REVIEW MATERIALS

COURSE 14239

MOLD PREVENTION AND REMEDIATION

6 Hour Continuing Education Course

USCONTRACTORLICENSE LLC dba Kevin Wunderlin
PO Box 268
Platteville, Wisconsin 53818
608-348-6688

Email: ***michael@uscontractorlicense.com***

This Course has been approved by the Wisconsin Department of Safety and Professional Services for the following Certifications, Registrations or License.

Effective October 15, 2010 you may not retake the same training session for credit more than once during the 1, 2 or 4 year term of a specific credential. You may take the same course in a different education cycle.

KEVIN WUNDERLIN LLC
PO BOX 268
PLATTEVILLE, WI 53818

Course: 14239 MOLD PREVENTION & REMEDIATION

This course is valid for these credentials:

Credential Description	Cred Code	Credit Hours
Dwelling Contractor Qualifier	DCQ	6.0
Manufactured Home Installer	MHI	6.0

MOLD PREVENTION AND REMEDIATION

Approved by the
Wisconsin Department of Safety and Professional Services
Course Identification Number 14239
Expiration Date: 12/17/2022
Educational Credit Hours: 6 Hours

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www.uscontractorlicense.com

Molds are the most common forms of fungi found on earth. They can grow on almost any material, as long as moisture and oxygen are available. Most molds reproduce through the formation of spores, tiny microscopic cells that are resistant to drying and are released into the air. Individuals involved in the construction trades come into contact with mold during a renovation or maintenance of building. This course is intended to give employers and employees a fundamental knowledge of mold prevention and remediation solutions when working on a construction project.

This course has been approved for the following Certification or License for 6 Hours of Continuing Education which are administered by the Wisconsin Department of Safety and Professional Services.

Dwelling Contractor Qualifier Certification	Manufactured Home Installer License

This course is a distance learning or e-learning course, which allows the attendee to complete the course on their time schedule.

OUTLINE OF COURSE

GLOSSARY OF TERMS
INTRODUCTION TO MOLD
- **What are Molds?**
- **What Mold needs to Grow**
- **Moisture Control**
- **Health Effects**
- **Allergic Reactions, Asthma Attacks, Irritant Effects**

LARGE AREAS AND OTHER SPECIAL CONSIDERATIONS

- **Remediating Large Areas of Mold Contamination**
- **Mold Remediation in HVAC System**
- **Confined Spaces**

CONTAINMENT AND PERSONAL PROTECTIVE EQUIPMENT

- **Overview of Containment**
  - **Limited Containment**
  - **Full Containment**
- **Personal Protective Equipment**

EVALUATING THE REMEDIATION

- **Completing Mold remediation**
- **Consider Bioaerosol Sampling**

COMMUNICATING WITH BUILDING OCCUPANTS

- **Communicate When You Remediate**

PREVENTION

- **Mold Prevention**
- **Hidden Areas**
- **Routine Maintenance**

RESOURCE LIST

INFORMATION FOR MOLD CONTRACTORS & CONSULTANTS IN WISCONSIN

INFORMATION FOR WISCONSIN RESIDENTS

- **Consumers**
- **Professional/Technical Information on Mold**

Exam

One Hundred eighty questions related to the Reference Materials are used to test the attendee on their comprehension of the materials. A 70% score will need to be attained in order to pass this course.

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Overview on Mold Prevention and Remediation



Please note that the course and this document, on which it is based, provide guidelines; other cleaning and remediation methods may be preferred by some professionals. This course does not cover all situations and all potentially useful methods or techniques. The absence of a method or technique from this course does not indicate or imply that it is not effective. Please consult the Resource List for additional information.

 This handout is intended for use as a reference guide to our Overview on Mold Prevention and Remediation.
Contact Kevin Wunderlin LLC – 608-348-6688 – if you have questions or comments.

Glossary of Terms

ACH - Air changes per hour. The amount of air in a building that leaks out or is removed by a fan and is replaced by outdoor air. Usually listed as a fraction of one air change per hour, such as .35 ACH.

ACID AEROSOL - Acidic liquid or solid particles that are small enough to become airborne. High concentrations of acid aerosols can be irritating to the lungs and have been associated with some respiratory diseases, such as asthma.

AIR CLEANING - An IAQ control strategy to remove various airborne particulates and/or gases from the air. The three types of air cleaning most commonly used are particulate filtration, electrostatic precipitation, and gas sorption.

AIR EXCHANGE RATE - The rate at which outside air replaces indoor air in a space. Expressed in one of two ways: the number of changes of outside air per unit of time air changes per hour (ACH); or the rate at which a volume of outside air enters per unit of time - cubic feet per minute (cfm).

AIR HANDLING UNIT (AHU) - Equipment that includes a blower or fan, heating and/or cooling coils, and related equipment such as controls, condensate drain pans, and air filters. Does not include ductwork, registers or grilles, or boilers and chillers.

AIR PASSAGES - Openings through or within walls, through floors and ceilings, and around chimney flues and plumbing chases, that permit air to move out of the conditioned spaces of the building.

ALLERGEN - A substance, such as mold, that can cause an allergic reaction.

ALLERGIC RHINITIS - Inflammation of the mucous membranes in the nose that is caused by an allergic reaction.

ANTIMICROBIAL - Agent that kills microbial growth (i.e., chemical or substance that kills mold or other organisms). See "Biocide" and " Fungicide".

BIOLOGICAL CONTAMINANTS - 1) Living organisms, such as viruses, bacteria, or mold (fungi), 2) the remains of living organisms, or 3) debris from or pieces of dead organisms. Biological contaminants can be small enough to be inhaled, and may cause many types of health effects including allergic reactions and respiratory disorders.

BIOCIDE - A substance or chemical that kills organisms such as mold.

BREATHING ZONE - Area of a room in which occupants breathe as they stand, sit, or lie down.

BUILDING-RELATED ILLNESS, or BRI - Diagnosable illness whose symptoms can be identified and whose cause can be directly attributed to airborne building pollutants (e.g., Legionnaire's disease, hypersensitivity pneumonitis). Also: A discrete, identifiable disease or illness that can be traced to a specific pollutant or source within a building. (Contrast with "Sick building syndrome").

CARBON DIOXIDE, or CO_2 - a colorless, odorless, and tasteless product of combustion. All combustion processes and human metabolic processes are sources of CO_2. Concentrations of CO_2 from people are always present in all occupied buildings, and at concentrations normally found in buildings, CO_2 is not a health hazard.

CARBON MONOXIDE, or CO- a colorless, odorless, and tasteless gas which results from combustion of fuels. It is often associated with combustion heating devices (e.g. boilers, furnaces) and auto, truck, or bus exhaust from attached garages, nearby roads, or parking areas. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, CO exposure can be fatal.

CHEMICAL SENSITIZATION - Evidence suggests that some people may develop health problems characterized by effects such as dizziness, eye and throat irritation, chest tightness, and nasal congestion that appear whenever they are exposed to certain chemicals. People may react to even trace amounts of chemicals to which they have become "sensitized."

CONDENSATION - The transformation of the water vapor content of the air into liquid water on cold surfaces. The beads or drops of water (or frost in extremely cold weather) that accumulate on the inside of the exterior covering of a building when warm, moisture-laden air from the interior reaches a point where the temperature no longer permits the air to sustain the moisture it holds.

DAMPPROOFING - Sealing the foundation walls to help prevent outside moisture from entering the basement.

DISINFECTANTS - One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a disinfectant when it destroys or irreversibly inactivates infectious or other undesirable organisms, but not necessarily their spores. EPA registers three types of disinfectant products based upon submitted efficacy data: limited, general or broad spectrum, and hospital disinfectant.

DUST SPOT EFFICIENCY - A measure of the ability of a filter to remove atmospheric dust from air (expressed in percent).

EXPOSURE - The initial contact of the body with a substance.

FUNGI - A separate kingdom comprising living things that are neither animals nor plants. The kingdom Fungi includes molds, yeasts, mushrooms, and puffballs. In the mold course, the terms fungi and mold are used interchangeably.

FUNGICIDE - A substance or chemical that kills fungi.

HEPA - High efficiency particulate air (filter).

HUMIDIFIER FEVER - A respiratory illness caused by exposure to toxins from microorganisms found in wet or moist areas in humidifiers and air conditioners. Also called air conditioner or ventilation fever.

HVAC - Heating, ventilation, and air-conditioning system.

HYPERSENSITIVITY - Great or excessive sensitivity.

HYPERSENSITIVITY DISEASES - Diseases characterized by allergic responses to pollutants. The hypersensitivity diseases most clearly associated with indoor air quality are asthma, rhinitis, and hypersensitivity pneumonitis. Hypersensitivity pneumonitis is a rare but serious disease that involves progressive lung damage as long as there is exposure to the causative agent.

HYPERSENSITIVITY PNEUMONITIS - A group of respiratory diseases that cause inflammation of the lung (specifically granulomatous cells). Most forms of hypersensitivity pneumonitis are caused by the inhalation of organic dusts, including molds.

IAQ - Indoor air quality (IAQ) is a term referring to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.

MOLD - A group of organisms that belong to the kingdom Fungi. In this course, the terms fungi and mold are used interchangeably.

mVOC (microbial volatile organic compound) - A chemical made by mold that is a gas at room temperature and may have a moldy or musty odor.

MYCOTOXIN - A toxin produced by a mold.

NEGATIVE PRESSURE - A condition that exists when less air is supplied to a space than is exhausted from the space, so the air pressure within that space is less than that in surrounding areas. Under this condition, if an opening exists, air will flow from surrounding areas into the negatively pressurized space.

POLLUTANT PATHWAYS - Avenues for distribution of pollutants in a building. HVAC systems are the primary pathways in most buildings; however all building components interact to affect how air movement distributes pollutants.

PPB - Parts per billion

PPM - Parts per million. 1 ppm = 10^{-6} or .0001%, and 1% = 10,000 ppm.

PRESSED WOOD PRODUCTS - A group of materials used in building and furniture construction that are made from wood veneers, particles, or fibers bonded together with an adhesive under heat and pressure.

REMEDIATE - Fix.

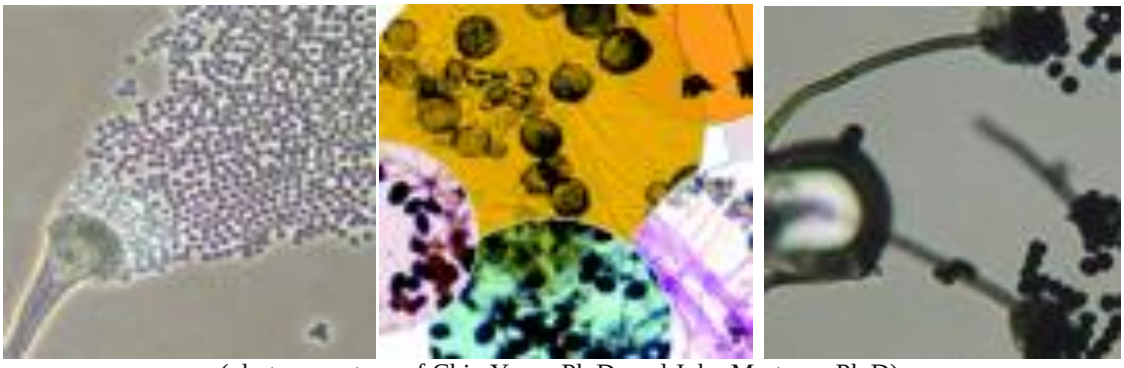
SANITIZER - One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an anti-microbial to be a sanitizer when it reduces but does not necessarily eliminate all the microorganisms on a treated surface. To be a registered sanitizer, the test results for a product must show a reduction of at least 99.9% in the number of each test microorganism over the parallel control.

SICK BUILDING SYNDROME, or SBS - Term that refers to a set of symptoms that affect some number of building occupants during the time they spend in the building and diminish or go away during periods when they leave the building. Cannot be traced to specific pollutants or sources within the building. (Contrast with "Building related illness').

SPORE - The means by which molds reproduce. Spores are microscopic. They vary in shape and range from 2 to 100 microns in size. Spores travel in several ways: passively moved by a breeze or water drop, mechanically disturbed (by a person or animal passing by), or actively discharged by the mold (usually under moist conditions or high humidity).

STERILIZER - One of three groups of antimicrobials registered by EPA for public health uses. EPA considers an antimicrobial to be a sterilizer when it destroys or eliminates all forms of bacteria, fungi, viruses, and their spores. Because spores are considered the most difficult form of a microorganism to destroy, EPA considers the term sporicide to be synonymous with "sterilizer."

TOXIGENIC - Producing toxic substances.



(photos courtesy of Chin Yang, Ph.D. and John Martyny, Ph.D)

Magnified mold and mold spores

INTRODUCTION TO MOLD

What Are Molds

Molds are organisms that may be found indoors and outdoors. They are part of the natural environment and play an important role in the environment by breaking down and digesting organic material, such as dead leaves. Also called fungi or mildew, molds are neither plants nor animals; they are part of the kingdom Fungi.

Molds can multiply by producing microscopic spores (2 - 100 microns [µm] in diameter), similar to the seeds produced by plants. Many spores are so small they easily float through the air and can be carried for great distances by even the gentlest breezes. The number of mold spores suspended in indoor and outdoor air fluctuates from season to season, day to day, and even hour to hour.

Mold spores are ubiquitous; they are found both indoors and outdoors. Mold spores cannot be eliminated from indoor environments. Some mold spores will be found floating through the air and in settled dust; however, they will not grow if moisture is not present.

Mold is not usually a problem indoors—unless mold spores land on a wet or damp spot and begin growing. As molds grow they digest whatever they are growing on. Unchecked mold growth can

damage buildings and furnishings; molds can rot wood, damage drywall, and eventually cause structural damage to buildings. Mold can cause cosmetic damage, such as stains, to furnishings. The potential human health effects of mold are also a concern. It is important, therefore, to prevent mold from growing indoors.

What Mold Needs to Grow

To grow indoors, mold needs moisture and food. Moisture is the most important factor influencing mold growth indoors. Controlling indoor moisture helps limit mold growth.

Moisture control is the key to mold control.

Mold does not need a lot of water to grow. A little condensation, in a bathroom or around a window sill, for example, can be enough. Common sites for indoor mold growth include bathroom tile and grout, basement walls, and areas around windows, near leaky water fountains, and around sinks. Common sources of water or moisture include roof leaks, condensation due to high humidity or cold spots in a building, slow leaks in plumbing fixtures, humidification systems, sprinkler systems, and floods.*

Besides moisture, mold needs nutrients, or food, to grow. Mold can grow on virtually any organic substance. Most buildings are full of organic materials that mold can use as food, including paper, cloth, wood, plant material, and even soil. In most cases, temperature is not an issue; some molds grow in warm areas, while others prefer cool locations such as bread stored in a refrigerator. Often, more than one type of mold can be found growing in the same area, although conditions such as moisture, light, and temperature may favor one species of mold over another.

Mold on the air seal of a sliding glass door.

*** Floods:** Buildings that have been heavily damaged by flood waters should be assessed for structural integrity and remediated by experienced professionals. Please note that the guidelines covered in this course were developed for damage caused by clean water (not flood water, sewage, or other contaminated water). See the EPA **Resource List**, which includes the EPA Fact Sheet: **Flood Cleanup - Avoiding Indoor Air Quality Problems**, for more information.

Health Effects That May Be Caused by Inhaling Mold or Mold Spores
Inhalation exposure to mold indoors can cause health effects in some people. Molds produce allergens (substances that can cause allergic reactions), irritants, and, in some cases, potentially toxic substances or chemicals (mycotoxins). Inhaling or touching mold or mold spores may cause allergic reactions in sensitive individuals. Mold does not have to be alive to cause an allergic reaction. Dead or alive, mold can cause allergic reactions in some people.

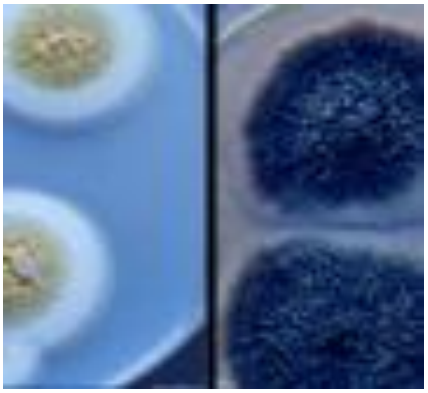
Allergic Reactions, Asthma Attacks, Irritant Effects
Allergic reactions to mold are common and can be immediate or delayed. Repeated or single exposure to mold, mold spores, or mold fragments may cause non-sensitive individuals to become sensitive to mold, and repeated exposure has the potential to increase sensitivity. Allergic responses include hay fever-like symptoms such as headache, sneezing, runny nose, red eyes, and skin rash (dermatitis). Molds can cause asthma attacks in people with asthma who are allergic to mold. In addition, molds can irritate the eyes, skin, nose, throat, and lungs of individuals whether or not they are allergic to mold.

Other Health Effects
Breathing in mold may also cause hypersensitivity pneumonitis, an uncommon disease that resembles bacterial pneumonia. In addition, mold exposure may result in opportunistic infections in persons whose immune systems are weakened or suppressed.
When mold grows indoors, the occupants of a building may begin to report odors and a variety of symptoms including headaches, difficulty breathing, skin irritation, allergic reactions, and aggravated asthma symptoms. These and other symptoms may be associated with exposure to mold. But all of these symptoms may be caused by other exposures or conditions unrelated to mold growth. Therefore, it is important not to assume that, whenever any of these symptoms occurs, mold is the cause.
For more detailed information on mold and its health effects, consult a health professional. You may also wish to consult your state or local health department. (Also see the Resource List for additional information.)

Damp Buildings: Although mold is frequently found in damp buildings, it is not the only potential contaminant — biological contaminants other than mold, and nonbiological contaminants are often present and may also cause health effects. Damp buildings may attract rodents and other pests. Damp or wet building components and furnishings may release chemicals indoors.
Potential contaminants in damp or wet buildings include bacteria, dust mites, cockroaches and other pests, as well as chemicals emitted by damp building materials and furnishings. For more information on damp buildings and health effects, see the 2004 Institute of Medicine Report, *Damp Indoor Spaces and Health*, published by The National Academies Press in Washington, DC, and available on the Web. See Resource List for Web link.

Mycotoxins and Health Effects
As molds grow, some (but not all) of them may produce potentially toxic byproducts called mycotoxins under some conditions. Some of these molds are commonly found in moisture-damaged buildings. More than 200 mycotoxins from common molds have been identified, and many more remain to be identified. The amount and types of mycotoxins produced by a particular mold depends on many environmental and genetic factors. No one can tell whether a mold is producing mycotoxins just by looking at it. Some mycotoxins are known to affect people, but for many mycotoxins little health information is available. Research on mycotoxins is ongoing. Exposure to mycotoxins can occur from inhalation, ingestion, and skin contact. It is prudent to avoid unnecessary inhalation exposure to mold.

The Color of Mold
Molds come in many colors including white. "Black mold" is not a species or specific kind of mold, and neither is "toxic mold." Sometimes the news media use the terms "*toxic mold*" and "*black mold*" to refer to molds that may produce mycotoxins or for a specific mold, *Stachybotrys chartarum* . Molds that produce mycotoxins are often referred to as toxigenic fungi.



Mold growing in Petri dishes. The same type of mold is growing in both photos, but note that molds can change appearance as they age. In this example, the mold on the right has been growing for several days longer than the mold on the left.
(photo courtesy of Chin Yang, Ph.D.)

Moldy Smell
Some compounds produced by molds have strong smells and are volatile and quickly released into the air. These compounds are known as microbial volatile organic compounds (mVOCs). Because mVOCs often have strong or unpleasant odors, they can be the source of the "moldy odor" or musty smell frequently associated with mold growth. **A moldy odor suggests that mold is growing in the building and should be investigated.**
The health effects of inhaling mVOCs are largely unknown, although exposure to mVOCs has been linked to symptoms such as headaches, nasal irritation, dizziness, fatigue, and nausea. More research is needed to determine whether there are any human health effects from nonoccupational indoor exposures to mVOCs.

Biocides
Biocides are substances that can destroy living organisms. The use of a biocide or a chemical that kills organisms such as mold (chlorine bleach, for example) is not recommended as a routine practice during mold cleanup. There may be instances, however, when professional judgment indicates their use (for example, when immune-compromised individuals are present).

In most cases, it is not possible or desirable to sterilize an area; a background level of mold spores will remain, but these spores will not grow if the moisture problem has been resolved. If disinfectants or biocides are used, always ventilate the area and exhaust the air to the outdoors. Never mix chlorine bleach with other cleaning solutions or with detergents that contain ammonia because toxic fumes could be produced.
Please note: Dead mold is allergenic and may cause allergic reactions and other health effects in some individuals, so it is not enough to simply kill the mold. It must also be removed.

WHERE AND WHY MOLD GROWS

Introduction to Mold Growth
Mold can grow on virtually any organic material as long as moisture and oxygen are present. There are molds that grow on wood, paper, carpet, food, and insulation. Because mold eats or digests what it is growing on, it can damage a building and its furnishings. If left unchecked, mold eventually can cause structural damage to building materials.
Eliminating all mold and mold spores indoors is virtually impossible, but controlling indoor moisture will control the growth of indoor mold.

Mold on bread. (Note growth has started on the exterior and is gradually expanding and growing into the interior of the bread.)

Molds gradually destroy the things they grow on. You can prevent damage to buildings and building contents, save money, and avoid potential health problems by controlling moisture and eliminating mold growth.

Moisture Problems

Moisture problems can have many causes. Some moisture problems have been linked to changes in building construction practices since the 1970s. These practices led to buildings that are tightly sealed but, in some cases, lack adequate ventilation. Without adequate ventilation, moisture may build up indoors and mold may grow.

A building must be properly designed for climate, site location, and use, and its design must be accurately followed during construction or the building may have moisture control problems. For more information on building construction for moisture control, see the Resource List.

Delayed or insufficient maintenance can lead to moisture problems in buildings. Undiscovered or ignored moisture problems can create an environment in which mold can grow. Moisture problems in temporary structures, such as portable classrooms, are also frequently associated with mold problems.

Common moisture problems include:

- Leaking roofs.
- Leaking or condensing water pipes, especially pipes inside wall cavities or pipe chases.
- Leaking fire-protection sprinkler systems.
- Landscaping, gutters, and down spouts that direct water into or under a building.
- High humidity (> 60% relative humidity).
- Unvented combustion appliances such as clothes dryers vented into a garage. (Clothes dryers and other combustion appliances should be vented to the outside.)

(photo courtesy of Terry Brennan)

Some moisture problems are not easy to see. For example, the inside of walls where pipes and wires are run (pipe chases and utility tunnels) are common sites of mold growth. Mold is frequently found on walls in cold corners behind furniture where condensation forms. Other possible locations of hidden moisture, resulting in hidden mold growth are:

- Poorly draining condensate drain pains inside air handling units.

- Porous thermal or acoustic liners inside duct work.
- Roof materials above ceiling tiles.
- The back side of drywall (also known as gypsum board, wallboard, or SHEETROCK®), paneling, and wallpaper.
- The underside of carpets and pads.

You may suspect mold, even if you can't see it, if a building smells moldy. You may also suspect hidden mold if you know there has been a water problem in the building and its occupants are reporting health problems.

Building Design and Vapor Barriers: Many buildings incorporate vapor barriers in the design of their walls and floors. Vapor barriers must be located and installed properly or the building may have moisture problems. A vapor barrier is a layer of material that slows or prevents the absorption or release of moisture from or into a wall or floor. Vapor barriers can prevent damp or wet building materials from drying quickly enough to prevent mold growth. For more information on building design see the Resource List.

Humidity

Sometimes, humidity or dampness (water vapor) in the air can supply enough moisture for mold growth. Indoor relative humidity (RH) should be kept below 60 percent — ideally between 30 percent and 50 percent, if possible. Low humidity may also discourage pests (such as cockroaches) and dust mites.

Humidity levels can rise in a building as a result of the use of humidifiers, steam radiators, moisture-generating appliances such as dryers, and combustion appliances such as stoves. Cooking and showering also can add to indoor humidity.

Mold on grout.
(photo courtesy of Elissa Feldman)

HVAC System

One function of the building heating, ventilation, and air conditioning (HVAC) system is to remove moisture from the air before the air is distributed throughout the building. If the HVAC system is turned off during or shortly after major cleaning efforts that involve a lot of water, such as mopping

and carpet shampooing or cleaning, the humidity may rise greatly, and moisture or mold problems may develop.

Condensation

Condensation can be a sign of high humidity. When warm, humid air contacts a cold surface, condensation may form. (To see this, remove a cold bottle of water from a refrigerator and take it outside on a hot day. Typically, condensation will form on the outside of the bottle.) Humidity can be measured with a humidity gauge or meter; models that can monitor both temperature and humidity are generally available for less than $50 at hardware stores or on the Internet.

Moisture issue: Condensation on uninsulated air conditioning duct.
Fix: Insulate the duct on the outside.
(photo courtesy of Terry Brennan)

Ventilation Humidity Problems - Heating, Ventilation, and Air Conditioning (HVAC) System

Mold growing near the intake to an HVAC system indicates potential ventilation humidity problems. An HVAC system that is part of an identified moisture problem may also be a site of mold growth. Experience and professional judgment should be used when working with the HVAC system; consult a professional if needed.

The HVAC system has the potential to spread mold throughout a building. Known or suspected mold growth in HVAC ducts or other system components should be investigated and resolved promptly. If substantial amounts of mold can be seen growing on the inside of hard surface ducts (e.g., ducts made of sheet metal), consider cleaning the ducts. Consult the EPA guide *Should You Have the Air Ducts in Your Home Cleaned?* (see the Resource List). Although this publication focuses on ducts in homes, the information it contains is applicable to other building types.

If the HVAC system has insulation on the inside of the air ducts, and the insulation gets wet or moldy, it should be removed and replaced because the material cannot be cleaned effectively. **Please note that there are no antimicrobial products or biocides approved by EPA for use on lined ductwork.** Consult the EPA Web site on antimicrobial pesticides for more information (see the Resource List).

Controlling moisture is the most effective way of keeping mold from growing in air ducts. Steps to control moisture in ductwork include:

- Promptly and properly repairing any leaks or water damage.

- Removing standing water under the cooling coils of air handlers by making sure the drain pans slope toward the drain and the drain is flowing freely.
- Making sure ducts are properly sealed and insulated in all non-air-conditioned spaces so moisture due to condensation does not enter the system and the system works as intended. To prevent condensation, the heating and cooling system must be properly insulated.
- Operating and maintaining any in-duct humidification equipment strictly according to the manufacturer's recommendations.
- Making sure that carpets, drapes, furniture, and other furnishings are dried promptly after they have been cleaned.

Structural Integrity and Mold Growth

Molds gradually destroy whatever they grow on, so preventing mold growth also prevents damage to building materials and furnishings.

If a mold and moisture problem goes unaddressed long enough, structural damage is likely to result. For example, if a roof is allowed to leak long enough, molds can weaken floors and walls by feeding on the wet wood.

When mold is suspected of causing damage to the structural integrity of a building, a structural engineer or other professional with relevant expertise should be consulted.

Crawl Spaces

Crawl spaces where relative humidity (RH) is high are common sites of hidden mold growth, particularly if the crawl space has a bare earth floor. The soil will wick moisture, through capillary action, from moist to dry areas. The relative warmth of the crawl space will dry the soil by evaporation, adding this moisture to the air in the crawl space where it can cause mold to grow. Also, in areas where the water table is high and weather conditions are suitable, ground water may enter a crawl space.

The moisture that accumulates in a crawl space may also enter another part of the building and contribute to mold growth there. Moisture can pass from a crawl space into a building through cracks in walls, floors, and ceilings.

Crawl spaces should be designed specifically to avoid moisture problems. For information on constructing crawl spaces and other building features, see the Resource List.

Mineral deposits on the surface of a dirt crawl space caused by chronic water problems. (This is not mold.)
(photo courtesy of John Martyny, Ph.D.)

Drying Buildings, Building Materials, and Furnishings

Buildings and building furnishings will often get wet. They must be dried or "allowed to dry" quickly (within 24-48 hours) in order to avoid mold growth. In general, increasing air circulation and temperature will increase the speed of drying.

Commercial firms that do mold remediation work or work on water- and fire-damaged buildings often use large fans, dehumidifiers, and other equipment to dry wet buildings and items quickly before mold has a chance to grow. This action can save money in the long run, because if the building or furnishings are dried completely and quickly, mold will not grow, and a mold remediation will not be needed.

Drying a carpet with a commercial specialty blower with built-in heater.
(photo courtesy of Terry Brennan)

Floods

During a flood cleanup, the indoor air quality in your home or office may appear to be the least of your problems. However, failure to remove contaminated materials and to reduce moisture and humidity can present serious long-term health risks. Standing water and wet materials are a breeding ground for microorganisms, such as viruses, bacteria, and mold. They can cause disease, trigger allergic reactions, and continue to damage materials long after the flood.

Buildings that have been heavily damaged by flood waters should be assessed for structural integrity and remediated by experienced professionals.

Please note that the guidelines covered in this course were developed for damage caused by clean water (not flood water, sewage, or other contaminated water). See the **Resource List**, which includes the EPA Fact Sheet: **Flood Cleanup - Avoiding Indoor Air Quality Problems**, for more information.

FINDING MOLD AND MOISTURE

Where to Look for Mold Contamination - Building Investigation
As previously discussed, mold can grow in wet or damp spots in a building, or where humidity is high. Therefore, it is important to look for indoor areas where moisture is a concern. Reports of any of these problems should be investigated. If there has been a leaking pipe in the basement, for example, items such as carpets, paneling, and drywall there should be checked for water damage or mold growth. It is important to dry items quickly to prevent mold growth; in most cases, items dried within 24-48 hours will not become moldy.

Moisture meter, showing high moisture content in gypsum board behind tile.
(photo courtesy of Terry Brennan)

Carpet
Carpet backing or padding must be dried in addition to the carpet or mold will likely result.

Hidden Mold Growth
In some cases, indoor mold growth may not be obvious. Mold does not need light to grow: it can grow in dark areas and on hidden surfaces, such as the backside of drywall, wallpaper, and paneling; the top side of ceiling tiles; and the underside of carpets and pads. Possible locations of hidden mold also include damp areas behind walls and in crawlspaces, inside pipe chases and utility tunnels (areas in walls where water and other pipes are run), on acoustic liners in ventilation ducts, and on roof materials above ceiling tiles. Investigating hidden mold can be difficult and may require a professional with experience investigating water and mold-damaged buildings. Specialized equipment such as borescopes and moisture meters, and in some cases special sampling techniques, may be helpful in locating and identifying hidden mold areas.

Most mold is found by simply looking.
Mold beneath corkboard.
(photo courtesy of Terry Brennan)

Investigating hidden mold requires caution since disturbing moldy areas may spread mold throughout the building. Opening and closing air handlers, for example, can send high levels of dust and mold into the air. Personal protective equipment (PPE) is not always needed when looking for mold, but it should always be available. If mold might be released into the air, investigators should use PPE to reduce exposure.

Look for mold in wet or damp places and in places that smell moldy or musty. Indoor mold growth should be cleaned up. Remember that mold comes in many colors, not just black.

Homes

Areas that are always or often damp, such as bathrooms, laundry/utility rooms, and basements, are common locations for mold growth in homes. Regularly check areas that have been or are likely to get wet. If you hire a home inspector, building inspector, or other professional to locate a water or mold problem, make sure the professional has experience identifying and locating mold and water problems. Check references and look for membership in professional organizations.

Basement apartment (3-4 feet below ground) with mold on painted gypsum board, baseboard, and carpet.
(photo courtesy of Terry Brennan)

Commercial Buildings, Large Buildings, and Schools

A key step when looking for mold in a building is to determine whether there has been a water leak. Maintenance personnel are frequently among the first to know when moisture problems have occurred. In some cases, management or health and safety personnel will have been notified. Either way, touring the building with maintenance or other personnel involved with the water problem may be helpful.

If possible, crawl spaces should be included when examining the building. (A white, soluble fibrous material on the soil of the crawl space may be alkaline salts, not mold, indicating moisture has been a problem and suggesting that the area should be more extensively inspected.)

Moldy or musty odors should alert an investigator to the possible presence of mold. Complaints of past water problems or water leaks should be investigated to determine how much water was involved and how quickly it was removed.

The building's air-handling system should be inspected to determine whether it is moldy. Moisture may collect in the ventilation system due to poor condensate pan drainage, poor roof drainage, or high humidity in the ventilation ducts. In some cases, water may enter the ventilation ducts from a

leaky pipe. A contaminated ventilation system may spread mold spores throughout the building and should be considered a high priority for investigation and repair. Ventilation system mold contamination should be mitigated as soon as possible in a manner that does not expose building occupants to dust and mold spores.
During the building survey, any moldy or damp odors should be noted because damp or musty odors suggest that water is or was present and mold growth is likely. Occupant complaints of odors and health problems also should be investigated.

Mold on painted concrete in a school building. Rainwater is wicking directly through the concrete walls, and there is also condensation on the earth-chilled concrete. (The floor is about 3 feet below ground level.)
(photo courtesy of Terry Brennan)

Equipment
In general, the most important equipment is your own eyes and nose, although a good flashlight may help. Some investigators use borescopes to look for mold growth behind walls without significantly damaging the drywall. (A borescope is an optical probe, inserted through a small hole drilled into a wall, that lets an investigator inspect a small portion of the wall without causing extensive damage.) High humidity in a building can lead to mold growth, so humidity gauges may be useful for checking or monitoring humidity throughout the building.
Many investigators use moisture meters to find wet areas where mold may be growing. These meters measure the moisture in many types of building materials. They also can monitor the process of drying these materials. A moisture meter typically has a thin probe that can be inserted into the material to be tested or pressed directly against its surface.
Moisture meters can be used on carpet, wallboard, wood, brick, and concrete. Because mold often grows where moisture is high, a moisture meter can help an investigator locate hidden areas of mold growth.

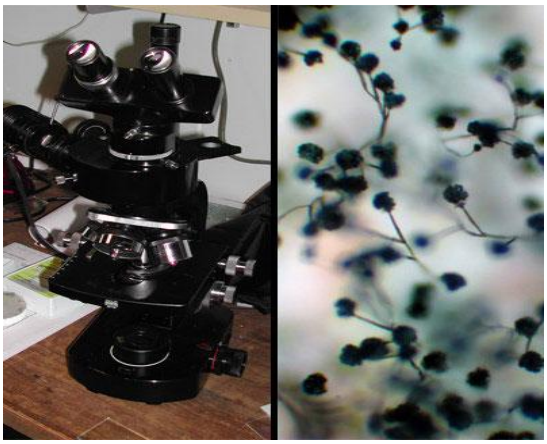
Measuring moisture levels of a sub floor.
(photo courtesy of Terry Brennan)

The use of personal protective equipment (PPE) should be considered during a mold investigation. The primary function of PPE is to avoid inhaling mold and mold spores and to avoid mold contact with the skin and eyes. Professional judgment should be used when selecting PPE. (See Table 1 for more on PPE.) The use of PPE is indicated when mold is disturbed and likely to become airborne during an investigation. There are also other situations when PPE should be used based on professional judgment. Anyone using respirators and other PPE in the workplace must be trained, must have a medical clearance, and must be fit-tested by a trained professional. Note that all Occupational Safety and Health Administration (OSHA) requirements must be met. (See the Resource List.)

Mold Sampling Considered - Visible Mold/ In most cases, if visible mold is present, sampling is unnecessary.

The most important sign of a mold problem is visible mold. If mold is found during a building investigation, the size and extent of the moldy area should be determined. Information on the water or moisture problems that allowed the mold to grow should be evaluated, in part because areas of hidden mold may surround the areas of visible mold.

Is sampling for mold needed? Usually, if the mold can be seen, sampling is unnecessary. After finding mold, the goal is to clean it up and fix the underlying water problem. Unless the results would or could make a change in your plans, you don't need to sample. Under certain circumstances, such as when litigation is involved, the source of the mold is unclear, or health concerns are a problem, you may consider sampling as part of your site evaluation. However, routine sampling for mold is not recommended. Keep in mind that the goal of mold remediation is to find the source of the water problem, fix it, and clean up the mold.



Bulk samples can be examined using reflective light microscopes, such as stereo microscopes or this EPI microscope.
(photo courtesy of Terry Brennan)

Sampling may help locate the source of mold contamination, identify some of the mold species present, and differentiate between mold and soot or dirt. Surface sampling may be useful in determining if an area has been adequately cleaned or remediated. After remediation, the types and concentrations of mold in indoor air samples should be similar to those in the local outdoor air. There are no EPA or other federal standards for airborne mold or mold spores, however, so sampling cannot be used to check a building's compliance with federal mold standards because there are none. Sampling for mold should be conducted by professionals who have specific experience in designing mold sampling protocols, sampling methods, and interpreting the results. Several problems can

occur when sampling. For example, there may be too few samples, sampling protocols may not be followed consistently, samples may become contaminated, outdoor control samples may be omitted, and since sampling can be expensive, sufficient funds may not be available to sample and to fix the water/mold problem. Professional advice may be necessary to determine if the project budget will allow enough samples to be taken to characterize a problem. If sampling cannot be done properly and enough samples to answer the questions posed cannot be taken, then it is preferable not to sample at all. Inadequate sample plans may generate misleading, confusing, and useless results. Samples should be analyzed according to the analytical methods recommended by the American Industrial Hygiene Association (AIHA), the American Conference of Governmental Industrial Hygienists (ACGIH), or other professional guidelines. (See the Resource List.)

Types of samples include air samples, surface samples, bulk samples (chunks of carpet, insulation, wall board, etc.), and water samples from condensate drain pans or cooling towers. Keep in mind that air sampling for mold provides information only for the moment when the sampling took place. For someone without experience, sampling results will be difficult to interpret. Experience in interpreting results is essential.

Mold Versus Soot and Dirt

Not everything that looks like mold is mold. Paint on the backside of drywall or wood may look like mold growth. Alkaline crystals on soil or concrete walls may look like mold, but, unlike mold, they are usually water-soluble. Carpet stains also may look like mold.

Some inexpensive and quick tests can be conducted if mold is suspected. In the case of carpets, a small portion of the suspect material can be submitted to a laboratory for identification. Most microbiology laboratories need only a little of the suspected mold on a clear strip of sticky tape to determine, using a microscope, whether it is actually mold or something that looks like mold. If you lack extensive experience or are in doubt about sampling, consult an experienced professional. Remember, sampling results may have limited use or application.

Clear plastic tape is used to collect a sample. The sample is analyzed with a microscope to determine whether the substance is mold or soot.
(photo courtesy of Terry Brennan)

GENERAL REMEDIATION ISSUES

Dry Quickly

Dry items before mold grows, if possible. In most cases, mold will not grow if wet or damp items are dried within 24-48 hours.

To dry carpet and backing within 48 hours, remove water with a wet vacuum, pull the carpet and pad off the floor, and dry them using a fan to blow air over them. A dehumidifier can be used to reduce the humidity in the room where the carpet and backing are drying, while fans can be used to accelerate the drying process.

Water can be removed from concrete or cinder block surfaces with a water-extraction vacuum. The drying also can be accelerated by using dehumidifiers, fans, and heaters.

Hard surface flooring (such as linoleum, ceramic tile, and vinyl) should be vacuumed or damp wiped with a mild detergent and allowed to dry. They should be scrubbed clean, if necessary. If the under-flooring is wet, it should be dried using a vacuum or by exposing it to the air.

Damp wiping surfaces with water and a small amount of detergent. (photo courtesy of Terry Brennan)

HEPA vacuum**.** Care is being taken to disturb the mold as little as possible while vacuuming. (photo courtesy of Terry Brennan)

Non-porous, hard surfaces such as plastics and metals should be vacuumed or damp wiped with water and mild detergent, then allowed to dry. Scrubbing may be necessary to thoroughly clean the surfaces.

Water should be removed from upholstered furniture with a water-extraction vacuum. Fans, dehumidifiers, and heaters may be used to accelerate the drying process. Completely drying upholstered furniture within 48 hours may be difficult, so if the piece is valuable, you may consider consulting a restoration or water-damage professional who specializes in furniture.

Drywall, also known as gypsum board or gypsum wallboard, may be dried in place if there is no obvious swelling and the seams are intact. Otherwise, removal is necessary. The wall cavity is the most difficult area to dry, and it should be ventilated if drywall is left to dry in place. (Drywall is not made out of boards of wood; traditionally, drywall is made of the mineral gypsum with a layer of heavy paper on the outside and inside.

Commercial gypsum boards and drywall are also available with a variety of outside layers and coatings. According to the U.S. Geological Survey, a typical new home contains more than 7 metric

tons of gypsum.) To clean water-damaged window drapes, follow the manufacturer's laundering or cleaning instructions.
To clean wooden surfaces, remove moisture immediately and use dehumidifiers, fans, and gentle heat to dry them. (Be very careful when applying heat to hardwood floors.) Treated or finished wood surfaces can be cleaned with mild detergent and clean water, then allowed to dry. Wet paneling should be pried from the wall for drying.
Some water-damaged items, including ceiling tiles, cellulose and fiberglass insulation, drywall and gypsum board, and books and papers, may have to be discarded. If valuable or important books, documents, or other items are moldy or water damaged, you may wish to consult a restoration, water damage, or remediation expert. (See Table 1 for more details.)
These guidelines are for damage caused by clean water. If you know or suspect that the water is contaminated with sewage, or with chemical or biological pollutants, then PPE and containment are required by OSHA. An experienced professional should be consulted if you or your remediators do not have expertise remediating in contaminated water situations. Do not use fans until you have determined that the water is clean or sanitary.

Picture on left: Limited PPE. (photo courtesy of Chin Yang, Ph.D.)

Picture on right: Cleaning with Limited Personal Protective Equipment (PPE) - gloves, goggles, N-95 respirator.

Assess Mold Problem
Before planning a remediation effort, the size and extent of the mold problem and any continuing moisture problems should be assessed. Remediations generally can be divided into small (less than 10 square feet of mold), medium (10-100 square feet of mold), and large jobs (more than 100 square feet of mold). A remediation manager should be selected for medium or large jobs. You may choose to involve an experienced health and safety professional in remediation projects, particularly on large or complex jobs.

Questions to consider before starting remediation include:
• Are there existing moisture problems in the building?
• Have building materials been wet more than 48 hours?
• Are there hidden sources of water, or is the humidity high enough to cause condensation?
• Are the building occupants reporting musty or moldy odors?
• Are the building occupants reporting health problems?
• Are building materials or furnishings visibly damaged?
• Has maintenance been delayed or has the maintenance plan been altered?
• Has the building been remodeled recently, or has its use changed?
• Are consultations with health professionals indicated?

Remediating mold and moisture problems may be complex, and it may increase workers' exposure to mold unless personal protective equipment (PPE) is used.

Avoid Mold Exposure
Do not touch mold or moldy items with your bare hands.
Do not get mold or mold spores in your eyes.
Avoid breathing in mold or mold spores.
Consider using PPE if disturbing mold during a building inspection, assessment, or walkthrough, for example. The minimum PPE is an N-95 respirator (available at most hardware stores), gloves, and goggles.
Review guidelines for using containment and PPE before starting remediation. (see Table 2)

Remediation workers, especially if they have health concerns, may want to check with their doctors before working on a mold investigation or remediation project. Anyone who has any doubts or questions should consult a healthcare professional before beginning work on a remediation project.

Remediation Plan
The highest priority in a remediation is to protect the health and safety of the building occupants and the remediation workers. Remediation plans vary according to the size and complexity of the job. They may require updating if circumstances change or more extensive contamination is discovered. The remediation plan should include:

- Whether containment will be required.
- What level of PPE will be used.
- How the water or moisture problem will be fixed so the mold problem does not recur.
- How the moldy building materials will be removed to avoid spreading mold.

Mold Remediation Procedures
A variety of methods are available to remediate damage to buildings and furnishings caused by moisture control problems and mold. The procedures selected depend on the size of the moldy area and the type of contaminated materials. Budget may also be a concern. The methods presented in this section outline one approach; some professionals may prefer to use other methods. If possible, remediation activities should be scheduled during off-hours, when building occupants are less likely to be affected.

Cleanup methods may include:

Wet Vacuum

Wet, or water-extraction, vacuums are designed to collect water. They can be used to remove water that has accumulated on floors, carpets, and hard surfaces. Wet vacuums should be used only when materials are still wet, otherwise they may spread mold spores. Wet vacuums alone will not dry carpets. Wet carpets must be pulled up and dried, then reinstalled. The carpet padding also must be dried. The tanks, hoses, and attachments of wet vacuums should be thoroughly cleaned and dried after use because mold and mold spores may stick to their surfaces.

Damp Wipe

Mold can generally be removed from hard surfaces by wiping or scrubbing with water and detergent. Always follow the cleaning instructions on product labels. Surfaces cleaned by damp wiping should be dried quickly and thoroughly to discourage further mold growth. Porous materials that are wet and have mold growing on them may have to be discarded. Because mold will infiltrate porous substances and grow on or fill in empty spaces or crevices, completely removing mold can be difficult, if not impossible. Mold can also cause staining and other cosmetic damage.

(photo courtesy of Terry Brennan)

HEPA Vacuum

High-Efficiency Particulate Air (HEPA) vacuums are recommended for the final clean up of remediation areas after materials have been thoroughly dried and contaminated materials have been removed. HEPA vacuums are also recommended for cleaning up dust that has settled outside the remediation area. When changing the vacuum filter, workers should wear PPE to prevent exposure to mold that has been captured in the vacuum. The filter and contents of the HEPA vacuum must be disposed of in well-sealed plastic bags. Care must be taken to ensure that the new filter is properly seated on the vacuum so there are no leaks.

(photo courtesy of Terry Brennan)

Throw Away Damaged Materials

Mold-contaminated building materials that cannot be salvaged should be double-bagged in 6-mil or thicker polyethylene bags. The bagged materials usually can be discarded as ordinary construction waste. Packaging mold-contaminated materials in sealed bags before removing them from the containment area is important to minimize the spread of mold spores throughout the building. Large items that have heavy mold growth should be covered with polyethylene sheeting and sealed with duct tape before being removed from the containment area.

Table 1: Water Damage - Cleanup and Mold Prevention	
Guidelines for Response to Clean Water Damage within 24-48 Hours to Prevent Mold Growth*	
Water-Damaged Material†	**Actions**
Books and papers	· **For non-valuable items, discard books and papers.** · **Photocopy valuable/important items, discard originals.** · **Freeze (in frost-free freezer or meat locker) or freeze-dry.**
Carpet and backing - dry within 24-48 hours§	· **Remove water with water extraction vacuum.** · **Reduce ambient humidity levels with dehumidifier.** · **Accelerate drying process with fans.**
Ceiling tiles	· **Discard and replace.**
Cellulose insulation	· **Discard and replace.**
Concrete or cinder block surfaces	· **Remove water with water extraction vacuum.** · **Accelerate drying process with dehumidifiers, fans, and/or heaters.**
Fiberglass insulation	· **Discard and replace.**
Hard surface, porous flooring§ (Linoleum, ceramic tile, vinyl)	· **Vacuum or damp wipe with water and mild detergent and allow to dry; scrub if necessary.** · **Check to make sure underflooring is dry; dry underflooring if necessary.**
Non-porous, hard surfaces (Plastics, metals)	· **Vacuum or damp wipe with water and mild detergent and allow to dry; scrub if necessary.**
Upholstered furniture	· **Remove water with water extraction vacuum.** · **Accelerate drying process with dehumidifiers, fans, and/or heaters.** · **May be difficult to completely dry within 48 hours. If the piece is valuable, you may wish to consult a restoration/water damage professional who specializes in furniture.**

Wallboard (Drywall and gypsum board)	· **May be dried in place if there is no obvious swelling and the seams are intact. If not, remove, discard, and replace.** · **Ventilate the wall cavity, if possible.**
Window drapes	· **Follow laundering or cleaning instructions recommended by the manufacturer.**
Wood surfaces	• **Remove moisture immediately and use dehumidifiers, gentle heat, and fans for drying. (Use caution when applying heat to hardwood floors.)** **Treated or finished wood surfaces may be cleaned with mild detergent and clean water and allowed to dry.** **Wet paneling should be pried away from wall for drying.**

*** If mold growth has occurred or materials have been wet for more than 48 hours, consult Table 2 guidelines. Even if materials are dried within 48 hours, mold growth may have occurred. Items may be tested by professionals if there is doubt. Note that mold growth will not always occur after 48 hours; this is only a guideline.**

These guidelines are for damage caused by clean water. If you know or suspect that the water source is contaminated with sewage, or chemical or biological pollutants, then Personal Protective Equipment and containment are required by OSHA. An experienced professional should be consulted if you and/or your remediators do not have expertise remediating in contaminated water situations. Do not use fans before determining that the water is clean or sanitary.

† If a particular item(s) has high monetary or sentimental value, you may wish to consult a restoration/water damage specialist.

§ The subfloor under the carpet or other flooring material must also be cleaned and dried. See the appropriate section of this table for recommended actions depending on the composition of the subfloor.

Table 2: Guidelines for Remediating Building Materials with Mold Growth Caused by Clean Water*			
Material or Furnishing	**Cleanup Methods†**	**Personal Protective Equipment**	**Containment**
SMALL - Total Surface Area Affected Less Than 10 square feet (ft^2)			
Books and papers	**3**	**Minimum** **N-95 respirator, gloves, and goggles**	**None required**
Carpet and backing	**1, 3**		
Concrete or cinder block	**1, 3**		
Hard surface, porous flooring (linoleum, ceramic tile, vinyl)	**1, 2, 3**		
Non-porous, hard surfaces (plastics, metals)	**1, 2, 3**		
Upholstered furniture & drapes	**1, 3**		
Wallboard (drywall and gypsum	**3**		
Wood surfaces	**1, 2, 3**		
Material or Furnishing	**Cleanup Methods†**	**Personal Protective Equipment**	**Containment**
MEDIUM - Total Surface Area Affected Between 10 and 100 (ft^2)			
Books and papers	**3**	**Limited or Full** **Use professional judgment, consider potential for remediator exposure and size of contaminated area**	**Limited** **Use professional judgment, consider potential for remediator/occupant exposure and size of contaminated area**
Carpet and backing	**1,3,4**		
Concrete or cinder block	**1,3**		
Hard surface, porous flooring (linoleum, ceramic tile, vinyl)	**1,2,3**		
Non-porous, hard surfaces (plastics, metals)	**1,2,3**		
Upholstered furniture & drapes	**1,3,4**		
Wallboard (drywall and gypsum	**3,4**		
Wood surfaces	**1,2,3**		
Material or Furnishing	**Cleanup Methods†**	**Personal Protective Equipment**	**Containment**

LARGE - Total Surface Area Affected Greater Than 100 (ft^2) or Potential for Increased Occupant or Remediator Exposure During Remediation Estimated to be Significant			
Books and papers	**3**	**Full** **Use professional judgment, consider potential for remediator exposure and size of contaminated area**	**Full** **Use professional judgment, consider potential for remediator/occupant exposure and size of contaminated area**
Carpet and backing	**1,3,4**		
Concrete or cinder block	**1,3**		
Hard surface, porous flooring (linoleum, ceramic tile, vinyl)	**1,2,3,4**		
Non-porous, hard surfaces (plastics, metals)	**1,2,3**		
Upholstered furniture & drapes	**1,3,4**		
Wallboard (drywall and gypsum board)	**3,4**		
Wood surfaces	**1,2,3,4**		

Table 1 continued

***Use professional judgment to determine prudent levels of Personal Protective Equipment and containment for each situation, particularly as the remediation site size increases and the potential for exposure and health effects rises. Assess the need for increased Personal Protective Equipment, if, during the remediation, more extensive contamination is encountered than was expected. Consult Table 1 if materials have been wet for less than 48 hours, and mold growth is not apparent.**

These guidelines are for damage caused by clean water. If you know or suspect that the water source is contaminated with sewage, or chemical or biological pollutants, then the Occupational Safety and Health Administration (OSHA) requires PPE and containment. An experienced professional should be consulted if you and/or your remediators do not have expertise in remediating contaminated water situations.

†Select method most appropriate to situation. Since molds gradually destroy the things they grow on, if mold growth is not addressed promptly, some items may be damaged such that cleaning will not restore their original appearance. If mold growth is heavy and items are valuable or important, you may wish to consult a restoration/water damage/remediation expert. Please note that these are guidelines; other cleaning methods may be preferred by some professionals.

Cleanup Methods

- **Method 1: <u>Wet vacuum</u> (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried). Steam cleaning may be an alternative for carpets and some upholstered furniture.**
- **Method 2: <u>Damp-wipe</u> surfaces with plain water or with water and detergent solution (except wood -use wood floor cleaner); scrub as needed.**
- **Method 3: <u>High-efficiency particulate air (HEPA)</u> vacuum after the material has been thoroughly dried. Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.**
- **Method 4: <u>Discard</u> - remove water-damaged materials and seal in plastic bags while inside of containment, if present. Dispose of as normal waste. HEPA vacuum area after it is dried.**

Personal Protective Equipment (PPE):

- **Minimum: Gloves, N-95 respirator, goggles/eye protection**
- **Limited: Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection**
- **Full: Gloves, disposable full body clothing, head gear, foot coverings, full-face respirator with HEPA filter**

Containment:

- **Limited: Use polyethylene sheeting ceiling to floor around affected area with a slit entry and covering flap; maintain area under negative pressure with HEPA filtered fan unit. Block supply and return air vents within containment area.**
- **Full: Use two layers of fire-retardant polyethylene sheeting with one airlock chamber. Maintain area under negative pressure with HEPA filtered fan exhaust outside of building. Block supply and return air vents within containment area.**

Table developed from literature and remediation documents including *Bioaerosols: Assessment and Control* (American Conference of Governmental Industrial Hygienists, 1999) and *IICRC S500, Standard and Reference Guide for Professional Water Damage Restoration* (Institute of Inspection, Cleaning and Restoration, 1999); see the Resource List for more information.

LARGE AREAS AND OTHER SPECIAL CONCERNS

Remediating Large Areas of Mold Contamination

For large or complex mold remediation jobs, you may consider hiring professionals who have experience working on large mold remediation projects, particularly since extensive containment and PPE may be needed. Be sure to check references and ensure that the professional has experience working in mold remediation situations. Remediators should follow EPA mold remediation guidance or other government or professional remediation guidance. Building occupants need to be informed about what is going to happen, when it will happen, and how they may be affected.

Containment should be designed to prevent the movement of mold spores from one area of the building to another. This effort usually requires full containment using double layers of polyethylene sheeting and fans to create negative air pressure. A decontamination chamber or airlock should be used to separate the clean areas from the contaminated areas during entry into and exit from the remediation area. The entryways to the airlock from the outside and from the airlock to the main containment area should consist of a slit with covering flaps on the outside surface of each entry. Contaminated PPE, except respirators, should be sealed in bags while inside the containment exit chamber. Workers should wear respirators until they are in the uncontaminated area, where the respirators can be removed. Disposable respirators can be thrown away and re-usable respirators can be put into a bag for cleaning. Full PPE may also be necessary during these operations and may

consist of protective clothing and full-face or powered air purifying respirators (PAPR) with HEPA filters. Protective clothing should include head and foot coverings with all gaps sealed with duct tape or the equivalent.

Full containment on a large job.
(photo courtesy of Terry Brennan)

Mold Remediation in Heating, Ventilation, and Air Conditioning (HVAC) Systems

Mold remediation involving a heating, ventilation, and air conditioning (HVAC) system should be done only by professionals experienced in working with HVAC systems. Professionals may have several different methods and techniques for approaching HVAC remediation. As with the rest of a mold remediation project, professional judgment is required when working with HVAC systems, and professionals may use materials, methods, and techniques not mentioned in this course.

An HVAC system found to be contaminated with mold should be turned off and not used until the system has been remediated; using a mold-contaminated HVAC system may spread mold throughout the building and increase the exposure of building occupants. (There may be some exceptions or instances when all or part or the HVAC system can be run, based on professional judgment, if there is no risk of increasing occupant or worker exposure). If possible, the HVAC system should be remediated during off hours when the building is not in use.

Effective containment of the area served by the ventilation system is important to avoid the spread of mold and mold-contaminated materials. All intakes and supply vents should be sealed with plastic and tape, and negative air pressure should be maintained in work areas. (A fan can be used.)

Contaminated porous materials in the HVAC system should be bagged and removed. Materials that can be cleaned should be vacuumed with a HEPA vacuum or cleaned with a moist cloth and detergent solution. All items should be dried promptly.

If you consider duct cleaning, first consult EPA's guide *Should You Have the Air Ducts in Your Home Cleaned?* (See the Resource List.)

Confined Spaces

Confined spaces include pipe chases (areas within and under buildings where steam and utility pipes are run) and valve pits (areas below grade that contain utility shut-off valves). Working in confined areas presents numerous challenges. Movement and communication are difficult and, if a problem arises, immediate exit from the area may be impossible.

The air in some confined spaces may be contaminated or low in oxygen, posing significant health risks for workers. Efficient rescue of an injured worker may be difficult or impossible. Poor lighting may result in increased injuries. Because exposures may be greatly magnified in a confined space, workers must use a higher level of PPE than they would when working in a more accessible area. Worker safety must be carefully considered when deciding whether to use disinfectants or biocides because confined spaces may increase the potential for exposure. In general, work in confined spaces should be conducted only by trained professionals who have the equipment required by OSHA to deal with the inherent dangers in this type of environment.

Before remediating mold in a confined space, the area should be evaluated for atmosphere and toxic substances. If there is any chance of low oxygen, the area should be tested using the appropriate equipment. The testing equipment should be kept on site and used periodically to ensure an adequate oxygen supply. If the area is sealed off from the rest of the building to prevent the spread of mold spores, oxygen testing should be conducted again after the area has been sealed. A frequent contaminant in crawlspaces and pipe chases of older buildings is asbestos; other chemicals such as natural gas and solvents can also be found in some of these spaces. These materials must be identified and dealt with properly to prevent worker exposure.

Once the hazards have been identified, procedures for working in the confined space should be included in the remediation plan. Special consideration should be given to who will be allowed into the area, how communications will be maintained, what materials can be taken into or used in the space, and what safety equipment is necessary. Only individuals trained in the hazards associated with that space should be allowed to enter. An attendant should be posted outside of the confined space area to summon help if necessary. The area should be well lit so that work can be conducted efficiently and injuries avoided.

In conducting the mold remediation, every effort should be made to keep dust and mold out of the air. This can be done by using moist techniques, such as a damp cloth or pad, for mold removal and by bagging the material in the confined space for later removal. Mold levels are likely to be high in a confined space, so PPE should be selected accordingly. Most cases will require full PPE, including skin and eye protection, and full respiratory protection using a full-face respirator or a powered air purifying respirator (PAPR) with a HEPA filter. The presence of asbestos may require other PPE for workers as well as monitoring and medical evaluation.

CONTAINMENT AND PERSONAL PROTECTIVE EQUIPMENT (PPE)

Overview of Containment

The goal of containment is to limit the spread of mold throughout the building in order to minimize the exposure of remediators and building occupants to mold.

The larger the contaminated area, and the greater the possibility that someone will be exposed to mold, the greater the need for containment. Although, in general, the size of the contaminated area indicates the level of containment required, the final choice of containment level should be based on professional judgment. Heavy mold growth in a small area, for example, could release more mold spores than lighter growth in a relatively large area. In this case, the smaller contaminated area may warrant a higher level of containment.

Two types of containment are described in EPA's mold remediation guidance: limited and full. Limited containment is generally used for areas involving between 10 and 100 square feet of mold contamination. Full containment is used when areas larger than 100 square feet are to be remediated or in cases where it is likely that mold could be spread throughout the building during remediation. (See Table 2.)

Maintaining the containment area under negative pressure will keep contaminated air from flowing into adjacent, uncontaminated areas and possibly spreading mold. A fan exhausted to the outside of the building can be used to maintain negative air pressure. If the containment is working, the polyethylene sheeting of the containment area should billow inward on all surfaces. If it flutters or billows outward, containment has been lost, and the problem should be found and corrected before remediation continues.

Bookcases and books protected during clean-up.
(photo courtesy of Terry Brennan)

Depending on the situation, professional remediators may choose to use a variety of containment methods not described in detail here. For example, a remediator repairing a large building with extensive mold damage in the walls may choose to remove the outside layer of the wall and work inward, relying on appropriate containment to ensure mold is not spread throughout the building. Or, to limit the amount of mold that gets into the air, a remediator may apply sticky-backed paper or covering to a moldy wall component before removing it.

Limited Containment

Limited containment consists of a single layer of 6-mil fire-retardant polyethylene sheeting enclosing the moldy area. Access to the contained area is through a slit entry covered by a flap on the outside of the containment area. Limited containment is generally recommended for areas involving 10 to 100 square feet of mold contamination.

In small areas, the polyethylene sheeting can be secured to the floor and ceiling with duct tape. In larger areas, a frame of steel or wooden studs can be built to hold the polyethylene sheeting. Epoxy can also be used to fasten the sheeting to the floor or ceiling.

All supply and air vents, doors, and pipe chases in the containment area must be sealed with polyethylene sheeting to minimize the spread of mold and mold spores to other areas of the building. Stairs should also be sealed if a riser is missing or open. (A pipe chase is an enclosure through which pipes are run; a riser is the upright piece of a stair step, from tread to tread.)

Heavy mold growth on ceiling tiles may affect HVAC systems if the space above the ceiling is used as a return air plenum. In such cases, containment would be installed from floor to ceiling deck. The filters in the air-handling units serving the affected area may have to be replaced once the remediation is complete.

Full Containment

Full containment is recommended for the clean up of mold-contaminated surface areas of more than 100 square feet and when intense or long-term exposures are expected. It is also recommended if it appears likely that the occupant's space would be further contaminated if full containment were not used because high levels of airborne dust or mold spores are likely. Full containment requires double layers of polyethylene sheeting to create a barrier between the moldy area and other parts of the building. A decontamination chamber or airlock—an area with doors between the contaminated area and the clean area—should be built for entry into and exit out of the remediation area.

The entryways from the outside into the airlock and from the airlock into the containment area should be slits covered by flaps on the outside surface. The chamber should be large enough to hold a waste container and allow a worker to put on and remove Personal Protective Equipment (PPE). All contaminated PPE, except respirators, should be placed in a sealed bag while in this chamber. Respirators should be worn until remediation workers are outside the decontamination chamber.

Examples of full containment. (photos courtesy of Terry Brennan)

Personal Protective Equipment (PPE)

The primary function of personal protective equipment (PPE) is to limit mold exposure. If a remediation job disturbs mold, and mold spores then become airborne, the risk of respiratory exposure increases. Actions likely to stir up mold include breaking moldy porous materials such as wallboard, using invasive procedures to examine or remediate mold growth in wall cavities, stripping or peeling wallpaper to remove it, and using fans to dry items.

Gloves

Gloves protect the skin from contact with mold. They also protect the skin from potentially irritating cleaning solutions. Long gloves that extend to the middle of the forearm are recommended. The material from which gloves are made should be suited to the type of materials being handled. If you choose to use a biocide, such as chlorine bleach, or a strong cleaning solution, gloves should be made from natural rubber, neoprene, nitrile, polyurethane, or polyvinylchloride (PVC). If a mild detergent is being used, ordinary household rubber gloves are suitable. The routine use of biocides is not recommended.

Goggles

Properly fitted goggles or full-face respirators provide eye protection. Goggles must be designed to keep out dust and small particles. Safety glasses or goggles that have open vent holes are not acceptable.

Respirators

Respirators protect remediation workers from inhaling airborne mold, mold spores, and dust. Three types of respiratory protection are described: minimum, limited, and full. Only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) should be worn during mold remediation. These respirators must be used according to any applicable Occupational Safety and Health Administration (OSHA) regulations.

Use minimum PPE when cleaning up a small area affected by mold (less than 10 square feet total). Minimum PPE includes gloves, goggles/eye protection and an N-95 respirator. An N-95 respirator covers the nose and mouth, filters out 95 percent of airborne particulates, and is available in most hardware stores. It does not provide eye protection.

Cleaning with Personal Protective Equipment (PPE) - gloves, goggles, N-95 respirator.

Limited PPE includes the use of half-face or full-face air purifying respirators (APRs) equipped with P100 filter cartridges. These respirators have inhalation and exhalation valves that filter the air and ensure it is free of mold particles. The P100 filters do not remove vapors or gases, and the half-face APRs do not protect the wearer's eyes. Limited PPE may be warranted when the total surface area affected by mold is between 10 and 100 square feet. Professional judgment should be used to make the final determination about whether to wear limited PPE.

Example of Limited PPE

Full PPE includes a full-face, powered air purifying respirator (PAPR). It is recommended when more than 100 square feet of mold is found, when high levels of airborne dust or mold spores are likely, or when intense or long-term exposures are expected. A powered air purifying respirator uses a blower to force air through a P100 filter. The filtered air is supplied to a mask that covers the wearer's face or a hood that covers the entire head. Positive pressure within the hood prevents unfiltered air from entering through penetrations or gaps. Individuals must be trained to use their respirators before they begin remediation.

Disposable clothing is recommended for medium and large remediation projects. It prevents the transfer and spread of mold to clothing and eliminates skin contact with mold. When limited protection is warranted, disposable paper coveralls can be used. When full protection is required, a body suit of breathable material, such as TYVEK® , and mold-impervious disposable head and foot coverings should be used. All gaps, such as those around ankles and wrists, should be sealed. (Many remediators use duct tape to seal clothing.)

Personal Protective Equipment (PPE)
• Minimum: Gloves, N-95 respirator, goggles/eye protection
• Limited: Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection
• Full: Gloves, disposable full body clothing, head gear, foot coverings, full-face respirator with HEPA filter

EVALUATING THE REMEDIATION

Completing Mold Remediation — Fix the water problem and clean up the mold

How do you know when you have finished remediation? Ultimately, it is a judgment call. People should be able to occupy or work in the building without health complaints or physical symptoms. The most important action, if mold growth is to be controlled in a building, is to eliminate the source of moisture that caused the mold problem. No matter how good the mold cleanup is, if the water problem is not solved, mold will return. Therefore, determining whether moisture in the building is being controlled is key in assessing the effectiveness of the remediation effort. If moisture is not being controlled, even removing all the mold growing in the building will be only a temporary solution.

A visual inspection of the area that has been remediated should show no evidence of present or past mold growth. There should be no moldy or musty odors associated with the building, because these odors suggest that mold continues to grow. If mold or moldy odors are present in the building, the remediation has not been effective.

Keep in mind that remodeling, cleaning, and construction may have introduced new building materials or chemicals capable of causing upper respiratory irritation that, in some individuals, may mimic the symptoms caused by exposure to mold.

How Do You Know When You Have Finished Remediation/Cleanup?

1. You must have completely fixed the water or moisture problem.
2. You should complete mold removal. Use professional judgment to determine if the cleanup is sufficient. Visible mold, mold-damaged materials, and moldy odors should not be present.
3. If you have sampled, the kinds and concentrations of mold and mold spores in the building should be similar to those found outside, once cleanup activities have been completed.
4. You should revisit the site(s) shortly after remediation, and it should show no signs of water damage or mold growth.
5. People should be able to occupy or re-occupy the space without health complaints or physical symptoms.
6. Ultimately, this is a judgment call; there is no easy answer.

Considering Bioaerosol Sampling

Bioaerosol sampling (air sampling for mold or other biological contaminants) usually is not necessary to determine remediation effectiveness. In fact, bioaerosol sampling may be less effective at determining the success of remediation than visual and sensory surveys of the area.

Although sampling may be of some help in judging remediation effectiveness, remember that a negative sampling report must not be used in place of a visual survey. Factors such as barometric pressure, inside and outside temperatures, activity levels, and humidity may dramatically reduce or increase the spore levels within a building. Air sampling for mold provides information on what was in the air only for the moment when the sampling occurred. It is important, therefore, that sampling not replace visual inspection.

COMMUNICATING WITH THE BUILDING OCCUPANTS

Communicate When You Remediate

Communication with building occupants is essential for successful mold remediation. Some occupants will naturally be concerned, and their concern may increase if they believe information is being withheld. The status of the building investigation and remediation should be openly communicated, along with information on known or suspected health risks.

Small-scale remediations will not usually require a formal communication process, but do be sure to take individual concerns seriously and consider whether formal communication is required.

Managers of medium or large remediation efforts should make sure they understand and address the concerns of the building occupants and communicate clearly what has to be done. Depending on the situation, communication, communication strategies, and communication issues may also be handled by others such as building owners, school principals, and public relations specialists. Some organizations or buildings may have a communications strategy that can be used, or they may wish to develop a comprehensive strategy.

Communication techniques may include regular memos and meetings with occupants (with time for questions and answers). The communication techniques used will depend on the scope of the remediation and the level of occupant concern. Tell the occupants about the size of the remediation project, the activities planned, and the schedule. Send or post regular updates on the remediation's progress. Send or post a final memo when the project is completed or hold a final meeting. Try and resolve issues and occupant concerns as they come up. When building wide communications are frequent and open, remediation managers can spend more time resolving the mold problem and less time responding to occupant concerns.

Communicate When You Remediate

- Establish that the health and safety of building occupants are top priorities.
- Demonstrate that the occupants' concerns are understood and taken seriously.
- Present clearly the current status of the investigation or remediation efforts.
- Identify a person whom building occupants can contact directly to discuss questions and comments about the remediation activities

Communication is especially important if occupants are relocated during remediation. When deciding whether to relocate occupants, consider the size of the area affected, the extent and types of health effects exhibited by the occupants, and the potential health risks associated with debris and activities during the remediation. Be sure to ask about, accommodate, and plan for individuals with asthma, allergies, compromised immune systems, and other health concerns. Smooth the relocation process and give occupants an opportunity to participate in resolving the problem by clearly explaining the disruption of the workplace and work schedules. Notify individuals of relocation efforts in advance, if possible.

Special communication strategies may be warranted when treating a mold problem in a school. Teachers, parents, and other affected groups should be notified as soon as significant issues are identified. Consider holding a special meeting so parents can learn about the problem and ask questions of school authorities, particularly if it is necessary or advisable to vacate the school during remediation.

In some cases, particularly when large areas are contaminated with mold or complaints run high among teachers or students, it may be a good idea to hire a remediation professional who can provide expert information to concerned parents and teachers, as well as do the remediation work. Often, giving parents and teachers access to a professional early in the investigation and remediation process will reduce their concern during the latter stages of the remediation. It is important that the best information available be provided to everyone who might be affected by the investigation and remediation.

Please note: EPA does not regulate mold or mold spores in the air. EPA does not certify mold remediators or inspectors.

PREVENTION

Mold Prevention

The key to mold prevention is moisture control. Water entry into buildings or building crawl spaces should be controlled. If water enters a building through a leaking roof or because of a flood or accident, it should be removed immediately and affected areas should be dried out.

Mold Prevention

Keep the building and furnishings dry.

When things get wet, dry them quickly (24-48 hours).

Perform routine maintenance, cleaning, and repairs.

Hidden Areas

Special attention should be given to areas that are hidden, but that might have gotten wet. Areas behind walls and in ceilings, crawl spaces, and attics are frequently overlooked and not dried carefully. In general, all wet areas should be completely dried within 48 hours to prevent mold from growing.

Routine Maintenance is Important

A number of items frequently involved in mold problems should be checked and maintained routinely. Furnace humidifiers must be cleaned regularly to prevent mold and bacterial growth. Ducts in which humidifiers are installed should also be checked to ensure water has not leaked into the furnace or filter areas. Stand-alone humidifiers should be cleaned very frequently to ensure that they are not moldy. Special attention should be paid to any filters in the humidifier because they can become moldy and the humidifier can spread spores throughout the area. Carpeted areas around the humidifiers should also be monitored for wetness. Humidifiers should be set to produce less than 60 percent relative humidity in the building. Relative humidity greater than 60 percent is likely to result in condensation in the building, which can lead to mold growth.

HVAC systems should be checked routinely because mold in a ventilation system may be spread throughout the building. Drain or condensate pans should also be checked routinely because they can become reservoirs for mold and bacteria if not installed and maintained properly. These pans are designed to remove water produced by cooling hot air from the ventilation system. If the pans do not drain, or are not cleaned frequently, they may allow water to enter the HVAC system and contaminate the ventilation ducts in the building. The pans themselves may also grow mold and allow mold spores to be spread throughout the building. Filters for the HVAC system also should be kept dry and changed frequently.

Moisture issue: Foundation is wet; drain gutters are too short. Fix: Drain rain water away from the house, generally about 5 feet away from the foundation. Gutters below grade (below the soil) are protected from damage, while those above grade may be more easily damaged. (photo courtesy of Terry Brennan)

Toilet and bathroom areas should be carefully monitored for water and plumbing leaks. Rippling wall coverings, cracked drywall tape, peeling paint, and other signs of water damage should be investigated quickly. These signs frequently indicate that water has leaked, and hidden mold growth and damage are likely. Water seepage into crawl spaces or basements should also be stopped quickly to ensure that mold will not grow, and measures such as the installation of sump pumps or a regrading of the area around the building should be considered to prevent future leaks. Any areas that smell moldy or musty should also be investigated to ensure that water has not entered and mold is not growing.

Buildings should be located, landscaped, built, and renovated with consideration for the climate. A building that is not suited to the climate can have moisture problems. Buildings inevitably will get

wet, both inside and out, and they must be allowed to dry or mold will grow in them. Selection and location of building materials and furnishings can also be made with mold prevention in mind. In frequently damp or wet areas, more mold resistant materials can be used; for example, some woods are more resistant to mold than particle board or pressed board.

Mold Prevention Tips

MOISTURE CONTROL IS KEY

- Keep the building clean and dry. Dry wet or damp areas within 48 hours.
- Fix leaky plumbing and leaks in the building envelope as soon as possible.
- Watch for condensation and wet spots. Fix the sources of moisture problems as soon as possible.
- Prevent moisture due to condensation by increasing surface temperature or reducing the moisture level in air (humidity). To increase surface temperature, insulate or increase air circulation. To reduce the moisture level in air, repair leaks and increase ventilation (if outside air is cold and dry), or dehumidify (if outdoor air is warm and humid).
- Keep heating, ventilation, and air conditioning (HVAC) drip pans clean, flowing properly, and unobstructed.
- Vent moisture generating appliances, such as dryers, to the outside where possible.
- Maintain low indoor humidity, below 60 percent relative humidity (RH), ideally 30 percent to 50 percent, if possible.
- Perform regular building and HVAC inspections and maintenance as scheduled.
- Don't let foundations stay wet. Provide drainage and slope the ground away from the foundation.
- If you are not experienced with home/building repairs you may want to consult a professional when making repairs, or for assistance with mold-prevention-related changes to your home/building.
-

--For large buildings: Use EPA's I-BEAM software to help manage indoor air quality. Routine maintenance and repairs reduce the likelihood of a mold problem in the building. (See the Resource List)
--For schools: Use the EPA IAQ (Indoor Air Quality) Tools for Schools guidance. (See the Resource List)

Mold Image Gallery

Gallery 1: Mold in the Environment

Mold growing outdoors on firewood. Molds come in many colors; both white and black molds are shown here.

Decomposing leaves.

Orange colored mushroom growing on forest floor amid pine needles.

Partially decomposed beech leaves.

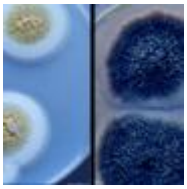
Mold on bread. (Note growth has started on the exterior and is gradually expanding and growing into the interior of the bread.)

Partially decomposed beech leaves.

Mushroom: Grey Ink Cap mushroom. (photo courtesy of Terry Brennan)

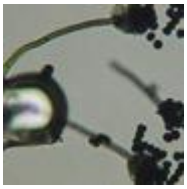
Gallery 2: Magnified Mold

Mold growing in Petri dishes.
(photo courtesy of Stephen Vesper, Ph.D.)



Mold growing in Petri dishes. The same type of mold is growing in both photos, but note that molds can change appearance as they age. In this example, the mold on the right has been growing for several days longer than the mold on the left. (photo courtesy of Chin Yang, Ph.D.)

Magnified mold and mold spores.
(photo courtesy of Chin Yang, Ph.D.)



Magnified mold spores.
(photo courtesy of John Martyny, Ph.D.)

Magnified mold and mold spores.
(photo courtesy of John Martyny, Ph.D.)

Highly magnified mold spores, lit from behind. The spores are very small (2-5 microns) and become airborne easily. (photo courtesy of Terry Brennan)

Mold spores, highly magnified. (photo courtesy of John Martyny, Ph.D.)

Gallery 3: Moisture and Moisture Damage

Condensation.

Icicles.

Water leaks.

Water stains.

Water stains on wall and ceiling.
(photo courtesy of John Martyny, Ph.D.)

Acoustic ceiling tiles with water damage.
(photo courtesy of Terry Brennan)

Water stains in basement.
(photo courtesy of Terry Brennan)

Water-damaged ceiling tiles. Air conditioning ducts above the ceiling were not insulated in several areas resulting in condensation on the ducts that dripped onto the ceiling tiles. (photo courtesy of Terry Brennan)

Puddles on flat roof.

Wood showing water stains caused by roof leak.

Water from roof leak has seeped into a wall causing the paint to buckle and peel. (photo courtesy of Terry Brennan)

When built, the roof had a hole for the drainpipe; however, a drainpipe was not installed until years later. The white stains on the brick are mineral deposits resulting from rain pouring through the drain hole onto the walls. (photo courtesy of Terry Brennan)

In this case, the icicles result from warm air in the house leaking into an attic without sufficient insulation. (photo courtesy of Terry Brennan)

Several inches of water in a basement with a broken sump pump. (photo courtesy of Terry Brennan)

Water in the ground has seeped through the concrete walls of the basement, leaving white mineral deposits on the walls. The water has evaporated into this basement, increasing humidity. Mold is growing in some areas. (photo courtesy of John Martyny, Ph.D.)

Mineral deposits on the surface of a dirt crawl space caused by chronic water problems. (This is not mold.) (photo courtesy of John Martyny, Ph.D.)

Flooding. EPA mold guidance is not for flood water.

Gallery 4: Prevention

Moisture issue: Foundation is wet; drain gutters are too short. Fix: Drain rain water away from the house, generally about 5 feet away from the foundation. Gutters below grade (below the soil) are protected from damage, while those above grade may be more easily damaged. (photo courtesy of Terry Brennan)

Moisture issue: Rainwater is falling and collecting near the foundation of this house. Fix: It is important that the water drain away from the foundation—the ground could be sloped away from the foundation so that the water will run off. (photo courtesy of Terry Brennan)

Moisture issue: Disconnected downspout deposits rainwater from roof onto walls and near foundation. Fix: Connect the 2 downspouts. (photo courtesy of Terry Brennan)

Moisture Issue: A lawn sprinkler is located near the outside wall of a building; the sprinkler sprays the wall directly, and water leaks through wall into the building. Fix: Move the sprinkler away from the building so that water does not wet the walls or collect near the foundation.
(photo courtesy of Terry Brennan)

Moisture Issue: Foundation was chronically wet, water and mold damage was found on original structure. Fix: Area was regraded during construction of an addition so that water drains away from the foundation.

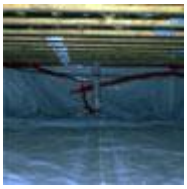
An example of window flashing, applied so that water drains to the outside of the window and not into the surrounding frame or walls.
(photo courtesy of Terry Brennan)

Rust is an indication that condensation occurs on this drainpipe. The pipe should be insulated to prevent condensation.

Moisture issue: Condensation on uninsulated air conditioning duct. Fix: Insulate the duct on the outside. (photo courtesy of Terry Brennan)

Moisture issue: Leaking pipes. The leaking pipes under the kitchen sink were taped; the pipes continued to leak, and the area got moldy. Fix: The pipes should be fixed by a plumber or other qualified professional. (photo courtesy of Terry Brennan)

Example of a drain pan beneath a cooling coil that slopes to a drain line and is constructed of stainless steel. (photo courtesy of Terry Brennan)



Example of a crawlspace without mold or water problems. The site is well drained. The crawlspace has a vapor barrier over the earth, is air-sealed, and insulated on the walls. (photo courtesy of Terry Brennan)

Two examples of dehumidifiers. For spaces that are damp, often at high humidity, but do not have liquid water running through them, a dehumidifier can be used to reduce humidity. (photo courtesy of Terry Brennan)

Example of exhaust vent in a bathroom. (photo courtesy of Terry Brennan)

Example of an exhaust hood and fan over a stovetop in a kitchen. An exhaust fan over a range draws heat, moisture, and contaminants out of the house. Range hoods should vent to the outside. (photo courtesy of Terry Brennan)

Gallery 5: Mold in Buildings

Mold growing on a suitcase stored in a humid basement.

Basement apartment (3-4 feet below ground) with mold on painted gypsum board, baseboard, and carpet. (photo courtesy of Terry Brennan)

Mold on ceiling. (photo courtesy of Terry Brennan)

Mold on painted concrete in a school building. Rainwater is wicking directly through the concrete walls, and there is also condensation on the earth-chilled concrete. (The floor is about 3 feet below ground level.)
(photo courtesy of Terry Brennan)

Mold on drywall under leaky sink. (photo courtesy of John Martyny, Ph.D.)

Plumbing leak inside wall led to mold on paneling behind mirror above bathroom sink. (The mirror has been removed in this photo.)
(photo courtesy of S. McNeel, DVM)

Moisture damage and mold growth under bathtubs. (photo courtesy of Terry Brennan)

Mold on grout. (photo courtesy of Elissa Feldman)

Mold inside a bathroom cabinet where condensation forms. (photo courtesy of Terry Brennan)

Mold on shower curtain. (photo courtesy of Terry Brennan)

Mold on air seal on sliding glass door.

Extensive mold contamination of ceiling and walls. (photo courtesy of Terry Brennan)

Mold on basement ceiling resulting from chronic high humidity (>90% relative humidity [RH]). (photo courtesy of Terry Brennan)

Colorful mold growth. (photo courtesy of Terry Brennan)

Sections of moldy gypsum board. (photo courtesy of Terry Brennan)

Mold on first floor beneath a through-the-wall air conditioner on the second floor. (photo courtesy of Terry Brennan)

Mold on fragment of ceiling tile.

Mold surrounding air conditioning vent in ceiling due to water leak. (photo courtesy of John Martyny, Ph.D.)

Mold growing on oriented strand board used for structural wood floor in crawl space. (photo courtesy of John Martyny, Ph.D.)

Mold on gypsum wallboard. (photo courtesy of Terry Brennan)

Mold growth on fiberboard shelf (left) and on cardboard boxes (right) due to high humidity. Water is condensing from the basement air, which is at approximately 90% relative humidity (RH). (photo courtesy of Terry Brennan)

Mold inside a wall cavity. (photo courtesy of Terry Brennan)

Mold on wooden paneling. (photo courtesy of Terry Brennan)

Gallery 6: Finding Mold and Moisture

Mold (and dirt) beneath refrigerator due to chronic drip-pan overflows. (photo courtesy of Terry Brennan)

Mold on a vacuum cleaner stored in a damp basement. (photo courtesy of Terry Brennan)

Moisture meter and moldy roof sheathing. (photo courtesy of Terry Brennan)

Measuring moisture levels of a sub floor. (photo courtesy of Terry Brennan)

Moldy bedroom closet. Water condensed from the air onto the gypsum board. The wall is cool enough for condensation because there is a hole in the insulation and it is cold outdoors. (photo courtesy of Terry Brennan)

Moisture meter, showing high moisture content in gypsum board behind tile. (photo courtesy of Terry Brennan)

Mold growth under ceramic tiles in a bathroom. (photo courtesy of John Martyny, Ph.D.)

Mushrooms growing at the base of and behind the baseboard below a water leak in a bathroom. The baseboard has been removed; the puckers in the paint are due to water damage. (photo courtesy of John Martyny, Ph.D.)

Most mold is found by simply looking. Mold beneath corkboard. (photo courtesy of Terry Brennan)

Mold inside a wall. This photo shows an interior wall with the lower portion of the drywall removed on one side; there is mold on the backside of the drywall caused by water leak. (photo courtesy of John Martyny, Ph.D.)

Opening a wall with a utility knife to minimize disturbance to mold in the wall cavity.

Inside of wall from above, moldy gypsum board, insulation. (photo courtesy of Terry Brennan)

Looking for mold in wall cavities by removing a section of drywall. (photo, John Martyny, Ph.D.)

Clear plastic tape is used to collect a sample. The sample is analyzed with a microscope to determine whether the substance is mold or soot. (photo courtesy of Terry Brennan)

Bulk samples can be examined using reflective light microscopes, such as stereo microscopes or this EPI microscope. (photo courtesy of Terry Brennan)

Gallery 7: Cleaning, Remediation

N-95 disposable respirator.

Cleaning with Personal Protective Equipment (PPE) – gloves, goggles, N-95 respirator.

Limited PPE. (photo courtesy of Chin Yang, Ph.D.)

Full containment on a large job. (photo courtesy of Terry Brennan)

Full containment. (photo courtesy of Terry Brennan)

Full containment. (photo courtesy of Terry Brennan)

Drying a carpet with a commercial specialty blower with built-in heater. (photo courtesy of Terry Brennan)

HEPA vacuum. Care is being taken to disturb the mold as little as possible while vacuuming. (photo courtesy of Terry Brennan)

Damp wiping surfaces with water and a small amount of detergent. (photo courtesy of Terry Brennan)

Bookcases and books protected during clean-up. (photo courtesy of Terry Brennan)

Resource List

EPA Mold Homepage - links to EPA mold documents and non-EPA resources

www.epa.gov/mold

EPA Resources

A Brief Guide to Mold, Moisture, and Your Home
www.epa.gov/iaq/molds/moldguide.html

Biological Contaminants
www.epa.gov/iaq/biologic.html

Fact Sheet: Flood Cleanup - Avoiding Indoor Air Quality Problems
www.epa.gov/iaq/pubs/flood.html

Hurricane Response 2005
www.epa.gov/Katrina

Hurricane Information
www.epa.gov/naturalevents/hurricanes.html

Indoor Air Quality (IAQ) Home Page
www.epa.gov/iaq

Indoor Air Quality Building Education and Assessment Model (I-BEAM)
www.epa.gov/iaq/largebldgs/ibeam_page.htm

IAQ in Large Buildings/Commercial Buildings
www.epa.gov/iaq/largebldgs

IAQ Tools for Schools
www.epa.gov/iaq/schools

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

Regulating Antimicrobial Pesticides
www.epa.gov/oppad001

Should You Have the Air Ducts in Your Home Cleaned?
www.epa.gov/iaq/pubs/airduct.html

U.S. EPA IAQ Clearinghouse
Phone: (800) 438-4318 or (703) 356-4020 (live operator during business hours)
Fax: (703) 821-8236
E-mail: iaqinfo@aol.com

Free indoor air-related documents, answers to indoor air quality (IAQ) questions, listing of state IAQ contacts and EPA regional contacts.

Mold: Information for Mold Contractors and Consultants in Wisconsin

To be included on the lists of IAQ Consultants or Mold Remediation Contractors, please provide the following information via email or regular mail to the Indoor Air Program at the address below:

1. Specify which list you want to be on: IAQ Consultants or Mold Remediation Contractors;
2. Your Company Name, web address, counties served, Phone Number(s), E-Mail Address, and Mailing Address as you would like them listed on the web;
3. A list of your credentials, including a list of training certificates (please include the name of the training provider);
4. An example of the type of reports you generate/work you do;
5. Any relationships, financial or otherwise, you have with any other IAQ consultant or mold remediation contractor; and
6. Any other item you feel that is important for us to review.

Our list is updated periodically. The sooner you can provide us with the information the sooner you can be added to the list.

Having your name on this list is **NOT** an endorsement from the Department of Health Services nor is it considered certification with the State of Wisconsin. It is only a starting point for interested parties who need assistance in investigating indoor air quality complaints in their buildings. DHS will not include individuals on this list who provide us with fraudulent information or if individuals advertise as being "State Certified" or "State Endorsed."

If you need any additional information about this process, or to submit the materials above, please contact:

Indoor Air Program
Wisconsin Department of Health Services
Division of Public Health, Bureau of Environmental and Occupational Health
1 West Wilson Street, Box 2659
Madison, WI 53701-2659
Walton.Smith@wi.gov
(608) 266-1120 Phone
(608) 267-4853 Fax

Mold: Information for Wisconsin Residents

These resources are intended to help educate Wisconsin residents regarding the impact of mold exposure on their health. The links below were developed based on a review of reputable and relevant guidance from government, educational and professional organizations. The information in the position statement below and Frequently Asked Questions was developed through a joint effort between the Wisconsin Department of Health and Family Services and the Wisconsin Section of the American Industrial Hygiene Association whose contributions are kindly acknowledged. We encourage you to explore the information provided. If you still can't find what you're looking for, or you want more information, contact the Wisconsin Division of Public Health, Bureau of Environmental and Occupational Health, PO Box 2659, Madison, WI 53701-2659, (608) 266-1120, or email the webmaster at DHSWEBMAILDPH@wisconsin.gov.

Position Statement Regarding the Impact of Mold on Health:

Molds grow abundantly in outdoor plant and soil materials. Molds produce spores that are normally found in both indoor and outdoor dust. Mold growth is familiar to most people when it is seen as a fuzzy patch or stain spreading across food or damp surfaces. It is known that many molds produce chemicals that can be toxic if eaten. Little if any of these chemicals are commonly found in indoor air and are not suspected to be a health hazard to the general public.

Mold exposure from breathing indoor or outdoor air can be irritating and can aggravate allergies and asthma. Health effects of mold can be a concern where exposures are very high, such as in sawmills, grain elevators, and agricultural settings. Where there are people with severely weakened immune systems, such as in hospital transplant units, mold infection can be a serious concern and exposures should be aggressively controlled. A physician should be seen whenever health effects are experienced.

It is not practical to expect a building to be completely free of mold, nor is it necessary. However, mold growth on indoor surfaces is a sign of moisture presence, the cause of which should be identified and corrected. Indoor mold growth should be removed regardless of mold type, using appropriate cleaning methods for small spots and careful attention to dust control, seeking professional assistance for larger amounts.

Mold Information for Consumers

Basic Information | **Mold in Your Home** | **Landlord/Tenant Concerns** | **Contractor Hiring Tips**

Professional/Technical Information on Mold

Frequently Asked Questions | **Contractors/ Consultants** | **Health Professionals** | **Mycotoxins** | **Resource**