Mold and Mildew Awareness

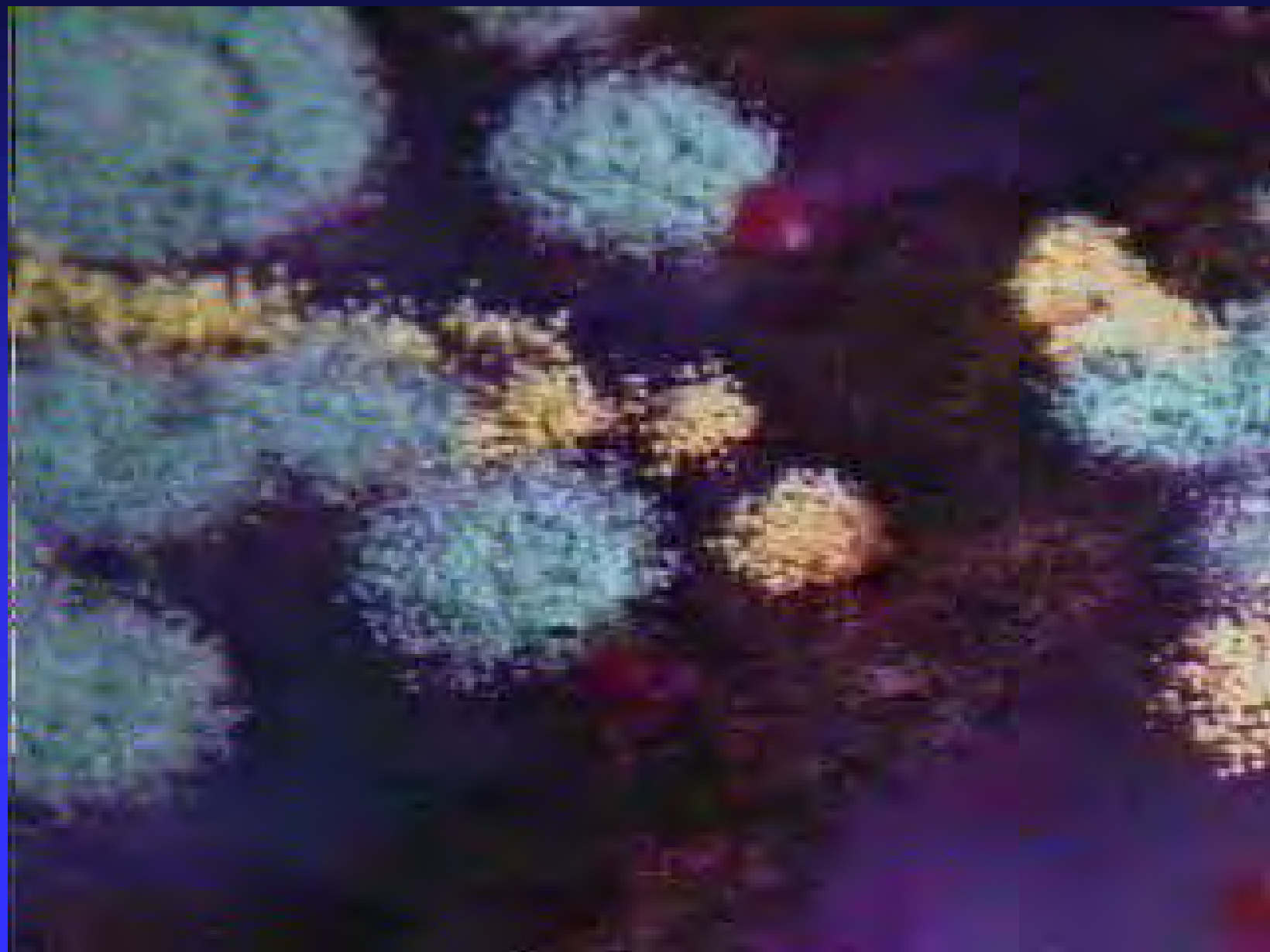
Indoor Air Quality

Toxic Mold

- A few years ago, few people had ever heard of "Toxic Mold“
- Stachybotrys
  - $100 million lawsuits and of $18 million mold verdicts
  - People moving out of their homes and leaving behind all their worldly possessions
  - People with mold colonies in their lungs
  - In Sacramento, three major apartment complexes have had outbreaks

Mold is Everywhere

Why is there such a concern?



Mold is Everywhere

Why is there such a concern?

- There is also a significant cost associated with mold growth
- There are very serious liability risks
- Currently there are very few regulations regarding the identification, testing, or remediation of mold problems

Litigation

- Landlords have been sued for the condition of their rental units
- Concerned parents for mold in schools are suing school districts
- Employers have been sued by their employees for mold growth in the office buildings and exposure to molds on the job
- Contractors who may work with water damaged homes

Litigation

- Insurance companies have been sued for failure to properly repair water damage
- Home Builders have been sued for construction defects in the houses they have built, which leads to suits against the subcontractors involved
- Home inspectors or pest inspectors for failing to recognize a mold problem or moisture problem that will lead to a mold problem in the future

Mold Biology

- Molds are types of fungi, which are not plants or animals
- They feed on dead, organic material
- They reproduce through spores, which become airborne
- These are microscopic and are inhaled into our lungs along with pollen, dust and other tiny particles in the air
- Molds produce mycotoxins

Mold Biology

- For mold to grow it needs a food source with a high organic content
  - Wood
  - Paper
  - cotton’
  - Wicker
  - Other plant-derived materials

Mold Biology

- Mold needs moisture to grow
  - Leaks
  - Floods
  - Condensation
  - Steam
  - From high humidity

Sources of Moisture

- If mold growth is found on a wall it may be the result of a roof or pipe leak
  - If it is on an exterior wall then there may be water intrusion from outside or there may not be enough insulation so that condensation is occurring
- The moisture source may not always be from a structural or design problem with the building
  - It may be due to human activity inside, like steam from showers or cooking, a spilled fish tank, or a leaking waterbed

Mold Facts

- Molds and fungi are simple, microscopic organisms, found virtually everywhere
  - Indoors and outdoors
- Molds and fungi can be found on plants, dry leaves, and other organic material
  - Molds and fungi play an important role in the environment by breaking down dead, organic material
- Mold and fungi spores are very tiny and lightweight, allowing them to travel through the air

Mold Facts

- Airborne levels vary according to locale and current environmental conditions
- Sometimes conditions indoors can be favorable for fungal growth resulting in increased levels of airborne fungal spores
- Inhalation of such elevated levels of airborne spores can result in allergic or toxic responses

Mold Facts

- Although infection can occur in an otherwise healthy individual, those most susceptible include:
  - Infants
  - Children
  - The elderly
  - Immune compromised individuals

Health Effects

- Exposure to mold spores and their mycotoxins can lead to a variety of non-specific health problems such as:
  - Sinus problems
  - Respiratory problems (wheezing, coughing, difficulty breathing)
  - Headaches
  - Cold and flu-like symptoms (fever, muscle aches, fatigue)
  - Sore throats
  - Eye irritation
  - Frequent bloody noses

Health Symptoms

- The types of health problems that develop depend on a variety of factors:
  - The length and amount of exposure
  - The mold growth conditions
- Health symptoms may develop from chronic exposure and the mold growth conditions or from acute term exposure at very high levels, like those that occur during mold abatement
- The greatest factor affecting the development of health problems is individual sensitivity

Health Effects

- Mold exposure may be especially hazardous to young infants
  - It is believed that the Stachybotrys mold may have caused the death of 12 infants and the hospitalization of 37 infants in the Cleveland area of Ohio
- In most cases mold induced health symptoms will diminish upon removal from the environment with mold abatement

Health Effects

- The health effects from molds depend on the length and level of exposure (chronic vs. acute) and on individual sensitivity
- Health effects from exposure to molds can be divided into four general categories:
  - Infection
  - Toxicosis
  - Allergy
  - Irritation

Infection

- Systematic Infection
- Opportunistic Infection
- Dermatophytic Infection

Types of Commonly Encountered Fungi

- Alternaria
- Aspergillus
- Chaetomium
- Cladosporium
- Fusarium
- Penicillium
- Stachybotrys
- Ulocladium

Mold Inspections

- An investigation for mold growth begins with an inspection for visible mold growth
- If there is no visible mold immediately noticeable, an inspection for signs of water damage is completed and areas with possible moisture sources are inspected

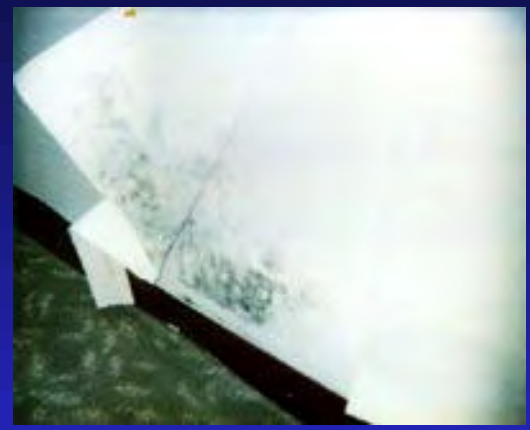
Sources of Moisture

- Sinks
- Dishwashers
- Leaking roofs and pipes
- Steam from cooking or showers
- Moisture vapor through slab foundations
- Indoor plants
- Wet towels or laundry
- Fish tanks
- Water heaters
- HVAC systems
- Washing machines

Sources of Moisture

- Improper grading of the yard
- Flower beds next to exterior walls
- Outside sprinklers spraying against the house
- Cracked stucco
- Clogged weep screeds
- Missing or torn moisture paper
- Or a combination of many of these problems

Signs of Mold Growth or Water Damage



- Cracked or bubbling paint
- Staining or discoloration
- Damp or soft walls or surfaces
- Buckling or warped flooring of baseboards
- Musty odors

Mold Sampling And Analysis

- Air Sampling
- Surface Sampling
  - Bulk sampling
  - Swab sampling
  - Tape sampling
- Dust Sampling

Mold Abatement

- The first step in mold abatement is to find and eliminate the source of mold
  - Flooring
  - sheet rock
  - Insulation
  - Any other materials with visible mold must be removed and disposed of

Mold Abatement

- Any surface that is not easily removed, like wood framing, may remain provided:
  - It is not severely impacted with mold growth
  - Is structurally sound
  - Is thoroughly treated to kill the mold and remove the dead spores
- In many cases this may require a 10% chlorine solution with several applications (Ordinary household bleach is usually a 0.5% chlorine solution

Mold Abatement

- When conducting abatement it is necessary to limit the amount of spores that become airborne and prevent cross contamination of spores to clean rooms
- This involves sealing off affected areas with plastic, sealing off and/or limiting use of the HVAC system, and using vacuums and air filtering devices with HEPA filters

Mold Abatement

- Mold abatement can be extremely hazardous if proper precautions are not taken
- It is very important that PPE be worn when doing any kind of mold cleanup

Common Misconceptions About Mold

- This isn't mold, its just mildew. *Or* this mold isn't the toxic mold
  - Mold and mildew are the same thing
  - Any mold growth on a surface has the potential to have negative health effects
- If the mold is not *Stachybotrys,* it is safe to clean it myself
  - When doing any kind of mold abatement, it is necessary to take steps to limit exposure, no matter what type of mold it is

Common Misconceptions About Mold

- If you have *Stachybotrys* in your home you have to get rid of all your personal belongings
  - As long as there is no moisture on those surfaces the spores will not form active growth
  - Since the spores are primarily just on the surface of the furniture, they can be treated and removed

Common Misconceptions About Mold

- I want to make sure that my house is free of mold
  - No house is completely free of mold
  - Molds are very common outside, so some mold spores will always be present in the air indoors as well

Common Misconceptions About Mold

- I cleaned the mold with bleach, so I have fixed the problem

  - Bleach is not always effective at killing mold, especially if the mold is present on a porous or fibrous material, like wood or sheet rock
  - If mold growth is significant, it is better to remove the impacted material
  - Cleaning the mold also does not fix the underlying moisture problem that is allowing the mold to grow

10 Things You Should Know About Mold

- Exposure to elevated levels of molds can cause serious health problems
- There are many molds that have the potential to cause health problems including:
  - *Alternaria*
  - *Aspergillus*
  - *Chaetomium*
  - *Cladosporium*
  - *Fusarium*
  - *Penicillium*
  - *Stachybotrys*

10 Things You Should Know About Mold

- Mold spores can cause health problems even if the spores are dead
- Mold requires an organic food source, such as cloth, sheet rock, or wood, and a moisture source to grow
- Mold spores are very common outdoors and there is no practical way to eliminate all mold spores indoors

10 Things You Should Know About Mold

- Molds can grow undetected inside wall spaces, under carpet, and inside HVAC systems
- Mold growth can often be the visible sign of a structural defect that allows moisture to intrude into a building
- When doing mold abatement, it is first necessary to find and eliminate the moisture source

10 Things You Should Know About Mold

- Cleanup of large areas of mold growth can cause airborne levels of spores to increase up to 10,000 times that of background levels resulting in acute exposure
- The best way to abate mold growth indoors is to remove the impacted materials

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Mold Awareness & Inspection

Introduction

A few years ago, few people had ever heard of "Toxic Mold". Although not many people know how to pronounce Stachybotrys, just about everyone thinks they know what it means. There is a news story about toxic mold on the TV, in the newspapers, or on the Internet almost daily. There are stories of $100 million lawsuits, of $18 million mold verdicts, people moving out of their homes and leaving behind all their worldly possessions, and people with mold colonies in their lungs. In Sacramento alone, three major apartment complexes have had outbreaks resulting in many apartments being condemned and hundreds of tenants being relocated or evicted. The cost of relocating can be significant, because other apartment communities will not let these people move in without a certification that their belongings are free of mold. The media frenzy that has evolved has created an abundance of misinformation that is leaving many people in a panic.

Mold is everywhere, so why is there such a concern? The potential impact of mold growth indoors is hard to define. It can result in serious health problems, some of which can be long term. It will reduce the property value of the home. Sometimes even if the mold has been abated, there is a stigma attached to it and the fear of the return of mold will limit the value. It may result in a building being condemned for code violations. It raises environmental justice issues because poor and underprivileged families often live in older homes or apartments that are not well maintained and prone to water and mold problems.

There is also a significant cost associated with mold growth. Mold abatement can cost thousands of dollars depending on the severity of the problem. Because of the potential hazard posed by mold, personnel that are trained in the handling of biohazard materials should be involved with mold abatement. Amplified mold growth indoors is usually caused by excessive moisture, which could be related to a construction defect. It is therefore essential that any mold growth be properly remediated. A mold problem that is not taken care of early on will cost much more to resolve later.

Given all the tangible and intangible costs associated with mold growth, there are also very serious liability risks faced by many different parties. Mold litigation has become one of the fastest growing fields of litigation. Everyone with a mold problem in his or her home or who has suffered exposure to high levels of mold is looking for someone to blame. Currently there are very few regulations regarding the identification, testing, or remediation of mold problems in California. This makes many different parties

vulnerable to suits filed by people who are seeking compensation for their health problems, abatement costs, or lost property value.

Landlords have been sued for the condition of their rental units. Concerned parents for mold in schools are suing school districts. Employers have been sued by their employees for mold growth in the office buildings and exposure to molds on the job, as in the case of renovation contractors who may work with water damaged homes. Insurance companies have been sued for failure to properly repair water damage.

Home Builders have been sued for construction defects in the houses they have built, which leads to suits against the subcontractors involved. Could home inspectors or pest inspectors be liable for failing to recognize a mold problem of moisture problem that will lead to a mold problem in the future?

The number of homes with mold problems is steadily increasing. The houses that are built now are much more susceptible to the mold problems than the houses built 30 years ago. The energy crisis in the 70's has lead to the creation of tighter building envelopes, which do not provide as much ventilation with outside air and trap moisture inside. Building materials are now organic based and safer for the environment, but also a better food source for mold. Homes are also being built on former plains, swampland, and proper quality land, which may cause more moisture problems.

Most new homes are also track homes, which may have an increased potential for mold growth to occur. With track homes, the building process is speeded up, and sometimes slab foundations do not cure properly before the home is built. Many subcontractors are often involved in track homes, so there is less control over the building conditions, which can lead to construction defects. Homes are also built all year round; so building materials are exposed to rain causing mold growth before the house is even finished.

This course is intended to provide you, the home inspector, with an understanding of the effects of mold growth and the types of conditions that lead to mold growth. With this knowledge, you can take pro-active steps during the construction process to limit the opportunity for molds to grow in the homes you build and recognize existing mold problems so you can remedy them early, thereby reducing the cost and time needed for the abatement and minimize future liability.

Mold Biology

Molds are types of fungi, which are not plants, or animals, but a separate kingdom of their own. They feed on dead, organic material and play an important ecological role by decomposing dead leaves, grass, and other plant material so they do not build up outside.

They reproduce through spores, which become airborne and spores are very common in the air both inside and outside. These are microscopic and are inhaled into our lungs along with pollen, dust and other tiny particles in the air.

Molds produce mycotoxins, which are chemicals associated with growth, self-defense, and metabolism. These mycotoxins can be found on the surface of mold spores and are inhaled into the lungs along with the spores.

In order for mold to grow it needs a **food source** with a high organic content. This includes wood, paper, cotton, wicker, and other plant-derived materials. Non-organic material, like porcelain and tile are not food sources for mold. When mold is found on these surfaces, as in bathrooms or sinks, it is usually feeding on other organic material that has accumulated on the surface. Thus mold growth in toilets, sinks, or showers can generally be prevented through regular cleaning or maintenance.

Mold also needs **moisture** to grow. This moisture can come from leaks, floods, condensation, steam, or from high humidity. If mold is present on a surface, then it either currently or in the past had access to moisture. As a home inspector, this is important to know so that you can evaluate any possible structural issues with a home that may be creating a moisture source and allowing mold to grow. Sometimes the source of the moisture may not be obvious, *but it has to be there*.

If mold growth is found on a wall it may be the result of a roof or pipe leak. If it is on an exterior wall then there may be water intrusion from outside or there may not be enough insulation so that condensation is occurring on the wall surface inside. The moisture source may not always be from a structural or design problem with the building. It may be due to human activity inside, like steam from showers or cooking, a spilled fish tank, or a leaking waterbed.

The key to preventing mold grow indoors is to limit the opportunities for moisture to come into contact with potential food sources for mold.

Mold Facts

Molds and fungi are simple, microscopic organisms, found virtually everywhere, indoors and outdoors. Molds and fungi can be found on plants, dry leaves, and other organic material. Molds and fungi play an important role in the environment by breaking down dead, organic material. Mold and fungi spores are very tiny and

lightweight, allowing them to travel through the air. Mold growths can often be seen as a form of discoloration ranging from white to pink and from green to brown and black.

Molds occur in nature, and as such, are always present in the air at ambient levels. Although airborne levels vary according to locale and current environmental conditions, most individuals will not suffer adverse health effects from exposure to background levels. Sometimes, though, conditions indoors can be favorable for fungal growth resulting in increased levels of airborne fungal spores, which can overwhelm the body's natural defenses. Inhalation of such elevated levels of airborne spores can result in allergic or toxic responses. Although infection can occur in an otherwise healthy individual, those most susceptible include infants, children, the elderly, and immune compromised individuals such as those undergoing chemotherapy or suffering from liver disease. The health effects from molds depend on the length and level of exposure (chronic vs. acute) and on individual sensitivity. Health effects from exposure to molds can be divided into four general categories: infection, toxicosis, allergy and irritation.

Infection

There is now over 100 species that are known to cause infection in humans. The three classifications of infection cause by fungi are systematic, opportunistic, and dermatophytic.

1. ***Systematic Infection*** is usually initiated when fungal spores are inhaled. A large minority of these infections are self-limiting and produce minimal or no symptoms. However, immune suppressed individuals may develop chronic localized infections that may disseminate throughout the body, possibly becoming fatal.
2. ***Opportunistic Infection*** is generally limited to immune suppressed individuals where infection is secondary to a primary disease. These fungi can thrive on both living and dead substrates for nutrients.
3. ***Dermatophytic Infection*** is cause by a group of fungi that infect the hair, skin and nails. Infection usually occurs through direct contact with an infected individual. Transmission to humans from an environmental source is rare although outbreaks from soil have been reported.

Toxicosis

Many fungi produce toxic metabolites called mycotoxins. The health effects from exposure to the levels of mycotoxins that may be encountered in contaminated indoor environments are not yet completely known. However, dramatic toxic and carcinogenic effects have been reported for animals and humans exposed to high levels of mycotoxins in laboratory studies. Generally mycotoxins are nonvolatile and exposure usually occurs only after disturbance of a contaminated source. Symptoms of exposure may include headache, nosebleeds, dermatitis, and immune suppression.

Allergy

Allergenic response is the most common symptom associated with exposure to elevated levels of fungal spores or mycelial fragments. Any fungus can be allergenic, producing antigenic proteins and polysaccharides that can cause allergic reactions in sensitive individuals. These reactions may be similar to those caused by pollen and may be seasonal in nature. Many people experience allergic responses in the fall when outdoor levels of mold are typically high.

Irritation

Fungi produce volatile organic compounds during degradation of substrates that cause the "moldy" odor associated with fungal contamination. These compounds can be irritating to mucous membranes causing headaches and other symptoms due to the decaying plant material.

Some of the common molds known to cause health problems include species of *Stachybotrys, Penicillium, Aspergillus, Fusarium, Alternaria,* and *Cladosporium.* These molds, with the exception of *Stachybotrys,* are very common outdoors.

Health Effects Of Mold Exposure

Molds are very common in nature and are to some extent always present in both indoor and outdoor air. Humans have a natural tolerance to molds and moist individuals will not suffer adverse health effects from exposure to background levels of mold spores. Mold growth indoors can cause indoor levels to increase to elevated levels, a condition called mold amplification. Inhalation of a large number of mold spores can overwhelm the body’s natural defenses causing adverse health effects.

Allergic responses are the most common health problems associated with exposure to elevated levels of mold spores. These reactions may be similar to those of hay fever or exposure to high

levels of pollen, such as headaches, sinus problems, congestion, sore throats, or coughing. These effects may be seasonal in nature. Many people experience allergic responses to molds in the fall when outdoor levels of molds are typically high.

Molds can also produce mycotoxins, which are chemicals associated with growth, digestion, and self-defense. Mycotoxins can be toxic to other organisms. Antibiotics like penicillin are made from mycotoxins that kill bacteria. Some mycotoxins can be toxic to humans and can cause very serious health problems. Mycotoxins can enter the body via inhalation, skin absorption, or ingestion. These chemicals are found on the surface of the spores and can be hazardous even if the mold spore is dead. Different mold species produce different mycotoxins, which can cause various reactions in exposed individuals. One mold called Aspergillus versicolor produces trichothecene toxins that are believed to cause neurological problems, such as memory loss, mood changes, constant headaches and trouble concentrating.

Exposure to mold spores and their mycotoxins can lead to a variety of non-specific health problems such as:

- Sinus problems
- Respiratory problems (wheezing, coughing, difficulty breathing)
- Headaches
- Cold and flu-like symptoms (fever, muscle aches, fatigue)
- Sore throats
- Eye irritation
- Frequent bloody noses

The types of health problems that develop depend on a variety of factors such as the length and amount of exposure and the mold growth conditions. Health symptoms may develop from chronic exposure and the mold growth conditions. Health symptoms may develop from chronic exposure at slightly elevated levels over a long period of time, or from acute term exposure at very high levels, like those that occur during mold abatement. The growth conditions of the mold, such as the organic content of the food source, temperature, and the amount of moisture present affects the production of mycotoxins, which in turn affects exposure to the toxins.

The greatest factor affecting the development of health problems is individual sensitivity. Some people are naturally more sensitive to the molds than others. When a family is living in a home with elevated levels of mold spores, often only one or two family members will suffer any health problems while the other family

members experience no ill effects. Individuals that are most susceptible include children, the elderly, and the immune-compromise patients, such as those undergoing chemotherapy or suffering from liver problems.

Mold exposure may be especially hazardous to young infants. It is believed that the Stachybotrys mold may have caused the death of 12 infants and the hospitalization of 37 infants in the Cleveland area of Ohio. These infants were hospitalized for pulmonary hemosiderosis, or bleeding of the lungs, which caused the infants to drown in their own blood. These infants all came from homes that had suffered recent flood damage and had growth of Stachybotrys in their home. The Centers for Disease Control is currently reviewing the data and has said that the association is not conclusive.

In most cases, the mold induced health symptoms will diminish upon removal from the environment with mold. Many doctors, however, believe that people having been exposed to high levels of molds have an increased sensitivity to them so in the future it takes less exposure to molds to develop the same symptoms. In some cases, exposure to high levels of molds can lead to scarring of the lungs or the development of asthma, especially in children, which can have long-term effects.

If a person suspects that they are being or have been exposed to high levels of molds and they are concerned about health problems, they should consult a qualified physician familiar with respiratory problems. If they have had testing done and have any laboratory data, they should bring the data with them to the doctor. While there are many molds that have the potential to be hazardous, only a physician can decide if mold is causing a particular individual’s health symptoms or determine if the mold exposure may have any long-term effects.

Common Symptoms of Health Effects

- Respiratory problems, such as wheezing, and difficulty in breathing
- Nasal and sinus congestion
- Eyes-burning, watery, reddened, blurry vision, light sensitivity
- Dry, hacking cough
- Sore throat
- Nose and throat irritation
- Shortness of breath
- Skin irritation
- Central nervous system problems (constant headaches, memory problems, and mood changes)
- Aches and pains
- Fever
- General malaise
- Chronic fatigue
- Bloody noses

Requirements of Mold Growth

- A food source –such as leaves, wood, paper or dirt
- A source of moisture
- An optimal location (warm stagnant air)

Sources of Indoor Moisture

- Slab foundations
- Flooding
- Backed-up sewers
- Leaky roofs
- Humidifiers
- Damp basement or crawl spaces
- Construction defects
- Plumbing leaks
- House plants- watering can generate large amounts of moisture
- Steam from cooking
- Shower/bath steam and leaks
- Wet clothes on indoor drying lines
- Clothes dryer vented indoors
- Combustion appliances (e.g. stoves) not exhausted to the outdoor

Characteristics of Commonly Encountered Fungi

Alternaria

Specimens of Alternaria are often found growing on carpets, textiles and horizontal surfaces such as window frames. It is commonly found in soil, seeds and plants. It is know to be a common allergen and is associated with hypersensitive pneumonia. Because of its small spore size, it is capable of being deposited in the nose, mouth and upper respiratory system. Sores in the nose, injured skin, and nail infections are prime targets and are easily irritated by Alternaria. It appears as a velvety tuft with long soft hairs and is often confused with Ulocladium as its color ranges from dark olive green to brown. Alternaria is a dry spore and is readily found in air samples as well as on tape lift samples.

Aspergillus

This genera is found on many different textiles and organic materials such as soil, compost, stored grain, wood and paper and its moisture requirements vary widely with some preferring dryer conditions. It is often found in water-damaged carpet. It is a dry spore and spores may be carried in the air making Aspergillus a common cause of respiratory irritation and infection. The mold may be woolly or cottony in texture and shades of green, brown or black in color. The spores are similar to *Penicillium* spores and sometimes indistinguishable though non-viable analysis, and as such, are often classified as Penicillium/Aspergillus.

Chaetomium

This fungus is an allergenic mold genus. Although it is not well documented it is known to cause hay fever and other common allergy symptoms and is sometimes associated with nail infections. It thrives on cellulose containing materials such as paper and plant compost. It is quite commonly found on wet sheetrock paper. It grows very quickly and may be cottony in appearance. It will range in color from white to gray, to olive green and olive brown to black. It has small brown oblong shaped spores that are easily spread by wind, insects and water splash.

Cladosporium

It is the most common mold found in outdoor environments. It is also found indoors on the surface of fiberglass duct liners and interior of supply ducts as well as on dead plants. It is drawn to food, straw, soil, paint, wood, textiles, and grows well on moist windowsills. Cladosporium grows at 0° C so it commonly associated with refrigerator foods. It is a common cause of hay fever, asthma and is a known allergen. It has a distinctive appearance and yields an olive brown pigmentation. The spores

are dry and easily become airborne if disturbed. The mold is moderately fast growing, and may look velvety or woolly.

Fusarium

This mold is found in soil, and on many plants. It requires very wet conditions to grow and is often found in humidifiers. It is know to produce trichothecene toxins, which effect the circulatory, alimentary, skin and nervous systems. On grains, it produces vomitoxin, which can affect you through ingestion and inhalation. Exposure to Fusarium can lead to hemorrhagic syndrome (symptoms include nausea, vomiting, dermatitis, and extensive internal bleeding). Fusarium is allergenic and is often associated with eye, skin and nail infections, and readily infects burn victims. Colonies of Fusarium appear in shades of pink, orange and purple, tan, yellow, and red. It is a wet spore so it does not generally appear in air samples.

Penicillium

This mold is commonly found in air samples as well as in soil, food, grains, paint, compost piles, wallpaper and interior fiberglass duct insulation. It is often found in water-damaged carpets. It can produce mycotoxins, which are allergenic and infect the skin. This soft mold is most commonly found in shades of blue, green and white, and may be velvety, woolly or cottony. Worldwide it is one of the most commonly found fungal genera and is accompanies by a heavy must odor. Identification to the species level can be difficult and the spores are very similar to *Aspergillus* species. See *Aspergillus* above.

Stachybotrys

Is found in building materials with high cellulose content. It is found indoors and grows well in damp straw, wicker and other wood or paper products. It is not known to compete well with other molds, but if there is a high level and constant availability to water for an extended period of time it may become the dominant mold. It is not very common outdoors and is usually not found in outdoor air samples. It has not, until recently, been extensively studied, but is believed to have caused bleeding in the lungs of several children in Cleveland, Ohio. Exposure to Stachybotrys can be particularly hazardous and is reported to produce flu-like symptoms including sore throat, diarrhea, and vomiting. In some cases it is reported to cause hair loss and dermatitis. Stachybotrys appears distinctively from other molds and is a dark gray to black color, sometimes with green, and is shiny when wet. It is a wet spore and does not generally become airborne unless it is disturbed.

Ulocladium

This mold is found on gypsum board, tapestries, wood and other organic materials. It is a potential allergen and produces symptoms such as hay fever and asthma. It is a dry spore and is detected by air samples as well as tape samples. Ulocladium has an appearance similar to Alternaria but tends to appear more brownish whereas Alternaria more often appears as a dark olive green color. Colonies grow rapidly and have a texture similar to velvet.

Mold Inspections

An investigation for mold growth begins with an inspection for visible mold growth. If there is no visible mold immediately noticeable, an inspection for signs of water damage is completed and areas with possible moisture sources are inspected. In general, mold requires a source of moisture to grow.

An obvious source of moisture is the bathroom. Mold growth in bathtubs, showers, and toilets is common and can usually be taken care of through regular housekeeping and maintenance. Similarly, light mold growth is often found on windowsills near the glass, where water condenses. This too can often be taken care of through regular housekeeping, and is usually not a problem unless the mold covers a large surface area or is allowed to grow unchecked such that it becomes

established deep in the wood fibers of the sill. Mold growth on windowsills is often a species of *Cladosporium,* which grows very quickly and is very common outdoors. This mold is usually not hazardous to healthy individuals unless it is present at high levels indoors. If mold growth around windows becomes a problem or a nuisance, installation of double paned windows or a ceiling fan may help to reduce condensation on the glass surface, there by limiting mold growth.

Mold growth over a large area on the windowsill or on sheet rock next to or below the windowsill is a more serious problem, as these surfaces are more likely to support the more hazardous molds, like *Stachybotrys*. Growth under or next to a windowsill may be the result of a construction defect or a flashing problem allowing water intrusion around the window. If water is allowed to intrude into a wall space, the paper backing on the sheet rock (a food source for molds) and the dark, stagnant air spaces create a perfect environment for mold growth to occur. If mold growth is visible on sheet rock inside a room, there may be a larger colony of mold growing on the other side of the sheet rock inside the wall space. If mold growth is suspected inside a wall space, drilling a small hole through the wall can collect an in-wall air sample.

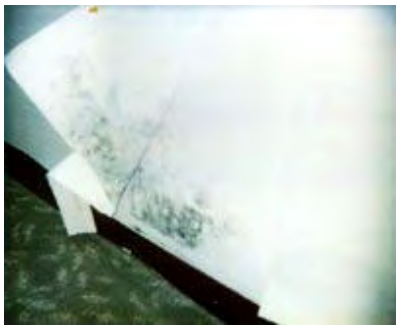
Other possible sources of moisture include:

- Sinks
- Dishwashers
- Leaking roofs and pipes
- Steam from cooking or showers
- Moisture vapor through slab foundations
- Indoor plants
- Wet towels or laundry
- Fish tanks
- Water heaters
- HVAC systems
- Washing machines

Moisture can also intrude into a home through exterior walls as the result of:

- Improper grading of the yard
- Flower beds next to exterior walls
- Outside sprinklers spraying against the house
- Cracked stucco
- Clogged weep screeds
- Missing or torn moisture paper
- *Or a combination of many of these problems*

Areas associated with these moisture sources should be inspected for signs of mold growth or water damage. These signs include:



- Cracked or bubbling paint
- Staining or discoloration
- Damp or soft walls or surfaces
- Buckling or warped flooring of baseboards
- Musty odors

Moisture from slab foundations can be a problem that leads to mold growth under flooring. Some moisture vapor emission from slab foundations is normal and unavoidable and the flooring industry standard for acceptable moisture emission is 3lbs of water per 1,000 square feet per day.

Sometimes the construction of the slab, the soil conditions under the slab, or the amount of time that there was allowed to cure before the house was built can lead to increased amounts of moisture vapor emitted through the foundation. This is not an obvious source of moisture and it often goes undetected for many years. The excess moisture vapor can be widespread, mold growth in carpeting or under tile of linoleum. The mold growth is often not visible, even if the underside of the flooring is inspected, but it does lead to highly elevated levels of airborne molds.

Typically excess moisture is only detected when it starts to cause discoloration of bubbling under linoleum. Sometimes, the signs of excess moisture vapor can be observed by white deposits, or dust, on the bare cement when carpeting is pulled back. These are minerals that precipitate out of the water vapor. Any dark sections of concrete are also signs of moisture. Any discoloration resembling mold growth on the edges of the bottom of the carpet tack strips can also indicate slab moisture problems.

If a slab foundation shows signs of excess moisture, a simple test can be completed to determine just how much moisture is being emitted.

The moisture vapor emission rate (MVER) test uses a canister with calcium chloride crystals that absorb moisture vapor and a plastic “dome” that is placed over the canister and sealed to the cement to create a controlled environment. The test runs for a period between 60 and 72 hours. The canister is weighed before and after the test and the change in weight is used to calculate the MVER.

The comparison of relative humidity and temperature readings inside and outside the building can also be helpful in the evaluation of mold problems inside buildings. Relative humidity levels higher than 60% indoors can foster mold growth as well as other air quality problems such as the growth of dust mites. If the relative humidity is much higher indoors than outdoors, it may be an indication that too much moisture is being trapped inside the building. The home may have a problem with mold or will likely have a mold problem in the future if the moisture is not resolved.

If a mold problem is suspected, because building occupants are experiencing mold related health symptoms or detect musty odors, a client interview may also help to locate the source of mold. Questions to include background information on the building, whether there has been any water damage in the past (even if it was supposedly fixed), when and where health symptoms or odors are most pronounced, and information of building use such as housekeeping activities and ventilation with outside air. A typical inspection checklist can be used as a guide when completing a mold inspection/investigation.

If mold growth is encountered during an inspection, it is important to determine what the specific moisture source is. Even if the mold is abated, it will return if the moisture problem is not resolved. Even a light amount of mold growth on sheet rock can be an indication of a roof or pipe leak or moisture intrusion from the outside. While the visible mold may not seem significant, there may be a larger problem inside the wall space.

A properly constructed and maintained building that has not experienced any water damage should generally not have a problem with mold growth, so if mold is present, a closer look should be taken at the structural issues related to the building.

Mold Sampling And Analysis

There are three basic methods of mold sampling: **air sampling, surface sampling,** and **dust sampling.**

Air Sampling

Air sampling involves drawing a known volume of air over a slide or petri dish with a growth medium. Air sampling can be one of the most effective ways to sample for the presence of mold because it provides quantitative data that can be used to evaluate exposure. It is a measure of the number of mold spores present in the air and an indication of the level of mold spores that is being inhaled in to the lungs. Air sample results are given as either a colony forming units of spores per cubic meter. Air sampling can often detect hidden mold problems, such as growth in carpeting, HVAC systems or inside wall spaces. Air sampling will generally report more species of molds than surface sampling. Surface samples often report between one and four species of molds on each sample, depending on the type of mold growth. Air sample results will detect as many as 30 different types of molds. Whereas a surface sample may miss some species of molds growing over a large surface, these molds will usually show up as elevated in an air sample, as any visible mold growth will usually release spores into the air. Air samples can also be collected from inside wall spaces without any destruction to the wall surfaces.

Air sampling is more expensive due to the equipment required to sample and the higher cost for laboratory analysis. Air sampling may also miss some molds, like the *Stachybotrys* mold, if the spores are not airborne. *Stachybotrys* has “sticky” spores that often do not become airborne unless they are disturbed, which can sometimes lead to false negatives in air samples.

The interpretation of air sampling data can sometimes be difficult. Evaluation of air sample data is based on a comparison of indoor levels to outdoor levels, so an outdoor air sample is always taken whenever an indoor air sample is collected. Generally, indoor spore levels should be 30-80% those of outdoor levels and the distribution of spore types should be similar. Outdoor levels, though, can fluctuate greatly based on many factors including the time of the day, weather conditions, the level of organic debris outside, and the time of year. Wind and rain will increase the levels of some molds and lower the levels of other molds. Organic debris, such as dead leaves or grass are a food source for mold so lawn maintenance will affect the outdoor mold levels. This often leads to higher levels of outdoor molds in the fall.

The degree to which indoor levels correspond to outdoor levels depends on a variety of factors as well, the most important of which is the amount of ventilation with outdoor air that a building has. While outdoor levels change throughout the day, the indoor levels may experience a lag in a corresponding change if the building is not ventilated to the outside. Housekeeping activities will also affect

indoor levels. Mold spores are a natural component of dust. Vacuuming without a HEPA air filter can temporarily cause mold levels to increase.

Dusting with a feather duster can also increase spore levels, while regular dusting with a damp cloth may help reduce mold levels. The level of activity indoors will also affect indoor levels as high activity can disturb settled spores. Air samples are a “snap shot” of the conditions at a given moment and are used as indicators for potential exposure.

Surface Sampling

Surface sampling can be used to determine what kind of mold growth, if any, is growing on a surface. Surface sampling is relatively simple and inexpensive and is effective in identifying the species or genus of *visible* mold growth. Surface sampling will determine the relative density of each of the mold species present on the surface rated of 1+ to 4+ with 4+ denoting the highest number of mold spores. This data can often be misleading without information on the sampling location and the surface area covered by the mold growth. A square foot area on a wall with 2+ levels of a mold species is much more serious than a dime size area with a 4+ level. One of the disadvantages of surface sampling is that it is a check of one particular area. Often if mold growth covers a large surface area, several different types of molds are present and different species are predominant in different areas. It may be necessary to collect multiple samples from several locations to identify all the molds present, especially if trying to determine if *Stachybotrys* is present. Surface sampling also does not provide any information on exposure to airborne spores.

There are three basic methods of surface sampling: bulk sampling, swab sampling, and tape sampling.

Bulk sampling involves the collection of a piece of material that may have mold growth on it. This material can be a piece of sheet rock, carpet, wood, wall paper, cloth, paper, soil, or any other material that is easily collected. Bulk sampling is generally best, as it will allow the lab technician to see the full growth structures of the molds and to look at a larger surface area, which may reveal the presence of multiple species of mold.

Swab sampling involves the use of a sterile swab sample that is misted with water and then moved across the surface of any *visible* mold growth. The swab is then placed in a sterile test tube and submitted for laboratory analysis. For mold growth over a large area, the swab is typically moved in a Z-pattern over a 1 square inch area.

Tape sampling is a very simple method of sampling for molds. To collect a tape sample, you simply place a piece of clear tape on a surface and press down to coat the tape. The tape is then placed on a microscopic slide or is folded over itself. If you are not wearing gloves, you will need to use a paper towel or cloth to press down on the tape to avoid betting fingerprints on the tape.

Dust Sampling

Dust sampling is a relatively new sampling technique that is believed to be a way to evaluate long-term levels of airborne mold spores. Airborne mold spores settle and become a natural part of dust.

Dust sampling involves the collection of dust using a modified vacuum to vacuum a section of carpet or from the air intake filter for the HVAC system. The dust is weighed at the laboratory and then plated onto a growth medium to culture the mold.

This technique is still being evaluated for its effectiveness in determining long-term airborne mold levels. One problem with this technique is that there is no way to correspondingly measure the outdoor mold levels to use for comparison. Another drawback is that the samples can only be analyzed using viable analysis methods, which is discussed in the next section.

In general, sampling using a combination of different sampling methods is the best way to investigate a potential mold problem inside a building.

Sample Analysis

There are two techniques for analyzing mold samples: **viable (culture)** and **non-viable direct exam)**. With viable analyses collected mold specimens are placed on different growth media in petri dishes and after a growth period of 7-14 days, the molds that develop are examined and identified. With non-viable analyses, the mold specimens are examined under a microscope and are identified based on the visual characteristics of the collected spores or specimens. It does not determine weather the mold is viable or non-viable. Both air and surface equipment is used for collecting air samples, depending on whether viable or non-viable techniques. Different kinds of equipment are used for collecting air samples, depending on whether viable or non-viable analysis is needed. Dust samples can only be analyzed using viable methods.

Viable analysis report results as colony forming units of mold species. Air sample data are reported as colony forming units (CFUs) per cubic meter or other volume of air. If a surface sample is collected over a known area, then the culture results will be reported in CFUs per unit of area. Dust sample results are reported as CFUs per gram of dust.

Direct examination of surface samples only reports the relative densities of the molds present on a scale of +1 to +4 with +4 denoting the highest density. Non-viable analysis reports the number of individual spores detected in an air sample, and the results are reported as spores per cubic meter. Sometimes spores are found in clumps, and with direct exam spores in these clumps are counted individually. With culturable methods, a clump of many spores will only develop into one colony-forming unit.

Like the different sampling methods, the different methods for sample analysis have advantages and disadvantages. Direct examination will identify any airborne molds present in the sample, regardless of whether they are viable or non-viable.

This is important because the mycotoxins present on the mold spores can still be harmful even if the spores are dead. Also, some molds, like the *Stachybotrys* mold, can become dormant under certain conditions, such as when exposed to light. These dormant spores are no longer actively growing and reproducing, but are not dead. They will not grow in a viable culture, but may grow again later inside the building where the sample was collected when conditions become favorable again. *Stachybotrys* is thus rarely detected in viable air samples. Direct examinations can also be completed by the lab immediately upon receipt of samples so results can be obtained as soon as the day of sampling if rush service is needed, whereas viable sampling can take up to two weeks.

One problem with direct examination of air and surface samples is that it can be difficult to identify some mold species, and often identification is only possible down to the genus level. Two of the most common molds, the *Aspergillus* and *Penicillium* genera, are indistinguishable using non-viable analysis methods, so they are often grouped together on direct examination reports as spores typical of *Penicillium/Aspergillus*.

Viable cultures can also over represent or under represent some mold species or miss some altogether, depending on the growth media used and other factors such as competition. Some molds will compete better and reproduce in some media, which can make it appear that the airborne levels are higher than they really are. Usually, viable samples are cultured with different types of media to try to reduce this error. Viable analysis also takes longer than direct examination since the lab must wait for the molds to grow before identifying them.

One benefit to viable analysis is that it can differentiate the *Penicillium* and *Aspergillus* molds and identify the different *Aspergillus* species. This is important because the different *Aspergillus* species can produce different mycotoxins, which can

cause different health problems. One species, *Aspergillus* versicolor, produces a mycotoxin called Sterigmatocystin, which is a carcinogen.

Like the different sampling methods, it is generally best to use a combination of analysis methods to fully define a mold problem in a building. If a sampling budget limits the amount of samples that can be collected, though, it is generally better to use non-viable analysis on the samples, so as not to miss any marker genera, like *Stachybotrys*.

Mold Abatement

The first step in mold abatement is to find and eliminate the source of mold. The mold-impacted materials including flooring, sheet rock, insulation, and any other materials with visible mold must be removed and disposed of. It is always safer to remove all the infected material than to try to treat and risk the mold returning, especially if mold is growing on porous materials like sheet rock or wood. For substantial mold growth, this may require removing interior walls and/or siding to expose the framing as shown in the photo.

Any surface that is not easily removed, like wood framing, may remain provided it is not severely impacted with mold growth, is structurally sound, and is thoroughly treated to kill the mold and remove the dead spores. In many cases this may require a 10% chlorine solution with several applications. (Ordinary household bleach is usually a 0.5% chlorine solution) Chlorine at this strength is very caustic to the skin and procedures hazardous fumes and should be used only by a certified and experienced hazardous materials abatement team.

The abatement work depends on the types of molds present. *Stachybotrys* can be especially difficult to eradicate and sometimes require more extensive treatments. With other molds, once the source is removed and the surfaces treated, it is acceptable to still have background levels of spores in the indoor air since these molds are very common outdoors and indoors. *Stachybotrys* is not normally found outside and should not be present in indoor air samples at all. The spores are also sticky so they will stick to furniture and can become dormant, but germinate later if conditions are favorable. Thus, when conducting mold abatement with *Stachybotrys,* it is necessary to fully remove all of the airborne spores as well as the physical growth from the building. This requires additional air filtering and air exchanges during abatement.

When conducting abatement it is necessary to limit the amount of spores that become airborne and prevent cross contamination of spores to clean rooms. This involves sealing off affected areas with plastic, sealing off and/or limiting use of the HVAC system, and using vacuums and air filtering devices with HEPA filters.

Abatement zones should be kept under a negative pressure with engineered controls. Personal protective equipment (PPE) should be used and all personnel should go through decontamination. After the abatement is completed, it is also a good idea to have the HVAC system fully cleaned.

Mold abatement can be extremely hazardous if proper precautions are not taken. Mold spores are found on the surface of mold and become airborne when disturbed. During abatement or cleanup activities mold levels will increase from 10 to 10,000 background levels. It is very important that PPE be worn when doing any kind of mold cleanup. At the very minimum, gloves, goggles, and a dust mask should be worn. Personnel trained in the proper handling of hazardous materials should complete mold abatement of large areas of mold growth. For these jobs, level C PPE is required which includes gloves, full coveralls, and a full-face respirator, as shown in picture to the right.

It is very important that all moisture intrusion issues be resolved after the abatement is completed. The mold will return if all moisture sources are not eliminated!

Confirmation testing should also be completed after the abatement work is completed to verify the success of the abatement work. Samples should include viable surface samples of treated surfaces and air samples in all treated areas. If mold growth is reported from any viable surface samples, additional treatment is necessary. If airborne levels are higher than background levels for any mold species, additional treatment of the surfaces and/or air may be necessary.

Common Misconceptions About Mold

1. **This isn't mold, its just mildew. *Or* this mold isn't the toxic mold.**

   Mold and mildew is the same thing. Mildew is often the term used for mold growth on clothing or fabric. Clothing and fabric

can have a high organic content making them great food sources for mold. The term toxic mold has most often been applied to the *Stachybotrys* mold and can be misleading. While the *Stachybotrys* mold has the potential to be hazardous, there are many other species of mold like *Aspergillus, Penicillium, Fusarium,* and *Alternaria* that are very common and can be just as hazardous. Any mold growth on a surface with an organic content (i.e. paper, cloth, wood, sheet rock, etc) has the potential to be *Stachybotrys* or one of these molds know to have potential negative health effects.

There are even more types of molds that have the potential to cause health problems if present at high enough levels. Any significant amounts of visible mold will likely cause elevated levels of mold spores in the air. Just because mold is not *Stachybotrys*, it does not mean that the mold is not a problem and that it cannot be harmful. Immediate steps should be taken to eliminate any mold growth indoors, regardless of the type, and care should be taken in completing the mold abatement.

2. If the mold is not *Stachybotrys,* it is safe to clean it myself.

When doing any kind of mold abatement, it is necessary to take steps to limit exposure, no matter what type of mold it is. This includes wearing gloves, coveralls, and respiratory protection. Mold levels can increase up to *10 to 100,000* times background levels during mold clean up resulting in acute exposure. For large areas of mold it is recommended that individuals properly trained in the handling of hazardous materials complete the clean up. It is also important to ensure that all infected materials are properly treated or removed so the mold does not return.

3. If you have *Stachybotrys* in your home you have to get rid of all your personal belongings.

When *Stachybotrys* is present there is a risk of cross contamination of spores to clean areas because the *Stachybotrys* spores are sticky and may stick to the surfaces of furniture and other belongings. If *Stachybotrys* contamination is extensive in a home it may be safer and more cost effective to throw away the personal belongings rather than treat them and risk bringing the mold spores into a new residence.

If *Stachybotrys* is growing on wall or other surfaces in a home, it can release spores into the air that will settle on the *surface* of furniture and other belongings. As long as there is no moisture on those surfaces the spores will not form active growth. Since the spores are primarily just on the surface of the furniture, they can be treated and removed.

Soft furniture items may require additional cleaning to remove spores. Furniture can also be tested to determine if they contain *Stachybotrys* spores prior to moving into a new home.

4. I want to make sure that my house is free of mold.

No house is completely free of mold. Molds are very common outside, so some mold spores will always be present in the air indoors as well. We are exposed to the outdoor or background levels of molds every time we go outside, and in most cases will not experience any adverse reactions, with the exception of hay fever or allergy like symptoms in some sensitive individuals when outdoor levels are high. Mold *growth* inside a building is *not* normal, though. If mold is growing on a surface inside a home, it will create indoor levels of spores that are higher than what the body is normally used to, which can overwhelm our natural defenses to mold spores and cause adverse reactions. When a home is tested for mold, it is checked to make sure that the levels of molds indoors is comparative to the background levels, and that mold is not actively growing inside.

5. I cleaned the mold with bleach, so I have fixed the problem.

Bleach is not always effective at killing mold, especially if the mold is present on a porous or fibrous material, like wood or sheet rock. If mold growth is significant, it is better to remove the impacted material, rather than treat it. For some surfaces that are harder to remove, like wood framing in homes, it may be necessary to complete multiple treatments with a stronger chlorine solution than is found in bleach.

Cleaning the mold also does not fix the underlying moisture problem that is allowing the mold to grow. Mold should not grow without a moisture source, so if mold is growing on a wall, there may be a hidden leak somewhere or there may be a problem with water intrusion from outside. If mold is growing on sheet rock, there are may be a larger, hidden problem inside the wall space, which is not accessible without removing the sheet rock.

Ten Things You Should Know About Mold

1. Exposure to elevated levels of molds can cause serious health problems, such as respiratory problems and sinus problems, cold and flu-like symptoms, headaches, fatigue, trouble concentrating, and memory loss. Those most susceptible include young children, the elderly, those with

compromised immune systems, and other sensitive individuals.

2. There are many molds that have the potential to cause health problems including *Alternaria, Aspergillus, Chaetomium, Cladosporium, Fusarium, Penicillium,* and *Stachybotrys.* (Just because you can't pronounce it doesn't mean it can't harm you.)
3. Mold spores can cause health problems even if the spores are dead.
4. Mold requires an organic food source, such as cloth, sheet rock, or wood, and a moisture source to grow. Mold can begin to grow if any organic material that remains wet for more than 48 hours. The way to control mold growth indoors is to control moisture indoors.
5. Mold spores are very common outdoors and there is no practical way to eliminate all mold spores indoors.
6. Molds can grow undetected inside wall spaces, under carpet, and inside HVAC systems.
7. Mold growth can often be the visible sign of a structural defect that allows moisture to intrude into a building.
8. When doing mold abatement, it is first necessary to find and eliminate the moisture source. If the moisture problem is not resolved, the mold growth will return.
9. Cleanup of large areas of mold growth can cause airborne levels of spores to increase up to 10,000 times that of background levels resulting in acute exposure to those doing the cleanup if personal protective equipment is not worn.
10. The best way to abate mold growth indoors is to remove the impacted materials. Cleaning the surface of a material with mold growth may not always kill the mold, especially if mold is growing on porous materials like sheet rock or wood.

Frequently Asked Questions About Mold

Q. What are molds?

With more than 100,000 species in the world, it is no wonder molds can be found everywhere. Neither animal nor plant, molds are microscopic organisms that produce enzymes to digest organic matter and spores to reproduce. These organisms are part of the fungi kingdom, a realm shared with mushrooms, yeast, and mildews. In nature, mold plays a key role in the decomposition of leaves, wood, and other plant debris. Without mold, we would find ourselves wading neck-deep in dead plant matter. And we wouldn't have great foods and medicines, such as cheese and penicillin. However, problems arise when mold starts digesting organic materials we don't want them to, like our homes.

Q. How do molds grow in my home?

Once mold spores settle in your home, they need moisture to begin growing and digesting whatever they are growing on. There are molds that can grow on wood, ceiling tiles, wallpaper, paints, carpet, sheet rock, and insulation. When excess moisture or water builds up in your home from say, a leaky roof, high humidity, or flooding, conditions are often ideal for molds. Longstanding moisture or high humidity conditions and mold growth go together. Realistically, there is no way to rid all mold and mold spores from your home; the way to control mold growth is to control moisture.

Q. How can I be exposed to mold?

When molds are disturbed, their spores may be released into the air. You then can be exposed to the spores through the air you breathe. Also, if you directly handle moldy materials, you can be exposed to mold and mold spores through contact with your skin. Eating moldy foods or hand-to-mouth contact after handling moldy materials is yet another way you may be exposed.

Q. How can molds affect my health?

Generally, the majority of common molds are not a concern to someone who is healthy. However if you have allergies or asthma, you may be sensitive to molds. You may experience skin rash, running nose, eye irritation, cough, congestion, and aggravation of asthma. Also if you have an immune suppression or underlying lung disease, you may be at increased risk for infections from molds.

When necessary, some resourceful molds produce toxins in defense against other molds and bacteria called mycotoxins. Depending on exposure level, these mycotoxins may cause toxic effects in people, also. Fatigue, nausea, headaches, and

respiratory and eye irritation are some symptoms that may be experienced from exposure to mycotoxins. If you or your family members have health problems that you suspect are caused by exposure to mold, you should consult with your physician.

Q. How do I know if I have a mold problem?

You may have seen white thread-like growths or clusters of small black specks along your damp bathroom or basement walls, or smelled a "musty" odor. Seeing and smelling mold is a good indication that you have a mold problem. However, you cannot always rely upon your senses to locate molds. Hidden mold can be growing behind wall coverings or ceiling tiles.

Common places to find mold are in areas where water has damaged building materials and furnishings perhaps from flooding or plumping leaks. Mold can also be found growing along walls where warm moist air condenses on cooler wall surfaces, such as inside cold exterior walls, behind dressers, headboards, and in closets where articles are stored against walls. Rooms with both high water usage and humidity, such as kitchens, bathrooms, laundry rooms, and basements are often havens for mold. If you notice mold or know of water-damaged areas in your home, it is time to take action to control its growth.

Q. How can I control mold growth in my home?

Fix any moisture problems in your home:

- Stop all water leaks first. Repair leaking roofs and plumbing fixtures. Move water away from concrete slabs and basement walls.
- Increase air circulation within your home, especially along the inside of exterior walls, and ventilate with fresh air from outside. Provide warm air to all areas of the home. Move large objects away from the inside of exterior wall just a few inches to provide good air circulation.
- Install and use exhaust fans in bathrooms, kitchens, and laundry rooms.
- Ventilate and insulate attic and crawl spaces. Cover earth floors in crawl spaces with heavy plastic.
- Clean and dry water damaged carpets, clothing, bedding, and upholstered furniture within 24 to 48 hours, or consider removing and replacing damaged furnishings.
- Vacuum and clean your home regularly.

Q. What about cleanup?

The time you are most likely to stir up spores and be exposed is the very time you are trying to clean up your mold problem. That's when you need to be the most careful. First, try to determine the extent of the mold infestation. If the area is small and well defined, clean up can be done by you, as long as you are free of any health symptoms or allergies. However, if the mold problem is extensive, such as between the walls or under the floors, you should leave clean up to a professional.

Large Areas	**1.**	Consider having a professional cleanup the area. To find a professional, check under "Fire and Water Damage Restoration" in your Yellow Pages. If you decide to clean up on your own, follow the guidance below.
	2.	Protect yourself by using goggles, gloves, and breathing protection while working in the area. For large consolidated areas of mold growth, you should use an OSHA (Occupational Safety & Health Administration) approved particle mask.
	3.	Seal off area from the rest of your home. Cover heat registers or ventilation ducts/grills. Open a window before you start to clean up.
	4.	Remove all your furnishings to a neutral area to be cleaned later. Follow cleaning directions below.
	5.	Bag all moldy materials, you will be discarding.
	6.	Scrub all hard surfaces with a solution of ¼ cup bleach to one quart of water. Wait 20 minutes and repeat.
	7.	Rinse all hard surfaces with a mild detergent solution, such as laundry detergent and warm water.
	8.	Give the entire area a good cleaning, vacuum floors, and wash bedding and clothes if exposed.

Small Areas	**1.**	Protect yourself by using goggles, gloves, and breathing protection while working in the area. For small isolated areas of mold growth, a cotton dust mask should do.
	2.	Seal off area from the rest of your home. Cover heat registers or ventilation ducts/grills. Cover all your furniture. Open a window before you start clean up.
	3.	Bag all moldy materials, you will be discarding.
	4.	Scrub all hard surfaces with a solution of ¼ cup bleach to one quart of water. Wait 20 minutes and repeat.
	5.	Rinse all hard surfaces with a mild detergent solution, such as laundry detergent and warm water.
	6.	Give the entire area a good cleaning, vacuum floors, and wash bedding and clothes if exposed.

Clean all furnishings exposed to mold.

Permeable and washable		Such as clothing, bedding, and other washable articles. Simply run through the laundry.
Non-permeable and washable		Such as wood, metal, plastic, glass, and ceramics. Mix a solution of one cap bleach to one quart of water. Bleach may fade colors, so test your beach solution before using. If fine, wipe down your articles.
Permeable but not washable		Such as beds and furniture. If these furnishings are moldy you should consider discarding and replacing them. If you decide it is a keeper, take the furnishing outside. Give it a good vacuuming, and let it air out. When finished, if you do not notice an odor it should be okay. However, watch for any mold growth or health problems.

Indoor Air Quality

January 1999

Primer

Environmental Health Programs
Office of Toxic Substances

The purpose of this document is to give the reader a brief overview of possible residential indoor air quality (IAQ) problems and provide a basic understanding of problem identification, control methodologies, some specific pollutants, their sources, potential health effects, and indoor air monitoring methodology.

IAQ in our homes, schools, and office buildings has received increasing attention in the past few years from scientists, engineers, regulatory groups, and the public. There is growing concern and mounting evidence that our indoor environment may be responsible for persistent, irritating health effects. Traditionally, it has been assumed that people were protected from air pollution when indoors, particularly near industrialized areas. However, recent research has shown, that this is not necessarily true. Current research indicates that our indoor air may be more polluted than outside air, even in industrialized areas. This increased concern is accompanied by the realization that most people spend 80-90 percent of their time indoors and that the young, aged, and health-compromised may be at greater risk.

As a result of the energy crisis of the early seventies, the cost of energy increased by a factor of almost ten. During that time, the U.S. Government, private industry, and the commercial sector all developed ways to better design new buildings and homes, as well as retrofit existing buildings and homes with better insulation and energy conservation devices. This resulted in energy savings by decreasing ventilation, thus reducing or eliminating the amount of outside air that needs to be heated or conditioned. However, the efforts to conserve energy, along with the increasing use of synthetic building materials, contributes to an indoor air environment that is a possible cause of increasing adverse health effects. In certain circumstances, reduced ventilation alone has resulted in adverse health effects to occupants due to increased levels of indoor air pollutants.

Several indoor air pollutants have received special public health attention. These include formaldehyde, asbestos, radon, and tobacco smoke. Other indoor pollutants that can be associated with health or irritating effects are carbon monoxide, nitrogen oxides, household and personal care products, microorganisms, and allergens.

Although standards for work place exposure to many toxic compounds have been established in the United States and other countries, almost no regulatory standards or guidelines have been established in the U.S. for residential indoor air. Several other countries have established residential IAQ standards for several pollutants, particularly formaldehyde. Our ability to accurately assess the health risks associated with exposure to these compounds is limited. There is insufficient data on the number of people exposed, the susceptibility of individuals, the patterns and degree of exposure, and the actual health effects from exposure to low levels and mixtures of pollutants typically found in the residential environment.

Problem Identification

IAQ related illnesses are usually characterized by one or more of the following symptoms: irritation of the eyes, nose and/or throat; headache; cough; runny nose; lethargy; and difficulty sleeping. Other less common symptoms reported include dizziness, nausea, diarrhea, dry skin, and rash. Symptoms appear unrelated to any identifiable common illness. However, because these symptoms are common to many different ailments, a physician, allergist, or dermatologist should be consulted to determine any physical condition that may account for the symptoms experienced. The symptoms are often most severe during the winter months. Symptoms may affect only selected individuals in the home and usually are most severe in family members who spend the greatest amount of time at home, such as mothers and their young children. Symptoms become less severe when away from the indoor environment in question and often disappear with extended absences (e.g., during vacations). Symptoms will often become less severe or disappear when the home is ventilated by opening windows or during cold winter days when air infiltration is high and humidity is low.

The first appearance of symptoms are commonly associated with:

- Moving into a recently purchased home or new mobile home.
- Recent remodeling.
- Homes with urea-formaldehyde foam insulation.
- Implementing energy conservation measures that significantly reduce heat loss and ventilation rates.
- Purchase of new furnishings.
- Installation of new kitchen or bathroom cabinets.
- Installation of new carpeting or cleaning of carpeting.
- Use of some recreational vehicles.

Office building workers have often been victims of indoor air pollution commonly referred to as "Sick Building Syndrome" (SBS). SBS events are characterized by a significant number of building occupants with specific health complaints. Investigations usually reveal several indoor pollutants, more often than not in extremely low concentrations. Usually no one indoor air pollutant can be identified as the likely cause of health complaints. It is often thought that the many pollutants in combination are responsible for reported health effects. Investigations have indicated that SBS occurs most often in buildings where ventilation rates are maintained near minimum requirements. Often improved ventilation alleviates the problem. Nonresidential IAQ is discussed in a separate fact sheet distributed by the Washington State Department of Labor and Industries. Copies can be obtained by calling (360) 902-5436.

Control of Indoor Air Pollutants

Three general methods are used for controlling indoor air pollutants: source removal or modification, ventilation, and air cleaning.

Source Removal/Source Modification

Source removal and source modification (or substitution) are generally considered before other alternatives because the pollutant sources and their rates of emission are the most important factors in determining the overall IAQ. Source removal is the most desirable since it permanently removes the pollutant source. In practice, source modification and substitution are the more common forms of control. Source modification involves measures to reduce pollutant emissions, such as restricting smoking. Substitution usually involves replacement with a less toxic alternative, such as water based prodiucts versus solvent based.

Dilution Ventilation

Ventilation can be used to reduce pollutant concentrations to levels below which no adverse health effects are experienced. By increasing the ventilation rate in a building, pollutants are rapidly dissipated by providing less contaminated air from the outside to mix with and dilute higher indoor contaminant levels. This is generally accomplished through non-mechanical means such as infiltration or by opening windows and doors.

In older homes and new homes that are not well sealed, the air exchange rate is usually between 0.8 and 1.5 air changes per hour (ACH). Newer, well-constructed houses and older, weatherized houses generally have between .5 and 1.0 ACH. Apartments often have even lower ACH. One researcher reports that each 30 percent reduction in the ventilation rate, as can be expected between energy efficient and non-energy efficient homes, results in a 43 percent increase in indoor air contaminants. This increase is also dependent upon the contaminant, its source strength, and rate of emission.

For homes with very low ACH and those with certain pollutant producing sources, an active mechanical ventilation system may be necessary. This may be either a system for the entire home or to control a specific pollutant produced from an activity or appliance. For instance, it is recommended that gas ranges have a mechanical exhaust hood located directly above the cooking surface to exhaust combustion by-products directly to the outside. Because of the additional heating or cooling costs associated with whole house ventilation systems, such ventilation is not recommended without heat recovery. An efficient, economical mechanical ventilation system for the entire home is an air-to-air heat exchanger. These systems, when properly sized and installed, can provide an average of 60-85 percent heat recovery from exhaust air and substantially reduce the energy penalty associated with forced ventilation. In general, the higher the forced ventilation rate the greater the reduction in pollutants.

While ventilation is frequently helpful in reducing indoor air contaminant concentrations, it is more efficient to reduce or eliminate pollutants at the source.

Air Cleaning

Air cleaners operate by mechanical filtration, absorption, adsorption, or electrostatic precipitation of pollutants. Extended surface pleated filters serve the most effectively and will be the most useful over the widest range of pollutant types. These filters are available as stand-alone units, as add-ons, or as in-lines for most home systems. Filter size and efficiency vary. Contact your home system contractor for specific applications.

Negative ion generators can be effective air cleaners. Negative ion generators emit negative charged ions which attach to airborne particles, which then attach themselves to room surfaces removing them from the air. These particles, however, are potentially subject to resuspension and should be removed with high efficiency particulate air vacuum cleaners. Although some advertisers' claims regarding effectiveness and health benefits have not been verified, this method is considered moderately effective at reducing particulate levels.

Electrostatic air precipitators are an effective air cleaning method to reduce indoor particulates. These units operate by putting an electrical charge on particulates and then removing them from the air by attracting them to an oppositely charged plate. These units are available for installation in the duct of a forced air heating or ventilation system or as independent units. Electrostatic precipitators and negative ion generators may produce ozone, a potential respiratory irritant. However, the amount of ozone produced is usually quite small.

Activated carbon and specialty filters with adsorbents are available for the removal of gaseous contaminants. This method of filtration can be quite effective; however, sizing and maintaining this type of filtration system can be complicated. The Department of Health recommends that you contact your heating contractor for help in selecting this type of filtration system.

Ozone generating devices have been much touted as the final cure for all indoor air problems. Testing has been done which indicates that these devices can and do exceed the work place standard of 0.1 parts per million (PPM). Since ozone is a potent irritant and toxic material implicated in lung tissue changes, immune system dysfunction and asthma severity and attack rates the Department of Health recommends against the use of ozone generating devices in an occupied space.

Additional information on filter types and applications can be obtained at the Environmental Protection Agency (EPA) IAQ clearinghouse at 1-800-438-4318, or through the American Lung Association at 1-800-LUNG USA.

Pollutants

Following is a brief discussion of common indoor air pollutants, their sources, potential health effects and acceptable mitigation measures. Pollutants included in this discussion are:

- Formaldehyde
- Asbestos
- Radon
- Tobacco smoke (ETS)
- Combustion by-products
- Household chemicals
- Pesticides
- Microorganisms, allergens, and mold

Formaldehyde

Formaldehyde (HCHO) is a colorless, flammable gas with a pungent suffocating odor. It is the most important aldehyde produced commercially, and is used in the preparation of urea-formaldehyde and phenol-formaldehyde resins. It is also produced during the combustion of organic materials and is a component of smoke.

Health Effects

Health effects associated with exposure to HCHO fall into several categories. These include: irritant effects, sensitization, and carcinogenicity. HCHO is intensely irritating to the mucous membranes, which includes

the eyes and respiratory tract. Common symptoms from exposure to HCHO include: burning eyes, nose, and throat; headache; and nausea. HCHO has the potential to sensitize exposed individuals, which can involve both asthma symptoms and skin reactions. Some people exposed to HCHO will develop asthma symptoms. These symptoms include wheezing and chest congestion. Urticaria (a skin condition marked by intensely itching wheals usually caused by an allergic reaction) has been reported following inhalation of HCHO fumes. HCHO can be considered a sensitizing agent. Documentation of this effect has been seen in dialysis patients, as well as persons chronically exposed to low levels in mobile homes. HCHO has been designated as a probable human carcinogen, and has also been designated as a workplace carcinogen by the National Institute for Occupational Safety and Health (NIOSH).

U.S. Occupational Safety and Health Administration and Washington State Department of Labor and Industries workplace regulations call for exposures which do not exceed 0.75 PPM as an eight hour time weighted average (TWA), with a 0.5 PPM action level, and a 2 PPM short-term exposure limit for 15 minutes. NIOSH recommends a 0.016 PPM eight hour TWA and a 0.1 PPM 15 minute ceiling. The American Council of Governmental Industrial Hygienist recommend a ceiling of 0.3 PPM.
No residential standard exists in Washington State. The American Society of Heating, Refrigeration, and Air Conditioning Engineers recommends a maximum continuous indoor air concentration of 0.1 PPM. Other states and several foreign countries have guidelines or standards for residential indoor air exposures which range from 0.1 to 0.5 PPM.

The odor threshold ranges from 0.05 PPM to 1 PPM. At concentrations of 0.05 to 0.5 PPM HCHO produces a definable sensation of eye irritation. In occupational studies, reports of eye tearing, prickling, stinging, and burning are reported at levels from 0.13 to 2.7 PPM. Airway irritation has been reported as low as 0.1 PPM, but more commonly occurs in ranges of 1 to 11 PPM. Symptoms range from the feeling of a dry throat, tingling of the nose, to a sore throat. However, airway irritation (at concentrations of 5-30 PPM) is characterized by cough, chest tightness, and wheezing. Chronic industrial exposure to concentrations ranging from 0.5 to 8.9 PPM produce changes in the nasal and pharyngeal mucosa, and complaints of throat irritation, diminished sense of smell, and dryness of the throat. HCHO has been associated with both the development of asthma and the initiation of asthma attacks. High levels (50-100 PPM) have been associated with swelling of the lung and movement of fluid into the lung, as well as pneumonia. Exposures to levels greater than 100 PPM can be fatal.

Sources
The major sources in residential settings are building materials. These products may contain phenol, urea, thiourea, or melamine resins which contain HCHO. HCHO has also been used in the paper, photographic, and clothing industries. It is used in the finishing of all permanent press material, and can be found in the glues used in furniture construction, or carpet and vinyl attachments.

Urea-formaldehyde resin containing products are the most common HCHO source in the home. This formulation is approved for interior grade materials such as plywood, hardwood cabinetry, and wall paneling. Urea-formaldehyde resins release trapped free HCHO, as well as HCHO resulting from chemical degradation. Degradation of HCHO resins can occur when these materials become

damp from exposure to high relative humidities, or if the HCHO materials are saturated with water during flooding, or when leaks occur. The release of HCHO occurs when the acid catalysts involved in the resin formulation are reactivated. Levels of out-gassing can also increase with increasing temperatures and relative humidity.

Control Methods
The prevention of problems associated with exposure to HCHO are best treated by source control. The selection of HCHO free or low-emitting products such as exterior grade plywood which use phenol HCHO resins for indoor use is the ideal starting point. Alternatives to source control include: filtration, sealants, and fumigation treatments. Filtration can be achieved using selected adsorbents. Sealants involve coating the materials in question with two or three coats of nitro-cellulose varnish, or water based polyurethane. Three coats of these materials can reduce out-gassing by as much as 90 percent. Professional carrier gas treatment with ammonia will also minimize HCHO out-gassing.

Testing for HCHO can be accomplished with passive monitors, real time active monitors, or colorimetric sorbent tubes. Passive monitors can be purchased through industrial hygiene suppliers or through independent contractors who manufacture their own monitors. For listings in your area, refer to your telephone book under **analytical laboratories** or **environmental services**.

Asbestos

Asbestos is the generic name for several fibrous minerals. The three main types are chrysotile (white), crocidolite (blue), and amosite (brown). Asbestos' characteristics of flexibility, strength, incombustibility, and durability resulted in its widespread use between the 1920s and mid 1970s. Chrysotile asbestos accounts for approximately 95 percent of all asbestos used and is anticipated to be less pathogenic than the amphibole type asbestos products.

Sources
Asbestos-containing materials may be present in many household products manufactured before 1977, as well as in many areas in and around the home. Some of the more common locations are old pipe and furnace insulation, vinyl floor tiles and vinyl sheet flooring, patching compounds and textured paints, brake and clutch pads, roofing materials, home siding, some 1930-1950 wall and ceiling insulations, some decorative ceiling materials, and other items requiring the characteristics of asbestos.

Health Effects
Asbestos exposure has been shown to cause cancer of the lung; a rare cancer of the chest and abdominal lining called mesothelioma; and cancers of the esophagus, stomach, colon, and other organs. It can also cause a noncancerous chronic and debilitating lung disease called asbestosis. Asbestosis is related to lengthy exposure to high levels of asbestos fibers as was common in some industrial environments during the 1920s to the 1940s. Asbestosis is not considered a significant outcome from incidental nonoccupational exposure. The amount of exposure necessary to cause disease is unknown and is probably different for different population subgroups. Asbestos-related diseases generally do not appear for 15-35 years after first exposure. This length of time between first exposure and onset of disease appears to be related to the amount and duration of exposure. However, it is believed that any exposure to asbestos involves some health risk. No safe level of exposure has been established.

Asbestos and cigarette smoking combined significantly increase the potential for lung

cancer. Studies have shown asbestos workers who smoke have a risk of lung cancer eight times greater than smokers in the general population. This same group has a lung cancer risk 92 times greater than unexposed nonsmokers.

The presence of asbestos in the home alone does not necessarily mean there is an exposure problem. Asbestos is hazardous if inhaled and this usually occurs only when asbestos-containing materials have been damaged and there is a release of asbestos fibers. Of greatest concern are asbestos products that are friable (this means easily crumbled, pulverized, or powdered by hand). Unless the material is crumbling, needs repair, or must be removed, it is recommended that it not be disturbed. Improper removal and handling can release high levels of fibers into the air that then become a continual source of exposure.

Control Methods

Asbestos control methods generally include source removal or source modification. Small minor repairs can often be taken care of by duct tape or other commercial products which seal the damaged area. Heat resistant paints and sealers are also sometimes suitable for small repairs. These products are often available through commercial paint and safety supply outlets.

Removal should be done only when necessary. Although current law permits a homeowner to perform their own removal work, **it is recommended that removal work be done only by contractors with highly-trained workers** who are required to be certified by the Washington State Department of Labor and Industries. These workers are knowledgeable about the permits that must be obtained, safe removal practices, necessary protective equipment, and proper disposal methods.

Homeowners choosing to do their own removal must first notify their local air pollution control authority. They may also be required to notify their local health department and other local government agencies. Information regarding proper removal practices, protective equipment, and disposal can be obtained through local health departments, local air pollution control authorities, and the Department of Labor and Industries.

Radon

Radon gas is a chemically inert, odorless, colorless, and tasteless naturally-occurring radioactive element found in soils and rocks that make up the earth's crust. It comes from the normal decay of radium. Because it is a gas, it can easily move through soil and water and enter the atmosphere. Radon gas has a half-life approximating four days, after which it decays into four daughter products. These solid decay products are not inert and often attach themselves to airborne particulates which may then enter the lungs. These particles with attached radon daughters may become lodged in the lungs where the radon daughters undergo rapid decay, emitting radiation that damages lung tissue.

Sources

In the Northwest, the major source of radon gas in the home is the soil beneath and surrounding the residence. Common entry routes are through cracks in concrete slabs; cracks between poured concrete slabs; and blocks, pores and cracks in concrete blocks, slab footing joints, and mortar joints; loose fitting pipes; sump pits; and floor drains. Houses built on foundations with a ventilated crawl space should have few problems. Houses with basements and those built directly on or in the ground have a higher potential for problems.

Concentrations
Concentrations of radon and its daughter products are usually measured in pico-Curies per liter (pCi/l). The current action level (the level at which you should consider modifications) is 4 pCi/l. The Bonneville Power Administration, in cooperation with the WSU cooperative extension service and local utilities, has measured radon in thousands of homes in Washington State. To date, levels have ranged from less than 1 to 103 pCi/l. Most of the higher levels have been found in Northeastern Washington, due to the naturally occurring radium in the soil and rock. Western Washington does not appear to have significant radon levels, although exceptions have been found. Nationally, the average radon concentration is approximately 1 pCi/1. **The only way to know about your house is to test.**

Health Effects
Like other radioactive materials, radon can cause cancer. Much of the knowledge of the health significance of radon and its progeny is based on the analysis of the effects of high exposures on underground miners. Based on several studies and current knowledge, the National Academy of Sciences believe that radon and its progeny are harmful at all exposure levels, and increased lengths of exposure and higher doses will increase the risk of cancer. EPA has estimated that as many as 10 percent of lung cancer deaths in the U.S. may result from exposure to indoor radon.

Control Methods
Usually, radon reduction is fairly simple and inexpensive. Methods, in order of increased complexity and expense, are:

- Seal radon entry points with appropriate caulking material and cover sumps and drains.
- Improve basement or crawl space ventilation by increasing vent number, size, and/or using fans.
- Increase the air pressure in ground floor or basement area to reduce radon entry.
- Ventilate the area under the basement or slab (sub-slab depressurization) to reduce the amount of radon available to enter the home.

Additional information and brochures regarding radon, its prevalence, measurement, and control techniques can be obtained by calling 1-800-SOS-RADON.

Tobacco Smoke

Indoor tobacco smoke is a major contributor to airborne contaminants in the home and other indoor environments. Over 4,000 chemical compounds, of which 40 are known or suspected carcinogens, have been identified in tobacco smoke. Some of the more important pollutants are carbon monoxide, acrolein, hydrogen cyanide, formaldehyde, nitrous oxides, pyrene, nicotine, cadmium, and numerous carcinogenic polycyclic aromatic hydrocarbons. Environmental tobacco smoke (ETS), or the smoke that comes directly from burning tobacco, has up to 50 times the concentration of some carcinogenic compounds as does mainstream or exhaled smoke, because of the lower combustion temperature. ETS contributes approximately 90 percent of the total products of combustion from a cigarette.

Tobacco smoke is also the major source of respirable suspended particulates (RSP). Wood smoke, unvented gas appliances, and kerosene heaters also contribute to indoor RSP concentrations. Studies have shown that particulate concentrations in public buildings and homes where smoking is permitted often

exceed EPA's 24-hour outdoor air quality standard.

Health Effects

The health effects related to ETS exposure have only recently been investigated. The acute effects of involuntary smoking often depend on the individual being exposed. Principal acute effects can include: irritation of the eyes, nose and throat; coughing; headache; nausea; increased blood pressure; increased heart rate; and elevated carboxyhemoglobin levels. Passive smoking also affects several vulnerable subgroups of the population more than others. Many people with pre-existing health conditions, particularly those with asthma and other respiratory diseases, are often severely affected by exposure to ETS.

Many studies have shown adverse health effects to children of smokers. These studies have shown an association with increased respiratory illness and decreased pulmonary function. Infants and children under two years old seem particularly susceptible. Infants exposed to passive smoke also have triple the rate of sudden infant death syndrome compared to nonexposed infants. In children of smoking parents, other effects also reported include decreased attention and work capacity, increased developmental disability and respiratory problems, and decreased school attendance.

It has long been known that smoking increases the risks of lung, laryngeal, oral, esophageal, other organ cancers, and heart disease. The association between ETS exposure and cancer is clear. Increasing evidence indicates a high risk of lung cancer and heart disease for persons exposed to ETS. Several studies of nonsmoking wives of smoking husbands have found a statistically significant association between passive smoke exposure at home and risk of lung cancer. A recent study has reported that nonsmoking wives of husbands who smoke have three times the risk of heart attack than nonsmoking women married to nonsmokers. ETS may very likely be the most harmful indoor air pollutant.

Control Methods

Only the prohibition of smoking assures a smoke-free environment. Other control methods generally consist of increasing ventilation, use of air cleaning devices, or the restriction of smoking. For air cleaning devices to be effective, they must be large enough to circulate large volumes of air. Air cleaners, such as electrostatic precipitators, are only partially effective in that they remove only particulates and not the gases associated with tobacco combustion.

Indoor Combustion By-Products

Indoor combustion of fuels can be a source of increased concentrations of gases and particulates. The major combustion by-products of concern are carbon monoxide (CO), nitrous oxides (NOx), and RSP. Other by-products may include sulfur dioxide, formaldehyde, carbon dioxide, hydrogen cyanide, and organic vapors. Common sources of indoor combustion by-products are unvented kerosene heaters, wood stoves, gas stoves, and tobacco smoke.

Carbon Monoxide

Cabon Monoxide (CO) is a colorless, odorless gas produced through incomplete combustion. CO is a poison that binds with hemoglobin, the oxygen-carrying molecule in human blood. Because CO's affinity to bind with hemoglobin is 250 times greater than oxygen, low airborne concentrations and long exposure times can result in substantial carboxyhemoglobin (COHb) concentrations in the blood. COHb is CO bound to hemoglobin. As COHb levels increase, less hemoglobin is available for the

transport of oxygen. This lack of oxygen-carrying capability, which is indicated by the increase in COHb, results in the symptoms we associate with CO poisoning.

Health Impacts

The acute health effects of CO exposure are well established. Mild exposure symptoms may include headache, dizziness, decreased vigilance, decreased hand-eye coordination, weakness, confusion, disorientation, lethargy, chest pain (in cardiac patients), nausea, and visual disturbances. Greater or prolonged exposure can cause unconsciousness and death. The severity of symptoms depends on the concentration of CO, length of exposure, and degree of physical activity, as well as the state of health of the exposed individuals. People who are exposed to high CO concentrations for long periods of time during strenuous activity will reach the highest COHb levels.

Even low levels of CO can present a health risk to susceptible individuals, such as persons with heart disease, sickle cell disease, and anemia. Age and general health may also affect susceptibility to CO. Exposure to low levels of CO may harm the developing fetus.

Angina pectoris is chest pain associated with impaired oxygen flow to the heart and may occur at COHb levels between 2.5 and 4.9 percent in cardiac patients. In healthy individuals, decreased vigilance, confusion and disorientation, behavioral, and central nervous system effects occur at COHb levels between 4 and 6 percent. **Remember that as symptoms of CO poisoning increase, you may become confused and less capable of making decisions that could save your life.**

Sources:

Environmental Pollution

The National Ambient (outdoor) Air Quality Standard for CO is 9 PPM averaged over an eight hour period, or 35 PPM averaged over one hour. These standards are based on preventing adverse effects in individuals with cardiac or vascular disease and in exercising humans. Seattle, Spokane, Yakima, and parts of Pierce and Thurston Counties may exceed these values during heavy traffic periods and when inversions occur. Inversions occur when cold stable air layers form above warmer air. This traps pollutants beneath the stable air layer. This can result in significant pollutant level increases, including CO. As outdoor levels increase due to peak traffic times, or because of an inversion, indoor levels will rise proportionately. If indoor sources of CO exist, indoor levels will be higher than those outside. **Avoid strenuous physical activity during peak traffic times, in high volume traffic areas, and during inversions.**

Appliances

Indoor wood stoves, gas ranges, gas hot water heaters, gas and oil heaters, furnaces, and kerosene space heaters can all be sources of CO. Heating season is a time of particular concern with regard to CO exposure. Gas and oil heaters that have not been used during the warm summer months should not be expected to perform efficiently without the benefit of service. It is imperative that furnaces be cleaned and serviced following the manufacturers instructions. Winter is also the time of year when people use space heaters. **It is very important to use the correct grade of kerosene (1-K or manufacturers suggested grade). Use of the incorrect grade of fuel will result in an increased production of CO.**

Flame color is a good way to check the combustion of a fuel burning appliance. The

flame should burn with a bright blue color. A yellow flame signals poor combustion and may indicate a problem with the flue or burner. Ideally, combustion air for fuel burning appliances should not be drawn from inside the home. Some newer furnaces draw air from outside the home and this alleviates the possibility of back drafting. Fuel burning appliances which do not draw combustion air from outside the home are subject to back drafting, which occurs when flue gases, including CO, are drawn back through the flue into the living space in the home. This occurs because of an air pressure drop in the home resulting from high wind conditions or in tight homes when local exhaust fans are used without adequate make-up air. Back drafting may also be caused by blocked or partially blocked flues. Flues should be inspected regularly. **If you suspect back drafting contact your furnace service representative or your fuel supplier.**

Power outages are a time of higher risk. During power outages, people often resort to the use of kerosene space heaters, fire places, gas ranges, and even barbecues to heat homes. Do not use barbecues or gas ranges for a heat source. If unvented fuel burning space heaters are used for warmth, be sure that windows are opened slightly to provide fresh air into the living areas. Additionally, gas ranges should not be used without local exhaust, such as exhaust fans or vented hoods that are exhausted to the outside.

Combustion

Tobacco smoke, including second hand smoke, is a large source of CO in homes with smokers. Smokers have higher COHb values than nonsmokers and exposure to secondary tobacco smoke results in an increase in COHb values. Smokers generally have COHb values of five to six percent. Nonsmokers have COHb levels of 0.5 percent, whereas nonsmokers exposed to secondary tobacco smoke have been shown to have COHb levels in the two to three percent range.

Automobiles, Campers, RVs, and Boats

CO produced from cars left running in closed garages can accumulate and enter the home. Traveling in truck canopies and campers presents an especially high risk for children. The University of Washington and Virginia Mason have reported deaths and loss of consciousness and other signs of CO exposure in children in Washington State who were affected while riding in covered truck beds. CO will accumulate in this space because the shape of the truck produces turbulence, which can lower the air pressure in the truck bed, drawing exhaust into the covered area. No one should ride inside covered truck beds. Every year there are deaths associated with CO poisoning. The majority of these deaths are associated with motor vehicle exhaust (CO) leaking into cars, campers, and motor homes. **Be sure to provide adequate ventilation. It is important that cars and trucks have a functional "tight" exhaust system.**

Prevention

To prevent or reduce exposure to CO, be sure to provide ventilation during fuel burning appliance use, do not run cars in closed garages, and maintain your car's exhaust system. If your home has fuel burning appliances you may want to obtain a CO alarm. These units are very similar to smoke alarms and warn occupants when CO levels become unsafe. There are also several monitors available that change color during CO exposure. These are not very precise in indicating CO levels. The gas company will test your home for CO if you are a customer and suspect a gas leak, smell combustion fumes, or describe symptoms

associated with CO exposure. There are also independent testing labs that can test your home; however, they do charge a fee. If you suspect a problem with a gas appliance, contact your gas supplier.

If you think you have a problem, act immediately: leave, call from outside the home, and do not return to the home until the problem has been resolved. Severe CO poisoning symptoms require emergency medical treatment.

Nitrogen Oxides

Nitrogen oxides are highly toxic and irritating gases with a pungent odor.

Sources

The primary source for indoor nitrous oxides are gas burning appliances.

Concentrations

Indoor nitrogen dioxide (NO_2) concentrations range between .03-.5 PPM with peak concentrations of .7 PPM having been measured in kitchens and other rooms of homes during conventional gas cooking and use of unvented gas appliances. EPA's standard for outdoor air is 0.05 PPM. Generally, indoor concentrations do not exceed these standards, except during and shortly after use of unvented gas appliances.

Health Effects

Inhalation of nitrogen dioxide can induce effects similar to CO. Nitrogen oxides react with the blood's hemoglobin, decreasing the blood's oxygen-carrying capabilities and increasing cardiovascular stress. Nitrogen oxides can also produce temporary and long-term damage to bronchial airway and other lung tissues. Several studies, although not conclusive, have shown that children living in homes with gas appliances have elevated rates of minor respiratory illness and reduced respiratory function.

Respirable Suspended Particulates

Respirable suspended particulates (RSP) are particles, organic and inorganic, that are suspended in the air and are small enough to be inhaled into the lungs. RSPs are also often referred to as PM2.5 or as PM_{10}s, particulate matter 2.5 microns or 10 microns in size or less.

Sources

The major source is tobacco smoke. There is increasing evidence that wood smoke is also a major contributor during the heating season. Unvented gas appliances and kerosene heaters also produce RSP.

Concentrations

There are no indoor standards for RSP. EPA has, however, established an annual average outdoor standard of 15 ug/m3 (micrograms per cubic meter), and a maximum 24-hour standard of 65 ug/m3 for PM 2.5's. PM 10 standards are set at 50 ug/m3 for an annual average outdoor, and a maximum 24 hour standard of 150 ug/m^3 for respirable particulates. As previously mentioned, these standards are often exceeded in indoor environments where smoking is permitted.

Health Effects

RSPs are comprised of many different compounds. Radon and benzo-a-pyrene, suspected carcinogenic agents, are transported by RSPs into the lungs. Gases or other substances may also be carried by RSPs into the lungs. Respiratory illness, especially chronic illnesses like bronchitis, emphysema, and asthma may be linked to, or aggravated by, exposure to RSPs.

Control Methods

Control approaches for these pollutants center on improving combustion efficiency of

various household equipment such as gas ranges, kerosene heaters, wood stoves, or fireplaces, along with adequate ventilation and substitution.

RSPs, tobacco smoke, allergens and microorganisms are often considered similarly with respect to control methods (see sections on tobacco smoke on page 8 and microorganisms and allergens on page 15).

Household Chemicals

Sources
Many consumer products emit gaseous or particulate contaminants during their use or in storage. Consumer products, such as cleaners, waxes, paints, adhesives, detergents, paint strippers, dry cleaning agents, deodorizers, pesticides, solvents, and many home craft products can be sources of both organic and inorganic contaminants. Aerosols, which are widely used to package products such as cleaners, waxes, pesticides, polishes, paints, and adhesives, can be particularly important because they dispense the contents in a form that makes them readily available for direct inhalation. Each use of these products can release substantial quantities of particulates, solvents, and propellant. Additional sources for indoor volatile chemicals include plastics, textiles, building materials, and carpets which may release small amounts over long periods of time.

Health Effects
The wide variety of chemicals used in consumer products and materials precludes a discussion of specific household chemicals and their potential adverse health effects. The health risks associated with long-term exposure to the low levels commonly experienced in the indoor environment has not been investigated adequately. Willful abuse of aerosols and careless use of solvents in enclosed spaces have resulted in acute and chronic disorders and even death.

Control Methods
The primary means of control have been substitution and increased ventilation. Increased awareness and concern by the public has resulted in manufacturers substituting less toxic chemicals in many consumer products and prompting them to make more products available in non-aerosol form. In addition, consumers are being more selective in the type of products they choose and how they are used.

Pesticides

Sources
Pesticides are chemical or biological substances used to destroy, prevent, or control insects, vegetation, rodents, and other pest organisms. A 1976-77 EPA survey revealed that over 90 percent of U.S. households used pesticides and that over 80 percent of the households used them indoors. Twelve of the most commonly used pesticides were insecticides. Some of the most widely used pesticides are the disinfectants (anti-microbials). The study showed that over 90 percent of households use disinfectants in either the liquid or aerosol forms.

Use of pesticides in dwellings may be by the occupant or building maintenance staff who purchase an "off-the-shelf" product, or by a commercial pest control applicator. On occasion, the source of pesticide indoors may result from drift of the chemical from an outside application through open windows and doors. In addition to the direct application of pesticide in to household air, there are other sources which continually emit vapors into the living space. For example, the intrusion of chemical vapors from insecticides through the floors and walls from application to the crawl space and foundation of the

dwelling, evaporation of residues from crack and crevice treatments to the interior of the building, and vapors from moth repellents and room deodorizers. In many areas pre- or post-construction treatment for carpenter ants or termite protection is undertaken. Some of these pesticides may persist in the home environment for many months or years after application. Chlordane (an insecticide of choice for termite and carpenter ant control) has been found to persist for over 20 years after treatment. Pesticides considered nonpersistent last much longer indoors, where they are protected from sunlight, water, and other factors which hasten their degradation.

Health Effects

The large variety of pesticides used in and around dwellings prohibits a discussion of specific symptoms and potential adverse health effects associated with each pesticide. The health risks associated with long-term inhalation exposure to low levels commonly experienced in the indoor environment has not been adequately investigated. In addition to pesticides themselves, approximately 1,200 inert ingredients are currently registered for use in pesticide formulations. These include solvents, propellants, emulsifiers, and adjuvants. Adequate toxicological data is available for only about one-third of these additives. The EPA has serious concerns about potential health effects associated with 120 of these additives. Proper interpretation of airborne pesticides values is very important. While there are occupational airborne pesticide permissible exposures levels (PEL), based on five 8-hour working days per week, these have limited value in the home situation. If residential values exceed the PEL, they would also be excessive for the home. However, if airborne pesticide values are below the PEL, for a given chemical, this does not mean they are safe for residential occupants. Full-time homemakers and small children may spend in excess of 21 hours per day inside the home, nearly three times the 8-hour shift. It has been recommended that a healthy adult living at home should not be exposed to more than one-fourth the work place PEL. In addition, an infant, elderly person, or someone who is ill may be more susceptible to the effects of small amounts.

Control methods

Corrective measures other than general improvement of IAQ is usually not warranted. Additional preventive measures are expensive and their success rate in lowering air concentrations is questionable. There are several ways to minimize exposure to indoor airborne pesticide levels:

- Increase the circulation of clean air in the house. When weather permits, periodically open windows and doors, and use fans to mix the air. In crawl spaces, clear or add vents and install a fan to constantly vent crawlspace air to the outside.
- Seal areas that directly contact treated soil, using grout, caulk, or sealant. Fill cracks in basement, ground floors, and walls, and openings around pipes, drains, and sumps.
- Install a system that supplies outside air to appliances like clothes dryers and furnaces that now draw air from inside the house. Appliances that use indoor air may actually help draw vapors from the soil into the house through walls, floors, and basements.
- Check the condition of ducts in the crawlspace of the basement. Use duct tape to seal openings and joints.

Additional Pesticide Assistance Information

Application of a pesticide by a commercial applicator or a private individual contrary to label instructions is termed a misapplication and is a violation of both state and federal

regulations. Enforcement of pesticide regulations and investigation of pesticide misapplications are under the jurisdiction of the Washington State Department of Agriculture (WSDA). If you believe that a misapplication has been made and you wish to file a complaint, contact WSDA at (360) 902-2040 in Olympia, or (509) 576-3064 in Yakima.

If you have questions regarding health effects, you can contact your local health department or this office (360) 2336-3360 or 1-888-586-9427. If you have symptoms which you believe are associated with a recent application, you should contact your physician or regional poison control center for advice.

Microorganisms, Allergens, and Mold

Sources
A large variety of biological material is present in the indoor environment. Sources include virtually everything indoors, but mainly people, animals, plants, and insects.

Health Effects
Many different organisms are known to cause infection and many more can produce allergic responses in man. The inhalation of biological aerosols from people and animals is the primary means of contracting respiratory infections, although air-cooling equipment, humidifiers, cool-mist vaporizers, and nebulizers can also incubate and distribute bacterial aerosols indoors and could be a source of infection.

According to the National Health Survey, respiratory illnesses are responsible for more than half of all acute conditions. Pollen, molds, dust mites, animal dander, algae, and insect parts are known allergens. The effect of these antigens in the asthmatic and allergic individual has been well-defined.

Control Methods
Many illnesses, including respiratory illnesses, appear to be transmitted primarily from person-to-person. Overcrowding, reduced ventilation, and increased use of untreated recirculated air have a potential to increase concentrations of microorganisms and allergens. There is limited data establishing a correlation between acute respiratory disease and ventilation rates. More common control methods for preventing transmission of illnesses include less crowded living conditions, isolation of infected individuals, and vaccination.

Temperature and humidity conditions are important for many microorganisms, allergens, and molds. Molds need available water to grow. Studies have shown a relationship between respiratory infections and low or high relative humidity. Studies have also shown that the survival or infectivity of microorganisms and allergic mite and fungal populations is directly dependent on relative humidity. These studies suggest that maintaining a relative humidity between 40 to 60 percent indoors would minimize adverse health effects from microorganisms and allergens by reducing their indoor populations. Many of the microorganisms and allergens are also dependent on suitable temperatures to survive.

For the sensitive individual with allergies, dust control methods (air-cleaning devices) are recommended to reduce the concentration of potential allergens in the home. However, it is important to realize the efficiency and effectiveness of these devices differ and that they should not be used without other environmental control methods. Recent reports have questioned the ability of these units to significantly reduce symptoms because allergens of most concern, such as animal allergens, mite fecal pellets, and pollens quickly settle to the floor and,

therefore, are not removed by air cleaning. Some studies have indicated that air conditioning alone is as effective as specialized air cleaning devices. This is most likely related to the control of relative humidity and the resulting control of microbial, mite, and fungal populations. The first step to controlling mold growth involves stopping all available water sources. Quick drying of wet materials is next and should be accomplished within 24 hours. The smell of mold and visible mold growth are indications of a problem and testing is not generally recommended. The last step is clean-up with a five percent bleach solution. Keep in mind that permeable objects like mattresses and furniture may not be cleanable. In this instance, disposal of the contaminated objects may be the only viable option.

Monitoring for Indoor Air Pollutants

Tools for monitoring and measuring indoor air pollutants are in a state of rapid evolution. Our capabilities to measure minute quantities of chemicals have evolved faster than our ability to identify the health implications associated with low levels commonly identified in the indoor environment. Currently, there are no recognized validated standard methods or procedures for monitoring and analyzing residential and nonoccupational indoor air. Generally, methods have either been research or standard methods that were developed for other uses, usually occupational. Increasing concern and demand has resulted in rapid development and marketing of devices for measuring residential indoor air pollutants, particularly formaldehyde and radon.

The most common methods used to measure indoor air pollutants are use of an air pump to actively move air through a media to collect the pollutant of concern; or, a passive method that collects the pollutant by diffusion or permeation to absorbent media. Other methods are laboratory analyses of bulk samples for asbestos and radon monitoring devices.

Active monitoring systems are used by laboratories and environmental services. These methods are generally considered to more accurately measure pollutant concentrations. These services can be located by looking under **Laboratories-Analytical**, in the Yellow Pages of the telephone book. The costs for these services vary from company-to-company and depend on the type of service required.

Passive monitors for chemical pollutants are available from several different sources such as analytical laboratories, environmental services, safety and supply companies, and the manufacturer. Recent developments in passive monitors for formaldehyde have improved their accuracy and reliability. Passive monitors are considered an inexpensive alternate to active monitoring methods, and are routinely recommended for residential screening.

Monitoring devices and/or methods for common measurable pollutants follow:

Formaldehyde

- Active monitoring–consult with private analytical laboratory or environmental service.

- Passive monitors–available from environmental services and some safety and supply companies. Monitors are placed in the home and then returned for analysis. Prices vary.

Radon

Radon-measuring devices are lightweight plastic monitors that vary in size from the size of a wristwatch to a tuna fish can. They are installed in the home and then returned to a

laboratory for analysis. Sampling times vary from one month to one year.

Asbestos
Asbestos cannot be identified by unaided visual inspection. However, it may be identified by chemical or microscopic methods. Bulk samples for asbestos analyses should be submitted to an analytical laboratory with asbestos analysis capabilities.

These laboratories are listed in the Yellow Pages of the telephone book under **Laboratories-Analytical**.

Nitrous Oxides
Passive monitors are also available for nitrous oxides. These monitors have been developed for industrial environment monitoring and usually are not sensitive enough to measure low levels found in the home. They may be useful for confirming higher levels of these pollutants. The monitors are available through safety and supply companies and some analytical laboratories.

Pesticides
Measurement of airborne pesticide levels basically consists of three elements:

1. Collection of the sample.
2. Chemical analysis of the sample.
3. Interpretation of the values found.

Measurement of airborne pesticide levels in a home is not something that the average homeowner can do for himself. In most cases, it takes expensive equipment which must be precisely calibrated. A person must rely on private consulting and analytical laboratories. Measurement and analysis of samples is by no means inexpensive. Unless you have a recommendation from someone, the best way to locate a firm is by looking in the Yellow Pages of the telephone book under **Laboratories-Analytical**.

Interpreting Results

Interpretation of results is often very difficult because of the wide susceptibility of individuals. In many instances where indoor air related illnesses have been suspected, a wide range of different pollutants have been identified with no one pollutant identifiable as a causative agent. In many instances, it may be a combination of two or more pollutants that produce the adverse health effects. Remember, there are no universally accepted IAQ standards for the residential and nonoccupational environment. Lastly, it must be realized that a host of variables can influence single readings and values may not necessarily reflect average values. Local health agencies can often be of assistance in interpreting results.

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Asbestos in the Home, U.S. Consumer Product Safety Commission and U.S. Environmental Protection Agency, Washington, D.C., 1982.

Need More Information?

Please contact:

- Local Health Agencies
- Environmental Protection Agency

(800) 438-4318

- Washington State Department of Ecology

Air Programs
(360) 407-6800

- Department of Labor & Industries

Non-Residential Problems
(800) 423-7233

- Department of Health

Office of Toxic Substances
Residential Problems
(360) 236-3360 or 1-888-586-9427.

Mold Links

Stachybotrys atra (pronounced Stack-ee-bot-ris) is an especially lethal mold. It's part of a family of molds (others are ***Memnoniella*** and ***Aspergillus versicolor***) that produce airborne toxins, called mycotoxins, that can cause serious breathing difficulties, memory and hearing loss, dizziness, flulike symptoms, and bleeding in the lungs. [from USA WEEKEND]

Mold Litigation Reports http://www.mealeys.com/mold.html

Stachybotrys chartarum (also known as ***Stachybotrys atra***) is a type of mold that has been associated with health effects in people. It is a greenish-black mold that can grow on materials with a high cellulose content - such as drywall sheetrock, dropped ceiling tiles, and wood - that become chronically moist or water-damaged, due to excessive humidity, water leaks, condensation, or flooding. [from New York City Department of Health - Environmental & Occupational Disease Epidemiology - Facts About Mold]

Some of the most common molds are ***Alternaria***, ***Aspergillus***, ***Aureobasidium***, ***Botrytis***, ***Cladosporium***, ***Epicoccum***, ***Fusarium***, ***Ganoderma***, ***Helminthosporium***, ***Leptosphaeria***, ***Mucor***, ***Penicillium***, ***Rhizopus***. Each of these molds reproduce by releasing literally millions of spores into the air. As with pollen, mold spores are unique to each species of mold and vary in size and shape. Also, like pollen, mold spores are extremely small and can stay suspended in the air almost indefinitely. For these reasons mold spores are difficult to filter from the air and require high efficiency filter medium. In the long run, it's usually easier to prevent mold growth than to effectively eliminate spores from the air. [from Mold and Asthma - Asthma]

Used as a biological weapon by the Russians, the neurotoxin is responsible for the recent deaths of 16 infants in Ohio. [from Click2Houston - Dangerous Mold Forcing People Out Of Their Homes]

Articles

CBS News | An Insidious Mold Melinda Ballard says her dream house was invaded by a dangerous mold.

CBS News | Invisible Killers Melinda Ballard's million-dollar dream house became a biohazard after it was invaded by toxic mold.

CBS News | Is Your Building Sick? The Stachybotrys mold can cause sick building syndrome.

Click2Houston - Dangerous Mold Forcing People Out Of Their Homes Mold is commonplace in homes and businesses, but for one Houston family a deadly form of mold forced them out of their homes. The Slim family moved out of their Kingwood home after a deadly mold called Stachybotrys was found in their home. "It was black gook. It was nasty," Lynn Slim said. The greenish-black mold became a nemesis for the family and others like them. Used as a biological weapon by the Russians, the neurotoxin is responsible for the recent deaths of 16 infants in Ohio.

Containing Noxious Mold (5/3/99) COVER STORY Mold stinks. No argument. Feed the fungi, water it, keep it in the dark and it will prosper. Disturb it and it will attack. No arguments there, either. Beyond that, in the wars against the most prolific building pest of the 1990s, almost everything else is up in the air. One big exception: The cost of abating extensive building mold growth--at best an irritant, at worst a killer--can be "astronomical."

Dallas Observer Online -- dallasobserver.com | News | Planet Mold The latest environmental hazard in Dallas and the country is displacing homeowners, covering walls and pets, and making lawyers even richer. Welcome to the weird world of toxic mold. Attack of the Black Mold by Rose Farley.

Earth Watch - Toxic Homes Your home. It's the place where you feel safest and most relaxed. It could also be the place that is making you sick. Indoor pollution is on the increase and poses serious health hazards that cause or contribute to a number of medical problems, especially for children, the elderly and the chronically ill.

Homeowners Against Deficient Dwellings HADD Sick Homes with Mold Sick Homes: Mold is Becoming a Huge Problem - Homeowners Against Deficient Dwellings HADD has complied the following links to news stories, victim stories, and web sites dealing with toxic molds in homes and office buildings.

Household mold hide-and-go-seek - 2/20/2000 - ENN News - Environmental News Network - Your leading news source on the environment Award winning producer of environmental news. ENN offers a variety of online services including daily feature stories, a free press release service, environmental news published throughout the day seven days per week, live chats with top environmental authors and panelists, weekly polls and daily streaming webcasts.

Indoor air and bacteria, odors, dust and mold. Facts about stachybotrys, cladosporium According to a Government Accounting report, 20% of the USA's 80,000 public schools have indoor air quality problems. Microbiological contaminants - particularly molds - account for half of indoor air health complaints. That means as many as 7,500 public schools have indoor air problems related to mold. Mold can start growing any time water leaks, and schools, many of which have flat roofs that collect water, are "notorious" for leaks. Chronic leaks can turn ceiling tiles, wallboard or wood into ready-to-eat mold food.

Miles & Stockbridge Law Offices: Mold Could Cost You Millions If You're Not Careful In June 1999, at least 125 New York tenants filed suit against their apartment building owners for $8 billion in personal injury and wrongful death damages. Last year after finding a Delaware apartment building owner and property management company negligent, a jury awarded a former resident over

$1 million. In early 2000, a former tenant sued a California apartment complex owner and its individual employees for personal injury and wrongful death damages. The primary culprit in this small sampling of "sick building" cases? Mold.

Mold Alert - SecurityWorld.com A mysterious illness is befalling many people across the nation. They are suffering from such symptoms as breathing difficulties, memory and hearing loss, dizziness, flu-like symptoms and bleeding in the lungs. The cause of this illness, a lethal version of household mold known as Stachybotrys atra. This illness is not new, however; the written history of microbial contamination dates clear back to the Bible. A passage from the book of Leviticus instructs the priest to tear out the contaminated stones from a building and throw them into an unclean place outside the town. If the mildew has spread, the entire house should be torn down. The system has changed little in thousands of years.

Mold Found In Girl's Lungs; Pupils' Illness Adds To Portables Controversy The little girl had a poisonous mold growing in her lungs, a mold that researchers with the state Department of Health Services say has appeared in portables around the nation - though tests, so far, show no signs of its spores in Santa Clarita classrooms, where at least five children and two teachers have tested positive for the poisonous stachybotrys. Their symptoms range from headaches to nosebleeds, lethargy to upper respiratory distress. Initial blood and urine tests show high levels of residue from the formaldehyde, inorganic arsenic and other chemicals used routinely in plywood, carpeting and pressed board paneling that can fill the air in a poorly ventilated portable classroom, said Dr. Gary Ordog, head of toxicology at Henry Mayo Newhall Memorial Hospital. "This is a highly toxic mold, and it can affect any area of the body," Ordog said. "And with any kind of prolonged exposure you can see a wide range of symptoms." The mold, Ordog said, can harm the neurological system, cause headaches and nerve and memory problems. It also can affect the immune system, alter the chemicals in the blood and damage the hormone systems, muscles, joints and lungs.

Mold Its Not Just Unsightly In the last five to ten years a body of scientific and anecdotal data has grown which points to interior mold contamination as a potentially serious health threat.

Mold Menace Forces School Evacuation Over 400 students and 30 staff members had to be evacuated from a midwestern elementary school for nearly five months as a result of health complaints from mold, mildew and chemicals.

sacbee Inside Business: Mold puts gloom in real estate: Lawsuits, remedies costly A Foresthill couple burn down their house. The owner of a 190-unit Antelope apartment complex kicks out all the tenants. And the state's biggest pension fund excludes certain industrial buildings from a major real estate purchase. At the root of all these recent incidents was a tiny organism -- mold -- that's causing big problems for one of California's biggest industries: real estate.

sacbee Local News: Sick of mold, they torch home: Illnesses and lack of money lead family to raze ailing dream house in Foresthill Steve and Karen Porath of Foresthill celebrated Valentine's Day in front of a fire. But it wasn't a romantic, crackling fire in a fireplace. They purposely had the local Fire Department burn their house -- including furniture and other belongings -- because the home was saturated with toxic molds. The dream home, which the Poraths purchased two years ago as a repossessed house from the U.S. Department of Veterans Affairs, went up in flames. The Poraths said the molds infected them and their two small children, leaving everyone suffering respiratory problems, nose bleeds, rashes and other illnesses.

Sick Building Syndrome / Victims Of Mysterious Illness Suffer From Public Ignorance It goes by many names. Sick Building Syndrome (SBS) occurs when you feel temporarily sick while occupying a building contaminated with one or more chemicals or organic compounds, such as "outgassing" emissions from new carpeting or floating spores from moldy air ducts, to which you are especially sensitive. On occasion, the exposure can render a victim chronically ill for years afterward, which is called Building Related Illness (BRI). Both belong to an

alphabet soup of similar disorders, such as Multiple Chemical Sensitivity (MCS), Toxicant-Induced Loss of Tolerance (TILT), Environmental Illness (EI) and becoming Chemically Injured (CI). Victims can suffer from a broad range of symptoms, such as chronic fatigue, nausea, vision problems and memory loss.

Sick Building Syndrome Part 2 / Tips For Keeping Your Home Healthy People who develop an acute sensitivity to one or more of these toxic "outgasses" can contract an "environmental illness," such as Sick Building Syndrome, with symptoms that range from chronic fatigue and nausea to vision problems and memory loss. Even people without an acute sensitivity can suffer from milder symptoms, such as a vague feeling of tiredness or lack of energy while indoors. So no matter what your state of health, you can improve your overall sense of well-being by improving the quality of the indoor air that you breathe.

Sick Building Syndrome Part 3 / Sufferers Start To Raise Voices, Take Action You may not realize it, but the buildings that we live and work in have the capacity to make people sick. A few agencies, such as the World Health Organization and the U.S. Environmental Protection Agency, have attempted to educate the public about the dangers of poor indoor air quality. But Sick Building Syndrome and related illnesses receive far less attention than smoking, auto exhaust and other more well-known forms of air pollution. What is new is that the people who get sick are also starting to get mad. Slowly, sometimes haltingly, they are also starting to organize.

Sinus News #4 (Mold Health Hazard, Chronic Illness, Sick Building Syndrome) "Deena Karabell had lived in her New York City apartment for 15 years, so when she fell ill in 1983, she never suspected that her apartment itself could be to blame. Over the next 15 years she grew progressively weaker. Finally, in the spring of 1998, she lost 30 pounds and went into anaphylactic shock three times. She literally lay dying in her bedroom when a hired nurse noticed a strong odor of mold in the closet. Suddenly things clicked. Karabell's family moved her out

immediately. Today-at a safe distance from the mold-she is almost back to normal…"

Stachybotrys Over the past several years, there have been a number of young infants (most under 6 months old), in the eastern neighborhoods of Cleveland, who have been coughing up blood due to bleeding in their lungs. Some infants have died and more infants continue to to get ill. This bleeding, a disorder called Pulmonary Hemorrhage appears to be caused by something in their home environments, most likely toxins produced by an unusual fungus called Stachybotrys chartarum or similar fungi.

Stucco-Pro.com June, 18 2000 No one could tell that David and Renee Saunders' stately Woodbury home was rotting away -- not even its owners -- until a cluster of mushrooms sprouted from a wall in the master suite. The couple faces an estimated $400,000 in repairs to replace mold-infested walls in a house that cost $550,000 to build seven years ago. "We see [mushrooms] in numerous homes," said Mike Happ, an investigator for the state building codes and standards division. The Saunders' home is a local example of a national problem: Moisture is creeping into houses across the country, causing walls to rot and destroying the house's basic structure. . . . A critical change in the way houses are built came in response to the energy crisis of the 1970s. Builders began constructing tighter houses to reduce energy costs and make houses more comfortable. Meanwhile, new engineered wood products, typically sheets of wood chips and glue, replaced traditional wood boards for construction. Along the way, one of life's necessities -- water -- became a villain.

USA WEEKEND Special Report: IT STARTED with a series of leaks. Within a year, Melinda Ballard's 11,500-square-foot Texas dream home was quarantined; her 3-year-old son, Reese, was on daily medication to treat scarred, asthmatic lungs; her husband, Ron Allison, had lost his memory along with his job; and the family was living out of suitcases and locked in a seemingly endless battle with their insurance company. The problem? Household mold.

Informative Resources

A Beginner's Guide to Reviewing EHS Issues at Your School Environmental, Health and Safety

Advisory on Relocatable and Renovated Classrooms

Air Filters and Cleaners

An Overview of Stachybotrys

Asthma Triggers- Molds

Biological Pollutants in Your home EPA

Biological Pollutants in Your Home Consumer Product Safety Commission

Causes and Symptoms of Mold and Dust Induced Respiratory Illness

Causes and Symptoms of Mold and Dust Induced Respiratory Illness - NASD

Clear Your Home of Asthma Triggers

Controlling Asthma Triggers American Lung Association

CPSC ISSUES ALERT ABOUT CARE OF ROOM HUMIDIFIERS Consumer Product Safety Commission

Dr. Fungus: The World of Fungi comprehensive resource for fungi and the infections that they cause

Facts About Mold and Moisture

Fungi & Indoor Air Quality - E H I B - c u r r e n t . t o p i c s

Fungi (mold)

Health Effects of Toxin-Producing Indoor Molds in California - E H I B - c u r r e n t . t o p i c s

Health information related to fungi (mold) environments

Home IAQ Remedies

Improving Air Quality in Your Home

iaq INDOOR ENVIRONMENTAL QUALITY GUIDANCE AND REFERENCE MANUAL

Inaccurate Interpretation of Serology involving Toxic Molds

Indoor Air Facts - Residential Air Cleaners EPA

Indoor Air Pollution American Lung Association

Indoor Air Pollution - An Introduction for Health Professionals EPA

Indoor Air Pollution: Introduction for Health Professionals Consumer Product Safety Commission

Indoor Air Quality Health Effects

EHS - Indoor Air Quality

Facts About Mold and Moisture

Is Indoor Mold Contamination a Threat to Health?

Managing Allergies and Asthma

Managing Asthma in the School Environment - IAQ Tools for Schools EPA

Microbiological Contamination of Residential Indoor Air

Mold and Asthma - Asthma

Mold and children

Mold and Moisture - IAQ Tools for Schools Kit

Mold, dust mites, fungi, spores, and pollen: Bioaerosols in the human environment

Mold/Fungi

Mold in Homes

Mold in My Home: What Do I Do?

Mold in My Home: What Do I Do? - California Department of Health Services

Mold in Your Home - Page 1 of 4

Molds in the Environment - 1988 NCEH Factsheet

NASD: Causes and Symptoms of Mold and Dust Induced Respiratory Illness

NYC Dept of Health - DOH Environmental Investigations - Facts About Mold

NYC Dept of Health - Environmental & Occupational Disease Epidemiology - Facts About Mold

NYC Dept of Health - Environmental & Occupational Disease Epidemiology - Guidelines on Assessment and Remediation of Fungi in Indoor Environments

OHD CEHS ESC: FACT SHEET: Household Mold

PEOSH Indoor Bioaerosols

Questions and Answers about Stachybotrys chararum and other molds CDC

Reducing Indoor Air Pollution -- Brochure

Residential Air-Cleaning Devices - A Summary of Available Information EPA

Residential Air Cleaning Devices: Types, Effectiveness and Health Impact

Residential Indoor Air Quality - Main Menu

Should you have the air ducts in your home cleaned?

SICK BUILDING SYNDROME

Sick Building Syndrom - EPA Fact Sheet EPA

Stachybotrys chartarum (atra): A mold that may be found in water-damaged homes

Stachybotrys Guide

Targeting Indoor Air Pollution - EPA's Approach and Progress EPA

The Inside Story - A Guide to Indoor Air Quality EPA

The Inside Story: A Guide to Indoor Air Quality Consumer Product Safety Commission

The Sci.Engr.Heat-Vent-AC F.A.Q. - faq1.htm Indoor Air Quality

Use and Care of Home Humidifiers EPA

Downloadable files:

Advisory on Relocatable and Renovated Classrooms [pdf file] This document summarizes the indoor environmental quality (IEQ) considerations regarding the purchase/lease of relocatable classrooms (or "portables") and the contracting for renovation of existing space. It is provided to advise school facility managers how to minimize potential health impacts from IEQ problems with cost-effective practices. The key IEQ concerns address design, construction/installation, first-use, and maintenance; some of the issues apply both to "portables" and renovated classrooms. Related documents where further technical details may be found are also listed.

Bioaerosols and Green-Waste Composting in California [doc file] Review of medical literature regarding biological agents and their metabolic or degradation products that are produced during the composting of yard waste (grass clippings, shrubbery, leaves, etc.). Common types, sources, exposure levels and potential health effects of biological agents such as Aspergillus fumigatus, bacterial endotoxins and thermophilic actinomycetes are described. The occurrence of these bioaerosols in the natural environment and at large municipal composting facilities is discussed.

Clear Your Home of Asthma Triggers: Your Children Will Breathe Easier [pdf file] Learn about simple steps you can take to reduce the five most common asthma triggers in your home to improve your and/or your children's asthma. This brochure educates readers about environmental asthma triggers, and highlights the importance of controlling them in order to avoid provoking asthma episodes. It describes five asthma triggers, and suggests simple measures to help curb their presence in the home. The brochure is suitable for a broad audience, with a particular emphasis on parents and care givers of asthmatics. EPA Document Number 402-F-99-005, July 1999.

Controlling Mold Growth in the Home [pdf file]

Fungal Contamination in Public Buildings: A Guide to Recognition and Management [pdf file] * 88 pages from Health Canada

Improving Air Quality in Your Home [pdf file] Research has shown that the quality of indoor air can be worse than that of outdoor air. Many homes are built or remodeled more tightly, without regard to the factors that assure fresh and healthy indoor air. Our homes today contain many furnishings, appliances and products that can affect indoor air quality.

Indoor Air Pollution [doc file] American Lung Association

Mold - How to Make Your Home Mold Free and Keep it That Way [pdf file]

Mold in My Home: What Do I Do? [pdf file]

Reducing Bacteria in Clothing and Textiles (Flood Fact Sheet) [pdf file] Clothing and textiles that have been in contact with floodwater need to be sanitized because floodwater may be contaminated with sewage wastes. Bacteria from floodwater can remain alive on fabrics for a long time. A disinfectant destroys harmful bacteria.

Respiratory Risks for Farmers: A Guide for Doctors and Health Care Professionals [pdf file]

Rid Your Home of Mildew [pdf file]

Stachybotrys chartarum (atra) — a mold that may be found in water-damaged homes [doc file] A fact sheet designed for general audiences describing growth characteristics of the mold, Stachybotrys chartarum. Also describes possible health effects from exposure to this mold, methods to prevent occurrence and recommendations for clean-up methods.

Stachybotrys chartarum: The Toxic Indoor Mold [pdf file]

How to protect your home from unhealthful molds

- Keep water out. Fix any leaks within 24 hours.
- Be on the lookout for discoloration of walls, ceiling, or anything made of wood or paper. Mold growth can be almost any color: white, black, green, fluorescent.
- Look behind cabinets or pictures on cold outside walls, where condensation can occur. Keep furniture away from outside walls.
- Check around air handling units (air conditioners, furnaces) for stagnant water. Keep these units serviced with regular cleaning of ducts and air filters.
- Be aware of odors. Mildew has been described as pungent, or "aromatic."
- Know the symptoms of mold-related illness, which can range from chronic sinus infections and asthma to nosebleeds, extreme fatigue, severe headaches, dizziness, rashes and central nervous system problems. Do the symptoms get better when you go on vacation and worse when you come home?
- To get your house checked for mold, contact the American Industrial Hygiene Association for a referral to a certified industrial hygienist (703-849-8888, or http://www.aiha.org/). Testing costs $200-$500.

[from USA WEEKEND]

To prevent or eliminate molds, humidity should be kept as low as possible. Central air-conditioning is the most effective way of controlling humidity, however vent openings are prime locations for the buildup of molds, so be sure to keep them clean. Use special filters to help trap airborne allergens and clear mold spores from the air. Books, leather products, wood paneling and wallpaper paste all support mold growth and should be avoided or treated with appropriate mold-killing solutions.

- It is particularly important to clear the sleeping environment of allergens because symptoms tend to worsen at night.
- Wash all bedding blankets, sheets, pillowcases and mattress pad in hot water weekly to kill dust mites. Avoid wool and down covers. Comforters should be

washed every two weeks or encased in allergen-impermeable covers. Avoid feather comforters and pillows and, if possible, remove carpeting, which is a major hiding place for dust mites.

- Keep surfaces smooth and uncluttered with few small objects such as books, knickknacks, CDs, tapes and stuffed animals which can all collect dust. Place them in drawers if possible.
- Check the bed for possible allergens. Fabrics – one boy was allergic to his polyester blanket– detergents and chlorine bleaches are possible irritants. One man was allergic to electricity and had severe problems until he removed clocks, lights and other electrical devices near his bed.
- Animals in the bedroom may have left urine, saliva and hair. Perfumes and potpourri may cause symptoms.
- Clean visible mold from walls and ceilings.
- Use an exhaust fan or open windows to remove humidity after showering.
- Use a squeegee to remove excess water from the shower stall, tub and tiles.
- Wash shower curtain, bathroom tiles, shower stall, tub and toilet tank with mold-killing, mold-preventing solutions.
- Do not carpet the bathroom.
- Although they may appear clean, damp towels rapidly– within 30 minutes– acquire colonies of bacteria and other living organisms. Wash towels weekly, if not more often.
- Air Filters The most effective filter is a high efficient particular air (HEPA) filter. HEPA systems require no maintenance and their efficacy only increases with use.
- Vacuum Cleaners It is important to know if your vacuum really eliminates dirt and dust from your home or merely recirculates tiny particles. These particles can linger in the air for up to an hour where they continue to provoke allergic and asthmatic reactions. Vacuums are available with HEPA filters that can trap particles as small as .3 microns, far smaller than a hair or dust mite.

from How to Allergy-Proof your Home

http://www.alternativemedicine.com/digest/issue29/29021R00.shtml

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Links

Allergy and Asthma Network / Mothers of Asthmatics Web Site

Allergy, Asthma, Immunology of Rochester

American Academy of Allergy, Asthma & Immunology Online

American Indoor Air Quality Council - IAQ Association

American Public Health Association - APHA

American Lung Association -- Air Quality -- Indoor Air Quality Index

Association of Occupational and Environmental Clinics

Asthma and Allergy Foundation of America (AAFA)

Asthma and Indoor Environments

Asthma In America: A Landmark Survey

California Indoor Air Quality Program

EPA's Indoor Air Quality (IAQ) Home Page

Fungal Research Group, Inc. (FRG)

Healthy Indoor Air for America's Homes; Indoor Air Quality

Homeowners Against Deficient Dwellings HADD Sick Homes with Mold *****

IAQ Tools for Schools Kit

Indoor Air Quality

Indoor Air Quality OSHA

Indoor Air Quality Branch Texas Dept. of Health

Indoor Air Quality (IAQ) - Hotlines and Resources

Indoor Air Top Page

Indoor Fungi Resources - DEHS, UMN

National Jewish Medical and Research Center #1 Respiratory Hospital in America

Osh.Net Newsletter Article 101900 Summary of Presentation on Mold

US EPA Office of Air Quality Planning & Standards - TTNWeb Home Page

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Stachybotrys chartarum

February 1998

Fact Sheet

Environmental Health Programs
Office of Environmental Health & Safety

Fungi are a class of organism that includes yeasts, molds, mildews, and mushrooms. Fungi, other than mushrooms, live as single cells or as threadlike structures known as hyphae. Fungi reproduce through the production of spores. Spores can enter the air (be aerosolized); therefore, humans can come in contact with spores through skin and respiratory exposure. Fungi can produce secondary metabolites which include antibiotics (penicillin) and mycotoxins. These toxins may adversely impact human health. Some other metabolites are volatile organic compounds that cause musty, moldy smells. Fungi require water to grow and can tolerate a wide range of temperatures.

Stachybotrys chartarum

Stachybotrys chartarum is a black slimy mold that is common outdoors, but can also grow indoors if requirements are met. (Note: not all black molds are *Stachybotrys chartarum.)* It can grow on paper, sheet rock, and other high cellulose materials. Spores of wet mold do not easily enter the air. However, dry mold-contaminated material that is disturbed allows spores to be aerosolized resulting in the possibility of human exposure.

Health Effects

Stachybotrys chartarum may cause health problems from volatile gases or toxicity from inhalation or skin contact with toxin-containing spores. Toxic effects at relatively low doses include rashes, mild neurotoxic effects such as headache, nausea, muscle aches and pains, and fatigue. The immune system may also be affected resulting in a decreased resistance to infections. Health problems related to long-term (chronic) exposure to toxins have not been studied.

Sources

Stachybotrys chartarum requires large amounts of water to grow indoors. Mold may be found in areas that have been flooded, where roofs or walls leak, or where plumbing leaks create a wet environment. Often such wet areas are hidden and mold contamination may not be readily visible, yet can be extensive. Most homes have areas where warm moist air comes in contact with a cooler outside wall or window allowing condensation to form. This is also an area where mold may form. Growth is often visible and less extensive.

Remediation

It is important to determine the extent of the contamination. If the area is small and well

defined, clean-up can be done by the homeowner. If the problem is extensive, (e.g., between the walls, under the floor) a professional will be required. If in doubt, consult a specialist.

Control of *Stachybotrys chartarum* requires control of moisture. Roof, wall, and plumbing leaks must be repaired and the area thoroughly dried. Contaminated material must be cleaned or removed. Mold can be killed by treating with ¼ cup bleach in one quart of water. After rinsing, the area can be cleaned with soap and water to remove residues which could still be allergenic or toxic. It is important to wear personal protective equipment, especially gloves, eye protection, and a good dust mask when handling contaminated material and clean-up.

Testing

Testing for *Stachybotrys chartarum* is expensive; the results are difficult to interpret and often inconclusive. If testing is necessary, consult the local health jurisdiction or the Washington State Department of Health❑

Bibliography

- **Biological Contaminants in Indoor Environments,** P. Morey, J. Feeley, and J. Otten, ASTM, 1990.

Need More Information?

Please Contact:

- Additional copies of this fact sheet can be obtained from:

Office of Environmental Health & Safety
P.O. Box 47825
Olympia, Washington 98504-7825
(360) 236-3380
Toll free: 1- 888 5 TOXICS

Appendix A

Indoor Air Quality Information Sheet

Mold in My Home: What Do I Do?

This fact sheet provides information to people who have experienced water damage to their home and presents the health concerns related to mold exposure. It also provides general guidelines on mold detection, cleanup & removal of mold-contaminated materials.

About Mold

What is it?

Molds are simple, microscopic organisms, found virtually everywhere, indoors and outdoors. Molds can be found on plants, foods, dry leaves, and other organic material. Molds are needed for breaking down dead material. Mold spores are very tiny and lightweight, and this allows them to travel through the air. Mold growths can often be seen in the form of discoloration, ranging, from white to orange and from green to brown and black. When molds are present in large quantities, they can cause allergic symptoms similar to those caused by plant pollen.

Should I be concerned about mold in my home?

Yes, if the contamination is extensive. When airborne mold spores are present in large numbers, they can cause allergic reactions, asthma episodes, infections, and other respiratory problems for people. Exposure to high spore levels can cause the development of an allergy to the mold. Mold can also cause structural damage to your home. Similarly, when wood goes through a period of wetting, then drying, it can eventually warp and cause walls to crack or become structurally weak.

What does mold need to grow?

For mold to grow, it needs:

- Food sources – such as leaves, wood, paper, or dirt
- A source of moisture
- A place to grow

Can mold become a problem in my home?

Yes, if there is moisture available to allow mold to thrive and multiple. The following are sources of indoor moisture that may cause problems:

- Flooding
- Backed-up sewers
- Leaky roofs
- Humidifiers
- Mud or ice dams
- Damp basement or crawl space
- Constant plumbing leaks
- House plants - watering can generate large amounts of moisture
- Steam from cooking
- Shower/bath steam and leaks
- Wet clothes on indoor drying lines
- Clothes and dryers vented indoors
- Combustion appliances (e.g. stoves) not exhausted to the outdoors.

Caution: If you see moisture condensation on the windows or walls, it is also possible that you have a combustion problem in your home. It is important to have sufficient fresh air available for fuel burning appliances, such as the furnace, water heater, stove/range, clothes dryer, as well as a fireplace. A shortage of air for these appliances can result in *back drafting* of dangerous gases such as carbon monoxide into the home. To prevent back drafting of air, you need to either open vents or a ventilation system that brings fresh air into the home to replace air that is exhausted out. *Have your local utility company or a professional heating contractor inspect your fuel-burning appliances annually.*

Health Effects

How am I exposed to indoor molds?

Mold is found everywhere, indoors and outdoors. It is common to find mold spores in the air of homes and growing on damp surfaces. Much of the mold found indoors comes from outdoor sources. Therefore, everyone is exposed to some mold on a daily basis without evident harm. Mold spores primarily cause health

problems when they enter the air and are inhaled in large numbers. People can also be exposed to mold through skin contact and eating.

How many molds can make me sick?

It depends. For some people, a relatively small number of mold spores can cause health problems. For other people, it may take many more. The basic rule is, if you can see or smell it, take steps to eliminate the excess moisture, and to cleanup and remove the mold.

Who is at greater risk when exposed to mold?

Exposure to mold is not healthy for anyone inside buildings. It is important to quickly identify and correct any moisture sources before health problems develop. The following individuals appear to be at higher risk for adverse health effects of molds:

- Infants and children
- Elderly
- Immune compromised patients *(people with HIV infection, cancer chemotherapy, liver disease, etc.)*
- Pregnant women
- Individuals with existing respiratory conditions, such as allergies, multiple chemical sensitivity and asthma.

People with these special concerns should consult a physician if they are having health problems.

What symptoms are common?

Allergic reactions may be the most common health problem of mold exposure. Typical symptoms reported (alone or in combinations) include:

- Respiratory problems, such as wheezing, and difficulty in breathing
- Nasal and sinus congestion
- Eyes-burning, watery, reddened, blurry vision, light sensitivity
- Dry, hacking cough
- Sore throat
- Nose and throat irritation
- Shortness of breath
- Skin irritation

- Central nervous system problems (constant headaches, memory problems, and mood changes)
- Aches and pains
- Possible fever

Are some molds more hazardous than others? Allergic persons vary in their sensitivities to mold, both as to amount and type needed to cause reactions. In addition, certain types of mold can produce toxins, called *mycotoxins that* the mold uses to inhibit or prevent growth of other organisms. Mycotoxins are found both living and dead mold spores. Materials permeated with mold need to be removed, even after they are disinfected with cleaning solutions. Allergic and toxic effects can remain in dead spores. Exposure to mycotoxins may present a greater hazard than that of allergenic or irritative molds. Mycotoxins have been found in homes, agricultural settings, food, and office buildings.

Detection Of Mold

How can I tell if I have mold in my house?

If you can see mold, or if there is an earthy or musty odor, you can assume you have a mold problem. Allergic individuals may experience the symptoms listed above. Look for previous water damage. Visible mold growth is found underneath materials where water has damaged surfaces or behind walls. Look for discoloration and leaching from plaster.

Should I test my home for mold?

The California Department of Health Services does not recommend testing as the first step to determine if you have a mold problem. Reliable sampling for mold can be expensive, and requires equipment not available to the general public. Residents of individual private homes must pay a contractor to carry out such sampling, as it is not usually done by public health agencies. Mold cleanup is usually considered one of the housekeeping tasks of private citizen, along with roof and plumbing repairs, sweeping and house cleaning.

Another problem is that there are few available standards of judging what is an acceptable quantity of mold. In all locations, there are some outdoor levels of mold. If sampling is carried out, an outdoor air sample needs to be taken at the same time as the sample indoors, to provide a baseline measurement. Since the susceptibility of individuals varies so greatly, sampling is at best a general guide. *The simplest approach is: if you can see or smell mold, you have a problem.* Once you know the problem exists, follow the procedure given next.

Unless the source of moisture is removed and the contaminated area is cleaned and disinfected, mold growth is likely to reoccur.

General Clean-Up Procedures

- Identify and correct the moisture source
- Clean, disinfect, and dry the moldy area
- Bag and dispose any material that has moldy residues, such as rags, paper, leaves, or debris.

What can I save? What should I toss?

Substances that are porous and can trap molds, such as paper, rags, wallboard, and rotten wood should be decontaminated and thrown out. Harder materials such as glass, plastic, or metal can be kept after they are cleaned and disinfected.

Ultimately, it is critical to remove the source of moisture first, before beginning remedial action, since mold growth will return shortly if an affected area becomes re-wetted.

Removal of Moldy Materials

After fixing the moisture source and removing excess moisture, the cleanup can begin:

- Wear gloves when handling moldy materials
- Remove porous materials (examples: ceiling times, sheet rock, carpeting, wood products)
- Carpeting can be a difficult problem—drying does not remove the dead spores. If there is a heavy mold, disposal of the carpet should be considered.
- Bag and discard the moldy substances
- Allow the area 2 or 3 days
- If flooded, remove all sheetrock to at least 12 inches above the high water mark. Visually inspect the wall interior and remove any other intrusive molds. (This step may have to be carried out by a licensed contractor).

Caution: Spores are easily released when moldy material is dried out.

Soap Cleanup

Before disinfecting contaminated areas, clean the areas to remove as much of the mold (and food it is growing on) as possible.

- Wear gloves when doing this cleanup

- Use a non-ammonia soap or detergent, or a commercial cleaner, in how water, and scrub the entire area affected by the mold
- Use a stiff brush or cleaning pad on block walls or uneven surfaces
- Rinse clean with water. A wet/dry vacuum is handy for this.

Disinfect Surfaces

- Wear gloves when using disinfectants
- After thorough cleaning and rinsing, disinfect the area with a solution of 10% household bleach (e.g. 1½ cup bleach per gallon of water.) Using bleach straight from the bottle will not be more effective
- *Never mix bleach with Ammonia – the fumes are toxic*
- For spraying exterior large areas, a garden hose and nozzle can be used
- When disinfecting a large structure, make sure the entire surface is wetted (floors, joists, and posts)
- Avoid excessive amounts of runoff or standing bleach
- Let disinfecting areas dry naturally overnight – this extended time is important to kill the entire mold.

Caution: Bleach fumes can irritate the eyes, nose, and throat, and damage clothing and shoes. Make sure the working area is ventilated well.

Can cleaning up mold be hazardous to my health?

Yes. Exposure to mold can occur during the cleaning stage. Mold counts are typically 10 to 1,000 times higher than background levels during the cleaning of mold damaged materials. Take steps to protect your health during cleanup:

- When handling or cleaning moldy materials, consider using a mask or respirator to protect you from breathing airborne spores. Respirators can be purchased from hardware stores; select one for particle removal (sometimes referred to as a N95 or TC-21C particulate respirator). Respirators are not as effective removing bleach fumes, so minimize your exposure when using bleach or other disinfectants.
- Wear protective clothing that is easily cleaned or discarded
- Use rubber gloves

- Try cleaning a small test patch of mold first. If you feel that this adversely affected your health, you should consider paying a licensed contractor or professional to carry out the work
- Ask family members or bystanders to leave areas when being cleaned.
- Work over short time spans and rest in a fresh air location.
- Air your house well during after the work

Caution: Never use a gasoline engine indoors (e.g. pressure washer, generator) –you could expose yourself and your family to carbon monoxide.

Can air duct systems become contaminated with mold?

Yes. Air duct systems can become contaminated with mold. Duct systems can be constructed of bare sheet metal, sheet metal with exterior fibrous glass insulation, sheet metal with an internal fibrous glass liner, or made entirely of fibrous glass. If your home's air duct system has had water damage, first identify the type of air duct construction that you have. Bare sheet metal systems, or sheet metal with exterior fibrous glass insulation, can be cleaned and disinfected.

If your system has sheet metal with an internal fibrous glass liner, or are made entirely of fibrous glass, the ductwork normally will need to be removed and discarded. Ductwork in difficult locations may have been abandoned.

If you have other questions, contact an air duct cleaning professional, or licensed contractor.

After I've cleaned everything as thoroughly as possible, can I still have mold odors?

Yes. It is possible that odors may persist. Continue to dry out the area and search for any hidden areas of mold. If the area continues to smell musty, you may have to re-clean the area again (follow the cleaning steps given in this sheet), Continue to dry and ventilate the area. Don't replace until the area has dried completely.

How can further damage to my home be prevented?

Check regularly for the following:

- Moisture condensation on windows
- Cracking of plasterboard
- Drywall tape loosening

- Wood warping
- Musty odor

If you see any of the above, seek out and take steps to eliminate the source of water penetration, as quickly as possible.

Can Ozone air cleaners help remove indoor mold, or reduce odor or pollution levels?

Some air cleaners are designed to produce ozone. Ozone is a strong oxidizing agent used as a disinfectant in water and sometimes to eliminate odors. However, ozone is a known lung irritant. Symptoms associated with exposure include cough, chest pain, and eye, nose, and throat irritation. Ozone generators have been shown to generate indoor levels above the safe limit. Furthermore, it has been demonstrated that ozone is not effective in controlling molds and fungi, even at high concentrations far above safe health levels. Also, ozone may damage materials in the home. For these reasons, the California Department of Health Services strongly recommends that you do not use an ozone air cleaner in any occupied residential space.

Refer to the CDHS IAQ Info Sheet: *Health Hazards of Ozone-generating Air Cleaning Devices* (January 1998).

Useful Publications

Biological Pollutants in Your Home, 1990. Available from local ALA or U.S. EPA's IAQINFO, *Concise booklet aimed at concerned or affected homeowner*

Mold, Moisture & Indoor Air Quality: A Guide to Designers, Builders, and Building Owners, *1994. Available from Building Science Corp. 617-323-6552.*

Moisture, Mold and Mildew in Building Air Quality (Appendix C), *1991. Available from U.S. EPA's IAQINFO. Illustrative and useful resource guide.*

Repairing Your Flooded Home, *Available from American Red Cross and FEMA offices. Excellent resource with details on technical & logistical issues.*

Clean-up Procedures for Mold in Houses, *Available from Canada Mortgage & Housing Corp. 800-668-2642. Effective, hands-on information for affected homeowner.*

NIOSH Warns of Hazards of Flood Cleanup Work*, National Institute of Occupational Safety and Health (NIOSH) Update. Aimed at flood emergency workers. 800-356-4674*

Factsheet on Stachybotrys atra (chartarum)*, CDHS Environmental Health Investigations Branch, April 1997. Summarizes information on S.A. and includes NYC recommendations for evaluating and remediating microbial contamination.*

Referrals To Occupational & Environmental Clinics

Association of Occupational & Environmental Clinics. 202-347-4976; http://gilligan.mc.duke.edu/oem/aoec.htm

American College of Occupational & Environmental Medicine. 847-228-6850;
http://www.acoem.org

For Further Help Or Information

Contact you County or City Department of Health or Environmental Health American Red Cross Disaster Response, Tel: 213-739-5200 or call local chapter

U.S. EPA's IAQ Information Clearing house (IAQ INFO), Tel: 800-438-4318 or 202-484-1307, Phone assistance (9am to 5pm, EST), http://www.epa.gov/iaq

CA Department of Health Services *indoor Air Quality Section,* 2151 Berkeley Way (EHLB) Berkeley, CA 94704, Assistance Line: 510-540-2476, http://www.cal-iaq.org

Appendix B

Building Indoor Air Quality

A healthy indoor environment is one in which the surroundings contribute to productivity, comfort, and a sense of health and well-being. The indoor air is free from significant levels of odors, dust and contaminants and circulates to prevent stuffiness without creating drafts. Temperature and humidity are appropriate to the season and to the clothing and activity of the building occupants. There is enough light to illuminate work surfaces without creating glare and noise levels do not interfere with activities. Sanitation, drinking water, fire protection, and other factors affecting health and safety are well planned and properly managed.

Good air quality is an important component of a healthy indoor environment. For the purposes of this document, the definition of good indoor air quality includes:

- Introduction and distribution of adequate ventilation air
- Control of airborne contaminants
- Maintenance of acceptable temperature and relative humidity

A practical guide to indoor air quality (IAQ) cannot overlook temperature and humidity, because thermal comfort concerns underlie many complaints about "poor air quality." Furthermore, temperature and humidity are among the many factors that affect indoor contaminant levels.

Good indoor air quality enhances occupant health, comfort, and workplace productivity. Rental properties can gain a marketing advantage if they are known to offer a healthy and pleasant indoor environment. Failure to respond promptly and effectively to IAQ problems can have consequences such as:

- Increasing health problems such as cough, eye irritation, headache, and allergic reactions, and, in some rare cases, resulting in life-threatening conditions (e.g., Legionnaire's disease, carbon monoxide poisoning)
- Reducing productivity due to discomfort or increased absenteeism
- Accelerating deterioration of furnishings and equipment

- Straining relations between landlords and tenants, employers and employees

- Creating negative publicity that could put rental properties at a competitive disadvantage

- Opening potential liability problems

(Note*:* Insurance policies tend to exclude pollution-related claims)

Some indoor air quality problems are complex and may require the assistance of outside professionals. When contracting for services, you need to be an informed client to avoid unnecessary costs and delays in solving the problem.

Factors Affecting Indoor Air Quality

Indoor air quality is not a simple, easily defined concept like a desk or a leaky faucet. It is a constantly changing interaction of a complex set of factors. Four of the most important elements involved in the development of indoor air quality problems are: a source of odors or contaminants; a problem with the design or operation of the HV A C system; a pathway between the source and the location of the complaint; and the building occupants.

An IAQ profile is a "picture" of building conditions from the perspective of indoor air quality .A review of construction and operating records, combined with an inspection of building conditions, helps to reveal potential indoor air problems and identify building areas that require special attention to prevent problems in the future. Baseline data collected for the IAQ profile can facilitate later investigations, should problems arise. *Section* 4 suggests a three- stage approach to developing an IAQ profile and describes the products of each stage.

Many indoor air problems can be pre- vented by following common sense recommendations, such as: maintain good sanitation, provide adequate ventilation, and isolate pollutant sources. Other preventive measures may require a careful review of j ob descriptions, contracts, supplies, and schedules. It is important to designate an IAQ manager to bear responsibility for coordinating the effort in your building. *Section* 5 discusses key elements to include in your IAQ management plan.

The basic approaches to mitigating indoor air quality problems are: control of pollutant sources; modifications to the ventilation system; air cleaning; and control of exposures to occupants. Successful mitigation often involves a combination of these techniques.

Indoor air quality is an emerging and interdisciplinary field. *Section* 8 provides guidance in hiring professional assistance if you decide that outside expertise is needed to determine the cause of an IAQ problem.

Appendix F: Glossary and Acronyms

Appendix F explains scientific and engineering terminology that may be unfamiliar to some readers.

Appendix G: Resources

Appendix G is intended for readers who want to pursue more detailed information about indoor air quality .It includes the names, addresses, and telephone numbers of Federal, State, and private sector organizations with interests related to IAQ, as well as a list of

The indoor environment in any building is a result of the interaction between the site, climate, building system (original design and later modifications in the structure and mechanical systems), construction techniques, contaminant sources (building materials and furnishings, moisture, processes and activities within the building, and outdoor sources), and building occupants.

The following four elements are involved in the development of indoor air quality problems:

- **Source:** there is a source of contamination or discomfort indoor, outdoors, or within the mechanical systems of the building.

- **HV AC:** the HV AC system is not able to control existing air contaminants and ensure thermal comfort (temperature and humidity conditions that are comfortable for most occupants).

- **Pathways:** one or more pollutant pathways connect the pollutant source to the occupants and a driving force exists to move pollutants along the pathway(s).

- **Occupants:** building occupants are present.

It is important to understand the role that each of these factors may play in order to prevent, investigate, and resolve indoors air quality problems.

Sources of Indoor Air Contaminants

Indoor air contaminants can originate within the building or be drawn in from outdoors. If contaminant sources are not controlled, IAQ problems can arise, even if the HV AC system is properly designed and well maintained. It may be helpful to think of air pollutant sources as fitting into one of the categories that follow. The examples given for each category are not intended to be a complete list.

Sources Outside Building

Contaminated outdoor air

- Pollen, dust, fungal spores. Industrial pollutants
- General vehicle exhaust
- Emissions from nearby sources
- Exhaust from vehicles on nearby roads or in parking lots, or garages .loading docks
- Odors from dumpsters
- Re-entrained (drawn back into the r" building) exhaust from the building itself or from neighboring buildings
- Unsanitary debris near the outdoor air intake

Soil gas

- Radon
- Leakage from underground fuel tanks
- Contaminants from previous uses of the site (e.g., landfills) pesticides

Moisture or standing water promoting excess microbial growth

- Rooftops after rainfall
- Crawlspace

Equipment

HVAC system

- Dust or dirt in ductwork or other components
- Microbiological growth in drip pans, humidifiers, ductwork, coils
- Improper use of biocides, sealants, and/ or cleaning compounds
- Improper venting of combustion products
- Refrigerant leakage

Non-HV A C equipment

- Emissions from office equipment (volatile organic compounds, ozone)
- Supplies (solvents, toners, ammonia) emissions from shops, labs, cleaning processes
- Elevator motors and other mechanical systems

Human Activities

Personal activities

- Smoking.
- Cooking
- Body odor
- Cosmetic odors

Housekeeping activities

- Cleaning materials and procedures
- Emissions from stored supplies or trash .use of deodorizers and fragrances
- Airborne dust or dirt (e.g., circulated by sweeping and vacuuming)

Maintenance activities

- Microorganisms in mist from improperly maintained cooling towers
- Airborne dust or dirt
- Volatile organic compounds from use of paint, caulk, adhesives, and other products
- Pesticides from pest control activities
- Emissions from stored supplies

Building Components and Furnishings

Locations that produce or collect dust or fibers

- Textured surfaces such as carpeting, curtains, and other textiles .open shelving
- Old or deteriorated furnishings
- Materials containing damaged asbestos

Unsanitary conditions and water damage

- Microbiological growth on or in soiled or water-damaged furnishings
- Microbiological growth in areas of surface condensation standing water from clogged or poorly designed drains
- Dry traps that allow the passage of sewer gas

Chemicals released from building components or furnishings

- Volatile organic compounds or
- Inorganic compounds

Other Sources

Accidental events

- Spills of water or other liquids. Microbiological growth due to flooding or to leaks from roofs, piping
- Fire damage (soot, PCBs from electrical equipment, odors)

Special use areas and mixed-use buildings.

- Smoking lounges
- Laboratories
- Print shops, art rooms
- Exercise rooms. Beauty salons
- Food preparation areas

Redecorating/remodeling/repair activities.

- Emissions from new furnishings
- Dust and fibers from demolition
- Odors and volatile organic and inorganic compounds from paint, caulk, adhesives
- Microbiologicals released from demolition or remodeling activities

Indoor air often contains a variety of contaminants at concentrations that are far below any standards or guidelines for occupational exposure. Given our present knowledge, it is difficult to relate com- plaints of specific health effects to exposures to specific pollutant concentrations, especially since the significant exposures may be to low levels of pollutant mixtures.

HVAC System design and Operation

The HVAC system includes all heating, cooling, and ventilation equipment serving a building: furnaces or boilers, chillers, cooling towers, air handling units, exhaust fans, ductwork, filters, steam (or heating water) piping. Most of the HVAC discussion in this document applies both to central HVAC systems and to individual components used as stand-alone units.

Large buildings often have interior ("core") spaces in which constant cooling " is required to compensate for heat generated by occupants, equipment, and lighting, while perimeter rooms may require heating or cooling depending on outdoor conditions.

Good quality design, installation, and testing and balancing are critically important to the proper operation of all types of HVAC systems, especially V A V systems, as are regular inspections and maintenance.

The amount of outdoor air considered adequate for proper ventilation has varied substantially over time. The current guideline issued by ASHRAE is ASHRAE Standard 62-1989. The building code that was in force when your building HV AC system was designed may well have established a lower amount of ventilation (in cubic feet of outdoor air per minute per person) than is currently recommended.

Control Odors and Contaminants

One technique for controlling odors and contaminants is to dilute them with outdoor air. Dilution can work only if there is a consistent and appropriate flow of supply air that mixes effectively with room air. The term "ventilation efficiency" is used to describe the ability of the ventilation system to distribute supply air and remove internally generated pollutants. Researchers are currently studying ways to measure ventilation efficiency and interpret the results of those measurements.

Another technique for isolating odors and contaminants is to design and operate the HV AC system so that pressure relationships between rooms are con- trolled. This control is accomplished by adjusting the air quantities that are supplied to and removed from each room. If more air is supplied to a room than is exhausted, the excess air leaks out of the space and the room is said to be under **positive pressure**. If less air is supplied than is exhausted, air is pulled into the space and the room is said to be under **negative pressure.**

A third technique is to use local exhaust systems (sometimes known as dedicated exhaust ventilation systems) to isolate and remove contaminants by maintaining negative pressure in the area around the contaminant source. Local exhaust can be linked to the operation of a particular piece of equipment (such as a kitchen range) or used to treat an entire room (such as a smoking lounge or custodial closet). Air should be exhausted to the outdoors, not recirculated, from locations, which produce significant odors and high concentrations of contaminants (such as copy rooms, bathrooms, kitchens, and beauty salons).

Air cleaning and filtration devices designed to control contaminants are found as components of HVAC systems (for example, filter boxes in ductwork) and can also be installed as independent units. The effectiveness of air cleaning depends upon proper equipment selection, installation, operation, and maintenance. Caution should be used in evaluating the many new technological developments in the field of air cleaning and filtration.

Pollutant Pathways and Driving Forces

Airflow patterns in buildings result from the combined action of mechanical ventilation systems, human activity, and natural forces. Pressure differentials created by these forces move airborne contaminants from areas of relatively higher pressure to areas of relatively lower pressure through any available openings.

The HVAC system is generally the predominant pathway and driving force for air movement in buildings. However, all of a building's components (walls, ceilings, floors, penetrations, HVAC equipment, and occupants) interact to affect the distribution of contaminants.

The basic principle of air movement from areas of relatively higher pressure to areas of relatively lower pressure can produce many patterns of contaminant distribution, including:

- Local circulation in the room containing the pollutant source
- Air movement into adjacent spaces that are under lower pressure *(Note:* Even if two rooms are both under positive pressure compared to the outdoors, one room is usually at a lower pressure than the other.)
- Recirculation of air within the zone containing the pollutant source or in adjacent zones where return systems overlap
- Movement from lower to upper levels of the building
- Air movement into the building through either infiltration of outdoor air or reentry of exhaust air

Air moves from areas of higher pressure to areas of lower pressure through any available openings. A small crack or hole can admit significant amounts of air if the pressure differentials are high enough (Which may be very difficult to assess).

Building Occupants

The term "building occupants" is generally used in this document to describe people who spend extended time periods (e.g., a full workday) in the building. Clients and visitors are also occupants; they may have different tolerances and expectations from those who spend their entire workdays in the building, and are likely to be more sensitive to odors.

Groups that may be particularly susceptible to effects of indoor air contaminants include, but are not limited to:

- Allergic or asthmatic individuals
- People with respiratory disease
- People whose immune systems are suppressed due to chemotherapy, radiation therapy, disease, or other causes
- Contact lens wearers

Some other groups are particularly vulnerable to exposures of certain pollutants or pollutant mixtures. For example, people with heart disease may be more affected by exposure at lower levels of carbon monoxide than healthy individuals. Children exposed to environ- mental tobacco smoke have been shown to be at higher risk of respiratory illnesses and those exposed to nitrogen dioxide have been shown to be at higher risk from respiratory infections.

Because of varying sensitivity among people, one individual may react to a particular IAQ problem while surrounding occupants have no ill effects. (Symptoms that are limited to a single person can also occur when only one workstation receives the bulk of the pollutant dose.) In other cases, complaints may be widespread.

A single indoor air pollutant or problem can trigger different reactions in different people. Some may not be affected at all. Information about the types of symptoms can sometimes lead directly to solutions. However, symptom information is more likely to be useful for identifying the timing and conditions under which problems occur.

Types of Symptoms and Complaints

The effects of lAQ problems are often non- specific symptoms rather than clearly defined illnesses. Symptoms commonly attributed to IAQ problems include:

- Headache
- Fatigue
- Shortness of breath
- Sinus congestion
- Cough
- Sneezing
- Eye, nose, and throat irritation

- Skin irritation
- Dizziness
- Nausea

All of these symptoms, however, may also be caused by other factors, and are not necessarily due to air quality deficiencies.

Environmental stressors such as improper lighting, noise, vibration, overcrowding, ergonomic stressors, and job-related psychosocial problems (such as job stress) can produce symptoms that are similar to those associated with poor air quality.

The term **sick building syndrome** (SBS) is sometimes used to describe cases in which building occupants experience acute health and comfort effects that are apparently linked to the time they spend in the building, but in which no specific illness or cause can be identified. The complaints may be localized in a particular room or zone or may be widespread throughout the building. Many different symptoms have been associated with SBS, including respiratory complaints, irritation, and fatigue. Analysis of air samples often fails to detect high concentrations of specific contaminants. Any or all of the following may cause the problem:

- The combined effects of multiple pollutants at low concentrations
- Other environmental stressors (E.g., overheating, poor lighting, noise)
- Ergonomic stressors
- Job-related psychosocial stressors (E.g., overcrowding, labor-management problems)
- Unknown factors

Look for IAQ problem indicators

The walkthrough inspection can be used to identify areas with a high potential for IAQ problems. The following are general indicators of IAQ problems:

- Odors
- Dirty or unsanitary conditions (e.g., excessive dust)

- Visible fungal growth or moldy odors (often associated with problem of too much moisture)

- Sanitary conditions at equipment such as drain pans and cooling towers

- Sanitary conditions in equipment such as drain pans and cooling towers

- Poorly-maintained filters

- Signs of mold or moisture damage at walls (e.g., below windows, at columns, at exterior corners), ceilings, and floors

- Staining and discoloration *(Note:* Make sure that stains are removed after leaks are repaired so that there will be visible evidence if the leak recurs.)

- Smoke damage *(Note:* If a fire has occurred involving electrical equipment, determine whether PCBs (polychlorinated biphenyls) may have been released from the equipment.)

- Presence of hazardous substances

- Potential for soil gas entry (e.g., unsealed openings to earth, wet earth smells)

- Unsanitary mechanical room, or trash or stored chemicals in mechanical room unusual noises from light fixtures or mechanical equipment

Appendix C:

Moisture, Mold and Mildew

Molds and mildew are fungi that grow on the surfaces of objects, within pores, and in deteriorated materials. They can cause discoloration and odor problems, deteriorate building materials, and lead to allergic reactions in susceptible individuals, as well as other health problems.

The following conditions are necessary for mold growth to occur on surfaces:

- Temperature range above 40°F and below 100°F
- Mold spores
- Nutrient base (most surfaces contain nutrients)
- moisture

Human comfort constraints limit the use of temperature control. Spores are almost always present in outdoor and indoor air, and almost all commonly used construction materials and furnishings can provide nutrients to support mold growth. Dirt on surfaces provides additional nutrients. Cleaning and disinfecting with non-polluting cleaners and antimicrobial agents provides protection against mold growth. Other sections of this document have discussed the importance of building maintenance and proper sanitation in preventing IAQ problems. However, it is virtually impossible to eliminate all nutrients. Moisture control is thus an important strategy for reducing mold growth.

Mold growth does not require the presence of standing water; it can occur when high relative humidity or the hygroscopic properties (the tendency to absorb and retain moisture) of building surfaces allow sufficient moisture to accumulate. Relative humidity and the factors that govern it are often misunderstood.

This appendix is intended to give building managers an understanding of the factors that govern relative humidity, and to describe common moisture problems and their solutions.

Background On Relative Humidity, Vapor Pressure, And Condensation

Water enters buildings both as a liquid and as a gas (water vapor). Water, in its liquid form, is introduced intentionally in bathrooms, kitchens, and laundries and accidentally by way of leaks and spills. Some of that water evaporates and joins the water vapor that is exhaled by building occupants as they breathe or that is introduced by humidifiers. Water vapor also moves in and out of the building

as part of the air that is mechanically introduced or that infiltrates and exfiltrates through openings in the building shell. A lesser amount of water vapor diffuses into and out of the building through the building materials themselves. The ability of air to hold water vapor decreases as the air temperature is lowered. If a unit of air contains half of the water vapor it can hold, it is said to be at 50% relative humidity (RH). As the air cools, the relative humidity increases. If the air contains all of the water vapor it can hold, it is at 100% RH, and the water vapor condenses, changing from a gas to a liquid. It is possible to reach 100% RH without changing the amount of water vapor in the air (its “vapor pressure” or “absolute humidity”); All that is required is for the air temperature to drop to the “dew point.”

Relative humidity and temperature often vary within a room, while the absolute humidity in the room air can usually be assumed to be uniform. Therefore, if one side of the room is warm and the other side cool, the cool side of the room has a higher RH than the warm side.

The highest RH in a room is always next to the coldest surface. This is referred as the “first condensing surface,” as it will be the location where condensation first occurs, if the relative humidity at the surface reaches 100%. It is important to understand this when trying to understand why mold is growing on one patch of wall or only along the wall-ceiling joint. It is likely that the surface of the wall is cooler than the room air because there is a void in the insulation or because wind is blowing through cracks in the exterior of the building.

Taking Steps To Reduce Moisture

Mold and mildew growth can be reduced where relative humidity near surfaces can be maintained below the dew point. This can be accomplished by reducing the moisture content (vapor pressure) of the air, increasing air movement at the surface, or increasing the air temperature (either the general space temperature or the temperature at building surfaces).

Either surface temperature or vapor pressure can be the dominant factor in causing a mold problem. A surface temperature-related mold problem may not respond very well to increasing ventilation, whereas a vapor pressure-related mold problem may not respond well to increasing temperatures. Understanding which factor dominates will help in selecting an effective control strategy.

Consider an old, leaky, poorly insulated building. It is in a heating climate and shows evidence of mold and mildew. Since the building is leaky, its high natural air exchange rate dilutes interior airborne moisture levels, maintaining a low absolute humidity during the heating season. Providing mechanical ventilation in this building in an attempt to control interior mold and mildew probably will not be

effective in this case. Increasing surface temperatures by insulating the exterior walls, and thereby reducing relative humidity next to the wall surfaces, would be a better strategy to control mold and mildew.

Reduction of **surface temperature-dominated mold and mildew** is best accomplished by increasing the surface temperature through either or both of the following approaches:

- Increase the temperature of the air near room surfaces either by raising the thermostat setting or by improving air circulation so that supply air is more effective at heating the room surface.
- Decrease the heat loss from room surfaces either by adding insulation or by closing cracks in the exterior wall to prevent wind-washing (air that enters a wall at one exterior location and exits another exterior location without penetrating into the building).

One or more of the following strategies can reduce **vapor pressure-dominated mold and mildew**:

- Source control (e.g., direct venting of moisture-generating activities such as showers) to the exterior
- Dilution of moisture-laden indoor air with outdoor air that is at a lower absolute humidity
- Dehumidification

Note that dilution is only useful as a control strategy during heating periods, when cold outdoor air tends to contain less moisture. During cooling periods, outdoor air often contains as much moisture as indoor air.

Identifying And Correcting Common Problems From Mold And Mildew

Exterior Corners

Exterior corners are common locations for mold and mildew growth in heating climates, and in poorly insulated buildings in cooling climates. They tend to be closer to the outdoor temperature than other parts of the building surface for one or more of the following reasons:

- Poor air circulation (interior)
- Wind-washing (exterior)
- Low insulation levels
- Greater surface area of heat loss

Sometimes mold and mildew growth can be reduced by removing obstructions to airflow (e.g., rearranging furniture). Buildings with forced air heating systems and/or room ceiling fans tend to have fewer mold and mildew problems than buildings with less air movement, other factors being equal.

"Set Back" Thermostats

Set back thermostats are commonly used to reduce energy consumption during the heating season. Mold and mildew growth can occur when building temperatures are lowered during unoccupied periods. (Maintaining a room at too low a temperature can have the same effect as a set back thermostat.) Mold and mildew can often be controlled in heating climate locations by increasing interior temperatures during heating periods. Unfortunately, this also increases energy consumption and reduces relative humidity in the breathing zone, which can create discomfort.

Air Conditioned Spaces

The problems of mold and mildew can be as extensive in cooling climates as in heating climates. The same principles apply: either surfaces are too cold, moisture levels are too high, or both.

A common example of mold growth in cooling climates can be found in rooms where conditioned "cold" air blows against the interior surface of an exterior wall. This condition, which may be due to poor duct design, diffuser location, or diffuser performance, creates a cold spot at the interior finish surfaces. A mold problem can occur within the wall cavity as outdoor air comes in contact with the cavity side of the cooled interior surface. It is a particular problem in rooms decorated with low maintenance interior finishes (e.g., impermeable wall coverings such as vinyl wallpaper) which can trap moisture between the interior finish and the gypsum board. Mold growth can be rampant when these interior finishes are coupled with cold spots and exterior moisture.

Possible solutions for this problem include:

- Preventing hot, humid exterior air from contacting the cold interior finish (i.e., controlling the vapor pressure at the surface)
- Eliminating the cold spots (i.e., elevating the temperature of the surface) by relocating ducts and diffusers
- Ensuring that vapor barriers, facing sealants, and insulation are properly specified, installed, and maintained
- Increasing the room temperature to avoid overcooling

In this case, increasing temperature decreases energy consumption, though it could cause comfort problems.

Thermal Bridges

Localized cooling of surfaces commonly occurs as a result of “thermal bridges,” elements of the building structure that are highly conductive of heat (e.g., steel studs in exterior frame walls, uninsulated window lintels, and the edges of concrete floor slabs). Dust particles sometimes mark the locations of thermal bridges, because dust tends to adhere to cold spots. The use of insulating sheathings significantly reduces the impact of thermal bridges in building envelopes.

Windows

In winter, windows are typically the coldest surfaces in a room. The interior surface of a window is often the first condensing surface in a room. Condensation on window surfaces has historically been controlled by using storm windows or “insulated glass” (e.g., double-glazed windows or selective surface gas-filled windows) to raise interior surface temperatures. The advent of higher performance glazing systems has led to a greater incidence of moisture problems in heating climate building enclosures, because the buildings can now be operated at higher interior vapor pressures (moisture levels) without visible surface condensation on windows. In older building enclosures with less advanced glazing systems, visible condensation on the windows often alerted occupants to the need for ventilation to flush out interior moisture (so they opened the windows).

Concealed Condensation

The use of thermal insulation in wall cavities increases interior surface temperatures in heating climates, reducing the likelihood of interior surface mold, mildew and condensation. However, the use of thermal insulation also reduces the heat loss from the conditioned space into the wall cavities, decreasing the temperature in the wall cavities and therefore increasing the likelihood of concealed condensation. The first condensing surface in a wall cavity in a heating climate is typically the inner surface of the exterior sheathing, the “back side” of plywood or fiberboard. As the insulation value is increased in the wall cavities, so does the potential for hidden condensation.

Concealed condensation can be con-trolled by either or both of the following strategies:

- Reducing the entry of moisture into the wall cavities (e.g., by controlling infiltration and/or exfiltration of moisture- laden air)
- Elevating the temperature of the first condensing surface. In heating climate locations, this change can be made by installing exterior insulation (assuming that no significant wind-washing is occurring). In cooling climate locations, this

change can be made by installing insulating sheathing to the interior of the wall framing and between the wall framing and the interior gypsum board.

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 humidities next to the room surfaces are 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.

Appendix D

Web Sites for More Information

Agency for Toxic Substances & Disease Registry
www.atsdr.cdc.gov

Allergy and Asthma Network
www.aanma.org

American Academy of Allergy, Asthma & Immunology
www.aaaai.org

American Academy of Pediatrics
www. pediatrics.org/cgi/content/full/99/1/e5

California Department of Health & Safety
www.cal-iaq.org/mold9803.htm

Case Western Reserve University
http://Gcrc.cwru.edu/stachy/default.htm

Center for Environmental Risk Reduction
www.cerr.ucla.edu

Centers for Disease Control & Prevention
www.cdc.gov

Chemical Industry Institute of Toxicology
www.ciit.org

The Consumer Product Safety Commission
www.cpsc.gov/cpscpub/425.html

Environment, Safety & Health Information Portal
http://nattie.eh.doe.gov

The Environmental Protection Agency
www.epa.gov/iaq/pubs/sbs.html

The Environmental Protection Agency
www.epa.gov/iaq

Environmental Microbiology Laboratory, Inc.
www.emlab.com/fungi.html

Florida State University Sensory Research Institute
www.psy.fsu.edu/~fsusri

Institute of Environmental Toxicology
www.iet.msu.edu

Mycotech Biological, Inc.
www.stachybotrys.net

The National Environmental Respiratory Center
www.nercenter.org

The National Institute of Allergy and Infectious Disease
www.niaid.nih.gov

The National Safety Council
www.nsc.org/ehc/indoor/sbs/htm

New York City Department of Health
http://Nycdoitt.ci.nyc.us/html/doh/html/epi/modrpt1.html

North Carolina State University
www.ces.ncsu.edu/depts/fcs/housing/docs/fcs3605.html

Northern Arizona University
http://Jan.ucc.nau.edu/%/7Eman5/eeop

Occupational Safety & Health Administration
www.osha-slc.gov/SLTC/indoorairquality/index.html

The Office of Biological & Environmental Research
www.er.doe.gov/production/ober/ober_top.html

Particulate Matter Research Laboratories
www.pmra.org

University of Maryland
www.inform.umd.edu/UA/research/jarvis.html

University of Minnesota
www.dehs.umn.edu/fungus/myco.html

University Texas-Houston Health Science Center
www.sph.uth.tmc.edu/www/ctr/leland/index.htm

US Department of Housing & Urban Development
www.hud.gov

The WWW Virtual Library
www.keil.ukans.edu/~fungi

Appendix E

Chain of Custody

CHAIN OF CUSTODY (COC) DOCUMENTATION

Chain of Custody/Submission Form

Environmental Microbiology Laboratory, Inc.
1800 Sullivan Ave., Suite 209, Daly City, CA 94015
(650) 991-3436 Fax (650) 991-2243
www.emlab.com

Company/Branch:_____Contact:_____Phone No.:_____ Page__of__

Project:_____ Standard Rush:__ Next day (+50%)__ Same day (+75%)__Weekend (+100%)__

Response:_____ Fax?__ Fax No.:_____Graph air sampling data_____

Sampling Date:_____Email?__ E-mail address:_____

Purchase Order No._____ Send invoice to:_____

Sample ID	***Location Description***	***Sample Type*** *(see below)*	***Flow Rate/ Time*** *(if applicable)*	***Total Volume/ Area*** *(as applicable)*	***Notes*** *(Bulks and swabs will be analyzed by direct exam unless culture is requested)*
AL = Allergenco BR = Burkard Z = Zefon Air-O-Cell AF = Andersen Fungal AB = Andersen Bacterial T = Tape S = Swab BL = Bulk					

1: Relinquished by: _____ Date: _____ Received by: _____ Date: _____
2: Relinquished by: _____ Date: _____ Received by: _____ Date: _____
3: Relinquished by: _____ Date: _____ Received by: _____ Date: _____

Please send with report: Interpretation sheet (for air sampling): Surface sampling "paper"_____ Price List: ___Reference book list: ___ This information as well as other articles and reference material, is available from our website: www.emlab.com. Also, feel free to email (info@emlab.com) or call for additional information.

Notes: Submission of samples with your company's internal forms is completely acceptable (and common). If you do so, please be sure it provides the same information. We do our best to provide a rapid response even without special "rush" requests. Although we try to accommodate all rush requests, we cannot guarantee rush availability.

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SAMPLE LABRATORY REPORT 1

Non-Viable laboratory report for a typical home

Environmental Microbiology Laboratory, Inc.
1800 Sullivan Ave., Suite 209, Daly City, CA 94015
(650) 991-3436 Fax (650) 991-2243 www.emlab.com

Client: GHH Engineering, Inc.
C/O: Ms. Jennifer Bailey
Re:

Date of Sampling: 09-20-2000
Date of Receipt: 09-22-2000
Date of Report: 09-26-2000

SPORE TRAP REPORT: NON-VIABLE METHODOLOGY

Instrument Used: Zefon Air-O-Cell volumetric air sampler

Location:	106443: Outdoor background		15348: #47 dining room		160486: #47, east bedroom		160449: $47, living room		160456: #47, master bedroom	
Comments (see below)	None		None		None		None		None	
	raw.ct.	Spores/m3	raw.ct.	Spores/m3	raw.ct.	Spores/m3	raw.ct.	Spores/m3	raw.ct.	Spores/m3
Alternaria	7	93					3	40		
Arthriium										
Ascospores*	20	267								
Aureobasidium										
Dasidiospores*	152	2.027	4	53	8	107	4	53	4	53
Bipolarist/Drechslera group										
Botrytis										
Chaitomium	2	27								
Cladosporium	620	8.267	8	107	36	480	44	587	16	213
Curvularia	1	13								
Epicoccum	2	27	1	13						
Fusarium										
Myrothecium										
Nigrospora	12	160					1	13		
Other colorless										
Penicillium/Apergillus types	40	533					4	53	4	53
Pithomyces										

Rusts*	1	13								
Smuts* Periconia, Myxomcetes*	27	360	5	67	4	53	1	13	2	27
Stachybotrys chartarum (atra)										
Stemphylium	1	13								
Torula										
Trichocladium							1	13		
Ulocladium										
Unknown										
Zygomycetes										
Background debris (1-4+) ††	>4+		4+		4+		4+		4+	
Sample Volume (liters)	75		75		75		75		75	
TOTAL SPORES/M3		11,800		240		640		799	346	

Comments:

*Most of these spore types are not seen with culturable methods (Andersen sampling), although some may appear as non-sporulating fungi. Most of the basidiospores are "mushroom" spores while the rusts and smuts are plan pathogens.

• The spores of *Aspergillus* and *Penicillium* (and others such as *Acremonium*, *Paceilomyces*) are small and round with very few distinguishing characteristics. They cannot be differentiated by non-viable sampling methods. Also, some species with very small spores are easily missed, and may be undercounted.

•Background debris is an indication of the amount of non-biological particulate matter present on the slide (dust in the air) and is graded from 1+ to 4+ with 4+ indicating the largest amounts. To evaluate dust levels it is important to account for differences in sample volume. This background material is also an indication of visibility for the analyst and resultant difficulty in reading the slide. For example, high background debris may obscure small pores such as the *Penicillium/Aspergillus* group. Counts from areas with 4+ background debris should be regarded as minimum counts and may actually be higher than reported.

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SAMPLE LABORATORY REPORT 2

Non-Viable laboratory report for a typical home

Environmental Microbiology Laboratory, Inc.
1800 Sullivan Ave., Suite 209, Daly City, CA 94015
(650) 991-3436 Fax (650) 991-2243 www.emlab.com

Client: GHH Engineering, Inc.
C/O: Mr. Gary Hall
Re:

Date of Sampling: 11-3-99
Date of Receipt: 11-5-99
Date of Report: 11-10-99

SPORE TRAP REPORT: NON-VIABLE METHODOLOGY

Instrument Used: Zefon Air-O-Cell volumetric air sampler

Location:	304540: Bedroom 1		304516: Bedroom 2		304530: Living Room		304521: Outdoor	
	raw.ct.	Spores/m3	raw.ct.	Spores/m3	raw.ct.	Spores/m3	raw.ct.	Spores/m3
Alternaria	26	310	68	810	56	667	18	214
Arthriium								
Ascospores*	32	381	48	571			32	381
Aureobasidium pullulans								
Basidiospores*	80	952	192	2,286	144	1,714	200	2,381
Botrytis	8	95						
Chaitomium	5	60	8	95	8	95	1	12
Cladosporium	1,296	15,429	1,950	26,214	1,296	15,429	808	9,619
Curvularia	3	36	20	238	12	143		
Drechslera/Bipolaris group			12	143				
Epicoccum	4	48	4	48	8	95		
Fusarium								
Myrothecium			4	48				
Nigrospora	14	167	88	1,048	60	714	27	321
Other colorless								
Penicillium/Apergillus types	15,840	188,571	14,400	171,429	12,240	145,714	208	2,476
Pithomyces					3	36		
Rusts*	1	12			3	36	2	24
Smuts* Periconia, Myxomcetes*	136	1,619	528	6,286	96	1,143	32	381
Stachybotrys chartarum (atra)			2	24				
Stemphylium								

Torula herbarum	3	36	12	143	16	190		
Ulocladium	6	71	24	286	4	48	2	24
Unknown	1	12						
Zygomycetes	160	1,905	96	1,143	24	286		
Background debris (1-4+) ††	>4+		>>4+		>4+		4+	
Sample Volume (liters)	84		84		84		84	
TOTAL SPORES/M3		209,704		207,812		166,310		15,833

Comments:

*Most of these spore types are not seen with culturable methods (Andersen sampling), although some may appear as non-sporulating fungi. Most of the basidiospores are "mushroom" spores while the rusts and smuts are plan pathogens.

• The spores of *Aspergillus* and *Penicillium* (and others such as *Acremonium*, *Paceilomyces*) are small and round with very few distinguishing characteristics. They cannot be differentiated by non-viable sampling methods. Also, some species with very small spores are easily missed, and may be undercounted.

•Background debris is an indication of the amount of non-biological particulate matter present on the slide (dust in the air) and is graded from 1+ to 4+ with 4+ indicating the largest amounts. To evaluate dust levels it is important to account for differences in sample volume. This background material is also an indication of visibility for the analyst and resultant difficulty in reading the slide. For example, high background debris may obscure small pores such as the *Penicillium/Aspergillus* group. Counts from areas with 4+ background debris should be regarded as minimum counts and may actually be higher than reported.

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SAMPLE LABORAORY REPORT 3

Laboratory report for an air sample collected one hour after the start of abatement work. The previous lab reports show the mold levels before the abatement work started.

Client: GHH Engineering, Inc.
C/O: Ms. Jennifer Tucker
Re:

SPORE TRAP REPORT: NON-VIABLE METHODOLOGY
Instrument Used: Zefon Air-O-Cell volumetric air sampler

Location:	308565: Rainbow room		313624: Bedroom #2		313633: Living Room	
Comments (see below)	None		None		None	
	raw.ct.	Spores/m3	raw.ct.	Spores/m3	raw.ct.	Spores/m3
Alternaria	35	389	16	178	14	156
Ascospores*	8	89	8	89	28	311
Aspergillus niger-like	73,990	822,111	42,350	470,556	728	8,089
Aureobasidium pullulans						
Basidiospores*	8	89	28	311	508	5,644
Botrytis						
Chaetomium	2,112	23,467	944	10,489	24	267
Cladosporium	84	933	92	1,022	408	4.533
Curvularia			1	11		
Drechslera/Bipolaris group	4	44	1	11		
Epicoccum	3	33	1	11	7	78
Nigrospora						
Other colorless						
Paecilomyces	1,748	19,422	2,660	29,556		
Penicillium/Apergillus types	333,200	3,702,000	210,000	2,333,333	2,030	22,556
Pithomyces						
Rusts*	1	11	1	11		
Scopulariopsis	28	311	420	4,667		
Smuts* Periconia, Myxomcetes*	2,728	30,311	488	5,422	48	533
Stachybotrys chartarum (atra)	36	400	6	67		
Stemphylium					1	11
Torula herbarum					2	22
Trichoderma	1,296	14,400	72	800		

Ulocladium	3	33	3	33		
Unknown						
Zygomycetes (possible)						
Background debris (1-4+) ††	1+		1+		4+	
Sample Volume (liters)	90		90		90	
TOTAL SPORES/M3		4,614,265		2,856,567		42,200

Comments:

*Most of these spore types are not seen with culturable methods (Andersen sampling), although some may appear as non-sporulating fungi. Most of the basidiospores are "mushroom" spores while the rusts and smuts are plan pathogens.

• The spores of *Aspergillus* and *Penicillium* (and others such as *Acremonium*, *Paceilomyces*) are small and round with very few distinguishing characteristics. They cannot be differentiated by non-viable sampling methods. Also, some species with very small spores are easily missed, and may be undercounted.

•Background debris is an indication of the amount of non-biological particulate matter present on the slide (dust in the air) and is graded from 1+ to 4+ with 4+ indicating the largest amounts. To evaluate dust levels it is important to account for differences in sample volume. This background material is also an indication of visibility for the analyst and resultant difficulty in reading the slide. For example, high background debris may obscure small pores such as the *Penicillium/Aspergillus* group. Counts from areas with 4+ background debris should be regarded as minimum counts and may actually be higher than reported.

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SAMPLE LABORATORY REPORT 4

Non-Viable laboratory report for a typical home

Environmental Microbiology Laboratory, Inc.
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(650) 991-3436 Fax (650) 991-2243 www.emlab.com

Client: GHH Engineering, Inc.
C/O: Ms. Jennifer Bailey
Re:

Date of Sampling: 7-21-2000
Date of Receipt: 7-25-2000
Date of Report: 08-03-2000

SWAB SAMPLES: FUNGAL CULTURE

Swab sample #51: West bed framing

Quantity	Fungi isolated (Cellulose, DG18, MEA)
<100cfu/swab	No growth

Swab Sample #51: South bathroom framing

Quantity	Fungi isolated (Cellulose, DG18, MEA)
<100cfu/swab	No growth

Swab sample #51: Curtain

Quantity	Fungi insolated (Cellulose, DG18, MEA)
60,000 cfu/swab	Yeasts, *Rhodotorula* species
17,000 cfu/swab	*Cladosporium species*
7,000 cfu/swab	*Ulocladium* species
2,000 cfu/swab	*Alternaria* species
2,000 cfu/swab	*Aspergillus niger*

Swab sample #47: Living room window

Quantity	Fungi isolated (Cellulose, DG18, MEA)
300 cfu/swab	*Chaetomium* species

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The Basic Guide to

Mold Awareness

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SAMPLE LABORATORY REPORT 5

Environmental Microbiology Laboratory, Inc.
1800 Sullivan Ave., Suite 209, Daly City, CA 94015
(650) 991-3436 Fax (650) 991-2243 www.emlab.com

Client: GHH Engineering, Inc.
C/O: Ms. Jennifer Bailey
Re:

Date of Sampling: 10-09-2000
Date of Receipt: 10-11-2000
Date of Report: 10-23-2000

Quantitative Dust: Fungal culture

Location	Air Filter		
Media used	Cellulose/DG18/MEA		
Comments (see below)	None		
	Sample ct.	%	Cfu/gm.
Acremonium			
Alternaria	100	<1	4,000
Aspergillus flavus			
Aspergillus fumigatus			
Aspergillus nidulans			
Aspergillus niger	38,000	88	1,520,000
Aspergillus ochraceus			
Aspergillus versicolor			
Aspergillus, other			
Aureobasidium			
Basidiomycetes			
Bipolaris/Drechslera group			
Botrytis			
Chaitomium			
Cladosporium	1,600	4	64,000
Curvularia			
Epicoccum			
Fusarium			
Mucor	100	<1	4,000

Non-sporulating fungi			
Paecilomyces			
Penicillium	3,600	8	144,000
Phoma			
Stachybotrys chartarum (atra)			
Trichoderma			
Ulocladium			
Yeasts			
Dilution factors plated	1:100 & 1:1,000		
Weight (grams)	0025		
TOTAL CFU*/GRAM			1,736,000

* cfu = colony forming units

Note: Caution should be used when interpreting percentages. Percentage totals may not equal 100 due to rounding.

Comments:

•Sample count is the calculated number of colonies that would have grown if the entire selected sample weight analyzed were plated out.

• Results represent a compiled result from multiple media and multiple dilutions. Sensitivity of the results depends largely upon the dilutions used and the weight of the sample. For example, a dilution of 1:100 means that 1 colony on a plate represents a sample count of 100. For a sample of 0.025 grams, this would represent 4,000 cfu/gram. For a sample weight of 0.002 grams, this would represent 50,000 cfu/gram.

Interpretation is left to the company and/or persons who conducted the fieldwork.

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SAMPLE LABORATORY REPORT 6

Environmental Microbiology Laboratory, Inc.
1800 Sullivan Ave., Suite 209, Daly City, CA 94015
(650) 991-3436 Fax (650) 991-2243 www.emlab.com

Client: GHH Engineering, Inc.
C/O: Ms. Jennifer Bailey
Re:

Date of Sampling: 08-11-2000
Date of Receipt: 08-12-2000
Date of Report: 08-15-2000

DIRECT MICROSCOPIC EXAMINATION REPORT

(Wet Mount)

Amorphous Debris and/or Description	Miscellaneous Spores/Pollen*	MOLD GROWTH: Mold seen with underlying mycelial and/or sporulating structures	Other Comments	General Impression
Bulk sample Bathroom sink: Bathroom sink, wood				
Wood fragments	Very few	<1+ colorless spores typical of *Penicillium/Aspergillus*	None	Minimal mold growth
Bulk sample Dish cloth: Dish cloth				
Fragment of damp dish cloth with visible black mold	None	4+ *Stachybotrys chartarum (atra)*	None	Mold growth
Swab sample Kitchen wall #1: Kitchen wall #1				
Moderate	None	4+ colorless spores typical of *Penicillium/Aspergillus* 4+ *Stachybotrys chartarum (atra)* 1+ *Chaetomium* species 1+ *Petriella* species	None	Mold growth
Swab sample Kitchen wall #2: Kitchen wall #2				
Moderate	Few	4+ colorless spores typical of *Pencillium/Aspergillus* 2+ *Chaetomium* species	None	Mold growth

		2+ *Petriella* species		
Bulk sample Kitchen cabinet #1: Kitchen cabinet #1				
Fragments of wood	None	3+ *Petriells* species 1+ *Chaetomium* species 1+ *Pencillium* species	None	Mold growth
Bulk sample Kitchen linoleum: Kitchen linoleum				
Fragments of linoleum	Few	1+ *Petriella* species <1+ *Chaetomium* species	None	Mold growth
Bulk Sample Under fridge: Under fridge				
Dried mat of amorphous debris	Very few	2+ colorless spores typical of *Penicillium/Aspergillus*	Flakes of dried bacteria and yeasts present.	

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Mold Awareness and Inspection Quiz

Indicate whether the statement is True or False

Read each question fully and carefully before making your selection.

*Write the Letter **T** for a True statement and the letter **F** for a False statement*	
1. _____	The evidence of existing mold could result in a building being condemned for code violations.
2. _____	Allergic responses are the most common health problems associated with exposure to elevated levels of mold spores.
3. _____	In general, mold requires a source of moisture to grow.
4. _____	If mold growth is suspected inside a wall space, the sheet rock must be removed immediately.
5. _____	Mold and Mildew are the same thing.
6. _____	There is no group of fungi that can be associated with infectious disease
7. _____	Mold litigation has become one of the fastest growing fields of litigation.
8. _____	It is believed that the Stachybotrys mold has actually caused death before.

Multiple Choice Select the answer that is generally accepted as correct. Read each question fully and carefully before making your selections.

1. Which of the following are Health Symptoms & Concerns affiliated with the presence of mold:
    a. Sinus Problems
    b. Bloody Noses
    c. Loss of Memory
    d. Skin Irritation
    e. All of the Above

2. Which of the following are Health Symptoms & Concerns affiliated with the presence of mold:
    a. Sinus Problems
    b. Bloody Noses
    c. Loss of Memory
    d. Skin Irritation
    e. All of the Above
3. Which of the following correctly defines Mycotoxins:
    a. Chemicals associated with the removal of mold
    b. Chemicals associated with growth, digestion, and self-defense
    c. Toxins with a relative density level of +1
    d. None of the above
4. When dealing with molds what is the greatest factor affecting the development of health problems:
    a. Size of individuals house
    b. Size of individual
    c. Individual Sensitivity
    d. Individual mold spores
5. What is the desired temperature range for mold growth:
    a. 0°- 20° C
    b. 40°- 100° F
    c. 0°- 20° F
    d. 40°- 100° C
6. Which of the following does mold typically feed on:
    a. dead, organic material
    b. living organisms
    c. tree roots
    d. none of the above
7. All of the following are associated with mycotoxins except:
    a. growth
    b. decomposition
    c. self-defense
    d. metabolism

8. In order for mold to grow it needs a food source with a high _____ content.
    a. organic
    b. oxygen
    c. nitrate
    d. water
9. All of the following household items are possible sources of moisture except:
    a. dishwasher
    b. plants
    c. steam from cooking
    d. electric oven
10. MVER is the acronym for which of the following:
    a. moisture vapor energy rate
    b. moisture ventilation emission rate
    c. moisture vapor emission rate
    d. moisture ventilation energy rate
11. Moisture can intrude into a home through exterior walls as the result of all of the following except:
    a. flower beds next to exterior walls
    b. clogged weep screeds
    c. staining or discoloration
    d. missing or torn moisture paper
12. The flooring industry standard for acceptable moisture emission is ___lbs. of water per day.
    a. 3
    b. 5
    c. 4
    d. 2
13. Which of the following can lead to increased amounts of moisture vapor emitted through the foundation:
    a. construction of the slab
    b. soil conditions under the slab
    c. amount of time that was allowed for the slab to cure
    d. all of the above

14. Sometimes, the signs of excess moisture vapor can be observed by white deposits, or _____, on the bare cement when carpeting is pulled back.
    a. crystals
    b. dust
    c. salt
    d. stains
15. Relative humidity levels higher than ___% indoors can foster mold growth.
    a. 50
    b. 60
    c. 65
    d. 33
16. The three basic methods of mold sampling are air sampling, surface sampling, and:
    a. wall sampling
    b. dust sampling
    c. floor sampling
    d. moisture sampling
17. In surface sampling, which of the following denotes the highest number of mold spores:
    a. 1+
    b. 4+
    c. 1-
    d. 4-
18. The three basic methods of surface sampling are bulk sampling, tape sampling, and:
    a. swab sampling
    b. air sampling
    c. condensed sampling
    d. conduced sampling
19. The following are the two techniques for analyzing mold samples:
    a. visible and invisible
    b. viable and non-viable
    c. direct and indirect
    d. formed and non-formed

20. Air Sample data is reported as which of the following:
    a. conducing frequently units
    b. colony forming units
    c. moisture vaporization rate
    d. moisture forming rate
21. In most cases solution containing ___% chlorine is used to remove mold.
    a. 10
    b. 5
    c. 20
    d. 7
22. PPE is the acronym for which of the following:
    a. professional public environment
    b. professional protective equipment
    c. personal protective equipment
    d. private protective equipment
23. All of the following are organic food sources required for mold growth except:
    a. cloth
    b. sheet rock
    c. cement
    d. wood
24. All of the following are commonly encountered fungal genera except:
    a. Alternaria
    b. Cladosporium
    c. Aspergillus
    d. Asparagus
25. _____ are simple, microscopic organisms, found virtually everywhere, indoors and outdoors.
    a. Amoeba
    b. Molds
    c. Moss
    d. Algae

26. All of the following are common indoor molds except:
    a. Mucor
    b. Penicillium
    c. Sterioracobia
    d. Asperigillus
27. All of the following are ways that people can decrease mold exposure except:
    a. keep humidity levels below 40%
    b. ventilating showers
    c. run A/C more often
    d. ventilating cooking areas
    e. all of the above
28. All of the following have high mold exposures except:
    a. antique shops
    b. mills
    c. bakeries
    d. flower shops
29. All of the following groups have greater risk of developing health problems associated with certain fungi except:
    a. infants (less than 12 months old)
    b. persons recovering from recent surgery
    c. lawyers
    d. people with immune suppression
30. When fungal growth requiring large-scale remediation is found, the building owner, management, and/or employer should notify occupants in the affected area of its presence. Notification should include:
    a. description of the remedial measures to be taken
    b. timetable for completion
    c. both a and b
    d. none of the above

31. Mold growth under or next to a window sill may be the result of:
    a. construction defect
    b. flashing problem
    c. both a and b
    d. none of the above
32. All of the following are possible signals of mold growth except:
    a. cracked or bubbling paint
    b. musty odors
    c. buckling or warped flooring of baseboards
    d. all of the above
    e. none of the above