

CIVE 3331 Environmental Engineering

CIVE 3331 - ENVIRONMENTAL ENGINEERING
Spring 2003

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Significance of Indoor Air Quality

Despite regulatory and “public perception” emphasis on outdoor air quality, indoor air quality is at least as important, if not more important. Typical working model of how pollutants affect receptors is:

Transport
Source -----> Receptor

Since receptors spend over ½ their time indoors, indoor air quality is critical. The outdoor air quality represents the background quality (if air indoors is refreshed rapidly, it should approach the quality of outdoor air).

“Indoor air levels of many pollutants may be 2-5 times, and occasionally, more than 100 times higher than outdoor levels. Indoor air pollutants are of particular concern because most people spend as much as 90% of their time indoors. Common sources can include burning kerosene, wood or oil, smoking tobacco products, releases from household cleaners, pesticides, building materials, and radon.

(USEPA <http://www.epa.gov/air/concerns/#indoor>)”

An Introduction to Indoor Air Quality

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Frequent Questions

Indoor Air Quality

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What Causes Indoor Air Problems?

Indoor pollution sources that release gases or particles into the air are the primary cause of indoor air quality problems in homes. Inadequate ventilation can increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the home. High temperature and humidity levels can also increase concentrations of some pollutants.

Pollutant Sources

There are many sources of indoor air pollution in any home. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products; building materials and furnishings as diverse as deteriorated, asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance, personal care, or hobbies; central heating and cooling systems and humidification devices; and outdoor sources such as radon, pesticides, and outdoor air pollution.

The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors such as how old the source is and whether it is properly maintained are significant. For example, an improperly adjusted gas stove can emit significantly more carbon monoxide than one that is properly adjusted.

Some sources, such as building materials, furnishings, and household products like air fresheners, release pollutants more or less continuously. Other sources, related to activities carried out in the home, release pollutants intermittently. These include smoking, the use of unvented or malfunctioning stoves, furnaces, or space heaters, the use of solvents in cleaning and hobby activities, the use of paint strippers in redecorating activities, and the use of cleaning products and pesticides in housekeeping. High pollutant concentrations can

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remain in the air for long periods after some of these activities.

Amount of Ventilation

If too little outdoor air enters a home, pollutants can accumulate to levels that can pose health and comfort problems. Unless they are built with special mechanical means of ventilation, homes that are designed and constructed to minimize the amount of outdoor air that can "leak" into and out of the home may have higher pollutant levels than other homes. However, because some weather conditions can drastically reduce the amount of outdoor air that enters a home, pollutants can build up even in homes that are normally considered "leaky."

Symptoms of diseases, including **asthma**, hypersensitivity pneumonitis, **humidifier fever**, also show up after exposure to some indoor pollutant

How Does Outdoor Air Enter a House?

Outdoor air enters and leaves a house by: infiltration, natural ventilation, and mechanical ventilation. In a process known as infiltration, outdoor air flows into the house through openings, joints, and cracks in walls, floors, and ceilings, and around windows and doors. In natural ventilation, air moves through opened windows and doors. Air movement associated with infiltration and natural ventilation is caused by air temperature differences between indoors and outdoors and by wind. Finally, there are a number of mechanical ventilation devices, from outdoor-vented fans that intermittently remove air from a single room, such as bathrooms and kitchen, to air handling systems that use fans and duct work to continuously remove indoor air and distribute filtered and conditioned outdoor air to strategic points throughout the house. The rate at which outdoor air replaces indoor air is described as the air exchange rate. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low and pollutant levels can increase.

What If You Live in an Apartment?

Apartments can have the same indoor air problems as single-family homes because many of the pollution sources, such as the interior building materials, furnishings, and household products, are similar. Indoor air problems similar to those in offices are caused by such sources as contaminated ventilation systems, improperly placed outdoor air intakes, or maintenance activities.

Solutions to air quality problems in apartments, as in homes and offices, involve such actions as: eliminating or controlling the sources of pollution, increasing ventilation, and installing air cleaning devices. Often a resident can take the appropriate action to improve the indoor air quality by removing a source, altering an activity, unblocking an air supply vent, or opening a window to temporarily increase the ventilation; in other cases, however, only the building owner or manager is in a

position to remedy the problem. (See "[The Inside Story: A Guide to Indoor Air Quality](#)"). You can encourage building management to follow guidance in EPA and NIOSH's "Building Air Quality: A Guide for Building Owners and Facility Managers" (<http://www.epa.gov/iaq/largebldgs/index.html>).

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Indoor Pollutant Sources

Indoor pollutants usually arise from building materials, and how the HVAC system is designed and operated. Energy cost savings often defeats well-designed systems because of reduced outside air mixing. Indoor pollution has made people ill and has killed people.

There are many sources of indoor air pollution. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products; building materials and furnishings as diverse as deteriorated, asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance, personal care, or hobbies; central heating and cooling systems and humidification devices; and outdoor sources such as radon, pesticides, and outdoor air pollution.

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Sick-building syndrome – allergy like symptoms from occupancy of particular buildings. Various suspected causes: mold in walls and HVAC system. CO build-up. Off-gas from construction materials. Etc.

Selected Indoor Pollutants

Asbestos and other fibers
Biological pollutants (mold etc.)
Carbon Monoxide
Formaldehyde
VOC
Lead
Nitrogen Dioxide
Pesticides
Radon
Particulates
Environmental Tobacco Smoke (ETS).



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Sources of Indoor Air Pollution - Asbestos

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Call EPA's **TSCA Assistance Line at (202) 554-1404** to find out whether your state has a training and certification program for asbestos removal contractors and for information on EPA's Asbestos programs or visit the [Office of Pollution Prevention and Toxic Substances Asbestos Home Page](#)

Asbestos is a mineral fiber that has been used commonly in a variety of building construction materials for insulation and as a fire-retardant. EPA and CPSC have banned several asbestos products. Manufacturers have also voluntarily limited uses of asbestos. Today, asbestos is most commonly found in older homes, in pipe and furnace insulation materials, asbestos shingles, millboard, textured paints and other coating materials, and floor tiles.

Elevated concentrations of airborne asbestos can occur after asbestos-containing materials are disturbed by cutting, sanding or other remodeling activities. Improper attempts to remove these materials can release asbestos fibers into the air in homes, increasing asbestos levels and endangering people living in those homes.

Sources of Asbestos

Deteriorating, damaged, or disturbed insulation, fireproofing, acoustical materials, and floor tiles.

Health Effects

No immediate symptoms, but long-term risk of chest and abdominal cancers and lung diseases. Smokers are at higher risk of developing asbestos-induced lung cancer. [Integrated Risk Information System description on Asbestos](#) (Chemical Abstract Service Registry Number - 1332-21-4).

The most dangerous asbestos fibers are too small to be visible. After they are inhaled, they can remain and accumulate in

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to some indoor air pollutants.

the lungs. Asbestos can cause lung cancer, mesothelioma (a cancer of the chest and abdominal linings), and asbestosis (irreversible lung scarring that can be fatal). Symptoms of these diseases do not show up until many years after exposure began. Most people with asbestos-related diseases were exposed to elevated concentrations on the job; some developed disease from exposure to clothing and equipment brought home from job sites.

Levels in Homes

Elevated levels can occur in homes where asbestos-containing materials are damaged or disturbed.

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Steps to Reduce Exposure

- It is best to leave undamaged asbestos material alone if it is not likely to be disturbed.
- Use trained and qualified contractors for control measures that may disturb asbestos and for cleanup.
- Follow proper procedures in replacing wood stove door gaskets that may contain asbestos.

If you think your home may have asbestos, don't panic!

Usually it is best to leave asbestos material that is in good condition alone. Generally, material in good condition will not release asbestos fiber. There is no danger unless fibers are released and inhaled into the lungs.

Do not cut, rip, or sand asbestos-containing materials.

Leave undamaged materials alone and, to the extent possible, prevent them from being damaged, disturbed, or touched. Periodically inspect for damage or deterioration. Discard damaged or worn asbestos gloves, stove-top pads, or ironing board covers. Check with local health, environmental, or other appropriate officials to find out about proper handling and disposal procedures. If asbestos material is more than slightly damaged, or if you are going to make changes in your home that might disturb it, repair or removal by a professional is needed. Before you have your house remodeled, find out whether asbestos materials are present.

When you need to remove or clean up asbestos, use a professionally trained contractor.

Select a contractor only after careful discussion of the problems in your home and the steps the contractor will take to clean up or remove them. Consider the option of sealing off the materials instead of removing them.

Call EPA's **TSCA Assistance Line at (202) 554-1404** to find out whether your state has a training and certification program for asbestos removal contractors and for information on EPA's Asbestos programs or visit the [Office of Pollution Prevention and Toxic Substances Asbestos Home Page](#)

Toxic Substances Control Act (TSCA) Hotline -

Sponsored by the Office of Pollution Prevention and Toxics, the TSCA Hotline provides technical assistance and information about asbestos programs implemented under TSCA, which include; the Asbestos School Hazard Abatement Act (ASHAA), the Asbestos Hazard Emergency Response Act (AHERA), and the Asbestos School Hazard Abatement Reauthorization Act (ASHARA). The Hotline provides copies of TSCA information, such as Federal Register notices and support documents, to requesters through its Clearinghouse function.

E-mail address: tsc hotline@epa.gov

Hours of Service: 8:30 a.m. - 5:00 p.m. (EST) M - F

Telephone: (202) 554-1404

TDD: 202-554-0551

Fax: 202-554-5603 (Fax available 24 hours a day)

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Subject-Specific Publications

[Asbestos in Your Home](#), Sept. 1990 (400-K-90-100)

This brochure, authored by EPA's [Office of Pollution Prevention and Toxic Substances' Asbestos Program](#), discusses health effects of asbestos exposure, identifies common products and building materials from the past that might contain asbestos, and describes conditions that may cause release of asbestos fibers. Describes how to identify materials that contain asbestos and how to control an asbestos problem. Explains the role of asbestos professionals and use of asbestos inspectors and removal contractors. This brochure was prepared by the American Lung Association, the U.S. Consumer Product Safety Commission and the U.S. Environmental Protection Agency).

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Last updated on Monday, February 10th, 2003
URL: <http://www.epa.gov/iaq/asbestos.html>



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Sources of Indoor Air Pollution - Biological Pollutants

Biological contaminants include bacteria, [molds](#), [mildew](#), viruses, [animal dander and cat saliva](#), [house dust](#), [mites](#), [cockroaches](#), and pollen. There are many sources of these pollutants. Pollens originate from plants; viruses are transmitted by people and animals; bacteria are carried by people, animals, and soil and plant debris; and household pets are sources of saliva and animal dander. The protein in urine from rats and mice is a potent allergen. When it dries, it can become airborne. Contaminated central air handling systems can become breeding grounds for mold, mildew, and other sources of biological contaminants and can then distribute these contaminants through the home.

By controlling the relative humidity level in a home, the growth of some sources of biologicals can be minimized. A relative humidity of 30-50 percent is generally recommended for homes. Standing water, water-damaged materials, or wet surfaces also serve as a breeding ground for molds, mildews, bacteria, and insects. House dust mites, the source of one of the most powerful biological allergens, grow in damp, warm environments.

Health Effects From Biological Contaminants

Some biological contaminants trigger allergic reactions, including hypersensitivity pneumonitis, allergic rhinitis, and some types of [asthma](#). Infectious illnesses, such as influenza, measles, and chicken pox are transmitted through the air. Molds and mildews release disease-causing toxins. Symptoms of health problems caused by biological pollutants include sneezing, watery eyes, coughing, shortness of breath, dizziness, lethargy, fever, and digestive problems.

Allergic reactions occur only after repeated exposure to a specific biological allergen. However, that reaction may occur immediately upon re-exposure or after multiple exposures over time. As a result, people who have noticed only mild allergic

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to some indoor air

reactions, or no reactions at all, may suddenly find themselves very sensitive to particular allergens.

pollutants.

Some diseases, like humidifier fever, are associated with exposure to toxins from microorganisms that can grow in large building ventilation systems. However, these diseases can also be traced to microorganisms that grow in home heating and cooling systems and humidifiers. Children, elderly people, and people with breathing problems, allergies, and lung diseases are particularly susceptible to disease-causing biological agents in the indoor air.

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Reducing Exposure to Biological Contaminants

- ***Install and use exhaust fans that are vented to the outdoors in kitchens and bathrooms and vent clothes dryers outdoors.***

These actions can eliminate much of the moisture that builds up from everyday activities. There are exhaust fans on the market that produce little noise, an important consideration for some people. Another benefit to using kitchen and bathroom exhaust fans is that they can reduce levels of organic pollutants that vaporize from hot water used in showers and dishwashers.

- ***Ventilate the attic and crawl spaces to prevent moisture build-up.***

Keeping humidity levels in these areas below 50 percent can prevent water condensation on building materials.

- ***If using cool mist or ultrasonic humidifiers, clean appliances according to manufacturer's instructions and refill with fresh water daily.***

Because these humidifiers can become breeding grounds for biological contaminants, they have the potential for causing diseases such as hypersensitivity pneumonitis and humidifier fever. Evaporation trays in air conditioners, dehumidifiers, and refrigerators should also be cleaned frequently.

- ***Thoroughly clean and dry water-damaged carpets and building materials (within 24 hours if possible) or consider removal and replacement.***

Water-damaged carpets and building materials can harbor mold and bacteria. It is very difficult to completely rid such materials of biological contaminants.

- ***Keep the house clean. House dust mites, pollens, animal dander, and other allergy-causing agents can be reduced, although not***

eliminated, through regular cleaning.

People who are allergic to these pollutants should use allergen-proof mattress encasements, wash bedding in hot (130°F) water, and avoid room furnishings that accumulate dust, especially if they cannot be washed in hot water. Allergic individuals should also leave the house while it is being vacuumed because vacuuming can actually increase airborne levels of mite allergens and other biological contaminants. Using central vacuum systems that are vented to the outdoors or vacuums with high efficiency filters may also be of help.

- ***Take steps to minimize biological pollutants in basements.***

Clean and disinfect the basement floor drain regularly. Do not finish a basement below ground level unless all water leaks are patched and outdoor ventilation and adequate heat to prevent condensation are provided. Operate a dehumidifier in the basement if needed to keep relative humidity levels between 30 - 50 percent.

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Subject-Specific Resources/Publications

[Indoor Environment's Asthma Web Site](#)

[Biological Pollutants in Your Home](#), January 1990 (402-F-90-102)

Explains indoor biological pollution, health effects of biological pollutants, and how to control their growth and buildup. One third of all structures have damp conditions that may encourage development of pollutants such as mold and bacteria, which can cause allergic reactions - including [asthma](#) - and spread infectious diseases. Describes corrective measures for achieving moisture control and cleanliness. This brochure was prepared by the American Lung Association and the U.S. Consumer Product Safety Commission.

Indoor Allergens: Assessing and Controlling Adverse Health Effects, Andrew M. Pope, Roy Patterson, and Harriet Burge, editors; Committee on the Health Effects of Indoor Allergens, Division of Health Promotion and Disease Prevention, Institute of Medicine. National Academy Press, 1993. 308 pages. ISBN 0-309-04831-1.

This project was supported by funds from the Environmental Protection Agency, National Institute of Environmental Health Sciences, National Institute of Allergy and Infectious Diseases, National Heart, Lung, and Blood Institute, and Agency for Toxic Substances and Disease Registry. Copies of this book are available from the National Academy Press, 2101 Constitution Ave., N.W., Box 285, Washington, DC 20055. Call 1-800-624-6242 or 202-334-3313 (in the Washington DC

metro area).

Indoor Air Fact Sheet No. 8 - [Use and Care of Home Humidifiers](#),
February 1991 (402-F-91-101)

Explains that some types of home humidifiers can disperse microorganisms from their water tanks into the indoor air. Describes the different types of humidifiers and provides recommendations for their use and maintenance.

Fact Sheet - [Flood Cleanup: Avoiding Indoor Air Quality Problems](#), August 1993 (402-F-93-005)

Discusses steps to take when cleaning and repairing a home after flooding. Excess moisture in the home is cause for concern about indoor air quality primarily because it provides breeding conditions for microorganisms. This fact sheet provides tips to avoid creating indoor air quality problems during cleanup.

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Sources of Indoor Air Pollution - Carbon Monoxide

Definition (from *The Condensed Chemical Dictionary*):

Colorless gas or liquid; practically odorless. Burns with a violet flame. Slightly soluble in water; soluble in alcohol and benzene. Specific gravity 0.96716; boiling point -190°C; solidification point -207°C; specific volume 13.8 cu. ft./lb. (70°F). Autoignition temperature (liquid) 1128°F. Classified as an inorganic compound.

Sources of Carbon Monoxide

Unvented kerosene and gas space heaters; leaking chimneys and furnaces; back-drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves. Automobile exhaust from attached garages. Environmental tobacco smoke.

Health Effects Associated with Carbon Monoxide

At low concentrations, fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, impaired vision and coordination; headaches; dizziness; confusion; nausea. Can cause flu-like symptoms that clear up after leaving home. Fatal at very high concentrations.

Levels in Homes

Average levels in homes without gas stoves vary from 0.5 to 5 parts per million (ppm). Levels near properly adjusted gas stoves are often 5 to 15 ppm and those near poorly adjusted stoves may be 30 ppm or higher.

Steps to Reduce Exposure to Carbon Monoxide

- Keep gas appliances properly adjusted.
- Consider purchasing a vented space heater when replacing an unvented one.
- Use proper fuel in kerosene space heaters.
- Install and use an exhaust fan vented to outdoors over gas stoves.
- Open flues when fireplaces are in use.
- Choose properly sized wood stoves that are certified to meet EPA emission standards. Make certain that doors on all wood stoves fit tightly.
- Have a trained professional inspect, clean, and tune-up central heating system (furnaces, flues, and chimneys) annually. Repair any leaks promptly.
- Do not idle the car inside garage.

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EPA's Office of Air and Radiation page - ["CO - How Carbon Monoxide Affects the Way We Live and Breathe"](#)

National Center for Environmental Health

Air and Respiratory Health Branch

Centers for Disease Control and Prevention

[Checklist for Prevention of Carbon Monoxide Poisoning](#)

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U.S. Consumer Product Safety Commission,

Office of Information and Public Affairs,

Washington, D.C. 20207

[Carbon Monoxide Questions and Answers](#) (CPSC document #466)

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American Lung Association Fact Sheet on Carbon Monoxide

http://www.lungusa.org/air/carbon_factsheet99.html [EXIT disclaimer](#)

Occupational Safety and Health Administration's Fact Sheet on Carbon Monoxide (a pdf file) -

http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf [EXIT disclaimer](#)

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[Protect Your Family and Yourself from Carbon Monoxide Poisoning](#), October 1996

Discusses health hazards associated with exposure to carbon monoxide (CO), a colorless gas which can cause headaches, dizziness, nausea, faintness, and, at high levels, death. Provides guidance on what to do if you think you are suffering from CO poisoning, what to do to prevent exposure to CO. Also included is a brief discussion about carbon monoxide detectors.

[Proteja su vida y la de su familia evitando el envenenamiento con monóxido de carbono](#) (ref. # 402-F-97-004)

This fact sheet has also been translated into **Vietnamese (ref. # 402-F-96-005C)**, **(ref. # 402-F-96-005A)**, and **Korean (ref. # 402-F-96-005B)**. To get copies of any of these, contact IAQINFO at 1-800-438-4318.

[The "Senseless" Killer](#), 1993

Prepared by the U.S. Consumer Product Safety Commission, this leaflet describes the symptoms of carbon monoxide poisoning, sources of carbon monoxide in the home, and actions to reduce the risk of carbon monoxide poisoning.

[What You Should Know About Combustion Appliances and Indoor Air Pollution](#), 1991

This brochure was prepared by the U.S. Consumer Product Safety Commission, the

Lung Association, and the EPA and answers commonly-asked questions about the combustion appliances (e.g., fuel-burning furnaces, space heaters, kitchen ranges fireplaces) on indoor air quality and human health. It describes other sources of CO pollutants in and around the home and it suggests ways to reduce exposure to such and encourages proper installation, use, and maintenance of combustion appliances.

[ALERT!! Preventing Carbon Monoxide Poisoning from Small Gasoline-Powered Engines \(1996\)](#)

This joint alert from NIOSH, CDPHE, CPSC, OSHA and EPA warns that people use gasoline-powered tools such as high-pressure washers, concrete cutting saws (walk-behind/hand-held), power trowels, floor buffers, welders, pumps, compressors, and generators in buildings or semi-enclosed spaces have been poisoned by Carbon Monoxide. Recommendations for preventing CO poisoning are provided for employers, equipment tool rental agencies, and tool manufacturers.

Single copies of the Alert [DHHS (NIOSH) Publication No. 96-118] are available for **Publication Dissemination, IED, National Institute for Occupational Safety and Health**, 4676 Columbia Parkway, Cincinnati, OH 45226
fax number: (513) 533-8573, phone number: 1-800-35-NIOSH (1-800-356-4674)
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Sources of Indoor Air Pollution - Formaldehyde

For further information on formaldehyde and consumer products, call the EPA Toxic Substance Control Act (TSCA) **Assistance Line** (202) 554-1404.

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Introduction

Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products. It is also a by-product of combustion and certain other natural processes. Thus, it may be present in substantial concentrations both indoors and outdoors.

Sources of formaldehyde in the home include building materials, smoking, household products, and the use of un-vented, fuel-burning appliances, like gas stoves or kerosene space heaters. Formaldehyde, by itself or in combination with other chemicals, serves a number of purposes in manufactured products. For example, it is used to add permanent-press qualities to clothing and draperies, as a component of glues and adhesives, and as a preservative in some paints and coating products.

In homes, the most significant sources of formaldehyde are likely to be pressed wood products made using adhesives that contain urea-formaldehyde (UF) resins. Pressed wood products made for indoor use include: particleboard (used as sub-flooring and shelving and in cabinetry and furniture); hardwood plywood paneling (used for decorative wall covering and used in cabinets and furniture); and medium density fiberboard (used for drawer fronts, cabinets, and furniture tops). Medium density fiberboard contains a higher resin-to-wood ratio than any other UF pressed wood product and is generally recognized as being the highest formaldehyde-

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to some indoor air

emitting pressed wood product.

pollutants.

Other pressed wood products, such as softwood plywood and flake or oriented strandboard, are produced for exterior construction use and contain the dark, or red/black-colored phenol-formaldehyde (PF) resin. Although formaldehyde is present in both types of resins, pressed woods that contain PF resin generally emit formaldehyde at considerably lower rates than those containing UF resin.

Since 1985, the Department of Housing and Urban Development (HUD) has permitted only the use of plywood and particleboard that conform to specified formaldehyde emission limits in the construction of prefabricated and mobile homes. In the past, some of these homes had elevated levels of formaldehyde because of the large amount of high-emitting pressed wood products used in their construction and because of their relatively small interior space.

The rate at which products like pressed wood or textiles release formaldehyde can change. Formaldehyde emissions will generally decrease as products age. When the products are new, high indoor temperatures or humidity can cause increased release of formaldehyde from these products.

During the 1970s, many homeowners had urea-formaldehyde foam insulation (UFFI) installed in the wall cavities of their homes as an energy conservation measure. However, many of these homes were found to have relatively high indoor concentrations of formaldehyde soon after the UFFI installation. Few homes are now being insulated with this product. Studies show that formaldehyde emissions from UFFI decline with time; therefore, homes in which UFFI was installed many years ago are unlikely to have high levels of formaldehyde now.

Sources of Formaldehyde

Pressed wood products (hardwood plywood wall paneling, particleboard, fiberboard) and furniture made with these pressed wood products. Urea-formaldehyde foam insulation (UFFI). Combustion sources and environmental tobacco smoke. Durable press drapes, other textiles, and glues.

Health Effects

Formaldehyde, a colorless, pungent-smelling gas, can cause watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans exposed at elevated levels (above

0.1 parts per million). High concentrations may trigger attacks in people with asthma. There is evidence that some people can develop a sensitivity to formaldehyde. It has also been shown to cause cancer in animals and may cause cancer in humans. Health effects include eye, nose, and throat irritation; wheezing and coughing; fatigue; skin rash; severe allergic reactions. May cause cancer. May also cause other effects listed under "organic gases." EPA's Integrated Risk Information System profile - <http://www.epa.gov/iris/subst/0419.htm>

Levels in Homes

Average concentrations in older homes without UFFI are generally well below 0.1 (ppm). In homes with significant amounts of new pressed wood products, levels can be greater than 0.3 ppm.

Steps to Reduce Exposure

- Use "exterior-grade" pressed wood products (lower-emitting because they contain phenol resins, not urea resins).
- Use air conditioning and dehumidifiers to maintain moderate temperature and reduce humidity levels.
- Increase ventilation, particularly after bringing new sources of formaldehyde into the home.

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Reducing Exposure to Formaldehyde in Homes

Ask about the formaldehyde content of pressed wood products, including building materials, cabinetry, and furniture before you purchase them.

If you experience adverse reactions to formaldehyde, you may want to avoid the use of pressed wood products and other formaldehyde-emitting goods. Even if you do not experience such reactions, you may wish to reduce your exposure as much as possible by purchasing exterior-grade products, which emit less formaldehyde. For further information on formaldehyde and consumer products, call the EPA Toxic Substance Control Act (TSCA) assistance line (202-554-1404).

Some studies suggest that coating pressed wood products with polyurethane may reduce formaldehyde emissions for some period of time. To be effective, any such coating must cover all surfaces and edges and remain intact. Increase the ventilation and carefully follow the manufacturer instructions while applying these coatings. (If you are sensitive to formaldehyde,

check the label contents before purchasing coating products to avoid buying products that contain formaldehyde, as they will emit the chemical for a short time after application.)

Maintain moderate temperature and humidity levels and provide adequate ventilation.

The rate at which formaldehyde is released is accelerated by heat and may also depend somewhat on the humidity level. Therefore, the use of dehumidifiers and air conditioning to control humidity and to maintain a moderate temperature can help reduce formaldehyde emissions. (Drain and clean dehumidifier collection trays frequently so that they do not become a breeding ground for microorganisms.) Increasing the rate of ventilation in your home will also help in reducing formaldehyde levels.

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[An Update on Formaldehyde](#): 1997 Revision (CPSC document #725). [U.S. Consumer Product Safety Commission](#) [EXIT disclaimer](#)

The U.S. Consumer Safety Commission has produced this booklet to tell you about formaldehyde found in the indoor air. This booklet tells you where you may come in contact with formaldehyde, how it may affect your health, and how you might reduce your exposure to formaldehyde. The PDF version of this document is available here ([formaldehyde_cpsc.pdf \(38 KB file\)](#)).

[Indoor Air Quality Guideline - Formaldehyde in the Home](#) [EXIT disclaimer](#) State of California Air Resource Board, #1, September 1991.

The National Safety Council's Environmental Health Center [fact sheet on Formaldehyde](#) [EXIT disclaimer](#)

[American Lung Association](#) [EXIT disclaimer](#)
1740 Broadway
New York, NY 10019-4374
(local ALA offices also have information)

The Formaldehyde Institute, Inc.
1330 Connecticut Ave., N.W.
Washington, DC 20036

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



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Sources of Indoor Air Pollution - Organic Gases (Volatile Organic Compounds - VOCs)

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[This information originates from the EPA publication, "[The Inside Story - A Guide to Indoor Air Quality](#)."]

Organic chemicals are widely used as ingredients in household products. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored.

EPA's Total Exposure Assessment Methodology (TEAM) studies found levels of about a dozen common organic pollutants to be 2 to 5 times higher inside homes than outside, regardless of whether the homes were located in rural or highly industrial areas. Additional TEAM studies indicate that while people are using products containing organic chemicals, they can expose themselves and others to very high pollutant levels, and elevated concentrations can persist in the air long after the activity is completed.

Sources

Household products including: paints, paint strippers, and other solvents; wood preservatives; aerosol sprays; cleansers and disinfectants; moth repellents and air fresheners; stored fuels and automotive products; hobby supplies; dry-cleaned clothing.

Health Effects

Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon

animals; some are suspected or known to cause cancer in humans.

after exposure to
some indoor air
pollutants.

The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effect. As with other pollutants, the extent and nature of the health effect will depend on many factors including level of exposure and length of time exposed. Eye and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some organics. At present, not much is known about what health effects occur from the levels of organics usually found in homes. Many organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.

Levels in Homes

Studies have found that levels of several organics average 2 to 5 times higher indoors than outdoors. During and for several hours immediately after certain activities, such as paint stripping, levels may be 1,000 times background outdoor levels.

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Steps to Reduce Exposure

- Use household products according to manufacturer's directions.
- Make sure you provide plenty of fresh air when using these products.
- Throw away unused or little-used containers safely; buy in quantities that you will use soon.
- Keep out of reach of children and pets.
- Never mix household care products unless directed on the label.

Follow label instructions carefully.

Potentially hazardous products often have warnings aimed at reducing exposure of the user. For example, if a label says to use the product in a well-ventilated area, go outdoors or in areas equipped with an exhaust fan to use it. Otherwise, open up windows to provide the maximum amount of outdoor air possible.

Throw away partially full containers of old or unneeded chemicals safely.

Because gases can leak even from closed containers,

this single step could help lower concentrations of organic chemicals in your home. (Be sure that materials you decide to keep are stored not only in a well-ventilated area but are also safely out of reach of children.) Do not simply toss these unwanted products in the garbage can. Find out if your local government or any organization in your community sponsors special days for the collection of toxic household wastes. If such days are available, use them to dispose of the unwanted containers safely. If no such collection days are available, think about organizing one.

Buy limited quantities.

If you use products only occasionally or seasonally, such as paints, paint strippers, and kerosene for space heaters or gasoline for lawn mowers, buy only as much as you will use right away.

Keep exposure to emissions from products containing methylene chloride to a minimum.

Consumer products that contain methylene chloride include paint strippers, adhesive removers, and aerosol spray paints. Methylene chloride is known to cause cancer in animals. Also, methylene chloride is converted to carbon monoxide in the body and can cause symptoms associated with exposure to carbon monoxide. Carefully read the labels containing health hazard information and cautions on the proper use of these products. Use products that contain methylene chloride outdoors when possible; use indoors only if the area is well ventilated.

Keep exposure to benzene to a minimum.

Benzene is a known human carcinogen. The main indoor sources of this chemical are environmental tobacco smoke, stored fuels and paint supplies, and automobile emissions in attached garages. Actions that will reduce benzene exposure include eliminating smoking within the home, providing for maximum ventilation during painting, and discarding paint supplies and special fuels that will not be used immediately.

Keep exposure to perchloroethylene emissions from newly dry-cleaned materials to a minimum.

Perchloroethylene is the chemical most widely used in dry cleaning. In laboratory studies, it has been shown to cause cancer in animals. Recent studies indicate that people breathe low levels of this chemical both in homes where dry-cleaned goods are stored and as they wear dry-cleaned clothing. Dry cleaners recapture the perchloroethylene during the dry-cleaning process so they can save money by re-using it, and they remove more of the chemical during the pressing and

finishing processes. Some dry cleaners, however, do not remove as much perchloroethylene as possible all of the time. Taking steps to minimize your exposure to this chemical is prudent. If dry-cleaned goods have a strong chemical odor when you pick them up, do not accept them until they have been properly dried. If goods with a chemical odor are returned to you on subsequent visits, try a different dry cleaner.

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Indoor Air Fact Sheet No. 4 (revised) - [Sick Building Syndrome](#),
April 1991 (402-F-94-004)

Explains the term "sick building syndrome" (SBS) and "building related illness" (BRI). Discusses causes of sick building syndrome, describes building investigation procedures, and provides general solutions for resolving the syndrome.

[Indoor Air Pollution: An Introduction for Health Professionals](#)

Assists health professionals (especially the primary care physician) in diagnosis of patient symptoms that could be related to an indoor air pollution problem. Addresses the health problems that may be caused by contaminants encountered daily in the home and office. Organized according to pollutant or pollutant groups such as environmental tobacco smoke, VOCs, biological pollutants, and sick building syndrome, this booklet lists key signs and symptoms from exposure to these pollutants, provides a diagnostic checklist and quick reference summary, and includes suggestions for remedial action. Also includes references for information contained in each section. This booklet was developed by the American Lung Association, the American Medical Association, the U.S. Consumer Product Safety Commission, and the EPA. EPA Document Reference Number **402-R-94-007**, 1994.

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[EPA's National Lead Information Center Hotline](#)

 1-800-LEAD-FYI
[1-800-532-3394]

You can order materials or speak to an information specialist by contacting The National Lead Information Center (NLIC) at 1-800-424-LEAD (5323). Information available 24 hours a day, seven days a week in English and Spanish. The Hotline provides basic information packet on lead in English and Spanish. The Packet includes the EPA brochure "[Lead Poisoning and Your Children](#)", three fact sheets, and a list of State and local contacts for additional information. Callers with specific questions are referred to the Clearinghouse to speak directly with an information specialist.

 EPA's [Office of Prevention, Pesticides, and Toxic Substances \(OPPTS\) Lead Program](#)

 EPA's [Office of Air and Radiation page on Lead](#)
Department of Housing and Urban Development,
Office of Healthy Homes and Lead Hazard
Control www.hud.gov/offices/lead/
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Lead has long been recognized as a harmful environmental pollutant. In late 1991, the Secretary of the Department of Health and Human Services called lead the "number one environmental threat to the health of children in the United States." There are many ways in which humans are exposed to lead: through air, drinking water, food, contaminated soil, deteriorating paint, and dust. Airborne lead enters the body when an individual breathes or swallows lead particles or dust once it has settled. Before it was known how harmful lead could be, it was used in paint, gasoline, water pipes, and many other products.

Old lead-based paint is the most significant source of lead exposure in the U.S. today. Harmful exposures to lead can be created when lead-based paint is improperly removed from surfaces by dry scraping, sanding, or open-flame burning. High concentrations of airborne lead particles in homes can also result from lead dust from

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to some indoor air pollutants.

outdoor sources, including contaminated soil tracked inside, and use of lead in certain indoor activities such as soldering and stained-glass making.

Definition

[From "The Condensed Chemical Dictionary, 9th ed., Van Nostrand Reinhold Company, New York, 1977.] Metallic element of atomic number 82, Group IVA of the periodic table. Atomic weight 207.2; valences 2, 4; 4 stable isotopes. The isotopes are the end products of the three series of natural radioactive elements uranium (206), thorium (208), and actinium (207).

Properties - Heavy, ductile, soft gray solid. Sp. gr. 11.35; m.p. 327.4°C; b.p. 1755°C; soluble in dilute nitric acid; insoluble in water but dissolves slowly in water containing a weak acid; resists corrosion; relatively impenetrable to radiation. Poor electrical conductor; good sound and vibration absorber. Non-combustible.

Sources of Lead

Lead-based paint, contaminated soil, dust, and drinking water.

Lead Health Effects

Lead affects practically all systems within the body. Lead at high levels (lead levels at or above 80 micrograms per deciliter of blood) can cause convulsions, coma, and even death. Lower levels of lead can cause adverse health effects on the central nervous system, kidney, and blood cells. Blood lead levels as low as 10 micrograms per deciliter can impair mental and physical development. EPA's Integrated Risk Information System profile on Lead and Lead Compounds - epa.gov/iris/subst/0277.htm

The effects of lead exposure on fetuses and young children can be severe. They include delays in physical and mental development, lower IQ levels, shortened attention spans, and increased behavioral problems. Fetuses, infants, and children are more vulnerable to lead exposure than adults since lead is more easily absorbed into growing bodies, and the tissues of small children are more sensitive to the

damaging effects of lead. Children may have higher exposures since they are more likely to get lead dust on their hands and then put their fingers or other lead-contaminated objects into their mouths.

Get your child tested for lead exposure. To find out where to do this, call your doctor or local health clinic. For more information on health effects, get a copy of the Centers for Disease Control's (CDC - www.cdc.gov [EXIT disclaimer](#)), "Preventing Lead Poisoning in Young Children."

Steps to Reduce Exposure to Lead

- Keep areas where children play as dust-free and clean as possible.
- Leave lead-based paint undisturbed if it is in good condition; do not sand or burn off paint that may contain lead.
- Do not remove lead paint yourself.
- Do not bring lead dust into the home.
- If your work or hobby involves lead, change clothes and use doormats before entering your home.
- Eat a balanced diet, rich in calcium and iron.

Keep areas where children play as dust-free and clean as possible.

Mop floors and wipe window ledges and chewable surfaces such as cribs with a solution of powdered automatic dishwasher detergent in warm water. (Dishwasher detergents are recommended because of their high content of phosphate.) Most multi-purpose cleaners will not remove lead in ordinary dust. Wash toys and stuffed animals regularly. Make sure that children wash their hands before meals, nap time, and bedtime.

Reduce the risk from lead-based paint.

Most homes built before 1960 contain heavily leaded paint. Some homes built as recently as 1978 may also contain lead paint. This paint could be on window frames, walls, the outside of homes, or other surfaces. Do not burn painted wood since it may contain lead.

Leave lead-based paint undisturbed if it is in good condition, do not sand or burn off paint that may contain lead.

Lead paint in good condition is usually not a problem except in places where painted surfaces rub against each other and create dust (for example, opening a window).

Do not remove lead paint yourself.

Individuals have been poisoned by scraping or sanding lead paint because these activities generate large

amounts of lead dust. Consult your state health or housing department for suggestions on which private laboratories or public agencies may be able to help test your home for lead in paint. Home test kits cannot detect small amounts of lead under some conditions. Hire a person with special training for correcting lead paint problems to remove lead-based paint. Occupants, especially children and pregnant women, should leave the building until all work is finished and clean-up is done.

For additional information dealing with lead-based paint abatement contact the Department of Housing and Urban Development for the following two documents: Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing: Report to Congress (December 7, 1990) and Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing (September 1990).

Do not bring lead dust into the home.

If you work in construction, demolition, painting, with batteries, in a radiator repair shop or lead factory, or your hobby involves lead, you may unknowingly bring lead into your home on your hands or clothes. You may also be tracking in lead from soil around your home. Soil very close to homes may be contaminated from lead paint on the outside of the building. Soil by roads and highways may be contaminated from years of exhaust fumes from cars and trucks that used leaded gas. Use door mats to wipe your feet before entering the home. If you work with lead in your job or a hobby, change your clothes before you go home and wash these clothes separately. Encourage your children to play in sand and grassy areas instead of dirt which sticks to fingers and toys. Try to keep your children from eating dirt, and make sure they wash their hands when they come inside.

[Find out about lead in drinking water.](#)

Most well and city water does not usually contain lead. Water usually picks up lead inside the home from household plumbing that is made with lead materials. The only way to know if there is lead in drinking water is to have it tested. Contact the local health department or the water supplier to find out how to get the water tested. Send for the EPA pamphlet, Lead and Your Drinking Water, for more information about what you can do if you have lead in your drinking water. Call EPA's Safe Drinking Water Hotline (800-426-4791) for more information.

Eat right.

A child who gets enough iron and calcium will absorb less lead. Foods rich in iron include eggs, red meats,

and beans. Dairy products are high in calcium. Do not store food or liquid in lead crystal glassware or imported or old pottery. If you reuse old plastic bags to store or carry food, keep the printing on the outside of the bag.

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National Lead Information Center Hotline

1-800-LEAD-FYI

[1-800-532-3394]

Information available 24 hours a day, seven days a week in English and Spanish. The Hotline provides basic information packet on lead in English and Spanish. The Packet includes the EPA brochure "[Lead Poisoning and Your Children](#)", three fact sheets, and a list of State and local contacts for additional information. Callers with specific questions are referred to the Clearinghouse to speak directly with an information specialist.

To heighten awareness about lead poisoning prevention, EPA's [Office of Prevention, Pesticides, and Toxic Substances \(OPPTS\) Lead Program](#) has developed [Lead in Your Home: A Parent's Reference Guide](#). The Agency believes this is an essential resource for anyone - from owners to tenants - concerned about the dangers of lead in their homes and environment. The Guidebook provides Agency recommendations on how you can reduce your family's risk of lead exposure and prevent lead poisoning, ranging from simple steps you can do now to more rigorous procedures that will permanently get rid of lead hazards in your home. (EPA document # 747-B-98-002, June 1998).

Lead Clearinghouse

1-800-424-LEAD

[1-800-424-5323]

[local - 202-833-1071; fax: 202-659-1192; TDD - 800/526-5456; e-mail: ehc@cais.com]

Available Monday through Friday 8:30am to 5:00pm EST. Inquiries can be mailed or faxed, or a phone message may be left at any time. Trained information specialists answer specific questions on lead-related issues in English and Spanish. It can also provide testing and laboratory information.

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Sources of Indoor Air Pollution - Nitrogen Dioxide (NO₂)

[This information originates from the EPA publication, "[The Inside Story: A Guide to Indoor Air Quality](#)."]

Sources of Nitrogen Dioxide

Kerosene heaters, un-vented gas stoves and heaters. Environmental tobacco smoke.

Health Effects Associated with Nitrogen Dioxide

Eye, nose, and throat irritation. May cause impaired lung function and increased respiratory infections in young children. EPA's Integrated Risk Information System profile for Nitrogen Dioxide - epa.gov/iris/subst/0080.htm

Levels in Homes

Average level in homes without combustion appliances is about half that of outdoors. In homes with gas stoves, kerosene heaters, or un-vented gas space heaters, indoor levels often exceed outdoor levels.

Steps to Reduce Exposure

(These are the same steps as those used to reduce exposure to [carbon monoxide](#)).

- Keep gas appliances properly adjusted.
- Consider purchasing a vented space heater when replacing an un-vented one.
- Use proper fuel in kerosene space heaters.
- Install and use an exhaust fan vented to outdoors over gas stoves.
- Open flues when fireplaces are in use.
- Choose properly sized wood stoves

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to

that are certified to meet EPA emission standards. Make certain that doors on all wood stoves fit tightly.

- Have a trained professional inspect, clean, and tune-up central heating system (furnaces, flues, and chimneys) annually. Repair any leaks promptly.
- Do not idle the car inside garage.

some indoor air pollutants.

Links

EPA's Office of Air and Radiation page - "[NOx - How Nitrogen Oxides Affect the Way We Live and Breathe](#)" and "[AIRTrends 1995 Summary on Nitrogen Dioxide](#)"

Maine's Department of Environmental Protection's [BEAM Chemical Fact Sheet on Nitrogen Dioxide](#) [EXIT disclaimer >](#)

Subject-Specific Publications

[What You Should Know About Combustion Appliances and Indoor Air Pollution](#), 1993 (400-F-91-100)

Answers commonly-asked questions about the effect of combustion appliances (e.g., fuel-burning furnaces, space heaters, kitchen ranges, and fireplaces) on indoor air quality and human health. Describes other sources of combustion pollutants in and around the home. Suggests ways to reduce exposure to such pollutants and encourages proper installation, use, and maintenance of combustion appliances. This brochure was prepared by the U.S. Consumer Product Safety Commission, the American Lung Association, and the EPA.

[Indoor Air Pollution: An Introduction for Health Professionals](#), 1994 (402-R-94-007)

Assists health professionals (especially the primary care physician) in diagnosis of patient symptoms that could be related to an indoor air pollution problem. Addresses the health problems that may be caused by contaminants encountered daily in the home and office. Organized according to pollutant or pollutant groups such as environmental tobacco smoke, VOCs, biological pollutants, and sick building syndrome, this booklet lists key signs and symptoms from exposure to these pollutants, provides a diagnostic checklist

and quick reference summary, and includes suggestions for remedial action. Also includes references for information contained in each section. This booklet was developed by the American Lung Association, the American Medical Association, the U.S. Consumer Product Safety Commission, and the EPA.

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Call the National Pesticide Telecommunications Network (NPTN)

EPA sponsors the NPTN (800-858-PEST) to answer your questions about pesticides and to provide selected EPA publications on pesticides.

Also, EPA's Office of Pesticide Programs is located at: www.epa.gov/pesticides/

[Sources of Pesticides](#)
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[This information originates from the EPA publication, "[The Inside Story - A Guide to Indoor Air Quality](#)."]

According to a recent survey, 75 percent of U.S. households used at least one pesticide product indoors during the past year. Products used most often are insecticides and disinfectants. Another study suggests that 80 percent of most people's exposure to pesticides occurs indoors and that measurable levels of up to a dozen pesticides have been found in the air inside homes. The amount of pesticides found in homes appears to be greater than can be explained by recent pesticide use in those households; other possible sources include contaminated soil or dust that floats or is tracked in from outside, stored pesticide containers, and household surfaces that collect and then release the pesticides. Pesticides used in and around the home include products to control insects (insecticides), termites (termiticides), rodents (rodenticides), fungi (fungicides), and microbes (disinfectants). They are sold as sprays, liquids, sticks, powders, crystals, balls, and foggers.

In 1990, the American Association of Poison Control Centers reported that some 79,000 children were involved in common household pesticide poisonings or exposures. In households with children under five years old, almost one-half stored at least one pesticide product

Sources of Indoor Air Pollution (in alphabetical order)

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[Carbon Monoxide](#)

[Formaldehyde/Pressed Wood Products](#)

[Household Cleaning and Maintenance, Personal Care, or Hobbies](#)

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[Secondhand Smoke/Environmental Tobacco Smoke](#)

Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to some indoor air

within reach of children.

pollutants.

EPA registers pesticides for use and requires manufacturers to put information on the label about when and how to use the pesticide. It is important to remember that the "-cide" in pesticides means "to kill". These products can be dangerous if not used properly.

In addition to the active ingredient, pesticides are also made up of ingredients that are used to carry the active agent. These carrier agents are called "inerts" in pesticides because they are not toxic to the targeted pest; nevertheless, some inerts are capable of causing health problems.

Sources of Pesticides

Products used to kill household pests (insecticides, termiticides, and disinfectants). Also, products used on lawns and gardens that drift or are tracked inside the house.

Health Effects

Irritation to eye, nose, and throat; damage to central nervous system and kidney; increased risk of cancer.

Both the active and inert ingredients in pesticides can be organic compounds; therefore, both could add to the levels of airborne organics inside homes. Both types of ingredients can cause the type of effects discussed in [Household Chemicals/Products](#). However, as with other household products, there is insufficient understanding at present about what pesticide concentrations are necessary to produce these effects.

Exposure to high levels of cyclodiene pesticides, commonly associated with misapplication, has produced various symptoms, including headaches, dizziness, muscle twitching, weakness, tingling sensations, and nausea. In addition, EPA is concerned that cyclodienes might cause long-term damage to the liver and the central nervous system, as well as an increased risk of cancer.

There is no further sale or commercial use permitted for the following cyclodiene or related pesticides: chlordane, aldrin, dieldrin, and heptachlor. The only exception is the use of heptachlor by utility companies to control fire ants in

underground cable boxes.

Levels in Homes

Preliminary research shows widespread presence of pesticide residues in homes.

Steps to Reduce Exposure

- Use strictly according to manufacturer's directions.
- Mix or dilute outdoors.
- Apply only in recommended quantities.
- Increase ventilation when using indoors. Take plants or pets outdoors when applying pesticides/flea and tick treatments.
- Use non-chemical methods of pest control where possible.
- If you use a pest control company, select it carefully.
- Do not store unneeded pesticides inside home; dispose of unwanted containers safely.
- Store clothes with moth repellents in separately ventilated areas, if possible.
- Keep indoor spaces clean, dry, and well ventilated to avoid pest and odor problems.

Read the label and follow the directions. It is illegal to use any pesticide in any manner inconsistent with the directions on its label.

Unless you have had special training and are certified, never use a pesticide that is restricted to use by state-certified pest control operators. Such pesticides are simply too dangerous for application by a non-certified person. Use only the pesticides approved for use by the general public and then only in recommended amounts; increasing the amount does not offer more protection against pests and can be harmful to you and your plants and pets.

Ventilate the area well after pesticide use.

Mix or dilute pesticides outdoors or in a well-ventilated area and only in the amounts that will be immediately needed. If possible, take plants and pets outside when applying pesticides/flea and tick treatments.

Use non-chemical methods of pest control when possible.

Since pesticides can be found far from the site of their original application, it is prudent to reduce the use of chemical pesticides outdoors as well as indoors. Depending on the site and pest to be controlled, one or more of the following steps can be effective: use of biological pesticides, such as *Bacillus thuringiensis*, for the control of gypsy moths; selection of disease-resistant plants; and frequent washing of indoor plants and pets. Termite damage can be reduced or prevented by making certain that wooden building materials do not come into direct contact with the soil and by storing firewood away from the home. By appropriately fertilizing, watering, and aerating lawns, the need for chemical pesticide treatments of lawns can be dramatically reduced.

If you decide to use a pest control company, choose one carefully.

Ask for an inspection of your home and get a written control program for evaluation before you sign a contract. The control program should list specific names of pests to be controlled and chemicals to be used; it should also reflect any of your safety concerns. Insist on a proven record of competence and customer satisfaction.

Dispose of unwanted pesticides safely.

If you have unused or partially used pesticide containers you want to get rid of, dispose of them according to the directions on the label or on special household hazardous waste collection days. If there are no such collection days in your community, work with others to organize them.

Keep exposure to moth repellents to a minimum.

One pesticide often found in the home is paradichlorobenzene, a commonly used active ingredient in moth repellents. This chemical is known to cause cancer in animals, but substantial scientific uncertainty exists over the effects, if any, of long-term human exposure to paradichlorobenzene. EPA requires that products containing paradichlorobenzene bear warnings such as "avoid breathing vapors" to warn users of potential short-term toxic effects. Where possible, paradichlorobenzene, and items to be protected against moths, should be placed in trunks or other containers that can be stored in areas that are separately ventilated from the home, such as attics and detached garages. Paradichlorobenzene is also the key active ingredient in many air fresheners (in fact, some labels for moth repellents recommend that these same products be used as air fresheners or deodorants). Proper ventilation and basic household cleanliness will go a long way toward preventing unpleasant odors.

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Additional Resources

[Office of Pesticides Publications List](#)

Call the National Pesticide Telecommunications Network (NPTN).

EPA sponsors the NPTN (800-858-PEST) to answer your questions about pesticides and to provide selected EPA publications on pesticides.

Pesticides: Uses, Effects and Alternatives to Pesticides in Schools, U.S. General Accounting Office, Report to the Ranking Minority Member, Committee on Governmental Affairs, Resources, Community, and Economic Development Division, U.S. Senate, November 29, 1999, GAO/RCED-00-17.

Orders by mail: U.S. General Accounting Office; P.O. Box 37050; Washington, DC 20013, or Visit: Room 110, 700 4th St., N.W.; U.S. General Accounting Office, Washington, DC, or call (202) 512-6000 or by fax (202) 512-6061, or TDD (202) 512-2537. You can also visit their web site at: www.gao.gov  or send

e-mail to info@www.gao.gov.

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[Short-term tests cannot be used for making a decision about whether to reduce the home's high radon levels](#)

MYTH: Scientists are not sure that radon really is a problem.

FACT: Although some scientists dispute the precise number of deaths due to radon, all the major health organizations (like the Centers for Disease Control and Prevention, the American Lung Association and the American Medical Association) agree with estimates that radon causes thousands of preventable lung cancer deaths every year. This is especially true among smokers, since the risk to smokers is much greater than to non-smokers.

MYTH: Radon testing devices are not reliable and are difficult to find.

FACT: Reliable radon tests are available from qualified radon testers and companies. Active radon devices can continuously gather and periodically record radon levels to reveal any unusual swings in the radon level during the test. Reliable testing devices are also available by phone or mail-order, and can be purchased in hardware stores and other retail outlets. Call your [state radon office](#) for a list of radon device companies that have met state requirements. See our [radon proficiency page](#) for information on how to find a "qualified" radon service professional.

MYTH: Radon testing is difficult and time-consuming.

FACT: Radon testing is easy. You can test your home yourself or hire a qualified radon test company. Either approach takes only a small amount of time and effort.

MYTH: Homes with radon problems cannot be fixed.

FACT: There are solutions to radon problems in homes. Thousands of home owners have already lowered elevated radon levels in their homes. Radon levels can be readily lowered for \$800 to \$2,500. Call your [state radon office](#) for a list of radon device companies that have met state requirements. See our [radon proficiency page](#) for information on how to find a "qualified" radon service professional.

MYTH: Radon affects only certain types of homes.

FACT: Radon can be a problem in all types of homes, including old homes, new homes, drafty homes, insulated homes, homes with basements and homes without basements. Local geology, construction materials, and how the home was built are among the factors that can affect radon levels in homes.

MYTH: Radon is only a problem in certain parts of the country.

FACT: High radon levels have been found in every state. Radon problems do vary from area to area, but the only way to know the home's radon level is to test.

MYTH: A neighbor's test result is a good indication of whether your home has a radon problem.

FACT: It is not. Radon levels vary from home to home. The only way to know if your home has a radon problem is to test it.

MYTH: Everyone should test their water for radon.

FACT: While radon gets into some homes through the water, it is important to first test the air in the home for radon. If your water comes from a public water system that uses ground water, call your water supplier. If high radon levels are found and the home has a private well, call the Safe Drinking Water Hotline at (800) 426-4791 for information on testing your water. Also, call your [state radon office](#) for more information about radon in air.

MYTH: It is difficult to sell a home where radon problems have been discovered.

FACT: Where radon problems have been fixed, home sales have not been blocked. The added protection could be a good selling point.

MYTH: I have lived in my home for so long, it does not make sense to take action now.

FACT: You will reduce your risk of lung cancer when you reduce radon levels, even if you have lived with an elevated radon level for a long time.

MYTH: Short-term tests cannot be used for making a decision about whether to reduce the home's high radon levels.

FACT: Short-term tests can be used to decide whether to reduce the home's high radon levels. However, the closer the short-term testing result is to 4 pCi/L, the less certainty there is about whether the home's year-round average is above or below that level. Keep in mind that radon levels below 4 pCi/L still pose some risk and that radon levels can be reduced to 2 pCi/L or below in most homes.

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Radon Risk Comparison Charts [\[En Español\]](#)

It's never too late to reduce your risk of lung cancer.

Don't wait to test and fix a radon problem.

If you are a smoker, stop smoking.

RADON RISK IF YOU SMOKE			
Radon Level	If 1,000 people who smoked were exposed to this level over a lifetime...	The risk of cancer from radon exposure compares to...	WHAT TO DO: Stop smoking and...
20 pCi/L	About 135 people could get lung cancer	100 times the risk of drowning	Fix your home
10 pCi/L	About 71 people could get lung cancer	100 times the risk of dying in a home fire	Fix your home
8 pCi/L	About 57 people could get lung cancer		Fix your home
4 pCi/L	About 29 people could get lung cancer	100 times the risk of dying in an airplane crash	Fix your home
2 pCi/L	About 15 people could get lung cancer	2 times the risk of dying in a car crash	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	About 9 people could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L	About 3 people could get lung cancer	(Average outdoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
Note: <i>If you are a former smoker, your risk may be lower.</i>			

RADON RISK IF YOU HAVE NEVER SMOKED			
Radon Level	If 1,000 people who never smoked were exposed to this level over a lifetime...	The risk of cancer from radon exposure compares to...	WHAT TO DO:
20 pCi/L	About 8 people could get lung cancer	The risk of being killed in a violent crime	Fix your home

10 pCi/L	About 4 people could get lung cancer		Fix your home
8 pCi/L	About 3 people could get lung cancer	10 times the risk of dying in an airplane crash	Fix your home
4 pCi/L	About 2 people could get lung cancer	The risk of drowning	Fix your home
2 pCi/L	About 1 person could get lung cancer	The risk of dying in a home fire	Consider fixing between 2 and 4 pCi/L
1.3 pCi/L	Less than 1 person could get lung cancer	(Average indoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
0.4 pCi/L	Less than 1 person could get lung cancer	(Average outdoor radon level)	(Reducing radon levels below 2 pCi/L is difficult.)
Note: If you are a former smoker, your risk may be higher.			

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Sources of Indoor Air Pollution - Respirable Particles/Combustion Products

Stoves, Heaters, Fireplaces, and Chimneys

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[This information originates from the EPA publication,
"[The Inside Story - A Guide to Indoor Air Quality](#)."]]

In addition to [environmental tobacco smoke](#), other sources of combustion products are unvented kerosene and gas space heaters, woodstoves, fireplaces, and gas stoves. The major pollutants released are [carbon monoxide](#), [nitrogen dioxide](#), and particles. Unvented kerosene heaters may also generate acid aerosols.

Combustion gases and particles also come from chimneys and flues that are improperly installed or maintained and cracked furnace heat exchangers. Pollutants from fireplaces and woodstoves with no dedicated outdoor air supply can be "back-drafted" from the chimney into the living space, particularly in weatherized homes.

Health Effects of Combustion Products

[Carbon monoxide](#) is a colorless, odorless gas that interferes with the delivery of oxygen throughout the body. At high concentrations can cause a range of symptoms from headaches, dizziness, weakness, nausea, confusion, and disorientation, to fatigue in healthy people and episodes of increased chest pain in people with chronic heart disease. The symptoms of carbon monoxide poisoning are sometimes confused with the flu or food poisoning. Fetuses, infants, elderly

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Symptoms of some diseases, including [asthma](#), hypersensitivity pneumonitis, and [humidifier fever](#), may also show up soon after exposure to some indoor air

people, and people with anemia or with a history of heart or respiratory disease can be especially sensitive to carbon monoxide exposures.

pollutants.

Nitrogen dioxide is a colorless, odorless gas that irritates the mucous membranes in the eye, nose, and throat and causes shortness of breath after exposure to high concentrations. There is evidence that high concentrations or continued exposure to low levels of nitrogen dioxide increases the risk of respiratory infection; there is also evidence from animals studies that repeated exposures to elevated nitrogen dioxide levels may lead, or contribute, to the development of lung disease such as emphysema. People at particular risk from exposure to nitrogen dioxide include children and individuals with [asthma](#) and other respiratory diseases.

Particles, released when fuels are incompletely burned, can lodge in the lungs and irritate or damage lung tissue. A number of pollutants, including **radon** and benzo(a)pyrene, both of which can cause cancer, attach to small particles that are inhaled and then carried deep into the lung.

Sources of Combustion Products

Fireplaces, wood stoves, and kerosene heaters. [Environmental tobacco smoke](#).

Health Effects

Eye, nose, and throat irritation; respiratory infections and bronchitis; lung cancer.

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Levels in Homes

Particle levels in homes without smoking or other strong particle sources are the same as, or lower than, outdoor levels.

Reducing Exposure to Combustion Products in Homes

- Take special precautions when operating fuel-burning unvented space heaters.

Consider potential effects of indoor air pollution if you use an unvented kerosene or gas space heater. Follow the manufacturer's directions, especially instructions on the proper fuel and keeping the heater properly adjusted. A persistent yellow-tipped flame is generally an indication of

maladjustment and increased pollutant emissions. While a space heater is in use, open a door from the room where the heater is located to the rest of the house and open a window slightly.

- Install and use exhaust fans over gas cooking stoves and ranges and keep the burners properly adjusted.

Using a stove hood with a fan vented to the outdoors greatly reduces exposure to pollutants during cooking. Improper adjustment, often indicated by a persistent yellow-tipped flame, causes increased pollutant emissions. Ask your gas company to adjust the burner so that the flame tip is blue. If you purchase a new gas stove or range, consider buying one with pilotless ignition because it does not have a pilot light that burns continuously. Never use a gas stove to heat your home. Always make certain the flue in your gas fireplace is open when the fireplace is in use.

- Keep woodstove emissions to a minimum. Choose properly sized new stoves that are certified as meeting EPA emission standards.

Make certain that doors in old woodstoves are tight-fitting. Use aged or cured (dried) wood only and follow the manufacturer's directions for starting, stoking, and putting out the fire in woodstoves. Chemicals are used to pressure-treat wood; such wood should never be burned indoors. (Because some old gaskets in woodstove doors contain asbestos, when replacing gaskets refer to the instructions in the CPSC, ALA and EPA booklet, [Asbestos in Your Home](#), to avoid creating an Asbestos problem. New gaskets are made of fiberglass.)

- Have central air handling systems, including furnaces, flues, and chimneys, inspected annually and properly repair cracks or damaged parts.

Blocked, leaking, or damaged chimneys or flues release harmful combustion gases and particles and even fatal concentrations of carbon monoxide. Strictly follow all service and maintenance procedures recommended by the manufacturer, including those that tell you how frequently to change the filter. If manufacturer's instructions are not readily available, change filters once every month or two during periods of use. Proper maintenance is important even for new furnaces because they can also corrode and leak combustion gases, including carbon monoxide. Read the booklet [What You Should Know About Combustion Appliances and Indoor Air Pollution](#) to learn more about combustion pollutants.

Steps to Reduce Exposure to Respirable Particles

- Vent all furnaces to outdoors; keep doors to rest of house open when using unvented space heaters.
- Choose properly sized woodstoves, certified to meet EPA emission standards; make certain that doors on all woodstoves fit tightly.
- Have a trained professional inspect, clean, and tune-up central heating system (furnace, flues, and chimneys) annually. Repair any leaks properly.
- Change filters on central heating and cooling systems and air cleaners according to manufacturer's directions.

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Subject-Specific Publications

[Should You Have the Air Ducts In Your Home Cleaned?](#) October

1997 (402-K-97-002)

This EPA publication is intended to help consumers answer this often confusing question. The guide explains what air duct cleaning is, provides guidance to help consumers decide whether to have the service performed in their home, and provides helpful information for choosing a duct cleaner, determining if duct cleaning was done properly, and how to prevent contamination of air ducts.

Indoor Air Fact Sheet No. 7 - [Residential Air Cleaners](#), February 1990 (20-A-4001)

Discusses air cleaning as a method of reducing pollutants in indoor air. Lists types of air cleaners for the home, factors to consider in selecting an air cleaner, and sources of additional information. U.S. EPA, Office of Air and Radiation, EPA Document Number 20A-4001, February 1990.

Indoor Air Fact Sheet No. 8 - [Use and Care of Home Humidifiers](#), February 1991 (402-F-91-101)

Explains that some types of home humidifiers can disperse microorganisms from their water tanks into the indoor air. Describes the different types of humidifiers and provides recommendations for their use and maintenance.

[Ozone Generators That Are Sold As Air Cleaners](#), April 1998

The purpose of this document (which is only available via this web site) is to provide accurate information regarding the use of ozone-generating devices in indoor occupied spaces. This information is based on the most credible scientific evidence currently available.

[Residential Air-Cleaning Devices: A Summary of Available Information](#), February 1990 (400/1-90-002)

Describes the general types of residential air cleaners and their effectiveness in reducing pollutants such as particles and gaseous contaminants. This detailed booklet discusses additional factors to consider when deciding whether to use an air cleaner, and provides guidelines to compare them.

[What You Should Know About Combustion Appliances and Indoor Air Pollution](#), 1993 (400-F-91-100)

Answers commonly-asked questions about the effect of combustion appliances (e.g., fuel-burning furnaces, space heaters, kitchen ranges, and fireplaces) on indoor air quality and human health. Describes other sources of combustion pollutants in and around the home. Suggests ways to reduce exposure to such

pollutants and encourages proper installation, use, and maintenance of combustion appliances. This brochure was prepared by the U.S. Consumer Product Safety Commission, the American Lung Association, and the EPA.

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Indoor Air - Secondhand Smoke

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IAQ Publications

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Office of Air and Radiation
Office of Radiation and Indoor Air
Indoor Environments Division (6609J)
EPA Document Number 402-F-94-005, June 1994

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Disclaimer: Environmental Tobacco Smoke and Lung Cancer

The Environmental Protection Agency firmly maintains that the bulk of the scientific evidence demonstrates that secondhand smoke -- environmental tobacco smoke, or "ETS" -- causes lung cancer and other significant health threats to children and adults. EPA's report ("Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders," EPA/600/6-90/006F) was peer-reviewed by 18 eminent, independent scientists who unanimously endorsed the study's methodology and conclusions. Since EPA's 1993 report which estimated the risks posed by ETS, numerous independent health studies have presented an impressive accumulating body of evidence that confirms and strengthens the EPA findings. It is widely accepted in

the scientific and public health communities that secondhand smoke poses significant health risks to children and adults.

A U.S. District Court decision has vacated several chapters of the EPA document "Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders" that served as the basis for EPA's classification of secondhand smoke as a Group A carcinogen and estimates that ETS causes 3,000 lung cancer deaths in non-smokers each year. The ruling was largely based on procedural grounds. EPA is appealing this decision. None of the findings concerning the serious respiratory health effects of secondhand smoke in children were challenged.

Background/Statistics/Conclusions

In early 1993, EPA released a report (Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders; EPA/600/6-90/006 F) that evaluated the respiratory health effects from breathing secondhand smoke (also called environmental tobacco smoke (ETS)). In that report, EPA concluded that secondhand smoke causes lung cancer in adult nonsmokers and impairs the respiratory health of children. These findings are very similar to ones made previously by the National Academy of Sciences and the U.S. Surgeon General.

The EPA report classified secondhand smoke as a Group A carcinogen, a designation which means that there is sufficient evidence that the substance causes cancer in humans. The Group A designation has been used by EPA for only 15 other pollutants, including asbestos, radon, and benzene. Only secondhand smoke has actually been shown in studies to cause cancer at typical environmental levels. EPA estimates that approximately 3,000 American nonsmokers die each year from lung cancer caused by secondhand smoke.

Every year, an estimated 150,000 to 300,000 children under 18 months of age get pneumonia or bronchitis from breathing secondhand tobacco smoke. Secondhand smoke is a risk factor for the development of asthma in children and worsens the condition of up to one million asthmatic children.

EPA has clear authority to inform the public about indoor air pollution health risks and what can be done to reduce those risks. EPA has a particular responsibility to do everything possible to warn of risks to the health of children.

A recent high profile advertising and public relations campaign by the tobacco industry may confuse the American public about the risks of secondhand smoke. EPA believes it's time to set the record straight about an indisputable fact: secondhand smoke is a real and preventable health risk.

EPA absolutely stands by its scientific and well documented report. The report was the subject of an extensive open review both by the public and by EPA's Science Advisory Board (SAB), a panel of independent scientific experts. Virtually every one of the arguments about lung cancer advanced by the tobacco industry and its

consultants was addressed by the SAB. The panel concurred in the methodology and unanimously endorsed the conclusions of the final report.

The report has also been endorsed by the U.S. Department of Health and Human Services, the National Cancer Institute, the Surgeon General, and many major health organizations.

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Classification of Secondhand Smoke as a Known Human (Group A) Carcinogen

The finding that secondhand smoke causes lung cancer in nonsmoking adults is based on the total weight of the available evidence and is not dependent on any single analysis. This evidence includes several important facts.

First, it is indisputable that smoking tobacco causes lung cancer in humans, and there is no evidence that there is a threshold below which smoking will not cause cancer.

Second, although secondhand smoke is a dilute mixture of mainstream" smoke exhaled by smokers and sidestream" smoke from the burning end of a cigarette or other tobacco product, it is chemically similar to the smoke inhaled by smokers, and contains a number of carcinogenic compounds.

Third, there is considerable evidence that large numbers of people who do not smoke are exposed to, absorb, and metabolize significant amounts of secondhand smoke.

Fourth, there is supporting evidence from laboratory studies of the ability of secondhand smoke both to cause cancer in animals and to damage DNA, which is recognized by scientists as being an instrumental mechanism in cancer development.

Finally, EPA conducted multiple analyses on the then-available 30 epidemiology studies from eight different countries which examined the association between secondhand smoke and lung cancer in women who never smoked themselves but were exposed to their husband's smoke. Since the epidemiology studies are the major thrust of the tobacco industry arguments against the EPA report, these studies are examined in more detail below.

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The Epidemiology Studies

The most important aspect of the review of the epidemiology studies

is the remarkable consistency of results across studies that support a causal association between secondhand smoke and lung cancer.

In assessing the studies several different ways, it becomes clear that the extent of the consistency defies attribution to chance. When looking only at the simple measure of exposure of whether the husband ever smoked, 24 of 30 studies reported an increase in risk for nonsmoking women with smoking husbands. Since many of these studies were small, the chance of declaring these increases statistically significant was small. Still, nine of these were statistically significant, and the probability that this many of the studies would be statistically significant merely by chance is less than *1 in 10 thousand*.

The simple overall comparison of risks in ever vs. never exposed to spousal smoking tends to hide true increases in risk in two ways. First, it categorizes many women as never exposed who actually received exposure from sources other than spousal smoking. It also includes some women as exposed who actually received little exposure from their husband's smoking. One way to correct for this latter case is to look at the women whose husbands smoked the most. When one looks at the 17 studies that examined cancer effects based on the level of exposure of the subjects, every study found an increased lung cancer risk among those subjects who were most exposed. Nine were statistically significant. The probability of 9 out of 17 studies showing statistically significant results occurring by chance is less than *1 in ten million*.

Probably the most important finding for a causal relationship is one of increasing response with increasing exposure, since such associations cannot usually be explained by other factors. Such exposure-response trends were seen in all 14 studies that examined the relationship between level of exposure and effect. In 10 of the studies the trends were statistically significant. The probability of this happening by chance is less than *1 in a billion*.

It is unprecedented for such a consistency of results to be seen in epidemiology studies of cancer from environmental levels of a pollutant. One reason is that it is extremely difficult to detect an effect when virtually everyone is exposed, as is the case with secondhand smoke. However, consistent increased risks for those most exposed and consistent trends of increasing exposure showing an increasing effect provide strong evidence that secondhand smoke increases the risk of lung cancer in nonsmokers.

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How Big a Lung Cancer Risk for Adults?

The evidence is clear and consistent: secondhand smoke is a cause of lung cancer in adults who don't smoke. EPA has never claimed that minimal exposure to secondhand smoke poses a huge individual cancer risk. Even though the lung cancer risk from secondhand smoke is relatively small compared to the risk from direct smoking, unlike a smoker who chooses to smoke, the nonsmoker's risk is often involuntary. In addition, exposure to secondhand smoke varies tremendously among exposed individuals. For those who must live or work in close proximity to one

or more smokers, the risk would certainly be greater than for those less exposed.

EPA estimates that secondhand smoke is responsible for about 3,000 lung cancer deaths each year among nonsmokers in the U.S.; of these, the estimate is 800 from exposure to secondhand smoke at home and 2,200 from exposure in work or social situations.

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The Risks to Children are Widely Acknowledged

The conclusion that secondhand smoke causes respiratory effects in children is widely shared and virtually undisputed. Even the tobacco industry does not contest these effects in its media and public relations campaign.

EPA estimates that every year, between 150,000 and 300,000 children under 1-1/2 years of age get bronchitis or pneumonia from breathing secondhand tobacco smoke, resulting in thousands of hospitalizations. In children under 18 years of age, secondhand smoke exposure also results in more coughing and wheezing, a small but significant decrease in lung function, and an increase in fluid in the middle ear. Children with asthma have more frequent and more severe asthma attacks because of exposure to secondhand smoke, which is also a risk factor for the onset of asthma in children who did not previously have symptoms.

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Other Risks

Secondhand smoke contains strong irritants and sensitizers and many adults, as well as children, suffer irritation and other acute effects whenever they are exposed to secondhand smoke. In addition, there is mounting evidence that exposure to secondhand smoke can have an effect on the cardiovascular system, although the EPA report does not address this issue.

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Tobacco Industry Media Campaign

The tobacco industry is raising numerous issues which may distract the public from the fact that secondhand smoke poses a real and preventable health risk. The tobacco industry neither acknowledges nor disputes EPA's conclusions of respiratory effects in children. It focuses instead on EPA's findings on lung cancer.

The overall thrusts of the tobacco industry's arguments are that EPA manipulated the lung cancer data to come to a predetermined conclusion. The industry also argues that a nonsmoker's exposure to secondhand smoke is so small as to be insignificant. The argument on minimal exposure is belied both by the acute irritation and respiratory effects and the fallacy of the cigarette equivalents"

approach discussed below. Responses to the specific criticisms of EPA's assessment of the lung cancer data follow.

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The 11 U.S. Lung Cancer Studies

Critics of the EPA report argue that by normal statistical standards, none of the 11 U.S. studies included in the EPA report showed a statistically significant increase in the simple overall risk measure, and that EPA should therefore have been unable to conclude that secondhand smoke causes lung cancer in nonsmokers. These critics are misrepresenting a small part of the total evidence on secondhand smoke and lung cancer.

The consistency of study results in the highest exposure category and exposure-response trends discussed above also apply to the U.S. studies. For example, seven of the 11 U.S. studies had fewer than 45 cases, making statistical comparisons difficult. Nonetheless, eight of the 11 had increased overall risks, and for the seven studies which reported on risks by amount of exposure, the highest exposure groups in all seven had increased risks. While the 11 U.S. studies are not, by themselves, conclusive, they do support the conclusion that secondhand smoke is causally associated with lung cancer.

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Studies Completed Since Release of the EPA Report

Critics claim that had EPA not excluded" the recent Brownson study, the Agency could not have concluded that secondhand smoke causes cancer. In fact, four new lung cancer epidemiology studies, including the Brownson study, have been published since the literature review cutoff date for the 1993 EPA report, and all support EPA's conclusions. Three of these are large U.S. studies funded, at least in part, by the National Cancer Institute. A 1992 study of Florida women by Stockwell et al. found a 60% overall increased risk of lung cancer from exposure to their husband's smoke, with significant results for both the highest exposure group and the exposure-response trend. The 1992 study of Missouri women by Brownson et al. found no overall increased risk, but did demonstrate a significant increase in risk in the highest spousal smoking exposure group and a positive exposure-response trend.

The 1994 study by Fontham et al. of women in two California and three Southern cities is the largest case-control study on the subject ever conducted and is considered by EPA to be the best designed study on secondhand smoke and lung cancer conducted to date. This study found significantly increased risks for overall exposure and in the highest exposure group and a strong positive exposure-response relationship. These findings were significant not only for exposure from spouses, but also for exposure in the workplace and in social situations.

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90% vs. 95% Confidence Intervals

Critics of the EPA report have charged that EPA changed the confidence interval in order to come to a predetermined conclusion. However, the conclusion that secondhand smoke is a known human carcinogen simply does not hinge on whether or not a 95% or 90% confidence interval" was used. A confidence interval is used to display variability in relative risk estimates in the epidemiology studies. As discussed above, the Group A designation is based on the total weight of the available evidence. The consistency of results that are seen in the numerous studies examined lead to a certainty of greater than 99.9% that secondhand smoke increases the risk of lung cancer in nonsmokers.

Use of what is called in statistics a one-tailed test of significance," which often corresponds to a 90% confidence interval, is a standard and appropriate statistical procedure in certain circumstances. The one-tailed test" is used when there is prior evidence that if there is an effect from a substance, it is highly likely to be an adverse rather than a protective effect, or vice versa. In the case of secondhand smoke, an extensive database exists for direct smoking indicating that if chemically similar secondhand smoke also has a lung cancer effect, this effect is likely to be similarly adverse. EPA used one-tailed significance tests for lung cancer in both external drafts of the risk assessment document as well as the final report. Ninety percent confidence intervals were also used in other EPA cancer risk assessments, including methylene chloride, coke oven emissions, radon, nickel, and dioxin.

In the non-cancer respiratory effects portions of the report, two-tailed tests" and 95% confidence intervals were used, since there was less prior evidence from smokers to suggest that secondhand smoke would cause bronchitis, pneumonia, and ear infections in children.

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The Meta-analysis

Meta-analysis was used for the lung cancer data as an objective method of combining results from many studies and was specifically endorsed by the SAB for use with this database. Some critics argue both that the meta-analysis was not an appropriate technique, and that had EPA included the Brownson study (addressed above) in the meta-analysis of overall spousal exposure, EPA could not possibly have classified secondhand smoke as a known human carcinogen. This just isn't true.

The finding that secondhand smoke is a known cause of lung cancer in humans is based on all the evidence and is not dependent on the meta-analysis of the simple ever- vs. never-exposed comparisons, as the critics suggest. If the meta-analysis were removed from the report entirely, the findings would be precisely the same. The meta-analysis was used primarily for estimating and quantifying the population risks from exposure to secondhand smoke, and an alternative approach also used in the report gave very similar results.

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Confounders

In the secondhand smoke report, a confounder would be a specific factor that could be responsible for the lung cancer increases observed in nonsmokers instead of secondhand smoke. The tobacco industry and its consultants have suggested, for example, that nonsmoking wives might share in the same poor dietary habits as their smoking husbands, increasing their risk.

The consistency of results across different countries where lifestyle factors, including diet, vary, argues against confounding. For example, while the tobacco industry theorizes that a high fat diet is a confounding factor, the studies from Japan, where dietary fat intake is among the lowest in the world, show a strong dose-response relationship for secondhand smoke and lung cancer.

The EPA report did examine the available data for six potential confounders such as occupation, dietary factors, and history of lung disease, and concluded that none was likely to explain the lung cancer increases seen in the studies.

The 1994 Fontham et al. study controlled for diet and other potential confounders, and concluded, These observations indicate that the strong association in this study between adult secondhand smoke exposure and lung cancer risk cannot be attributed to any likely confounder.

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"The Threshold Theory"

Although some have argued that tobacco smoke cannot cause cancer below a certain level, there is no evidence that this threshold exists. In the absence of such evidence, carcinogens at any level are considered by EPA to increase risk somewhat, although the degree of risk certainly is reduced as exposure decreases. The increased risks observed in the secondhand smoke epidemiology studies are further evidence that any threshold for secondhand smoke would have to be at very low levels.

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"Cigarette Equivalents"

The tobacco industry uses the cigarette equivalent" method of comparing smokers' and nonsmokers' exposures to a single component of tobacco smoke to infer that a nonsmoker's exposure to tobacco smoke is insignificant. However, the cigarette equivalent method has no scientific support, and was rejected by the SAB panel that reviewed the EPA report. Among the many problems with this method is the fact that while secondhand smoke and mainstream smoke contain the same approximately 4,000 compounds, their ratios of individual compounds differ by factors in the thousands. Thus, there is no single compound in tobacco smoke

that is an adequate indicator for drawing such comparisons. An RJ Reynolds newspaper ad, while utilizing the method, acknowledges it may not be relevant for assessing risk from secondhand smoke.

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Residential Exposures Translated to the Workplace

The tobacco industry frequently argues that because most studies were based on residential exposures, secondhand smoke has not been shown to be a hazard in the workplace. A substance capable of causing cancer in one environment is certainly capable of causing it in any other environment where exposures are comparable, as is the case with residential and workplace exposure to secondhand smoke. In fact, the 1994 Fontham study found a slightly higher risk for workplace exposure than for residential exposures.

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The Congressional Research Service (CRS) Report

The RJ Reynolds' media campaign cites a report prepared by the Congressional Research Service (CRS) on cigarette taxes to fund health care reform to argue that CRS believes that the epidemiological evidence on secondhand smoke and health effects is weak and uncertain." However, CRS has not taken a position on either EPA's risk assessment or the health effects of passive smoking.

Two economists from CRS, citing material largely prepared by the tobacco industry, included a discussion of EPA's risk assessment in an economic analysis of a cigarette excise tax proposal to fund health care reform. In EPA's view, the CRS economists' cursory look at the issues is not comparable to the exhaustive analyses and rigorous review process which EPA undertook when examining the extensive database on secondhand smoke and respiratory health. EPA is confident that a comprehensive analysis of the secondhand smoke database by expert scientists from CRS, with adequate peer review, will come to conclusions about the risks of secondhand smoke similar to those of EPA and many other organizations.

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Cigarette Prohibition

The claim that the government is attempting to bring back prohibition -- this time for cigarettes -- is a complete fabrication and utter nonsense. EPA's interest is to provide information to protect the nonsmoker from involuntary exposure to a hazardous substance. Having a choice to take a risk for themselves should not permit smokers to impose a risk on others.

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Secondhand Smoke Legislation

Congress has recently passed, and President Clinton has signed into law, legislation restricting smoking in nearly all public places where federal assistance is provided for services to children. Children exposed to secondhand smoke almost never have a choice. Protecting children from the health effects of secondhand smoke should be a priority for everyone.

The Clinton Administration supports pending legislation (H.R. 3434, S.1680, S. 262) that would protect nonsmokers, including children, from secondhand smoke in most public places. These bills would not take away the smoker's freedom to choose to smoke, nor would it bring government regulation into the home.

The bills would also make good economic sense. EPA estimates that smoking restrictions would result in saving \$4 billion to \$8 billion per year in housekeeping and maintenance expenses.

Perhaps most importantly, the bills would prevent thousands of premature deaths of nonsmokers per year and reduce the incidence of respiratory illness in children.

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For Further Information

For additional information on secondhand smoke and other indoor air pollutants, contact EPA's:

Indoor Air Quality Information Clearinghouse [IAQ INFO]

at 1-800-438-4318 or
(703) 356-4020 in Washington Metro area
PO Box 37133
Washington DC 20013-7133
(703) 356-5386 (fax)
iaqinfo@aol.com

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Take the Smoke-Free Home Pledge!

Take the Smoke-Free Homes Pledge! **1-866-SMOKE-FREE (1-866-766-5337)**

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Last updated on Thursday, March 6th, 2003
URL: <http://www.epa.gov/smokefree/pubs/strsfs.html>

CIVE 3331 Environmental Engineering

Allergens – irritate and stimulate immune system. Lead to asthma, infections, increased morbidity (illness) and premature mortality (death).

Toxic Mold - Some molds are very toxic, and they are relatively common. Toxic mold poisoning is probably quite rare. It is likely that most mold responses are allergic rather than poisoning. Emerging area of air quality research. De-humidification and use of cleansers (household bleach works) to control indoor environment so mold does not grow is a realistic and effective treatment. Need to remove source of moisture that starts mold growing in first place is required (leaky roof, plumbing leak, poor drainage around structure, etc.)



U.S. Environmental Protection Agency

Indoor Air - Mold/Moisture

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Mold Resources

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The EPA publication, "**A Brief Guide to Mold, Moisture, and Your Home**", is now available here in [HTML](#) and [PDF](#) formats. The printed version will be available soon.

The EPA publication, "**Mold Remediation in Schools and Commercial Buildings**", is available here in [HTML](#) and [PDF](#) (5MB file size) formats.

You can [order](#) these documents from [IAQ INFO](#) and EPA's [NSCEP](#). Use the EPA Document Number (EPA 402-K-01-001, March 2001) when ordering the mold remediation guidance.

A [PDF](#) version is available.

Introduction to Molds

Molds produce tiny spores to reproduce. Mold spores waft through the indoor and outdoor air continually. When mold spores land on a damp spot indoors, they may begin growing and digesting whatever they are growing on in order to survive. There are molds that can grow on wood, paper, carpet, and foods. When excessive moisture or water accumulates indoors, mold growth will often occur, particularly if the moisture problem remains undiscovered or un-addressed. There is no practical way to eliminate all mold and mold spores in the indoor environment; the way to control indoor mold growth is to control moisture.

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Basic Mold Cleanup

The key to mold control is moisture control. It is important to dry water damaged areas and items within 24-48 hours to prevent mold growth. If mold is a problem in your home, clean up the mold and get rid of the excess water or moisture. Fix leaky plumbing or other sources of water. Wash mold off hard surfaces with detergent and water, and dry completely. Absorbent materials (such as ceiling tiles & carpet) that become moldy may have to be replaced.

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Ten Things You Should Know About Mold

1. Potential health effects and symptoms associated with mold exposures include allergic reactions, asthma, and other respiratory complaints.
2. There is no practical way to eliminate all mold and mold spores in the indoor environment; the way to control indoor mold growth is to control moisture.
3. If mold is a problem in your home or school, you must clean up the mold and eliminate sources of moisture.

4. Fix the source of the water problem or leak to prevent mold growth.
5. Reduce indoor humidity (to 30-60%) to decrease mold growth by: venting bathrooms, dryers, and other moisture-generating sources to the outside; using air conditioners and de-humidifiers; increasing ventilation; and using exhaust fans whenever cooking, dishwashing, and cleaning.
6. Clean and dry any damp or wet building materials and furnishings within 24-48 hours to prevent mold growth.
7. Clean mold off hard surfaces with water and detergent, and dry completely. Absorbent materials such as ceiling tiles, that are moldy, may need to be replaced.
8. Prevent condensation: Reduce the potential for condensation on cold surfaces (i.e., windows, piping, exterior walls, roof, or floors) by adding insulation.
9. In areas where there is a perpetual moisture problem, do not install carpeting (i.e., by drinking fountains, by classroom sinks, or on concrete floors with leaks or frequent condensation).
10. Molds can be found almost anywhere; they can grow on virtually any substance, providing moisture is present. There are molds that can grow on wood, paper, carpet, and foods.

If you have IAQ and mold issues in your school, you should get a copy of the [IAQ Tools for Schools](#) Kit. Mold is covered in the IAQ Coordinator's Guide under [Appendix H - Mold and Moisture](#).

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Asthma and Mold

Molds can trigger asthma episodes in sensitive individuals with asthma. People with asthma should avoid contact with or exposure to molds.

EPA's [Asthma web site](#)

EPA's [Asthma Brochure](#)

EPA's [Mold page from Asthma web site](#)

- Allergy & Asthma Network/Mothers of Asthmatics (AAN/MA): (800) 878-4403; www.aanma.org [EXIT EPA ►](#)
- American Academy of Allergy, Asthma & Immunology (AAAAI): www.aaaai.org [EXIT EPA ►](#)
- American Lung Association: 1-800-LUNG-USA (1-800-586-4872); www.lungusa.org [EXIT EPA ►](#)
- Asthma & Allergy Foundation of America: (800) 7ASTHMA; www.aafa.org [EXIT EPA ►](#)
- Canada Mortgage and Housing Corporation (CMHC): www.cmhc-schl.gc.ca/cmhc.html [EXIT EPA ►](#)
- National Institute of Allergy and Infectious Diseases: www.niaid.nih.gov [EXIT EPA ►](#)
- National Jewish Medical and Research Center: (800) 222-LUNG (5864); www.njc.org [EXIT EPA ►](#)

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Floods/Flooding

Mold growth may be a problem after flooding. EPA's Fact Sheet: [Flood Cleanup: Avoiding Indoor Air Quality Problems](#) - discusses steps to take when cleaning and repairing a home after flooding. Excess moisture in the home is cause for concern about indoor air quality primarily because it provides breeding conditions for microorganisms. This fact sheet provides tips to avoid creating indoor air quality problems during cleanup. U.S. EPA, EPA Document Number 402-F-93-005, August 1993.

Federal Emergency Management Agency (FEMA): (800) 480-2520;

www.fema.gov [EXIT EPA ►](#) mitigation website: www.fema.gov/mit [EXIT EPA ►](#) publications on floods, flood proofing, etc.

University of Minnesota, Department of Environmental Health & Safety -

www.dehs.umn.edu/remanagi.html.  managing water infiltration into buildings.

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Health and Mold




Molds can trigger asthma episodes in sensitive individuals with asthma (See [Asthma Section](#) above); molds can also trigger allergies in sensitive individuals.

EPA's publication, [Indoor Air Pollution: An Introduction for Health Professionals](#), assists health professionals (especially the primary care physician) in diagnosis of patient symptoms that could be related to an indoor air pollution problem. It addresses the health problems that may be caused by contaminants encountered daily in the home and office. Organized according to pollutant or pollutant groups such as environmental tobacco smoke, VOCs, biological pollutants, and sick building syndrome, this booklet lists key signs and symptoms from exposure to these pollutants, provides a diagnostic checklist and quick reference summary, and includes suggestions for remedial action. Also includes references for information contained in each section. This booklet was developed by the American Lung Association, the American Medical Association, the U.S. Consumer Product Safety Commission, and the EPA. EPA Document Reference Number 402-R-94-007, 1994.

Allergic Reactions - excerpted from [Indoor Air Pollution: An Introduction for Health Professionals section on: Animal Dander, Molds, Dust Mites, Other Biologicals](#).

"A major concern associated with exposure to biological pollutants is allergic reactions, which range from rhinitis, nasal congestion, conjunctival inflammation, and urticaria to asthma. Notable triggers for these diseases are allergens derived from house dust mites; other arthropods, including cockroaches; pets (cats, dogs, birds, rodents); molds; and protein-containing furnishings, including feathers, kapok, etc. In occupational settings, more unusual allergens (e.g., bacterial enzymes, algae) have caused asthma epidemics. Probably most proteins of non-human origin can cause asthma in a subset of any appropriately exposed population."

Stachybotrys or *Stachybotrys atra* (*chartarum*) and health effects

- Consult the [Centers for Disease Control \(CDC\) website](#) 
- CDC's [National Center for Environmental Health \(NCEH\)](#)  has a toll-free telephone number for information and FAXs, including a list of publications: NCEH Health Line 1-888-232-6789.
- CDC's NCEH [factsheets, questions and answers on Stachybotrys chartarum and other molds](#) 

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Homes and Molds

The EPA publication, "**A Brief Guide to Mold, Moisture, and Your Home**", is available here in [HTML](#) and [PDF](#) formats. This Guide provides information and guidance for homeowners and renters on how to clean up residential mold problems and how to prevent mold growth. A printed version will be available soon.

[Biological Pollutants in Your Home](#) - This document explains indoor biological pollution, health effects of biological pollutants, and how to control their growth and buildup. One third to one half of all structures have damp conditions that may encourage development of pollutants such as molds and bacteria, which can cause allergic reactions -- including asthma -- and spread infectious diseases. Describes corrective measures for achieving moisture control and cleanliness. This brochure was prepared by the American Lung Association and the U.S.

Consumer Product Safety Commission. EPA Document Reference Number 402-F-90-102, January 1990.

Moisture control is the key to mold control, the Moisture Control Section from [Biological Pollutants in Your Home](#) follows:

Moisture Control

Water in your home can come from many sources. Water can enter your home by leaking or by seeping through basement floors. Showers or even cooking can add moisture to the air in your home. The amount of moisture that the air in your home can hold depends on the temperature of the air. As the temperature goes down, the air is able to hold less moisture. This is why, in cold weather, moisture condenses on cold surfaces (for example, drops of water form on the inside of a window). This moisture can encourage biological pollutants to grow.

There are many ways to control moisture in your home:

- Fix leaks and seepage. If water is entering the house from the outside, your options range from simple landscaping to extensive excavation and waterproofing. (The ground should slope away from the house.) Water in the basement can result from the lack of gutters or a water flow toward the house. Water leaks in pipes or around tubs and sinks can provide a place for biological pollutants to grow.
- Put a plastic cover over dirt in crawlspaces to prevent moisture from coming in from the ground. Be sure crawlspaces are well-ventilated.
- Use exhaust fans in bathrooms and kitchens to remove moisture to the outside (not into the attic). Vent your clothes dryer to the outside.
- Turn off certain appliances (such as humidifiers or kerosene heaters) if you notice moisture on windows and other surfaces.
- Use dehumidifiers and air conditioners, especially in hot, humid climates, to reduce moisture in the air, but be sure that the appliances themselves don't become sources of biological pollutants.
- Raise the temperature of cold surfaces where moisture condenses. Use insulation or storm windows. (A storm window installed on the inside works better than one installed on the outside.) Open doors between rooms (especially doors to closets which may be colder than the rooms) to increase circulation. Circulation carries heat to the cold surfaces. Increase air circulation by using fans and by moving furniture from wall corners to promote air and heat circulation. Be sure that your house has a source of fresh air and can expel excessive moisture from the home.
- Pay special attention to carpet on concrete floors. Carpet can absorb moisture and serve as a place for biological pollutants to grow. Use area rugs which can be taken up and washed often. In certain climates, if carpet is to be installed over a concrete floor, it may be necessary to use a vapor barrier (plastic sheeting) over the concrete and cover that with sub-flooring (insulation covered with plywood) to prevent a moisture problem.
- Moisture problems and their solutions differ from one climate to another. The Northeast is cold and wet; the Southwest is hot and dry; the South is hot and wet; and the Western Mountain states are cold and dry. All of these regions can have moisture problems. For example, evaporative coolers used in the Southwest can encourage the growth of biological pollutants. In other hot regions, the use of air conditioners which cool the air too quickly may prevent the air conditioners from running long enough to remove excess moisture from the air. The types of construction and weatherization for the different climates can lead to different problems and solutions.

[Should You Have the Air Ducts in Your Home Cleaned?](#) - excerpt on duct cleaning and mold follows, please review the entire document for additional information on duct cleaning and mold.

You should consider having the air ducts in your home cleaned if:

There is substantial visible mold growth inside hard surface (e.g., sheet metal) ducts or on other components of your heating and cooling system. There are several important points to understand concerning mold detection in heating and cooling systems:

- Many sections of your heating and cooling system may not be accessible for a visible inspection, so ask the service provider to show you any mold they say exists.
- You should be aware that although a substance may look like mold, a positive determination of whether it is mold or not can be made only by an expert and may require laboratory analysis for final confirmation. For about \$50, some microbiology laboratories can tell you whether a sample sent to them on a clear strip of sticky household tape is mold or simply a substance that resembles it.
- If you have insulated air ducts and the insulation gets wet or moldy it cannot be effectively cleaned and should be removed and replaced.
- If the conditions causing the mold growth in the first place are not corrected, mold growth will recur.

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Indoor Air Regulations and Mold

Standards or Threshold Limit Values (TLVs) for airborne concentrations of mold, or mold spores, have not been set. Currently, there are no EPA regulations or standards for airborne mold contaminants.

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Large Buildings and Mold

EPA has a number of resources available, you can start with ["Building Air Quality: A Guide for Building Owners and Facility Managers"](#) and the ["Building Air Quality Action Plan"](#)

Excerpt from the [Building Air Quality: A Guide for Building Owners and Facility Managers, Appendix C - Moisture, Mold and Mildew](#):

How to Identify the Cause of a Mold and Mildew Problem.

Mold and mildew are commonly found on the exterior wall surfaces of corner rooms in heating climate locations. An exposed corner room is likely to be significantly colder than adjoining rooms, so that it has a higher relative humidity (RH) than other rooms at the same water vapor pressure. If mold and mildew growth are found in a corner room, then relative humidity next to the room surfaces is above 70%. However, is the RH above 70% at the surfaces because the room is too cold or because there is too much moisture present (high water vapor pressure)?

The amount of moisture in the room can be estimated by measuring both temperature and RH at the same location and at the same time. Suppose there are two cases. In the first case, assume that the RH is 30% and the temperature is 70°F in the middle of the room. The low RH at that temperature indicates that the water vapor pressure (or absolute humidity) is low. The high surface RH is probably due to room surfaces that are "too cold." Temperature is the dominating factor, and control strategies should involve increasing the temperature at cold room surfaces.

In the second case, assume that the RH is 50% and the temperature is 70°F in the middle of the room. The higher RH at that temperature indicates that the water vapor pressure is high and there is a relatively large amount of moisture in the air. The high surface RH is probably due to air that is "too moist." Humidity is the dominating factor, and control strategies should involve decreasing the moisture content of the indoor air.

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Schools and Mold and Indoor Air Quality

The Agency's premier resource on this issue is the *Indoor Air Quality Tools for Schools* kit. Our schools-related resources on the web start at: epa.gov/iaq/schools.

The asthma companion piece for the *IAQ Tools for Schools* kit, titled *Managing Asthma in the School Environment* (epa.gov/iaq/schools/asthma) has been recently published. This publication has a section entitled *Clean Up Mold and Moisture Control* at: epa.gov/iaq/schools/asthma/eat-cumcm.htm

Excerpt from [IAQ Tools for Schools](http://epa.gov/iaq/schools) kit companion piece, [Managing Asthma in the School Environment](http://epa.gov/iaq/schools/asthma):

Common Moisture Sources Found in Schools

Moisture problems in school buildings can be caused by a variety of conditions, including roof and plumbing leaks, condensation, and excess humidity. Some moisture problems in schools have been linked to changes in building construction practices during the past twenty to thirty years. These changes have resulted in more tightly sealed buildings that may not allow moisture to escape easily. Moisture problems in schools are also associated with delayed maintenance or insufficient maintenance, due to budget and other constraints. Temporary structures in schools, such as trailers and portable classrooms, have frequently been associated with moisture and mold problems.

Suggestions for Reducing Mold Growth in Schools

Reduce Indoor Humidity:

- Vent showers and other moisture-generating sources to the outside.
- Control humidity levels and dampness by using air conditioners and de-humidifiers.
- Provide adequate ventilation to maintain indoor humidity levels between 30-60%.
- Use exhaust fans whenever cooking, dishwashing, and cleaning in food service areas.

Inspect the building for signs of mold, moisture, leaks, or spills:

- Check for moldy odors.
- Look for water stains or discoloration on the ceiling, walls, floors, and window sills.
- Look around and under sinks for standing water, water stains, or mold.
- Inspect bathrooms for standing water, water stains, or mold.
- Do not let water stand in air conditioning or refrigerator drip pans.

Respond promptly when you see signs of moisture and/or mold, or when leaks or spills occur:

- Clean and dry any damp or wet building materials and furnishings within 24-48 hours of occurrence to prevent mold growth.
- Fix the source of the water problem or leak to prevent mold growth.
- Clean mold off hard surfaces with water and detergent, and dry completely.
- Absorbent materials such as ceiling tiles, that are moldy, may need to be replaced.
- Check the mechanical room and roof for unsanitary conditions, leaks, or spills.

Prevent moisture condensation:

- Reduce the potential for condensation on cold surfaces (i.e., windows, piping, exterior walls, roof, or floors) by adding insulation.

Floor and carpet cleaning:

- Remove spots and stains immediately, using the flooring manufacturer's recommended techniques.
- Use care to prevent excess moisture or cleaning residue accumulation and ensure that cleaned areas are dried quickly.
- In areas where there is a perpetual moisture problem, do not install carpeting (i.e., by

drinking fountains, by classroom sinks, or on concrete floors with leaks or frequent condensation).

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Other Mold-Related Resources/Links

U.S. Environmental Protection Agency (EPA), Indoor Environments Division (IED)

An Office Building Occupant's Guide to IAQ - epa.gov/iaq/pubs/occupgd.html

Biological Contaminants - epa.gov/iaq/pubs/bio_1.html

Building Air Quality Action Plan (for Commercial Buildings) - epa.gov/iaq/largebldgs/actionpl.html

Floods/Flooding - epa.gov/iaq/pubs/flood.html

Mold Remediation in Schools and Commercial Buildings - epa.gov/iaq/molds/mold_remediation.html

For more subject-specific links, go to: epa.gov/iaq/schools/links.html, or epa.gov/iaq/asthma/links.html, or epa.gov/iaq/moreinfo.html.

Other Links

The following list of resources includes information created and maintained by other public and private organizations. The U.S. EPA does not control or guarantee the accuracy, relevance, timeliness, or completeness of this outside information. Further, the inclusion of such resources is not intended to endorse any views expressed or products or services offered by the author of the reference or the organization operating the service on which the reference is maintained.

American College of Occupational and Environmental Medicine (ACOEM)

(847) 818-1800 www.sioxlan.com/acoem/ [EXIT EPA ►](#)

Referrals to physicians who have experience with environmental exposures.

American Conference of Governmental Industrial Hygienists, Inc. (ACGIH)

(513) 742-2020 www.acgih.org [EXIT EPA ►](#)

Occupational and environmental health and safety information

American Industrial Hygiene Association (AIHA)

(703) 849-8888 www.aiha.org [EXIT EPA ►](#)

Information on industrial hygiene and indoor air quality issues including mold hazards and legal issues

American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)

(800) 527-4723 www.ashrae.org [EXIT EPA ►](#)

Information on engineering issues and indoor air quality

Association of Occupational and Environmental Clinics (AOEC)

(202) 347-4976 www.aoec.org [EXIT EPA ►](#)

Referrals to clinics with physicians who have experience with environmental exposures, including exposure to mold; maintains a database of occupational and environmental cases

Association of Specialists in Cleaning and Restoration (ASCR)

(800) 272-7012 www.ascr.org [EXIT EPA ►](#)

Disaster recovery, water and fire damage, emergency tips, referrals to professionals

Asthma and Allergic Diseases

American Academy of Allergy, Asthma & Immunology (AAAAI)
(800) 822-2762

www.aaaai.org 

Physician referral directory, information on allergies and asthma

Asthma and Allergy Foundation of American (AAFA)
(800) 7-ASTHMA (800-727-8462)

www.aaafa.org 

Information on allergies and asthma

American Lung Association (ALA)
(800) LUNG-USA (800-586-4872)

www.lungusa.org 

Information on allergies and asthma

Asthma and Allergy Network/Mothers of Asthmatics, Inc. (AAN*MA)
(800) 878-4403 or (703-641-9595)

www.aanma.org 

Information on allergies and asthma

National Institute of Allergy and Infectious Diseases (NIAID)
(301) 496-5717

www.niaid.nih.gov 

Information on allergies and asthma

National Jewish Medical and Research Center
(800) 222-LUNG (800-222-5864)

www.njc.org 

Information on allergies and asthma

Canada Mortgage and Housing Corporation (CMHC)
(613) 748-2003 [International]

www.cmhc-schl.gc.ca/cmhc.html 

Several documents on mold-related topics available and a discussion on mold at -

http://www.cmhc-schl.gc.ca/en/imquaf/hehosu/hoast/hoast_001.cfm 

including

- ["Fighting Mold - The Homeowner's Guide"](#) 
- ["The Condominium Owners' Guide to Mold"](#) 

Carpet and Rug Institute (CRI)
(800) 882-8846

www.carpet-rug.com 



Carpet maintenance, restoration guidelines for water-damaged carpet, other carpet-related issues

Centers for Disease Control and Prevention (CDC)
(800) 311-3435

www.cdc.gov 

Information on health-related topics including asthma, molds in the environment, and occupational health




CDC's National Center for Environmental Health (NCEH) (888) 232-6789

Mold page - <http://www.cdc.gov/nceh/airpollution/mold/> 
"Questions and answers on Stachybotrys chartarum and other molds" -
www.cdc.gov/nceh/airpollution/mold/stachy.htm 

Energy and Environmental Building Association
(952) 881-1098

www.eeba.org 

Information on energy-efficient and environmentally responsible buildings, humidity/moisture control/vapor barriers

Floods/Flooding
Federal Emergency Management Agency (FEMA) (800) 480-2520 www.fema.gov/mit  Publications on floods, flood proofing, etc.
University of Minnesota, Department of Environmental Health & Safety (612) 626-5804 www.dehs.umn.edu/remanagi.html  Managing water infiltration into buildings
University of Wisconsin-Extension, The Disaster Network (608) 262-3980 www.uwex.edu/ces/news/handbook.html  Information on floods and other natural disasters

Health Canada, Health Protection Branch, Laboratory Centre for Disease Control, Office of Biosafety
(613) 957-1779

www.hc-sc.gc.ca/main/lcdc/web/biosaftey/msds/index.html 

Material Safety Data Sheets with health and safety information on infectious microorganisms, including Aspergillus and other molds and airborne biologicals

Institute of Inspection, Cleaning and Restoration Certification (IICRC)
(360) 693-5675

www.iicrc.org 

Information on and standards for the inspection, cleaning, and restoration industry

International Sanitary Supply Association (ISSA)
(800) 225-4772

www.issa.com 

Education and training on cleaning and maintenance

International Society of Cleaning Technicians (ISCT)
(800) WHY-ISCT (800-949-4728)

www.isct.com 

Information on cleaning, such as a stain removal guide for carpets

Material Safety Data Sheets (MSDSs) - Cornell University

msds.pdc.cornell.edu/msdssrch.asp 

MSDSs contain information on chemicals or compounds including topics such as health effects, first aid and protective equipment for people who work with or handle these chemicals

MidAtlantic Environmental Hygiene Resource Center (MEHRC)
(215) 387-4096

www.mehrc.org 

Indoor environmental quality training on topics such as mold remediation

National Air Duct Cleaners Association (NADCA)

(202) 737-2926

www.nadca.com 

Duct cleaning information

National Association of the Remodeling Industry (NARI)

(847) 298-9200

www.nari.org 

Consumer information on remodeling, including help finding a professional remodeling contractor

National Institute of Building Sciences (NIBS)

(202) 289-7800

www.nibs.org 

Information on building regulations, science, and technology

National Institute for Occupational Safety and Health (NIOSH)

(800) 35-NIOSH (800-356-4674)

www.cdc.gov/niosh 

Health and safety information with a workplace orientation

National Pesticide Telecommunications Network (NPTN)

(800) 858-7378

ace.orst.edu/info/nptn 

Information on pesticides/antimicrobial chemicals, including safety and disposal information

New York Department of Health, Bureau of Environmental and Occupational Disease
Epidemiology

(212) 788-4290

[Guidelines on Assessment and Remediation of Fungi in Indoor Environments](#) 

This document revises and expands the original guidelines to include all fungi (mold). It is based both on a review of the literature regarding fungi and on comments obtained by a review panel consisting of experts in the fields of microbiology and health sciences. It is intended for use by building engineers and management, but is available for general distribution to anyone concerned about fungal contamination, such as environmental consultants, health professionals, or the general public.

Occupational Safety & Health Administration (OSHA)

(800) 321-OSHA (800-321-6742)

www.osha.gov 

Information on worker safety, including topics such as respirator use and safety in the workplace

Sheet Metal & Air Conditioning Contractors' National Association (SMACNA)

(703) 803-2980

www.smacna.org 

Technical information on topics such as air conditioning and air ducts

Smithsonian Center for Materials Research and Education (SCMRE)

(301) 238-3700

www.si.edu/scmre 

Guidelines for caring for and preserving furniture and wooden objects, paper-based materials; preservation studies

University of Michigan Herbarium

(734) 764-2407

www.herb.lsa.umich.edu 

Specimen-based information on fungi; information on fungal ecology

University of Tulsa Indoor Air Program

(918) 631-5246

www.utulsa.edu/iaqprogram 

Courses, classes, and continuing education on indoor air quality

Water Loss Institute, Association of Specialists in Cleaning and Restoration
(800) 272-7012 or (410) 729-9900

www.ascr.org/wli/ 

Information on water and sewage damage restoration

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How to order publications from EPA

IAQ INFO

P.O. Box 37133, Washington, DC 20013-7133

1-800-438-4318/703-356-4020

(fax) 703-356-5386

iaqinfo@aol.com

U.S. Environmental Protection Agency

National Center for Environmental Publications (NSCEP)

P.O. Box 42419

Cincinnati, OH 42419

1-800-490-9198/(513) 489-8695 (fax)

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[Mold Resources](#) | ["A Brief Guide to Mold, Moisture, and Your Home"](#) | ["Mold Remediation in Schools and Commercial Buildings"](#)

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View the graphical version of this page at: <http://www.epa.gov/iaq/molds/moldresources.html>

CIVE 3331 Environmental Engineering

Ventilation

Ventilation is the principal mechanism of controlling indoor air quality by dilution with outside air (hence the need to have outside air quality).

Infiltration – air exchange through cracks and holes in the building envelope.

Wind driven – dilutes pollutants

Stack driven – concentrates pollutants

Natural ventilation – windows, doors, vents.

Forced ventilation – blowers. Most office buildings have fixed windows for various reasons (structural integrity, security, energy management) and use forced ventilation exclusively. Energy conservation favors internal recycling to reduce cost to heat/cool humidify/dehumidify outside air, but allows pollutants to concentrate.

The rate at which outdoor air replaces indoor air is described as the air exchange rate. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low and pollutant levels can increase.