

## Introduction

Molds can be found almost anywhere; they can grow on virtually any organic substance, as long as moisture and oxygen are present. There are molds that can grow on wood, paper, carpet, foods, and insulation. When excessive moisture accumulates in buildings or on building materials, mold growth will often occur, particularly if the moisture problem remains undiscovered or unaddressed. It is impossible to eliminate all mold and mold spores in the indoor environment. However, mold growth can be controlled indoors by controlling moisture indoors.

Molds reproduce by making spores that usually cannot be seen without magnification. Mold spores waft through the indoor and outdoor air continually. When mold spores land on a damp spot indoors, they may begin growing and digesting whatever they are growing on in order to survive. Molds gradually destroy the things they grow on.

Many types of molds exist. All molds have the potential to cause health effects. Molds can produce allergens that can trigger allergic reactions or even asthma attacks in people allergic to mold. Others are known to produce potent toxins and/or irritants. Potential health concerns are an important reason to prevent mold growth and to remediate/clean up any existing indoor mold growth.

Since mold requires water to grow, it is important to prevent moisture problems in buildings. Moisture problems can have many causes, including uncontrolled humidity. Some moisture problems in buildings have been linked to changes in building construction practices during the 1970s, 80s, and 90s. Some of these changes have resulted in buildings that are tightly sealed, but may lack adequate ventilation, potentially leading to moisture buildup. Building materials, such as drywall, may not allow moisture to escape easily. Moisture problems may include roof leaks, landscaping or gutters that direct water into or under the building, and un-vented combustion appliances.

Delayed maintenance or insufficient maintenance is also associated with moisture problems in schools and large buildings. Moisture problems in portable classrooms and other temporary structures have frequently been associated with mold problems.

When mold growth occurs in buildings, adverse health problems may be reported by some building occupants, particularly those with allergies or respiratory problems. Remediators should avoid exposing themselves and others to mold-laden dusts as they conduct their cleanup activities. Caution should be used to prevent mold and mold spores from being dispersed throughout the air where they can be inhaled by building occupants. If you choose to use outside contractors or professionals, make sure they have experience cleaning up mold, check their references, and have them follow the recommendations presented in this document, the guidelines of the American Conference of Government Industrial Hygienists (ACGIH).

## Prevention

The key to mold control is moisture control. Solve moisture problems before they become mold problems:

- Fix leaky plumbing and leaks in the building envelope as soon as possible.
- Watch for condensation and wet spots. Fix source(s) of moisture problem(s) 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, 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% relative humidity (RH), ideally 30-50%, if possible.
- Perform regular building/HVAC inspections and maintenance as scheduled.
- Clean and dry wet or damp spots within 48 hours.
- Do not let foundations stay wet. Provide drainage and slope the ground away from the foundation.

## Investigating, Evaluating & Remediating Moisture & Mold Problems

### Plan the Remediation before Starting the Work

#### Remediation Plan

Assess the size of the mold and/or moisture problem and the type of damaged materials before planning the remediation work. Select a remediation manager for medium or large jobs (or small jobs requiring more than one person). The remediation plan should include steps to fix the water or moisture problem, or the problem may reoccur. The plan should cover the use of appropriate Personal Protective Equipment (PPE) and include steps to carefully contain and remove moldy building materials to avoid spreading the mold. A remediation plan may vary greatly depending on the size and complexity of the job, and may require revision if circumstances change or new facts are discovered.

The remediation manager's highest priority must be to protect the health and safety of the building occupants and remediators. It is also important to communicate with building occupants when mold problems are identified. In some cases, especially those involving large areas of contamination, the remediation plan may include temporary relocation of some or all of the building occupants.

The decision to relocate occupants should consider the size and type of the area

affected by mold growth, the type and extent of health effects reported by the occupants, the potential health risks that could be associated with debris and the amount of disruption likely to be caused by remediation activities. If possible, remediation activities should be scheduled during off-hours when building occupants are less likely to be affected.

Remediators, particularly those with health-related concerns, may wish to check with their doctors or health care professionals before working on mold remediation or investigating potentially moldy areas. If you have any doubts or questions, you should consult a health professional before beginning a remediation project.

## Questions to Consider Before Remediation

- 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 too high (high enough to cause condensation)?
- Are building occupants reporting musty or moldy odors?
- Are building occupants reporting health problems?
- Are building materials or furnishings visibly damaged?
- Has maintenance been delayed or the maintenance plan been altered?
- Has the building been recently remodeled or has building use changed?
- Is consultation with medical or health professionals indicated?

## Heating, Ventilation, & Air-Conditioning (HVAC) System

Do not run the HVAC system if you know or suspect that it is contaminated with mold. If you suspect that it may be contaminated (it is part of an identified moisture problem, for instance, or there is mold growth near the intake to the system), consult EPA's guide "Should You Have the Air Ducts in Your Home Cleaned?"

## Hidden Mold

In some cases, indoor mold growth may not be obvious. It is possible that mold may be growing on hidden surfaces, such as the back side of dry wall, wallpaper, or paneling, the top of ceiling tiles, the underside of carpets and pads, etc. Possible locations of hidden mold can include pipe chases and utility tunnels (with leaking or condensing pipes), walls behind furniture (where condensation forms), condensate drain pans inside air handling units, porous thermal or acoustic liners inside ductwork, or roof materials above ceiling tiles (due to roof leaks or insufficient insulation).

Some building materials, such as dry wall with vinyl wallpaper over it or wood paneling, may act as vapor barriers, trapping moisture underneath their surfaces and thereby providing a moist environment where mold can grow. You may suspect hidden mold if a building smells moldy, but you cannot see the source, or if you know there has been water damage and building occupants are reporting health problems.

Investigating hidden mold problems may be difficult and will require caution when the investigation involves disturbing potential sites of mold growth—make sure to use personal protective equipment (PPE). For example, removal of wallpaper can lead to a massive release of spores from mold growing on the underside of the paper. If you believe that you may have a hidden mold problem, you may want to consider hiring an experienced professional. If you discover hidden mold, you should revise your remediation plan to account for the total area affected by mold growth.

## Remediation

- Fix the water or humidity problem. Complete and carry out repair plan if appropriate.
- Revise and/or carry out maintenance plan if necessary. Revise remediation plan as necessary, if more damage is discovered during remediation.
- Continue to communicate with building occupants, as appropriate to the situation. Be sure to address all concerns.
- Completely clean up mold and dry water-damaged areas. Select appropriate cleaning and drying methods for damaged/contaminated materials. Carefully contain and remove moldy building materials. Use appropriate Personal Protective Equipment (PPE). Arrange for outside professional support if necessary.

## The Key to Mold Control is Moisture Control

- When addressing mold problems, do not forget to address the source of the moisture problem, or the mold problem may simply reappear!
- Remember to check for high humidity and condensation problems as well as actual water leaks, maintenance issues, and HVAC system problems.
- Protect the health and safety of the building occupants and remediators. Consult a health professional as needed. Use PPE and containment as appropriate when working with mold.

## Mold Remediation Guidelines

These guidelines are designed to protect the health of occupants and cleanup personnel during remediation. These guidelines are based on the area and type of material affected by water damage and/or mold growth. Please note that these are guidelines; some professionals may prefer other cleaning methods.

If you are considering cleaning your ducts as part of your remediation plan, you should consult EPA's publication entitled, "Should You Have the Air Ducts In Your Home Cleaned?" If possible, remediation activities should be scheduled during off-hours when building occupants are less likely to be affected.

Although the level of personal protection suggested in these guidelines is based on the total surface area contaminated and the potential for remediator and/or occupant

exposure, professional judgment should always play a part in remediation decisions. These remediation guidelines are based on the size of the affected area to make it easier for remediators to select appropriate techniques, not on the basis of health effects or research showing there is a specific method appropriate at a certain number of square feet. The guidelines have been designed to help construct a remediation plan. The remediation manager will then use professional judgment and experience to adapt the guidelines to particular situations. When in doubt, caution is advised. Consult an experienced mold remediator for more information.

In cases in which a particularly toxic mold species has been identified or is suspected, when extensive hidden mold is expected (such as behind vinyl wallpaper or in the HVAC system), when the chances of the mold becoming airborne are estimated to be high, or sensitive individuals (e.g., those with severe allergies or asthma) are present, a more cautious or conservative approach to remediation is indicated. Always make sure to protect remediators and building occupants from exposure to mold.

## **Mold and Indoor Air Regulations and Standards**

Standards or Threshold Limit Values (TLVs) for airborne concentrations of mold, or mold spores, have not been set. As of December 2000, there are no EPA regulations or standards for airborne mold contaminants.

If building occupants are reporting serious health concerns, you should consult a health professional.

## **Cleanup Methods**

A variety of mold cleanup methods are available for remediating damage to building materials and furnishings caused by moisture control problems and mold growth. The specific method or group of methods used will depend on the type of material affected. Please note that professional remediators may use some methods not covered in these guidelines; absence of a method in the guidelines does not necessarily mean that it is not useful.

### **Method 1: Wet Vacuum**

Wet vacuums are vacuum cleaners designed to collect water. They can be used to remove water from floors, carpets, and hard surfaces where water has accumulated. They should not be used to vacuum porous materials, such as gypsum board. They should be used only when materials are still wet—wet vacuums may spread spores if sufficient liquid is not present. The tanks, hoses, and attachments of these vacuums should be thoroughly cleaned and dried after use since mold and mold spores may stick to the surfaces.

## **Method 2: Damp Wipe**

Whether dead or alive, mold is allergenic, and some molds may be toxic. Mold can generally be removed from nonporous (hard) surfaces by wiping or scrubbing with water, or water and detergent. It is important to dry these surfaces quickly and thoroughly to discourage further mold growth. Instructions for cleaning surfaces, as listed on product labels, should always be read and followed. Porous materials that are wet and have mold growing on them may have to be discarded. Since molds will infiltrate porous substances and grow on or fill in empty spaces or crevices, the mold can be difficult or impossible to remove completely.

## **Method 3: HEPA Vacuum**

HEPA (High-Efficiency Particulate Air) vacuums are recommended for final cleanup of remediation areas after materials have been thoroughly dried and contaminated materials removed. HEPA vacuums are also recommended for cleanup of dust that may have settled on surfaces outside the remediation area. Care must be taken to assure that the filter is properly seated in the vacuum so that all the air must pass through the filter. When changing the vacuum filter, remediators should wear PPE to prevent exposure to the mold that has been captured. The filter and contents of the HEPA vacuum must be disposed of in well-sealed plastic bags.

## **Method 4: Remove Damaged Materials and Seal in Plastic Bags**

Building materials and furnishings that are contaminated with mold growth and are not salvageable should be double-bagged using 6-mil polyethylene sheeting. These materials can then usually be discarded as ordinary construction waste. It is important to package mold-contaminated materials in sealed bags before removal from the containment area to minimize the dispersion 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 they are removed from the containment area.

The purpose of mold remediation is to remove the mold to prevent human exposure and damage to building materials and furnishings. It is necessary to clean up mold contamination, not just to kill the mold. Dead mold is still allergenic, and some dead molds are potentially toxic. The use of a biocide, such as chlorine bleach, is not recommended as a routine practice during mold remediation, although there may be instances where professional judgment may indicate its use (for example, when immune-compromised individuals are present). In most cases, it is not possible or desirable to sterilize an area; a background level of mold spores will remain in the air (roughly equivalent to or lower than the level in outside air). These spores will not grow if the moisture problem in the building has been resolved.

If you choose to use disinfectants or biocides, always ventilate the area. Outdoor air may need to be brought in with fans. When using fans, take care not to distribute mold spores through an unaffected area. Biocides are toxic to humans, as well as to mold.

You should also use appropriate PPE and read and follow label precautions. Never mix chlorine bleach solution with cleaning solutions or detergents that contain ammonia; toxic fumes could be produced.

Some biocides are considered pesticides, and some States require that only registered pesticide applicators apply these products in schools. Make sure anyone applying a biocide is properly licensed, if necessary. Fungicides are commonly applied to outdoor plants, soil, and grains as a dust or spray—examples include phthalimides, hexachlorobenzene, organomercurials, pentachlorophenol, and dithiocarbamates. Do not use fungicides developed for use outdoors for mold remediation or for any other indoor situation.

Mold growth can eventually cause structural damage to a school or large building, if a mold/moisture problem remains unaddressed for a long time. In the case of a long-term roof leak, for example, molds can weaken floors and walls as the molds feed on wet wood. If you suspect that mold has damaged building integrity, you should consult a structural engineer or other professional with expertise in this area.

Do not paint or caulk moldy surfaces; clean and dry surfaces before painting. Paint applied over moldy surfaces is likely to peel.

## **Personal Protective Equipment (PPE)**

If the remediation job disturbs mold and mold spores become airborne, then the risk of respiratory exposure goes up. Actions that are likely to stir up mold include: breakup of moldy porous materials such as wallboard; invasive procedures used to examine or remediate mold growth in a wall cavity; actively stripping or peeling wallpaper to remove it; and using fans to dry items.

The primary function of Personal Protective Equipment (PPE) is to avoid inhaling mold and mold spores and to avoid mold contact with the skin or eyes. The following sections discuss the different types of PPE that can be used during remediation activities. Please note that all individuals using certain PPE equipment, such as half-face or full-face respirators, must be trained, must have medical clearance, and must be fit-tested by a trained professional. In addition, the use of respirators must follow a complete respiratory protection program as specified by the Occupational Safety and Health Administration.

### **Skin and Eye Protection**

Gloves are required to protect the skin from contact with mold allergens (and in some cases mold toxins) and from potentially irritating cleaning solutions. Long gloves that extend to the middle of the forearm are recommended. The glove material should be selected based on the type of materials being handled.

If you are using a biocide (such as chlorine bleach) or a strong cleaning solution, you should select gloves made from natural rubber, neoprene, nitrile, polyurethane, or PVC. If you are using a mild detergent or plain water, ordinary household rubber gloves may be used.

To protect your eyes, use properly fitted goggles or a full-face respirator with HEPA filter. Goggles must be designed to prevent the entry of dust and small particles. Safety glasses or goggles with open vent holes are not acceptable.

## Respiratory Protection

Respirators protect cleanup workers from inhaling airborne mold, mold spores, and contaminated dust.

- **Minimum:** When cleaning up a small area affected by mold, you should use an N-95 respirator. This device covers the nose and mouth, will filter out 95% of the particulates in the air, and is available in most hardware stores. In situations where a full-face respirator is in use, additional eye protection is not required.
- **Limited:** Limited PPE includes use of a half-face or full-face air purifying respirator (APR) equipped with a HEPA filter cartridge. These respirators contain both inhalation and exhalation valves that filter the air and ensure that it is free of mold particles. Note that half-face APRs do not provide eye protection. In addition, the HEPA filters do not remove vapors or gases. You should always use respirators approved by the National Institute for Occupational Safety and Health.
- **Full:** In situations in which high levels of airborne dust or mold spores are likely or when intense or long-term exposures are expected (e.g., the cleanup of large areas of contamination), a full-face, powered air purifying respirator (PAPR) is recommended. Full-face PAPRs use a blower to force air through a HEPA filter. The HEPA-filtered air is supplied to a mask that covers the entire face or a hood that covers the entire head. The 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. The use of these respirators must be in compliance with OSHA regulations.

## Disposable Protective Clothing

Disposable clothing is recommended during a medium or large remediation project to prevent the transfer and spread of mold to clothing and to eliminate skin contact with mold.

- **Limited:** Disposable paper overalls can be used.
- **Full:** Mold-impervious disposable head and foot coverings, and a body suit made of a breathable material, such as TYVEK®, should be used. All gaps, such as those around ankles and wrists, should be sealed (many remediators use duct tape to seal clothing).

## Containment

The purpose of containment during remediation activities is to limit release of mold into the air and surroundings, in order to minimize the exposure of remediators and building occupants to mold. Mold and moldy debris should not be allowed to spread to areas in the building beyond the contaminated site.

The two types of containment recommended are limited and full. The larger the area of moldy material, the greater the possibility of human exposure and the greater the need for containment. In general, the size of the area helps determine the level of containment. However, a heavy growth of mold in a relatively small area could release more spores than a lighter growth of mold in a relatively large area. Choice of containment should be based on professional judgment. The primary object of containment should be to prevent occupant and remediator exposure to mold.

### Limited Containment

Limited containment is generally recommended for areas involving between 10 and 100 square feet (ft<sup>2</sup>) of mold contamination. The enclosure around the moldy area should consist of a single layer of 6-mil, fire-retardant polyethylene sheeting. The containment should have a slit entry and covering flap on the outside of the containment area. For small areas, the polyethylene sheeting can be affixed to floors and ceilings with duct tape. For larger areas, a steel or wooden stud frame can be erected and polyethylene sheeting attached to it. All supply and air vents, doors, chases, and risers within the containment area must be sealed with polyethylene sheeting to minimize the migration of contaminants to other parts of the building. Heavy mold growth on ceiling tiles may impact HVAC systems if the space above the ceiling is used as a return air plenum. In this case, containment should be installed from the floor to the ceiling deck, and the filters in the air handling units serving the affected area may have to be replaced once remediation is finished.

The containment area must be maintained under negative pressure relative to surrounding areas. This will ensure that contaminated air does not flow into adjacent areas. This can be done with a HEPA-filtered fan unit exhausted outside of the building. For small, easily contained areas, an exhaust fan ducted to the outdoors can also be used. The surfaces of all objects removed from the containment area should be remediated/cleaned prior to removal. The remediation guidelines can be implemented when the containment is completely sealed and is under negative pressure relative to the surrounding area.

### Full Containment

Full containment is recommended for the cleanup of mold-contaminated surface areas greater than 100 ft<sup>2</sup> or in any situation in which it appears likely that the occupant space would be further contaminated without full containment. Double layers of

polyethylene should be used to create a barrier between the moldy area and other parts of the building. A decontamination chamber or airlock should be constructed for 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 entry with covering flaps on the outside surface of each slit entry. The chamber should be large enough to hold a waste container and allow a person to put on and remove PPE. All contaminated PPE, except respirators, should be placed in a sealed bag while in this chamber. Respirators should be worn until remediators are outside the decontamination chamber. PPE must be worn throughout the final stages of HEPA vacuuming and damp-wiping of the contained area. PPE must also be worn during HEPA vacuum filter changes or cleanup of the HEPA vacuum.

## Containment Tips

- Always maintain the containment area under negative pressure.
- Exhaust fans to outdoors and ensure that adequate makeup air is provided.

If the containment is working, the polyethylene sheeting should billow inwards on all surfaces. If it flutters or billows outward, containment has been lost, and you should find and correct the problem before continuing your remediation activities.

## Equipment

### Moisture Meters

Moisture meters may be helpful for measuring the moisture content in a variety of building materials following water damage. They can also be used to monitor the process of drying damaged materials. These direct reading devices have a thin probe which can be inserted into the material to be tested or can be pressed directly against the surface of the material. Moisture meters can be used on materials such as carpet, wallboard, wood, brick, and concrete.

### Humidity Gauges or Meters

Humidity meters can be used to monitor humidity indoors. Inexpensive (<\$50) models are available that monitor both temperature and humidity.

### Humidistat

A humidistat is a control device that can be connected to the HVAC system and adjusted so that, if the humidity level rises above a set point, the HVAC system will automatically come on.

## HVAC System Filter

Use high-quality filters in your HVAC system during remediation. Consult an engineer for the appropriate efficiency for your specific HVAC system and consider upgrading your filters if appropriate. Conventional HVAC filters are typically not effective in filtering particles the size of mold spores. Consider upgrading to a filter with a minimum efficiency of 50 to 60% or a rating of MERV 8, as determined by Test Standard 52.2 of the American Society of Heating, Refrigerating, and Air Conditioning Engineers. Remember to change filters regularly and change them following any remediation activities.

## Air Sampling

Is sampling for mold needed? In most cases, if visible mold growth is present, sampling is unnecessary. In specific instances, such as cases where litigation is involved, the source(s) of the mold contamination is unclear, or health concerns are a problem, you may consider sampling as part of your site evaluation. Surface sampling may also be useful in order to determine if an area has been adequately cleaned or remediated. Sampling should be done only after developing a sampling plan that includes a confirmable theory regarding suspected mold sources and routes of exposure. Figure out what you think is happening and how to prove or disprove it before you sample!

If you do not have extensive experience and/or are in doubt about sampling, consult an experienced professional. This individual can help you decide if sampling for mold is useful and/or needed, and will be able to carry out any necessary sampling. It is important to remember that the results of sampling may have limited use or application.

Sampling may help locate the source of mold contamination, identify some of the mold species present, and differentiate between mold and soot or dirt. Pre- and post-remediation sampling may also be useful in determining whether remediation efforts have been effective. After remediation, the types and concentrations of mold in indoor air samples should be similar to what is found in the local outdoor air. Since no EPA or other Federal threshold limits have been set for mold or mold spores, sampling cannot be used to check a building's compliance with Federal mold standards.

Sampling for mold should be conducted by professionals with specific experience in designing mold sampling protocols, sampling methods, and interpretation of results. Sample analysis should follow analytical methods recommended by the American Industrial Hygiene Association (AIHA), the American Conference of Governmental Industrial Hygienists (ACGIH), or other professional guidelines. 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.

A number of pitfalls may be encountered when inexperienced personnel conduct sampling. They may take an inadequate number of samples, there may be inconsistency

in sampling protocols, the samples may become contaminated, outdoor control samples may be omitted, and you may incur costs for unneeded or inappropriate samples. Budget constraints will often be a consideration when sampling; professional advice may be necessary to determine if it is possible to take sufficient samples to characterize a problem on a given budget.

If it is not possible to sample properly, with a sufficient number of samples to answer the question(s) posed, it would be preferable not to sample. Inadequate sample plans may generate misleading, confusing, and useless results.

Keep in mind that air sampling for mold provides information only for the moment in time in which the sampling occurred, much like a snapshot. Air sampling will reveal, when properly done, what was in the air at the moment when the sample was taken. For someone without experience, sampling results will be difficult to interpret. Experience in interpretation of results is essential.

## When is Remediation/Cleanup Finished?

- You must have completely fixed the water or moisture problem.
- 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.
- 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.
- You should revisit the site(s) shortly after remediation, and it should show no signs of water damage or mold growth.
- People should be able to occupy or re-occupy the space without health complaints or physical symptoms.
- Ultimately, this is a judgment call; there is no easy answer.

### Notes:

Molds are known allergens and may be toxic. You may wish to use Personal Protective Equipment (PPE) while investigating a mold problem, as well as during remediation/clean-up situations. The minimum PPE includes an N-95 respirator, gloves, and eye protection.

Although this document has a residential focus, it is applicable to other building types.

It is important that building materials be able to dry; moisture should not be trapped between two vapor barriers or mold may result.

Please note that this information contains general guidelines. The purpose is to provide basic information for remediation managers to first assess the extent of the damage and then to determine whether the remediation should be managed by in-house personnel or outside professionals. The remediation manager can then use the guidelines to help design a remediation plan or to assess a plan submitted by outside professionals.

## **Checklist for Mold Remediation**

### **Investigate and evaluate moisture and mold problems**

- Assess size of moldy area (square feet)
- Consider the possibility of hidden mold
- Clean up small mold problems and fix moisture problems before they become large problems
- Select remediation manager for medium or large size mold problem
- Investigate areas associated with occupant complaints
- Identify source(s) or cause of water or moisture problem(s)
- Note type of water-damaged materials (wallboard, carpet, etc.)
- Check inside air ducts and air handling unit
- Throughout process, consult qualified professional if necessary or desired

### **Communicate with building occupants at all stages of process, as appropriate**

- Designate contact person for questions and comments about medium or large scale remediation as needed

### **Plan remediation**

- Adapt or modify remediation guidelines to fit your situation; use professional judgment
- Plan to dry wet, non-moldy materials within 48 hours to prevent mold growth
- Select cleanup methods for moldy items
- Select Personal Protection Equipment - protect remediators
- Select containment equipment - protect building occupants
- Select remediation personnel who have the experience and training needed to implement the remediation plan and use Personal Protection Equipment and containment as appropriate

### **Remediate moisture and mold problems**

- Fix moisture problem, implement repair plan and/or maintenance plan
- Dry wet, non-moldy materials within 48 hours to prevent mold growth
- Clean and dry moldy materials; discard moldy items that cannot be cleaned

## **Guidelines for Remediating Building Materials with Mold Growth Caused by Clean Water**

This information presents remediation guidelines for building materials that have or are likely to have mold growth. The guidelines are designed to protect the health of occupants and cleanup personnel during remediation. These guidelines are based on the area and type of material affected by water damage and/or mold growth. Please note that these are guidelines; some professionals may prefer other cleaning methods.

If you are considering cleaning your ducts as part of your remediation plan, you should consult EPA's publication entitled, *Should You Have the Air Ducts in Your Home Cleaned?* If possible, remediation activities should be scheduled during off-hours when building occupants are less likely to be affected.

Although the level of personal protection suggested in these guidelines is based on the total surface area contaminated and the potential for remediator and/or occupant exposure, professional judgment should always play a part in remediation decisions. These remediation guidelines are based on the size of the affected area to make it easier for remediators to select appropriate techniques, not on the basis of health effects or research showing there is a specific method appropriate at a certain number of square feet. The guidelines have been designed to help construct a remediation plan. The remediation manager will then use professional judgment and experience to adapt the guidelines to particular situations. When in doubt, caution is advised. Consult an experienced mold remediator for more information.

In cases in which a particularly toxic mold species has been identified or is suspected, when extensive hidden mold is expected (such as behind vinyl wallpaper or in the HVAC system), when the chances of the mold becoming airborne are estimated to be high, or sensitive individuals (e.g., those with severe allergies or asthma) are present, a more cautious or conservative approach to remediation is indicated. Always make sure to protect remediators and building occupants from exposure to mold.

The following "Easy Reference Chart" will help you determine necessary precautions.

Guidelines for Remediating Building Materials with Mold Growth Caused by Clean Water*			
Material or Furnishing Affected	Cleanup Methods†	Personal Protective Equipment	Containment
Small – Total Surface Area Affected Less Than 10 square feet (ft. <sup>2</sup> )			
Books and papers	3	<b>Minimum</b>  N-95 respirator, gloves, and goggles	<b>None required</b>
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 board)	3		
Wood surfaces	1, 2, 3		
Medium – Total Surface Area Affected Between 10 and 100 (ft. <sup>2</sup> )			
Books and papers	3	<b>Limited or Full</b>  Use professional judgment, consider potential for remediator exposure and size of contaminated area	<b>Limited</b>  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 board)	3,4		
Wood surfaces	1,2,3		
Large – Total Surface Area Affected Greater Than 100 (ft. <sup>2</sup> ) or Potential for Increased Occupant or Remediator Exposure During Remediation Estimated to be Significant			
Books and papers	3	<b>Full</b>  Use professional judgment, consider potential for remediator/occupant exposure and size of contaminated area	<b>Full</b>  Use professional judgment, consider potential for remediator 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	1,2,4		
Wallboard (drywall and gypsum board)	3,4		
Wood surfaces	1,2,3,4		
<p>* 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. <b>These guidelines are for damage caused by clean water. If you know or suspect that the water source is contaminated with sewage, chemical, or biological pollutants, then the Occupational Safety and Health Administration (OSHA) requires PPE and containment.</b> An experienced professional should be consulted if you and/or your remediators do not have expertise in remediating contaminated water situations.</p> <p>† 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. <b>Please note that these are guidelines; other cleaning methods may be preferred by some professionals.</b></p>			

<b>CLEAN-UP METHODS</b>	
<b>Method 1</b>	Wet vacuum (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.
<b>Method 2</b>	Damp-wipe surfaces with plain water or with water and detergent solution (except wood—use wood floor cleaner); scrub as needed.
<b>Method 3</b>	High-efficiency particulate air (HEPA) vacuum after the material has been thoroughly dried. Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.
<b>Method 4</b>	Discard – 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
<b>PERSONAL PROTECTIVE EQUIPMENT (PPE)</b>	
<b>Minimum</b>	Gloves, N-95 respirator, goggles/eye protection
<b>Limited</b>	Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection
<b>Full</b>	Gloves, disposable full body clothing, head gear, foot coverings, full-face respirator with HEPA filter
<b>CONTAINMENT</b>	
<b>Limited</b>	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.
<b>Full</b>	Use two layers of fire-retardant polyethylene sheeting with one airlock chamber. Maintain area under negative pressure with HEPA filtered fan exhausted 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).	

## Introduction to Molds

### Molds in the Environment

Molds live in the soil, on plants, and on dead or decaying matter. Outdoors, molds play a key role in the breakdown of leaves, wood, and other plant debris. Molds belong to the kingdom Fungi, and unlike plants, they lack chlorophyll and must survive by digesting plant materials, using plant and other organic materials for food. Without molds, our environment would be overwhelmed with large amounts of dead plant matter.

Molds produce tiny spores to reproduce, just as some plants produce seeds. These mold spores can be found in both indoor and outdoor air, and settled on indoor and outdoor surfaces. When mold spores land on a damp spot, they may begin growing and digesting whatever they are growing on in order to survive. Since molds gradually destroy the things they grow on, you can prevent damage to building materials and furnishings and save money by eliminating mold growth.

Moisture control is the key to mold control. Molds need both food and water to survive; since molds can digest most things, water is the factor that limits mold growth. Molds will often grow in damp or wet areas indoors. Common sites for indoor mold growth include bathroom tile, basement walls, areas around windows where moisture condenses, and near leaky water fountains or sinks. Common sources or causes of water or moisture problems include roof leaks, deferred maintenance, condensation associated with high humidity or cold spots in the building, localized flooding due to plumbing failures or heavy rains, slow leaks in plumbing fixtures, and malfunction or poor design of humidification systems. Uncontrolled humidity can also be a source of moisture leading to mold growth, particularly in hot, humid climates.

### Health Effects and Symptoms Associated with Mold Exposure

When moisture problems occur and mold growth results, building occupants may begin to report odors and a variety of health problems, such as headaches, breathing difficulties, skin irritation, allergic reactions, and aggravation of asthma symptoms; all of these symptoms could potentially be associated with mold exposure.

All molds have the potential to cause health effects. Molds produce allergens, irritants, and in some cases, toxins that may cause reactions in humans. The types and severity of symptoms depend, in part, on the types of mold present, the extent of an individual's exposure, the ages of the individuals, and their existing sensitivities or allergies.

Allergic Reactions (e.g., rhinitis and dermatitis or skin rash); Asthma;  
Hypersensitivity Pneumonitis; Other Immunologic Effects

Research on mold and health effects is ongoing. This list is not intended to be all-inclusive.

The health effects listed above are well documented in humans. Evidence for other health effects in humans is less substantial and is primarily based on case reports or occupational studies.

## **Specific Reactions to Mold Growth Include the Following:**

### **Allergic Reactions**

Inhaling or touching mold or mold spores may cause allergic reactions in sensitive individuals. Allergic reactions to mold are common - these reactions can be immediate or delayed. Allergic responses include hay fever-type symptoms, such as sneezing, runny nose, red eyes, and skin rash (dermatitis). Mold spores and fragments can produce allergic reactions in sensitive individuals regardless of whether the mold is dead or alive. Repeated or single exposure to mold or mold spores may cause previously non-sensitive individuals to become sensitive. Repeated exposure has the potential to increase sensitivity.

### **Asthma**

Molds can trigger asthma attacks in persons who are allergic (sensitized) to molds. The irritants produced by molds may also worsen asthma in non-allergic (non-sensitized) people.

### **Hypersensitivity Pneumonitis**

Hypersensitivity pneumonitis may develop following either short-term (acute) or long-term (chronic) exposure to molds. The disease resembles bacterial pneumonia and is uncommon.

### **Irritant Effects**

Mold exposure can cause irritation of the eyes, skin, nose, throat, and lungs, and sometimes can create a burning sensation in these areas.

## Opportunistic Infections

People with weakened immune systems (i.e., immune-compromised or immune-suppressed individuals) may be more vulnerable to infection by molds (as well as more vulnerable than healthy persons to mold toxins). *Aspergillus fumigatus*, for example, has been known to infect the lungs of immune-compromised individuals. These individuals inhale the mold spores which then start growing in their lungs. *Trichoderma* has also been known to infect immune-compromised children.

Healthy individuals are usually not vulnerable to opportunistic infections from airborne mold exposure. However, molds can cause common skin diseases, such as athlete's foot, as well as other infections such as yeast infections.

## Mold Toxins (Mycotoxins)

Molds can produce toxic substances called mycotoxins. Some mycotoxins cling to the surface of mold spores; others may be found within spores. More than 200 mycotoxins have been identified from common molds, and many more remain to be identified. Some of the molds that are known to produce mycotoxins are commonly found in moisture-damaged buildings. Exposure pathways for mycotoxins can include inhalation, ingestion, or skin contact. Although some mycotoxins are well known to affect humans and have been shown to be responsible for human health effects, for many mycotoxins, little information is available.

Aflatoxin B1 is perhaps the most well-known and studied mycotoxin. It can be produced by the molds *Aspergillus flavus* and *Aspergillus parasiticus* and is one of the most potent carcinogens known. Ingestion of aflatoxin B1 can cause liver cancer. There is also some evidence that inhalation of aflatoxin B1 can cause lung cancer. Aflatoxin B1 has been found on contaminated grains, peanuts, and other human and animal foodstuffs. However, *Aspergillus flavus* and *Aspergillus parasiticus* are not commonly found on building materials or in indoor environments.

Much of the information on the human health effects of inhalation exposure to mycotoxins comes from studies done in the workplace and some case studies or case reports.\* Many symptoms and human health effects attributed to inhalation of mycotoxins have been reported including: mucous membrane irritation, skin rash, nausea, immune system suppression, acute or chronic liver damage, acute or chronic central nervous system damage, endocrine effects, and cancer. More studies are needed to get a clear picture of the health effects related to most mycotoxins. However, it is clearly prudent to avoid exposure to molds and mycotoxins.

Some molds can produce several toxins, and some molds produce mycotoxins only under certain environmental conditions. The presence of mold in a building does not necessarily mean that mycotoxins are present or that they are present in large quantities.

**Information on ingestion exposure, for both humans and animals, is more abundant – wide ranges of health effects have been reported following ingestion of moldy foods including liver damage, nervous system damage, and immunological effects.**

Some molds, such as *Aspergillus versicolor* and *Stachybotrys atra* (chartarum), are known to produce potent toxins under certain circumstances. Although some mycotoxins are well known to affect humans and have been shown to be responsible for human health effects, for many mycotoxins, little information is available, and in some cases research is ongoing. For example, some strains of *Stachybotrys atra* can produce one or more potent toxins. In addition, preliminary reports from an investigation of an outbreak of pulmonary hemorrhage in infants suggested an association between pulmonary hemorrhage and exposure to *Stachybotrys chartarum*. Review of the evidence of this association at CDC resulted in an a published clarification stating that such an association was not established. Research on the possible causes of pulmonary hemorrhage in infants continues. Consult the Centers for Disease Control and Prevention (CDC) for more information on pulmonary hemorrhage in infants.

## Microbial Volatile Organic Compounds (mVOCs)

Some compounds produced by molds are volatile and are released directly into the air. These are known as microbial volatile organic compounds (mVOCs). Because these compounds often have strong and/or unpleasant odors, they can be the source of odors associated with molds. Exposure to mVOCs from molds has been linked to symptoms such as headaches, nasal irritation, dizziness, fatigue, and nausea. Research on MVOCs is still in the early phase.

## Glucans or Fungal Cell Wall Components

(Also known as  $\beta$ -(1→3)-D-Glucans)

Glucans are small pieces of the cell walls of molds which may cause inflammatory lung and airway reactions. These glucans can affect the immune system when inhaled. Exposure to very high levels of glucans or dust mixtures including glucans may cause a flu-like illness known as Organic Dust Toxic Syndrome (ODTS). This illness has been primarily noted in agricultural and manufacturing settings.

## Spores

Mold spores are microscopic (2-10  $\mu\text{m}$ ) and are naturally present in both indoor and outdoor air. Molds reproduce by means of spores. Some molds have spores that are easily disturbed and waft into the air and settle repeatedly with each disturbance. Other molds have sticky spores that will cling to surfaces and are dislodged by brushing against them or by other direct contact. Spores may remain able to grow for years after they are produced. In addition, whether or not the spores are alive, the allergens in and on them may remain allergenic for years.