten years after the first exposure. Asbestos workers were also found to have increased chances of getting one of two types of cancers: cancer of the lung tissue itself, and mesothelioma, a cancer of the thin membrane that surrounds the lung and other internal organs.

## What's Going On In This Photo?



The supply grille is not properly sealed to the ceiling. This can result in conditioned air blowing around the grille, and coming out between the grille and ceiling surface.

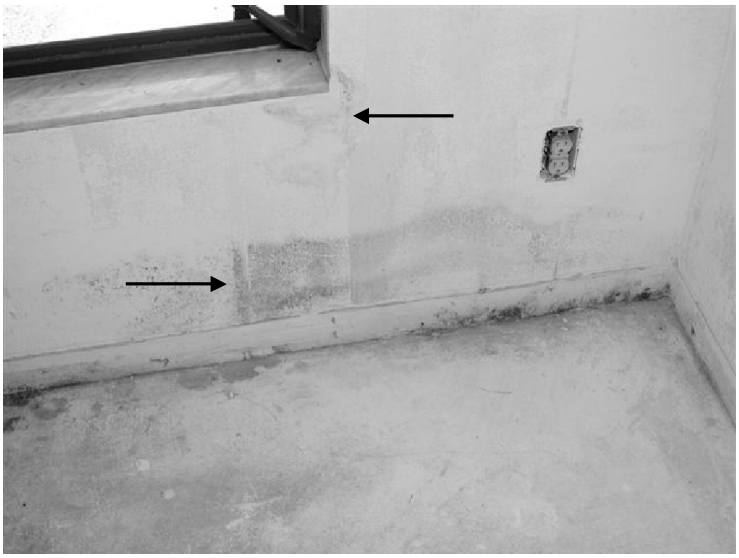
If the air is not filtered properly, dust in the air stream will "catch" on the ceiling surface, resulting in the familiar dirty patches at the corners of the grille.

If at the same time there are humidity control problems, this air may be cool enough to cause condensation to occur as well. Water + dirt = mold.

**Note**:

Look carefully; sometimes the black marks are just dirt. Some people dab suspected areas with a drop of chlorine bleach on a cotton swab (always follow precautions when using chlorine bleach). If the color changes or disappears, generally the stain is organic and probably a mold. If the suspected area smears, you most likely have dirt.

## What's Going On In This Photo?



The cheap, single-pane aluminum frame window is cold enough in winter to cause condensation. Resulting moisture drains off the sill and into the wall. Notice the water stains at the corner of the window.

Also notice the vertical stripes/lines—there used to be vinyl wallpaper acting as a vapor barrier, trapping moisture in the wall. Lower, cooler sections of the wall are affected more.

## Why did the drywall at the base of the walls need to be replaced?

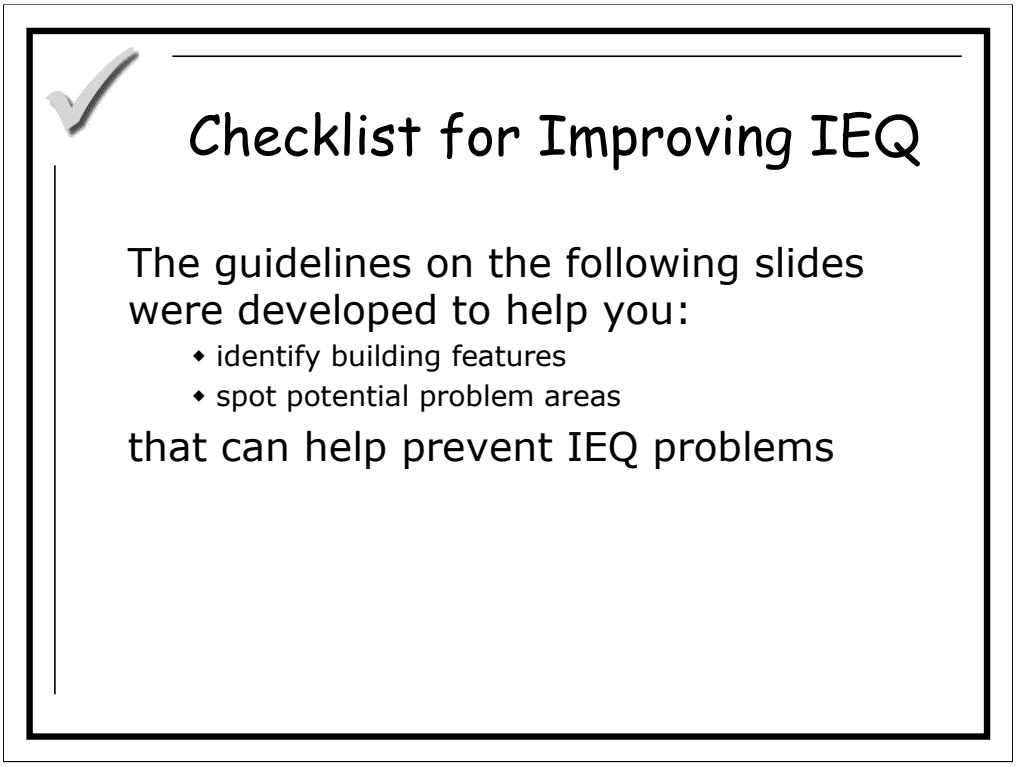
Mold was found at the base of the wall.

Possible causes:

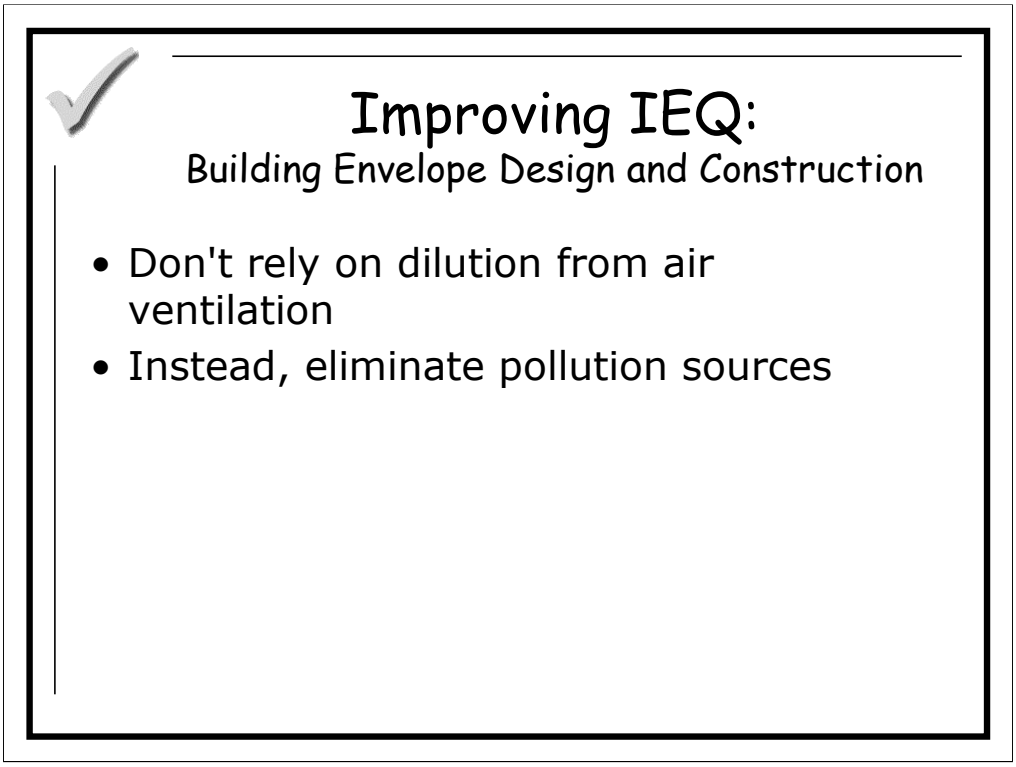
1. Kraft paper-backed insulation acted as an interior vapor barrier, trapping moisture inside.
2. External cladding failure: the outside wall surface allowed moisture to penetrate.
3. Improper window installation.

As a side note: observe that the insulation is poorly installed: it is jammed into the wall spaces. Insulation should never be compressed.

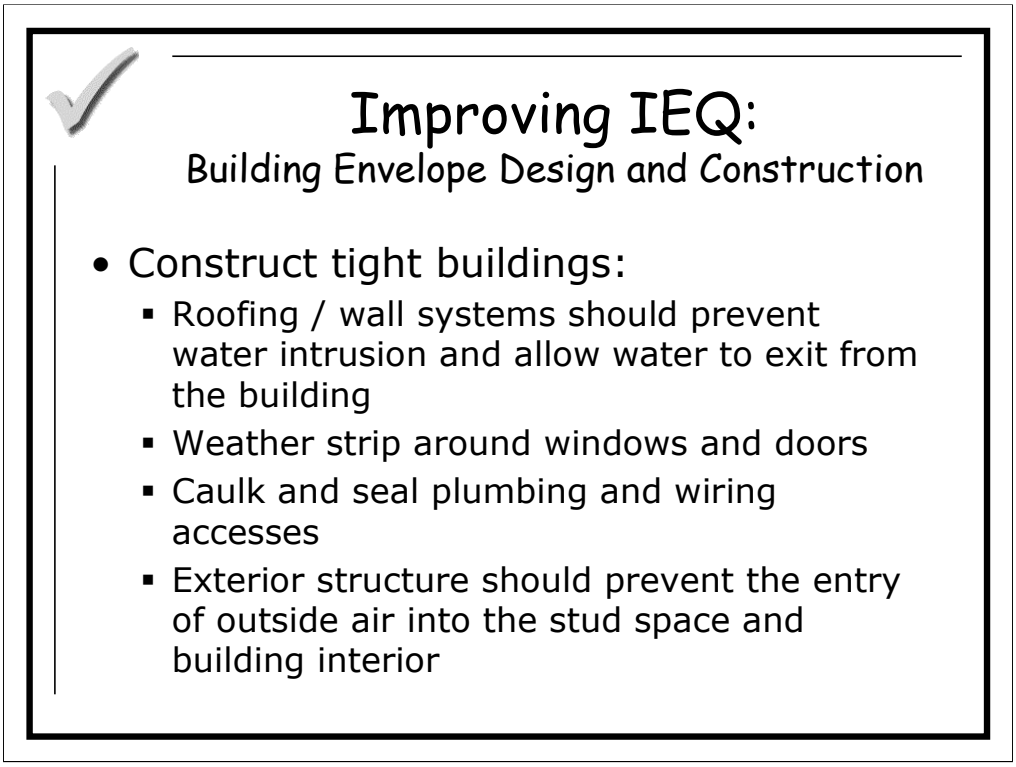
# Checklist for Improving Indoor Environmental Quality




Given the many potential sources of indoor air pollutants and the serious problems they cause, the following guidelines were developed to help you identify the features of buildings that can help prevent IEQ problems and spot potential problem areas.

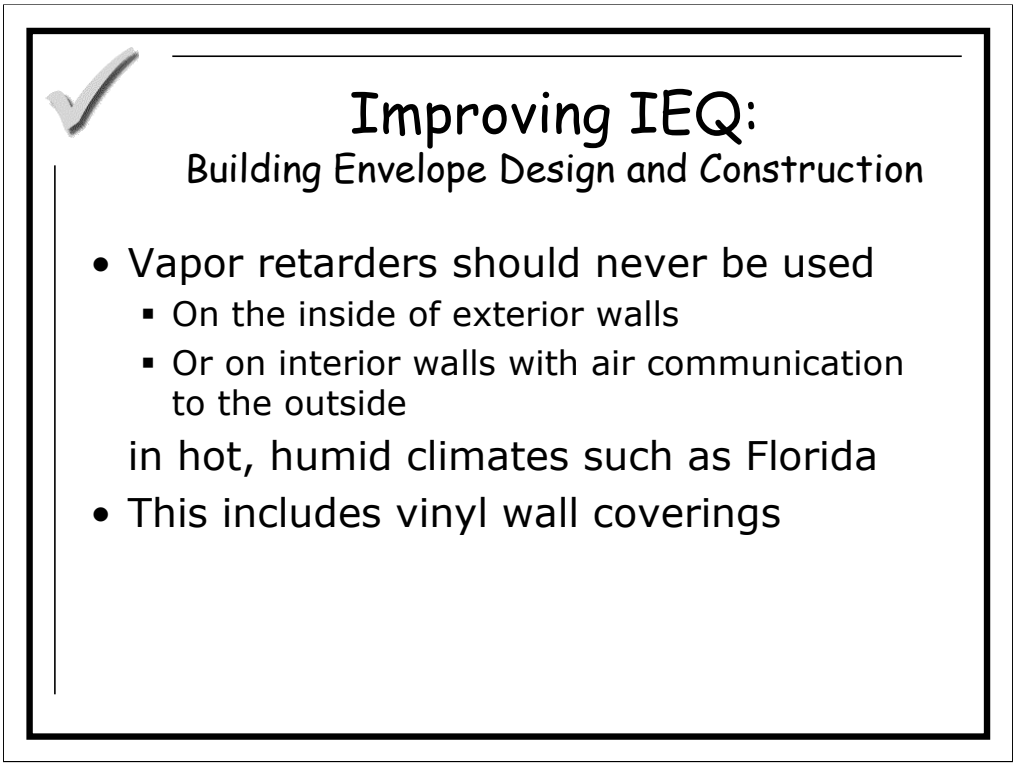



- Eliminate pollution sources rather than rely on dilution from air ventilation.



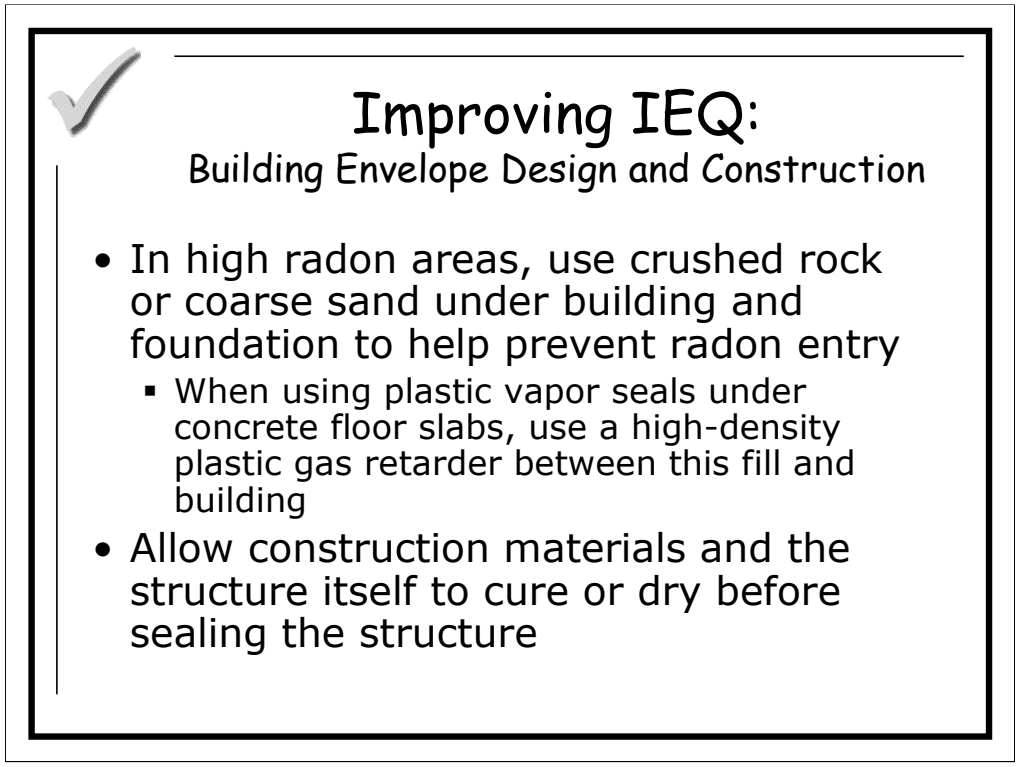

Construct tight buildings:

- Roofing and wall systems should prevent water intrusion and allow water to exit from the building.
- Weather strip around windows and doors.
- Caulk and seal plumbing and wiring accesses throughout the building envelope.
- The exterior structure should be tight enough to prevent the entry of outside air into the stud space and the building interior.

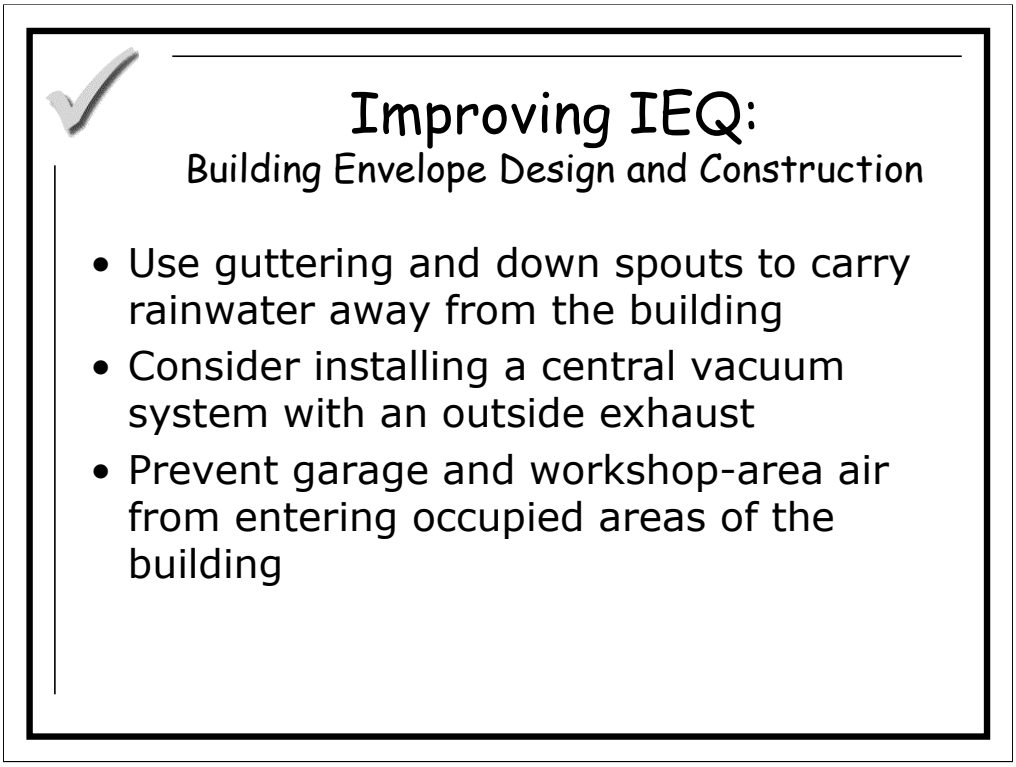



Vapor retarders should never be used on the inside of exterior walls or interior walls with air communication to the outside in hot, humid climates such as Florida. This includes vinyl wall coverings.

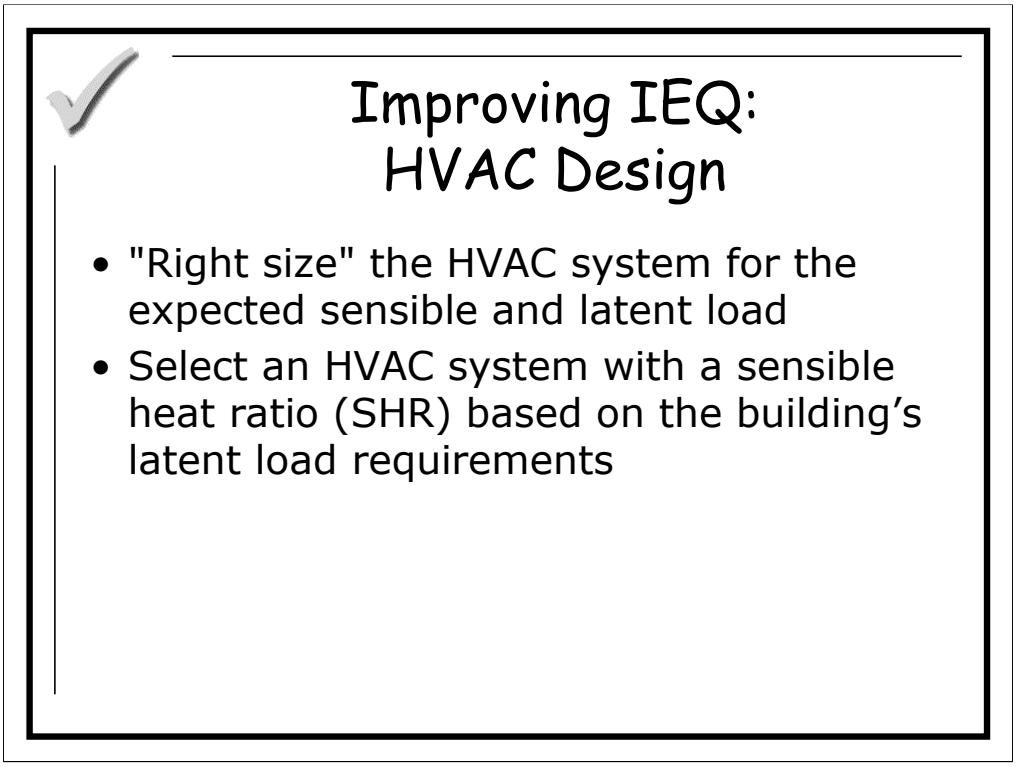

- When using plastic vapor seals under concrete floor slabs, make sure the plastic sheet has no holes or tears.
- Seal all seams, tears, or punctures before the concrete is poured.
- Use a 6-mil black plastic sheet for ground cover below off-grade structures to prevent moisture and soil gas entry.
- Seal or tape areas needing attention or tape edges to stem walls as appropriate.



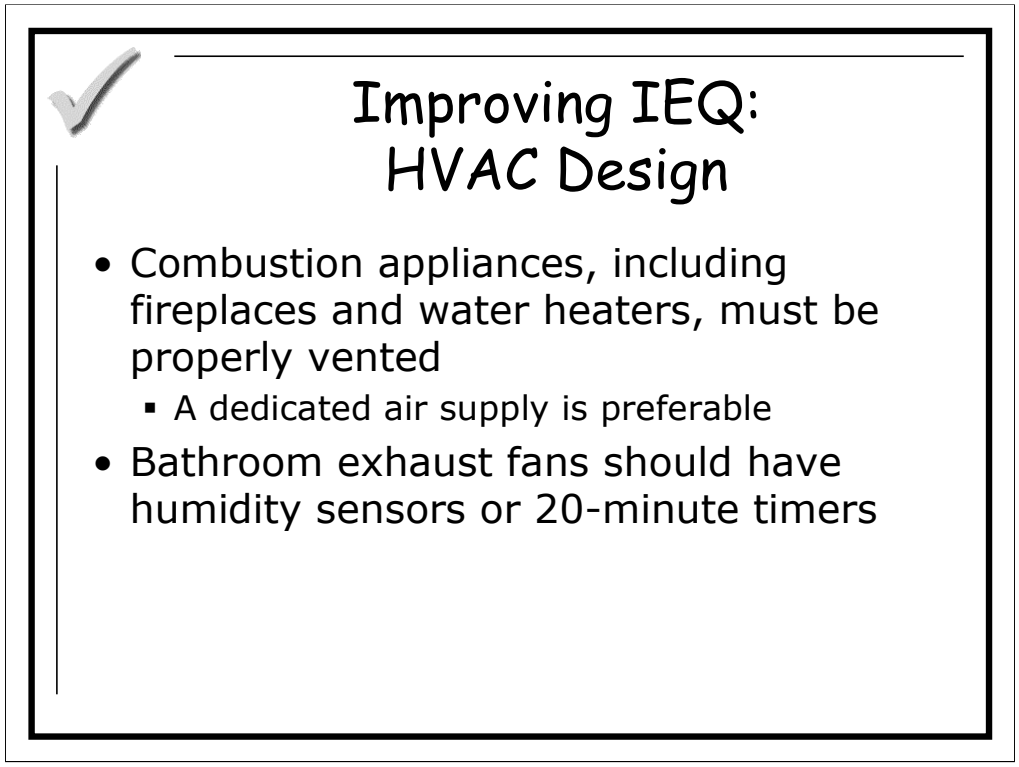

- Use crushed rock or coarse sand to help provide gas communication under building and foundation to prevent radon entry in high radon areas.
- When using plastic vapor seals under concrete floor slabs, use a high-density plastic gas retarder between this fill and building.
- Allow construction materials and the structure itself to cure or dry before sealing the structure.



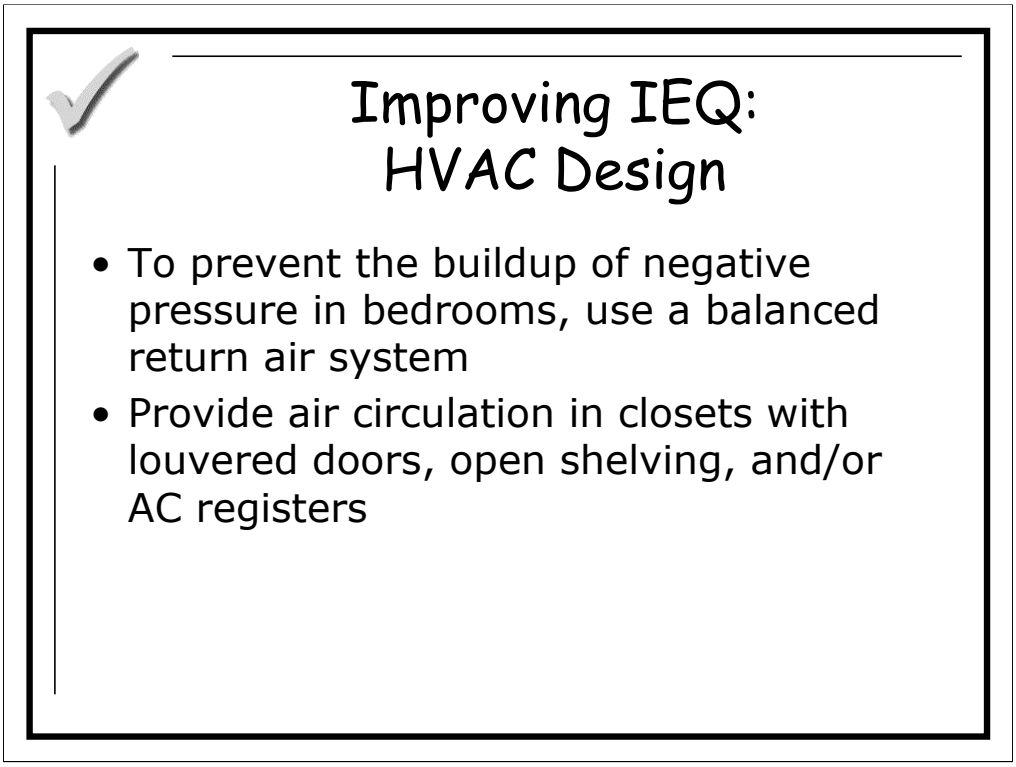

- Use guttering and down spouts to carry rainwater away from the building. This will reduce the opportunity for rain to seep under a building and diffuse through the foundation or flooring.
- Consider installing a central vacuum system with an outside exhaust. This is a much better option than using traditional portable vacuums that spew particulates, dander, spores, and other agents through inadequate filter bags.
- Prevent garage and workshop-area air from entering occupied areas of the building to reduce hydrocarbon and VOC transfer.



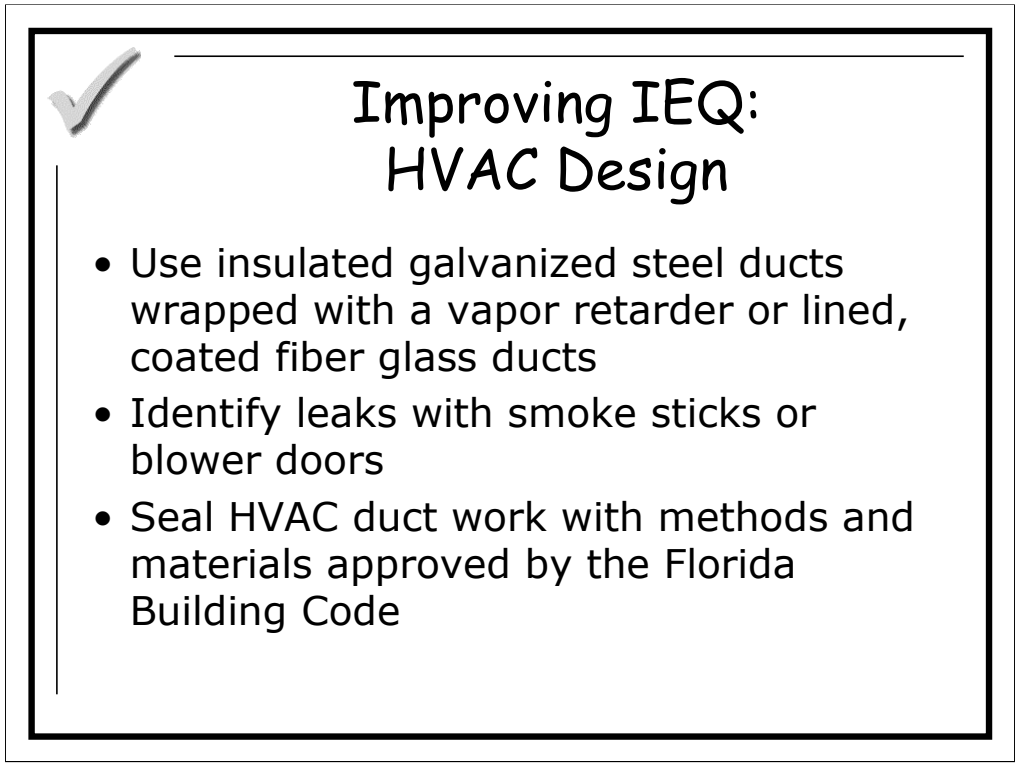

The HVAC system must be the right size for the expected sensible and latent load. The HVAC system must have the proper sensible heat ratio (SHR). The SHR should generally be based on the building's latent load requirements. This will vary according to the building's design energy load. A SHR of 0.7 means the AC will dedicate 70% of its total effort to cooling air and 30% to removing moisture. Some high efficiency AC systems have SHRs too high to remove moisture in Florida buildings properly.



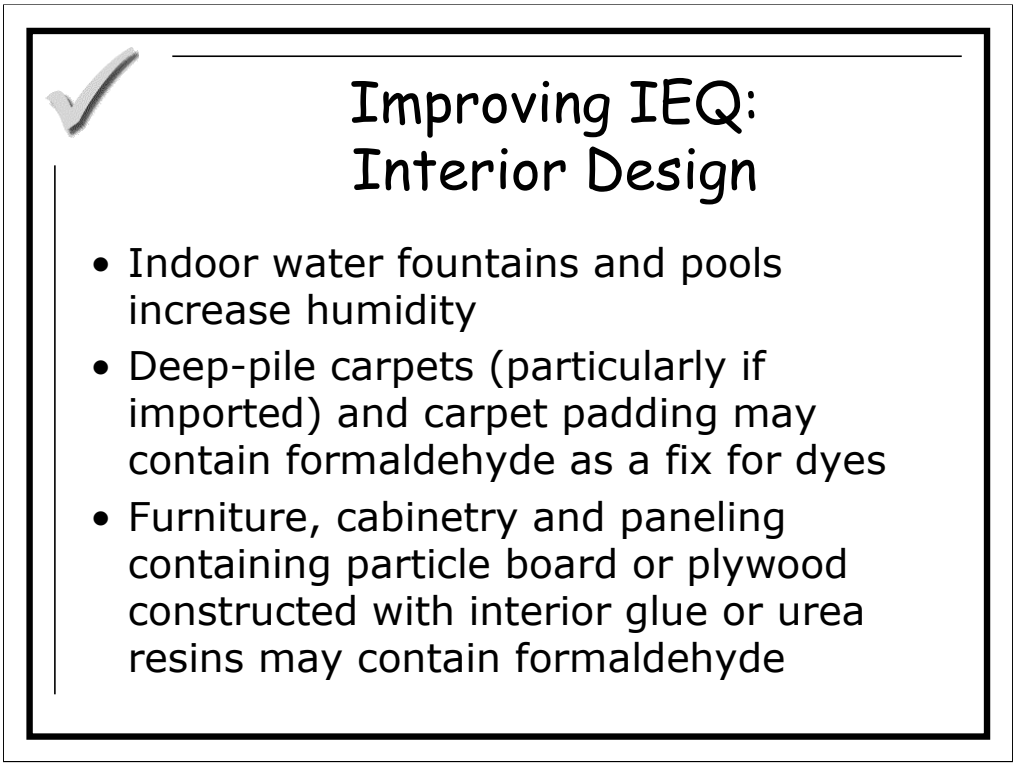

- Combustion appliances, including fireplaces and water heaters, must be properly vented. A dedicated air supply is preferable.
- Bathroom exhaust fans should have humidity sensors or 20-minute timers to remove moisture from tub and shower areas efficiently.



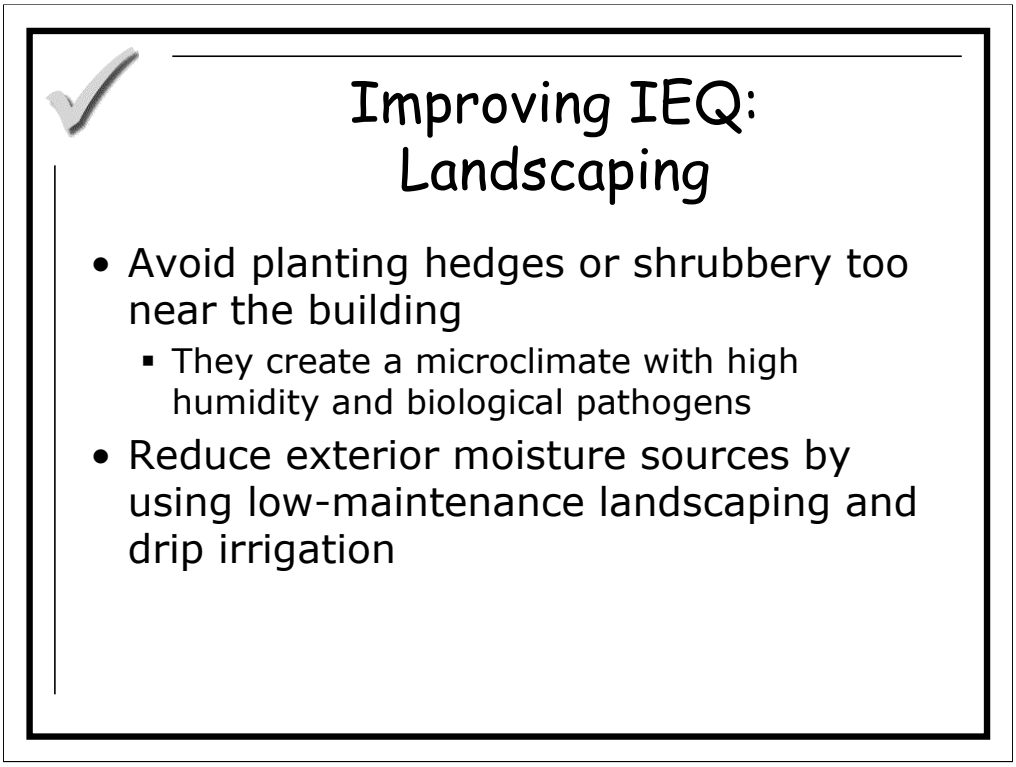

- A balanced return air system can help prevent the buildup of negative pressure in bedrooms.
- In homes, louvered doors, open shelving, and/or AC registers can provide air circulation in closets.



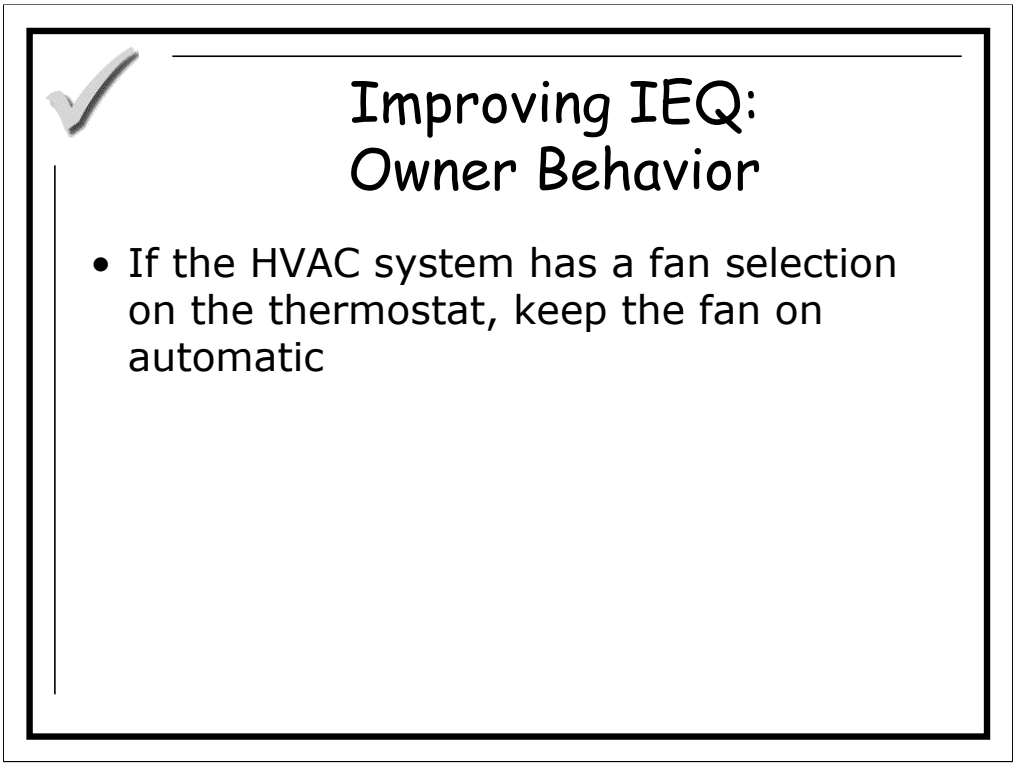

- Use insulated galvanized steel ducts wrapped with a vapor retarder or lined, coated fiber glass ducts.
- Use blower doors and smoke sticks to identify leaks. Seal HVAC duct work with methods and materials approved by the Florida Building Code.



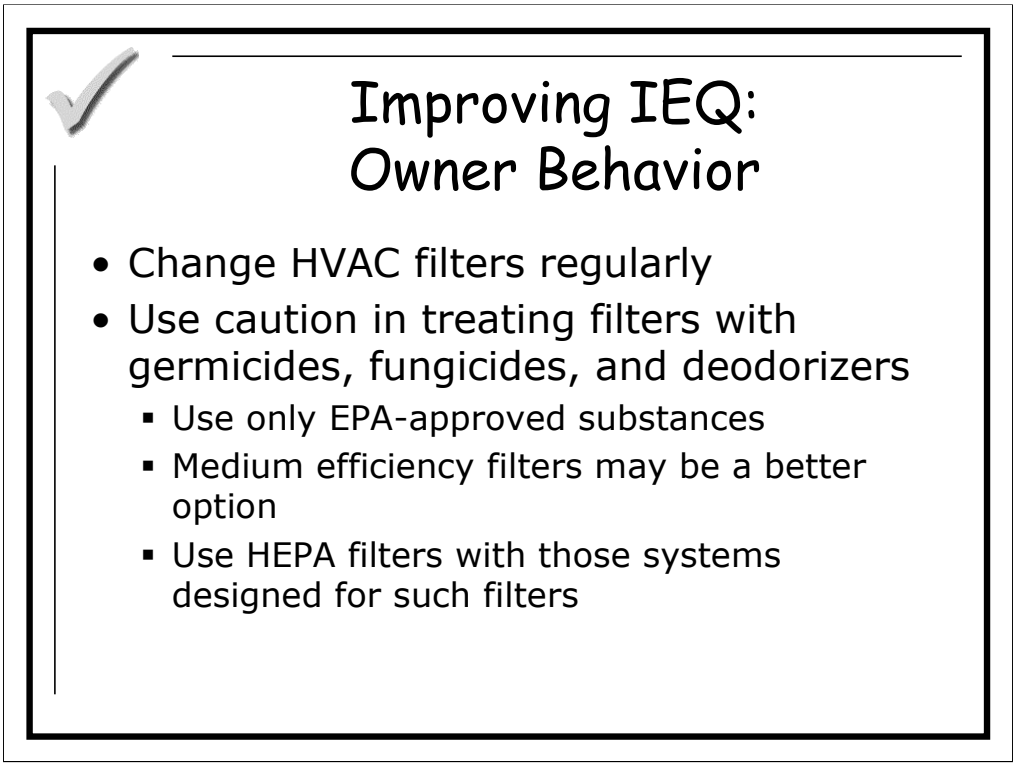

- Indoor water fountains and pools increase humidity.
- Deep-pile carpets (particularly if imported) and carpet padding may contain formaldehyde as a fix for dyes.
- Furniture, cabinetry and paneling containing particle board or plywood constructed with interior glue or urea resins may contain formaldehyde.



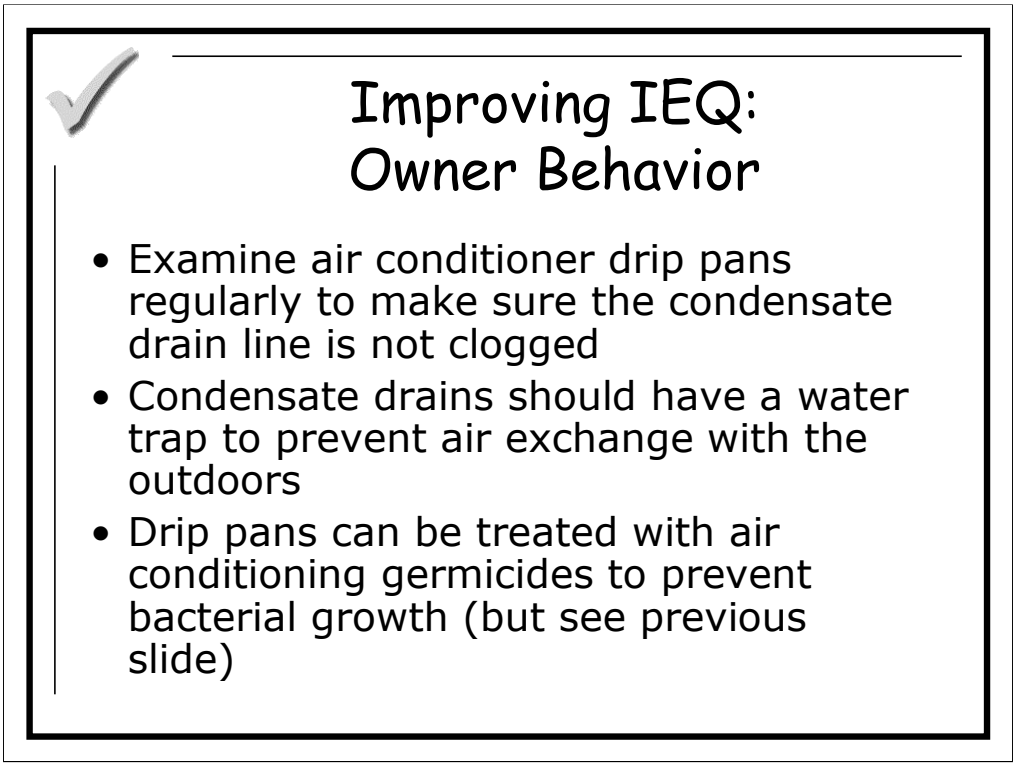

- Avoid planting hedges or shrubbery too near the building because they will create a microclimate with high humidity and biological pathogens.
- Low maintenance landscaping and drip irrigation help reduce exterior sources of moisture.



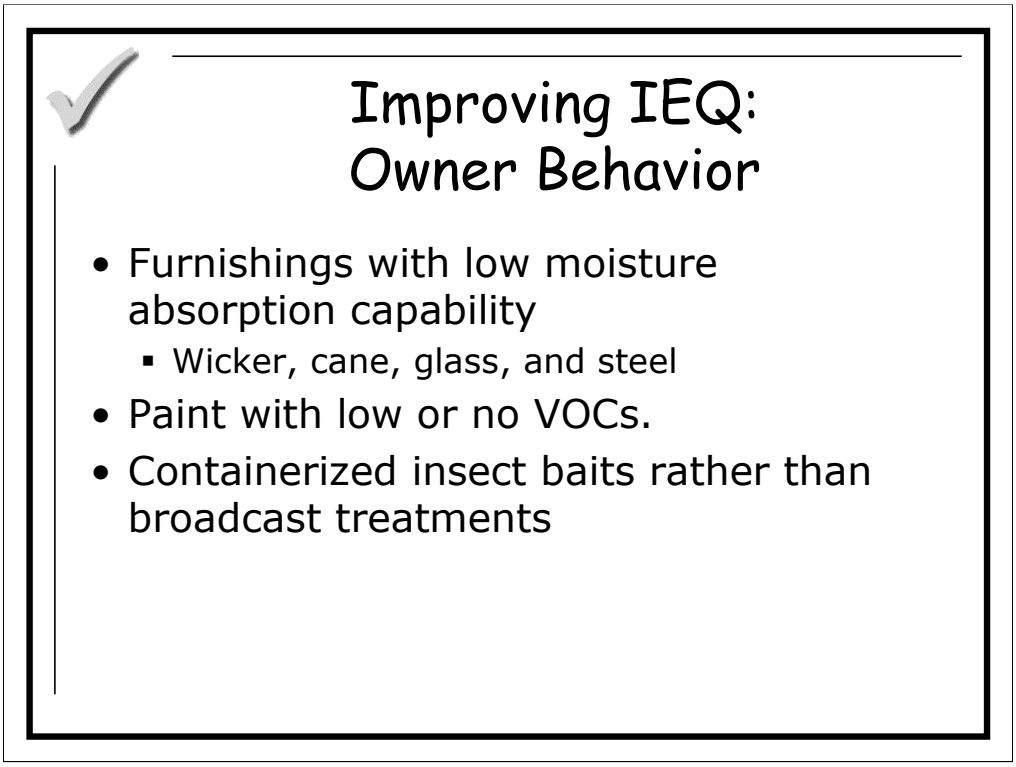

- With HVAC systems that have a fan selection on the thermostat, occupants should keep the fan on automatic.




Owners must change HVAC filters regularly. Use caution in treating filters with germicides, fungicides, and deodorizers; use only EPA-approved substances. Medium efficiency filters may be a better option. Use high efficiency particulate air (HEPA) filters with those systems designed for such filters.




- Examine air conditioner drip pans regularly to make sure the condensate drain line is not clogged.
- Condensate drains should have a water trap to prevent air exchange with the outdoors.
- Drip pans can be treated with air conditioning germicides (use only EPA-approved germicides) to prevent bacterial growth.




- Furnishings that have low moisture absorption capability, such as wicker, cane, glass, and steel, are the best choice in Florida.
- Tell owners to use paint with low or no VOCs.
- Once the home is constructed, containerized insect baits are a better choice than broadcast treatments.

## Summary

- As you've seen in this module, improperly designed, constructed and/or maintained homes can result in many problems for both you and the homeowner.
- It's worth making the effort to ensure your work has not caused or contributed to these problems.

In summary…the US Census Bureau reported in 2003 that there are over 119 million housing units in the United States and nearly 4.7 million commercial buildings. Nearly all of these structures experience leaks, flooding, or other forms of excessive indoor dampness at some time. Excessive indoor moisture and humidity are not *in themselves* a cause of ill health, but as you've seen, their presence provides a favorable environment for many structural and potential health problems.

The National Academies (an umbrella organization for the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council) state in a report dated May 25, 2004,

> Scientific evidence links mold and other factors related to damp conditions in homes and buildings to asthma symptoms in some people with the chronic disorder, as well as to coughing, wheezing, and upper respiratory tract symptoms *in otherwise healthy people* [emphasis added]…Given the frequent occurrence of moisture problems in buildings and their links to respiratory problems, excessive indoor dampness should be addressed through a broad range of public health initiatives and changes in how buildings are designed, constructed, and maintained.

If you have specific questions about indoor environmental quality, your local contact within the Florida Department of Health may be able to lend assistance. Local contacts are listed on the Florida Department of Health web site
http://www.doh.state.fl.us/environment/facility/iaq/iaqctlst.htm

# Post-test

**Course Title: Indoor Environmental Quality Overview**

**Course #:** _____

**Date:** _____ **Location:** _____

1. Formaldehyde emissions and concentration levels are increased by
   a. high humidity
   b. low humidity
   c. the presence of oxygen
   d. the presence of carbon monoxide

2. Backdrafting occurs when:
   a. there is positive pressure in the area where the combustion device is operating
   b. there is negative pressure in the area where the combustion device is operating
   c. the air pressure inside is greater than the air pressure outside
   d. a combustion device is turned off

3. Building-related bacteria usually are associated with the presence of:
   a. high humidity
   b. high temperature
   c. moldy building materials
   d. stagnant water

4. Which of the following building materials may contain VOCs?
   a. carpets
   b. cabinets
   c. paints and sealers
   d. all of the above
   e. a and c only

5. True or false? Lead and asbestos were commonly used in building until the late 1980s and should be removed as soon as detected.
   a. true
   b. false

6. Five major indoor triggers of asthma are:
   a. secondhand smoke, mold, formaldehyde, lead, and pests
   b. dust mites, formaldehyde, pests, mold, and secondhand smoke
   c. dust mites, lead, pet dander, mold, and secondhand smoke
   d. dust mites, pet dander, pests, mold, and secondhand smoke

7. True or false? In most homes, particle board and medium density fiberboard (MDF) are by far the major sources of formaldehyde in the indoor environment.
   a. true
   b. false

8. True or false? Elevated indoor concentrations of radon can be found in every state.
   a. true
   b. false

9. True or false? Building-related illnesses can be fatal.
   a. true
   b. false

10. The optimum zone of relative humidity, where the presence of many pollutants is minimized, is:
    a. 50% to 70%
    b. 40% to 60%
    c. 35% to 70%
    d. 35% to 55%

# Course Evaluation

**Course Title: Indoor Environmental Quality Overview**

**Course #:** _____

**Date:** _____ **Location:** _____

| **Please circle your response:** | **Strongly Disagree** ⟷ | | | | **Strongly Agree** |
|---|---|---|---|---|---|
| Question 1:<br>The course objectives were accomplished. | 1 | 2 | 3 | 4 | 5 |
| Question 2:<br>The course started and finished on time. | 1 | 2 | 3 | 4 | 5 |
| Question 3:<br>The instructor(s) was well-versed in their topic and well-prepared. | 1 | 2 | 3 | 4 | 5 |
| Question 4:<br>The materials presented were effective. | 1 | 2 | 3 | 4 | 5 |
| What did you like most about the course? | | | | | |
| What did you like least about the course? | | | | | |
| Please list other comments about this course, including ways to improve the course or suggestions for other courses. | | | | | |