TEXAS A&M UNIVERSITY KINGSVILLE

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# Physical Plant Procedure Letter

TO: All Physical Plant Personnel

FROM: David Standish, Director of Physical Plant

DATE: August 21, 2003

RE: **Mold Prevention and Remediation**

All Physical Plant Personnel are to take a Pro-Active stance in the prevention of Mold development and in any of the remediation procedures in eliminating Mold that has already occurred in and around the Texas A&M University – Kingsville facilities.

Taking a pro-active stance will allow the University to maximize it's mission through the extension of maintaining our operational capabilities, by identifying potential mold growth causes and sources, and conducting immediate remediation of such. Being proactive may also reduce our financial costs from having fewer remediation requirements, less property damage, and fewer man-hours lost from illness or allergies.

**Mold Prevention** will include the Physical Plant requirement by all personnel for continuous facility inspections, monitoring, and adjustments to control humidity levels, maintain cleanliness, and in the prevention of water leaks and water intrusion. Any suspected problems will be submitted as a work request for inspection and possible remediation by the appropriate shop. An expanded list of mold problem prevention, control tips, signs of, and cleaning is included as additional pages to this Procedure letter.

**Mold Remediation** steps will include resolving the source and causes of mold as listed in the Mold Preventative Paragraph above and following pages, as well as the containment, identification, and appropriate cleaning requirements. Any mold that is found on a porous surface that will require the material to be removed for mold remediation, will automatically initiate the requirement for an asbestos survey, and possible asbestos abatement prior to any demolition and/or mold remediation.

Any suspected mold inducing problems or mold itself found by, or reported to Physical Plant personnel, will be reported immediately to the next supervisory level for control and interdiction. Physical Plant personnel that are involved in remediation efforts will be issued the appropriate personal equipment, ie. Half face Respirator, gloves, eye goggles, impervious suit, ie.Tyvek (Trademarked), etc, as appropriate.

The following information pertaining to Mold is included to provide more extensive information for Physical Plant Personnel and should be used as a guideline in the prevention, locating, and remediation of Mold found in and around our facilities. This information may not be all inclusive, and any additional items may be addressed through the Environmental Health and Safety Office, and Physical Plant Administration.

**References: Toxic Black Mold Information Center,** Div. of Indoor Health Products, Inc., 887 N. McCormick Way, # 3, Layton, UT 84041; Web Site: http://www.toxic-black-mold-info.com. August 21, 2003.

**MOLD PREVENTION AND CLEANING**

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# Ways to Prevent Mold Problems

**"The only factor that can be controlled is moisture."**

*National Association of Home Builders (NAHB)*
*statement on controlling mold*

**"The way to control indoor mold growth is to control moisture."**

*The U.S. Environmental Protection Agency*

## Why *Proactive* instead of *Reactive*

***Financial Cost***

Once mold infests a facility, it is very expensive to clean up.

***Health Cost***

Mold causes strong allergic reactions in many people. If the mold level is high enough in the home, or if those exposed have vulnerable immune systems (e.g. children, elderly), it can also cause neurological effects.

***Facilities Operations***

Mold infestation can decrease the operational use and capabilities within a facility, negatively impacting the mission of the University. If it has not been cleaned properly, it may not be inhabitable.

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## Mold Prevention & Control Tips

### Controlling Humidity Level (Relative Humidity)

If the humidity level in any part of your home or building **approaches or exceeds 55% Relative Humidity (RH)**, then it needs to be corrected. Toxic molds and other forms of biological contaminates (like dust mites) will thrive and expand in this type of atmosphere.

There are **two elements to controlling humidity levels**:

1. Monitoring Relative Humidity
2. Dehumidification

### Monitoring Relative Humidity

It is absolutely vital to know whether or not you have a humidity problem. Not only do you need to know "if", but you also need to know "where" (which areas or rooms) a humidity problem may exist, since the humidity level will not necessarily be consistent throughout a building.

Otherwise, you will not know if something needs to be done to correct the problem, or where you need to focus your efforts.

To monitor the relative humidity level throughout the building, you will need **relative humidity sensors**, also known as **hygrometers** or **moisture meters**.

***Places where you should monitor Relative Humidity*** *(at least periodically)**:***

- Each of the rooms (especially bathrooms)
- Attic, space between roof and ceiling
- Basements, crawl spaces, cellars
- In wall cavities
- Ductwork, especially closer to air handler (nearby where filter is installed)
- Cabinets
- Closets, food storage areas

## Dehumidification

If you find through monitoring the relative humidity that the building (or certain areas within it) has chronically high relative humidity (55% or more), then you will need to use dehumidifiers. Dehumidifiers will **control the humidity level**, which will help **minimize toxic mold** and other microbiological contaminates.

With dehumidifiers, it is **more effective to use multiple room units**, as opposed to a single large unit that attempts to dehumidify a large area. It is also affordable to include a few **small-area units** for bathrooms, closets, cabinets, etc. Dehumidifiers can reduce the humidity in the room or area where they are placed, but a single unit will not impact the humidity level beyond this area very much, if at all.

Here are **other factors** to consider with **dehumidifiers**:

- Water extraction (measured in pints)
- Automatic tank shut off (when tank is full)
- Air filtration
- Anti-frost sensor
- Efficient air flow
- Water pumped out of room/home
- LCD screen
- Fan speeds
- Energy consumption
- Chassis material
- Lowest temperature at which it can operate
- Noise level

## Preventing Water Leaks / Water Intrusion

Other than just having a high humidity level in the building (due to humid climate), water leaks and other forms of water intrusion into the home or building is the most common reason a toxic black mold problem originates.

**Below are types of water leaks and places where unwanted water can enter the building**, and ways to avoid these types of water intrusion problems.

### Leaking Pipes:

**Condensation** or **rusting** on or around a pipe is a sign of a leak. Covering cold surfaces, such as cold water drainpipes, with insulation helps to prevent condensation.

The most difficult part of preventing leaking pipes is determining whether or not they are leaking in the first place, since they are normally concealed from view.

***Here are some signs to look for:***

1. You can hear running water sounds when nothing is turned on.

2. Musty odors that seem to originate from walls or floors.

3. Running toilets and dripping faucets.

4. Abnormally high water bills.

5. A water meter reading that changes when you aren't using any water for an hour.

6. Discolored or damaged walls.

7. A cracked or damp foundation or slab.

8. Warm spots on concrete slab floors, mildew, or excess moisture under carpets.

9. Regular sewer backups.

10. Areas in the yard that are too wet and with unusual plant or grass growth.

### Foundation:

To prevent water from collecting around the foundation, and seeping up through the walls, make sure the **ground slopes away** from the foundation.

Here are some **additional tips** in preventing water seepage through the foundation:

1. Ensure the floor is well ventilated and walls are properly sealed against moisture entry. Polythene put over damp ground can help prevent dampness rising into the house.

2. Insulate your home properly. In the winter, insulated ceilings, walls and floors have temperatures similar to those of the warmer air inside the home, therefore condensation is less likely to form.

3. Prevent rising damp from entering a foundation wall by improving your home's perimeter drainage. Direct all surface rainwater away from the home through drainpipes, culverts, French drains, etc.

4. If no other methods are feasible, a last resort would be to install either a physical or chemical horizontal damp-proof course.

### Roof:

***1. Ways to Inspect for a Roof Leak.***

A **common cause** of leaks is from **cracked or damaged chimneys**. Look for loose brick, cracked mortar joints, and a solid metal or concrete cap on top.

Look for **water stains on the inside ceiling**, and on the beams in an attic. Beams that have been exposed to water will become weakened and cause a sag in the roof.

Look for any **visible damage** such as cracks, tears, splits. These will most likely lead to leaking.

Closely inspect all **roof penetrations** (i.e. skylights, chimneys, vents, etc). Look for signs that the cement is separating from the surface, especially at a vertical penetration of the roof.

Check areas **where different materials meet** such as metal to brick, shingles to metal, etc. These surfaces expand and contract at varying rates and will pull away from each other. Make sure the seals between materials are tight, not loose.

You can attempt to find a leak from the inside by using a flashlight and tracing the leak uphill.

***2. How to Protect/Maintain the Roof.***

Inspect your roof at least twice a year. Especially proceeding harsh weather conditions and between seasons.

Roofs will weather under the heat/sunlight. It can essentially be “baked” and become dry and brittle (alligatoring), hence it is more likely to split and eventually leak. Metal components of the roof can rust and corrode, and asphalt-based plastic cement used for seals around pipes, vents, and other penetrations may deteriorate over time and leak. You can apply a coating to some roofs to create a layer of waterproof protection.

## Windows:

Condensation on or around the window is the sign of a excessive moisture. If this is happening, use a **sealant** around the window to make sure that it is completely airtight.

## Walls:

Taking measures to **reduce water leakage** through the **roof**, leaky **pipes**, and the **foundation** (see above for each of these), as well as through the **gutters** (below) will go a long way in keeping the walls from collecting too much moisture.

In addition to this, make sure that the **air pressure is not too high** on the **positive side** (see Ventilation tips below). However, you do want the air pressure inside to be slightly positive.

Also, make sure that the **relative humidity level is below 55%** to prevent your walls from taking in too much moisture. Use dehumidifiers if necessary.

## Gutters:

Clogged or faulty rain gutters can cause excessive water leakage through the walls, roof, and foundation of the building. You can **clean the rain gutters** with a light broom, a garden hose with a controllable-spray nozzle, or by using one of many gutter-cleaning devices on the market.

Adding **perforated covers** over your rain gutters will cut down on the frequency of cleaning. Rainwater and some dirt/small debris can permeate the cover but large debris, such as large leaves and twigs, cannot.

Make sure your gutters' **downspouts** are properly cleaned too. Spray water into the gutter or the top of the downspout to ensure it drains freely and with no obstructions. Water must also be diverted away from your home's foundation.

If you don't have a spout going directly into a drain system and toward the street or a drainage basin, use **splash blocks**. These relatively small devices will channel the water from your downspout and away from the facility.

## Basements/Crawl Spaces:

1. Put a **plastic cover** over dirt in **crawlspaces** to prevent moisture from coming in from the ground. Be sure crawlspaces/basements are **well ventilated** with good cross ventilation under the house so air will circulate freely. Make sure all vents are unobstructed and repair any torn vent screens. If you don’t have sufficient vents, add more.

2. Have your basement **waterproofed:**

3. Good building construction practices are used to prevent moisture in a new facility, particularly in the basement:

**Site selection.** The first and perhaps most important step is to select a suitable site. Moisture problems are greatly reduced if a building is built on a site with a high water table.

**Surface drainage.** Landscaping should be graded/sloped to direct rainwater away from the foundation. The grade or slope should be at least six inches over the first ten feet from the foundation wall.

**Damp-proofing.** Provide a damp-proof coating on the below grade portion of the foundation wall. Use a high quality, durable waterproofing. A thin damp-proof coating is vulnerable to damage during construction.

**Floor slab.** The basement floor can be a significant source of moisture. To reduce water absorption, the concrete slab should be poured on top of three to four inches of washed aggregate, with a sheet of polyethylene installed beneath the aggregate. Insulating the floor slab saves energy and improves comfort; it also reduces basement condensation in the summer.

**Drainage system.** An effective exterior drainage system drains bulk water away from the foundation. A channel of coarse rock or drainage tile may be used. The drainage system must be installed on the outside, and near the bottom of the footing

**Foundation wall insulation.** Foundation insulation may be placed on the exterior wall, be an integral part of the wall, or placed on the interior of the foundation wall. Regardless of where the insulation is placed, a moisture barrier is required to reduce outdoor moisture from coming through the foundation wall. In the case of insulation placed on the interior side of the foundation wall, both sides of the insulation must be protected. A moisture barrier is required between the insulation and the wall from floor to grade, and a vapor retarder is required on the interior side of the insulation.

4. To keep water out of crawlspaces, **dig ditches** around the sides of the building down to the footing. Install **gravel and drain lines** that are sloped about 2 inches per 10 feet to carry water away from the house. Direct the water to a natural drainage, to the street, or a French drain. Before backfilling, place waterproof membranes against the foundation wall. Also, ensure water from downspouts is directed away from the house.

## Ductwork / HVAC System

### Sanitize Cooling Coils

Make sure you periodically wipe any biological growth from the coils. Condensation is continually dripping off the coils when the HVAC system is running. This condensation provides a perfect place for mold to grow.

In which case, **disinfectant** should be periodically applied to the coils. You can also use an in-duct ultraviolet (UV) light air purifier, installed near the coil, to destroy mold before it has a change to grow. It will also destroy mold and other microbes that are caught in the filter.

In-duct ultraviolet (UV) light air purifiers are now being **specified by the U.S. government's General Services Administration (GSA)**, to be used in the ductwork (near the cooling coil and drain pan) of all new federal buildings. Their standards document concerning this reads:

"Ultraviolet light (C band) emitters shall be incorporated downstream of all cooling coils and above all drain pans to control airborne and surface microbial growth and transfer."

### Drain Pan

This is where the condensation from the cooling coils drips. If you have a flat drain pan, the stagnant water will become infested with mold growth. In which case, a **sloped drain pan** should be used, so the water runs off to the proper location. You also need to check to make sure that **drain lines** are flowing properly.

In addition, the drain pan should be cleaned with a **disinfectant** on occasion, and should be replaced when **corrosion** becomes significant.

### Filters

Change your HVAC filters on a regular basis. If this is not done, the filter itself can become a **fertile breeding ground** for all the molds and other biological contaminates that are collected. Once this happens, the **spores from the mold will multiply**, and will be **circulated** throughout the home or building through the ductwork.

### Insulation

If you have **insulation lining the interior** of the ductwork, then it should be **removed**, so you are left with bare sheet metal. The fiberglass insulation collects a lot of dirt and dust, which provides a good habitat for mold colonies. Once the mold begins to grow inside the ductwork, the mold spores will be spread throughout the house when the HVAC system is running.

## New Construction

In many cases, mold problems can be avoided or caused during the construction of a building. In which case, you can take precautions during this phase to save yourself mold headaches down the road.

First, **review many of the tips on this page** to make sure that the building is constructed in such a way that as many of these as possible can be put into place.

In addition, **avoid using moldy materials**, ensure that any fake stucco that is used is installed 100% properly, since this is a common cause for mold growth in exterior wall cavities. If you are really adamant about preventing potential mold problems, then you may want to avoid using fake stucco altogether.

## Dirt / Dust Removal

An environment that is "dirty" or "dusty" is far more conducive to mold problems than a clean environment. Dirt, dust, and grime are often composed of **organic material**, which is a staple of the **toxic "black" mold diet**.

Dust also serves as a **means for locomotion** for mold spores, enabling them to spread throughout the home more effectively.

## Ventilation

Proper ventilation can reduce moisture in the facility. Keeping the **air pressure** in the building at a *slightly* higher level than the air pressure outside will help to ensure proper ventilation. Slightly positive air pressure forces moisture and contaminates outside.

If the air pressurization is the other way around (negative), where the air pressure is higher outside, then it **will force moisture and pollutants back into the** building.

**Avoid over-pressurization** though (too much of a positive air pressure), since it will cause moisture to be forced into walls and structural cavities, compounding the moisture level inside, and potentially damaging the building.

In order to achieve a slightly positive air pressure, adjust the supply ventilation slightly higher than the exhaust ventilation.

Also, try to ventilate appliances and bathroom/kitchen fans outside if possible.

## Properly Vent Combustion Appliances

Combustion appliances include space heaters, ranges, ovens, stoves, furnaces, fireplaces, water heaters, and clothes dryers.

Typically these appliances are safe. However, the combustion process always **produces water vapor**, if the appliance is not properly vented, it can lead to increased amounts of moisture in the home and provide an ideal environment for mold growth.

**Examples of properly venting combustion appliances** include equipping ranges with hood fans that are exhausted to the outside, keeping doors open to rooms where these appliances are operating, making sure that the vents are connected and unblocked, and that there are no holes or cracks in the ventilation systems. Finally, make sure that you follow manufacturer instructions when installing and using combustion appliances.

## Shower Curtains

**Replace** shower curtains when mold begins to become visible.

## Air Purification

You may want to use an **air purifier** to minimize the airborne particulate, which allows mold spores to disperse to other areas of the home or building.

**Ionizers** are typically better than air filters, since they can remove smaller particles from the air, and do not rely on particulate passing through them in order to remove them from the air.

# Signs of a Mold Problem

*22 signs that you may have a potential mold problem in your building.*

## 1. High Humidity

If you live in an area with high humidity, then you should always be on the lookout for potential mold problems. Naturally, the outdoor humidity affect indoor humidity levels, creating a **perfect environment for toxic mold growth**.

A **relative humidity (RH) level** of ***greater than 55%*** **promotes the growth of mold** and other fungi. Although relative humidity remains fairly consistent outdoors, it **fluctuates drastically inside** as a result of being altered by the artificial heating and cooling (i.e. climate control by the HVAC system).

In which case, it is critical to closely monitor the relative humidity level in various parts of your home or building, since **relative humidity** can also **vary from room to room**.

In addition to using humidity sensors to monitor the moisture level, you can also run dehumidifiers and employ other products and methods to control humidity in the home or building.

## 2. Water/Pipe Leaks

Mold needs moisture in order to grow and thrive. Many mold problems originate as a result of some kind of water intrusion, especially those that are not resolved quickly. In which case, water and pipe leaks are common culprits, since they provide plenty of moisture, and are **often undetected** for days, months, or even years if minor enough.

When leaks are discovered, appropriate **steps are not normally taken** to minimize potential mold growth problems

By the time they are discovered, it is often too late, since the mold will have had ample opportunity to grow in the same **hard-to-find places** where water leaks occur, such as in wall cavities.

## 3. Flooding

Mold problems are very common after flooding for obvious reasons (plenty of moisture which is conducive for mold growth). Plus, it usually requires several days or weeks to fully dry out the building once flooding occurs, giving colonies of black mold more than adequate time to become fully ingrained in these sections.

## 4. Mildewy/Musty Odors

Odors can often be the **first or only sign** of a potential mold problem, since mold commonly propagates in places not normally in view. This does not necessarily mean that you definitely have a mold problem, but it should prompt you to **look for the other signs**, or to look for the mold growth itself.

In some cases, mildewy smells will only be evident when the air conditioning or heat is turned on, or it may just be **much more evident when the HVAC system** is running. If this is the case, then it is very possible that you have significant mold growth within the HVAC system.

## 5. Increased Allergy/Respiratory Symptoms

If one or more people working in a building (especially if it is an unusually high percentage of occupants) begin suffering allergic reactions that **seem to be associated with the building**, then it could be due to the presence of high levels of mold, especially if other signs are also present.

## 6. Signs of Toxic Poisoning

Toxic black mold and other fungi produce **Volatile Organic Compounds (VOCs)** during the process of degrading substances to obtain nutrition. The VOCs are the cause of the typical “moldy/musty” commonly associated with fungal contamination indoors. Exposure to high levels of VOCs may irritate the mucous membranes and the central nervous system leading to symptoms of **headaches**, **decreased attention span**, **difficulty in concentration**, and **dizziness**.

## 7. Leaky Roof

Like other types of water leaks, water intrusion through the roof is difficult to find until it is too late. If you suspect a leaky roof, **check in the attic** for signs of water damage or mold growth. Also be on the lookout for signs of water damage or mold growth in **ceilings** on the **uppermost floor** of the building.

## 8. Use of Humidifiers without Relative Humidity Control

Using humidifiers can easily **raise the moisture level** in the air to the point where **mold is able to grow** at a rapid rate. When using a humidifier, the key is to regulate the relative humidity level, to ensure it **stays within 55-60% RH**.

This can be accomplished with a relative humidity sensor. However, if you are using a humidifier, it is best to have one that can be **programmed to automatically shut off when relative humidity reaches 60%.**

## 9. Damp Basements or Crawl Spaces

Basements and crawl spaces tend to receive **less ventilation** (especially crawl spaces), while also seeing **cooler temperatures**. With all things being equal, cooler temperatures will lead to a **higher relative humidity** percentage, since cooler air is able to hold less water before **condensation** occurs. Of course condensation means moisture.

In addition to all of this, basements and crawl spaces are more likely to be **neglected** than other parts of the home, so mold can grow undeterred for a longer period of time.

Also, **water from leaks** in the home will eventually **make its way down** to the lowest areas, thanks to gravity.

## 10. Condensation or Rusting

Condensation on or around pipes, windows, or walls is a sign of a leak or high humidity. Rusting on pipes in particular, and anything else metal, is also a sign of a high humidity problem or nearby leak.

## 11. Lots of House Plants

House plants **require consistent watering**, which increases moisture levels inside.

## 12. Discoloration of Walls (Water Stains)

**Yellowish stains** on walls and ceilings are a sign of excessive moisture. In more obvious cases, where mold growth may already be in full swing, the wall or ceiling may have a **greenish**, **brownish**, or **blackish** discoloration to it.

You may also notice places where the paint is coming off due to moisture, or where it is "bowing" out.

One way to check for mold growth is to move a medical grade, flourescent tube (**"black light"**) around walls, ceilings, and even carpets while it is dark. A **yellow glow** is a sign of **mold growth**.

## 13. Cracked, Peeling Paint

This usually means that there is moisture build up behind the paint. By the time the paint shows these signs, the moisture has often had an opportunity to spawn the growth of mold within the wall.

## 14. Blocked Gutters

Gutters that are blocked can cause water to seep into walls, through the roof, and can cause water to collect at the base of the foundation, which will result in further water damage in the building.

## 15. Warped Wood

Naturally, moisture is going to cause wood to warp. If wooden materials in your building have been infiltrated by enough water to actually warp, then sufficient levels of moisture are probably present to accelerate mold growth.

## 16. Black Growth in Bathroom Tiles

Bathrooms are a favorite breeding ground of mold. The **increased moisture** and common presence of **tile** in bathrooms are each highly conducive to the proliferation of mold colonies.

**Tile grout** is **porous** and will allow **water penetration**, and behind the tiles themselves. In addition, **dirt and other grime** (favorite foods of mold) are **easily trapped** in the grout. This combination creates an ideal environment for mold to thrive.

Even if some type of sealant is applied, tiles expand and contract, and pieces of grout will eventually break off, compromising the seal. (**preventing mold growth in tiles/bathroom**)

## 17. Loosening of Drywall Tape

This is a sure sign that moisture has infiltrated the wall.

## 18. Visible Biological/Mold Growth

This may seem like an obvious sign, but many people do not take a little visible mold growth very seriously. However, this can be an indication of a much larger mold growth in less visible places.

Mold can take on a **variety of appearances**, such as black, grey-brown, grey-green, white & orange spots, or even pink or purple splotches if growing behind vinyl wallpaper. Stachybotrys is commonly a dark, slimy, greenish-black mold.

Some of the more **common locations** where mold is found inside includes in bathroom tile, basements/crawl spaces, and other damp and/or dark areas.

## 19. Clothes Dryers/Other Appliances Not Vented Outdoors

If the steam from these types of appliances is vented inside, then this significant amount of additional moisture creates a great environment for mold to flourish.

## 20. Poor Ventilation

If the air pressure in your home is "negative", meaning the air pressure outside is greater than it is inside, then it will force moisture and contaminates back into the home. If the air pressure is well into the "positive" side, then it can cause moisture to be forced into walls. The air pressure in your home should be slightly positive, or at least balanced.

## 21. Presence of Wet Materials Indoors

This can include rags, steam from cooking, indoor clothes lines, carpet, or furniture. If these or other items are damp for extended periods of time, then the moisture level can be high enough to accommodate mold growth.

## 22. Mold Test

There are a variety of sampling techniques that can be used to help determine whether or not you have excessive levels of mold. There are mold tests that take **samples from the air**, and some that take **samples from surfaces**. Each method has its advantages and disadvantages.

Mold tests **by themselves cannot give you the full picture**, but when combined with other evaluation methods (such as those listed on this page) you can better determine the extent of the problem.

Since they can be expensive, and **usually tell you only what you already know**, it is usually best to find the source of excessive moisture and to try fixing it before resorting to a mold test.

Some techniques identify what species of molds are present. This can be helpful since some mold species pose a greater health risk than others.

All in all, you are generally better off tracking relative humidity, since a relative humidity level of 55% or greater usually means that you will have indoor mold growth

### *What's Next?*

If the signs point to a mold problem, then the next step is to find the mold growth, so it can be cleaned and removed.

You should also start employing methods to prevent further mold growth (prevent it as much as humanly possible anyway).

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# How to Clean Up a Mold Problem

## Steps to Mold Clean-Up

### 1. Resolve Moisture Problem

**Most importantly**, the source of the water accumulation must be identified and fixed or fungal growth will continue to occur. If you have a high relative humidity in a room or area (55% or higher), then you should strongly consider a dehumidifier. To determine the relative humidity, you will need a relative humidity sensor, also known as a moisture meter or hygrometer.

If you experienced severe flooding or a water leak, then you want to remove or pump out the standing water, followed by drying the area. If the area is really wet, you will want to use **fans** and **dehumidifiers.** You may also want to move wet items **away from walls** and **off floors**.

The quicker you address the problem, the less extensive the damage will be since it may only take 24-48 hours for toxic mold to germinate and grow. Prompt remediation of contaminated areas and materials should be the primary response to water intrusion and indoor fungal growth.

### 2. Minimize Dust and Seal Off Area (Negative Pressure)

Before you begin cleaning and removing the mold, it is critical to make sure that you take measures to **prevent the mold spores from spreading** to other areas of the building. Since mold spores will likely be stirred, becoming airborne during the cleaning process, you need to properly contain each area being cleaned, while also minimizing dust (a primary means of transportation for mold spores).

#### *Containment:*

**Each room or area** should be **cleaned separately, one at a time**. Before cleaning each room or area, you should seal it off as best as you can. This will **prevent the mold from disseminating** to other areas of the building while it is being cleaned, since cleaning can disturb and stir up the mold, causing mold spores to become airborne.

Once they become **airborne**, they can **spread to other areas** to germinate and colonize, unless the **area being cleaned** is **properly sealed**.

**Properly sealing** (or **containment**) of a room or area **consists of** using plastic sheeting sealed with duct tape to cover doorways, vents, and other openings to occupied areas of the building.

If possible, you should place an **exhaust fan** next to an open (or partially open) door or window that is open to the outdoors. This will create **negative air pressure**, which will direct air flow outside, and therefore mold spores that have been stirred during cleaning will also be **channeled outside**. Just make sure the door or window is not near an air exchange that brings outdoor air into the home.

You should also **turn off the HVAC system** before cleaning mold.

#### *Minimizing Dust:*

Maintain dust levels as low as possible during cleaning to prevent spores from becoming airborne and spread to other areas. This will reduce the risk of exposure for those who are cleaning while reducing the potential for the mold spores landing and germinating in other parts of the home or building.

You may want to use an **air purifier** to minimize the airborne particulate, which allows mold spores to disperse to other areas of the home or building.

**Ionizers** are typically better than air filters, since they can remove smaller particles from the air, and do not rely on particulate passing through them in order to remove them from the air.

## 3. Cleaning the Mold

If the surface(s) you are cleaning are dry, or mostly dry, you should **lightly mist** them **with water** before cleaning the mold. If the mold is too dry, then the mold spores will have a much better chance of becoming airborne while being disturbed during the cleaning process.

Once the surface is lightly misted (if necessary), then **clean** the affected area(s) with **soap** to remove as much of the mold as possible, and then **apply a disinfectant to kill mold spores** that are left behind. Thoroughly clean all surfaces in the area that contain visible mold, and even surfaces that do not have visible mold, since **mold spores are microscopic very durable**, and can remain dormant for months or even years.

Once a surface has been cleaned and disinfected, it should be completely **dried**.

In which case, if mold spores are left behind, and are **introduced to moisture again** in the future, then you will have another significant mold growth problem on your hands.

**Non-porous material** such as metals, glass, hard plastics, and semi-porous materials include wood, concrete, etc, that are structurally sound with some visible mold growth may be cleaned and reused.

If the contamination is not too severe, **porous material** may be cleaned and reused. If the damage is extensive and the mold growth has **visibly destroyed** porous items beyond repair, they may need to be removed and replaced. Examples of porous materials are ceiling tiles, insulation, wallboards, carpet, soft furnishings, clothes, papers/books, etc.

All material that has been cleaned should be completely dry and visibly free of mold before it is reused and before sensitive individuals are exposed to it.

## 4. Remove the Mold

Carefully **remove and discard** mold and mold-infested materials into **heavy-duty plastic bags**. Do not transport the bags throughout the building, especially other clean areas. Doing so will risk further spreading and regerminating of the mold.

Instead, it is a good idea to get the bags outside **through a window** or **other opening** accessible to the room/area being cleaned, if possible. These bags with the mold-contaminated materials can be taken to any **landfill**.

## 5. Verifying the Mold Clean-Up Job was Successful

1. First and most importantly, you must have completely fixed the moisture problem to rid the home of excess water.

2. Mold removal should be complete. If this step is completed properly, there should not be any visible mold and musty/mildewy odors present (mold may cause staining and cosmetic damage).

3. There should not be any more signs of additional moisture/water damage or any recurring mold growth in the area. If either of these problems resurface, there may be an underlying or hidden problem and a more extensive investigation of the building is necessary.

4. Physical symptoms of the occupants should be greatly reduced and even ceased.

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## Protecting Your Health During Mold Clean-Up

Exposure to molds can occur during clean-up procedures since mold counts can be extremely high in the contaminated area. However, there are ways you can **minimize your exposure** to mold during clean-up procedures. It is **not recommended for those who may be at increased risk for experiencing adverse health effects** to perform the clean-up procedures or be in or around the area during clean-up, such as those with any kind of lung or allergy-related health conditions (like asthma or allergies).

Also, if the mold growth is extremely severe, you may need a professional to remediate the problem. If you do require a **professional mold remediation contractor**, make sure they are certified, and have multiple references you can check to validate the quality of their work.

## 1. Wear Respirator

Wear a medium-efficiency or high-efficiency filter dust mask or respirator with HEPA filter to protect against the inhalation of mold spores. For the best protection, choose a respirator designed for particle removal such as the model **N95** or **TC-21C particle respirator**.

## 2. Clothing

Wear protective clothing that is **easily removed**, **cleaned**, and that **covers all areas of the body** to prevent against any dermal (skin) exposure. You may even want to choose a protective outer layer that can be discarded such as a Tyvek suit. Other personal protective equipment that should worn are **rubber gloves** and **eye goggles**.

## 3. Evacuate

Ask any family members or houseguests to leave the area during clean-up, **if they are not part of the clean-up process**. Especially if they are in a high risk group for experiencing adverse health effects from the exposure to mold.

## 4. Work in Short Intervals

If the damage is extensive and requires many hours of cleanup, work over short time periods and rest in a fresh air location.

## 5. Moldy Materials

Enclose all moldy materials in sealed, plastic bags before carrying them away.

## 6. Seal Off Area

Hang plastic sheeting to separate the work area from the rest of the home. Also, use plastic to seal off ducts in the area where you are working, to prevent spores from traveling through the ductwork into other parts of the home or building.

## 7. Containment

Remove the outer layer of work clothing inside the work area, and wash it separately or bag it for disposal.

## 8. Air Out / Dry

Air the area out well after cleaning is finished. It may be helpful to use fans and dehumidifiers.

## 9. Air Purification

Using an air purifier will reduce the spores in the air that can be inhaled, or carried to other parts of the home or building to regerminate.

**Ionizers** are typically better than air filters, since they can remove smaller particles from the air, and do not rely on particulate passing through them in order to remove them from the air.

# Review of Mold Disinfectants

**1. Alcohols (ethanol, isopropanol):**

Bactericidal, Virucidal, Fungicidal. Use a diluted concentration of 60 to 90%.
***Advantages*** **-** nonstaining and nonirritating
***Disadvantages*** **-** inactivated by organic matter, highly flammable

**2. Quarternary Ammonium Compounds:**

Bactericidal and Virucidal with limited effectiveness, Fungicidal. Use a diluted concentration of 0.4 to 1.6%.
***Advantages*** **-** inexpensive
***Disadvantages*** **-** inactivated by organic matter, limited efficacy

**3. Phenolics:**

Bactericidal, Virucidal, Fungicidal. Use a diluted concentration of 0.4 to 0.5%.
***Advantages*** **-** inexpensive, residual
***Disadvantages*** **-** toxic, irritating, and corrosive

**4. Iodophors:**

Bactericidal, Virucidal, Fungicidal, Sporicidal and Tuberculocidal if contact time is for a prolonged period of time. Use a concentration of 75 ppm.
***Advantages*** **-** stable, residual action
***Disadvantages*** **-** inactivated by organic matter, expensive

**5. Glutaraldehydes:**

Bactericidal, Virucidal, Fungicidal, Sporicidal (prolonged contact time required), and Tuberculocidal. Use a diluted concentration of 2%.
***Advantages*** **-** unaffected by organics, noncorrosive
***Disadvantages*** **-** irritating/damaging vapors, highly toxic, expensive

**6. Hypochlorites (Chlorox Bleach):**

Bactericidal, Virucidal, Fungicidal, Sporicidal (prolonged contact time required), and Tuberculocidal. Use a diluted concentartion of 1:10 .

***Advantages*** **-** inexpensive
***Disadvantages*** **-** bleaching agent, toxic, corrosive, inactivated by organic matter; removes color from many interior fabrics; dissolves protein fibers (i.e. wool, silk); has not shown to be effective against stachybotrys spores.

**7. Hydrogen Peroxide:**

Bactericidal, Virucidal, Fungicidal, Sporicidal (prolonged contact time required), and Tuberculocidal. Use a diluted concentration of 3% or greater.
***Advantages*** **-** Relatively stable
***Disadvantages*** **-** corrosive, expensive, degrades in heat or UV light

## Cleaning Mold in the HVAC System

For the most part, the same cleaning procedures listed above apply to cleaning the HVAC system. Here are some additional things to remember though:

1. Clean the cooling coil (using same procedures listed above). If there is any rusting, then it should be replaced.

2. Clean the drain pan (using the same procedures listed above). If there is any rusting, then it should be replaced.

3. Remove and properly dispose of any interior insulation (insulation inside the ductwork).

4. Replace the filter, preferably with a HEPA filter.

5. Have the ducts professional cleaned only if they are very dirty. Make sure your duct cleaning professional does not allow the dirt and dust from the ducts to enter into the rest of the home or building.

## Common Species of Mold

**Note:** Different mold species can have varying health effects, but it is important to remember that any excessive mold growth needs to be taken care of, regardless of the species. Any excessive mold growth can lead to increased allergies, toxicity, and house/building structural problems.

## *Aspergillus spp*

*Aspergillus* is the most common genus of fungi in our environment with more than 160 different species of mold. Sixteen of these species have been documented as causing human disease. Aspergillosis is now the **2nd most common fungal infection requiring hospitalization** in the United States .

***Aspergillus fumigatus.*** The most encountered species causing infection. It is seen abundantly in decomposing organic material, such as self-heating compost piles, since it readily grows at temperatures up to 55 C. People who handle contaminated material often develop hypersensitivity to the spores of *Aspergillus* and may suffer severe allergic reactions upon exposure.

***Aspergillus flavus.*** The 2nd most encountered fungi in cases of *Aspergillus* infection. It is also known to produce the mycotoxin aflatoxin, one of the most potent carcinogens known to man. In the 1960s, 100,000 turkey poults in Great Britain died from ingesting contaminated feed. Most countries have established levels for aflatoxin in food. However, the risks associated with airborne exposure are not adequately studied and no exposure standards exist.

***Aspergillus niger.*** The 3rd most common *Aspergillus* fungi associated with disease and the most common of any *Aspergillus* species in nature due to it's ability to grow on a wide variety of substrates. This species may cause a "fungal ball", which is a condition where the fungus actively proliferates in the human lung, forming a ball. It does so without invading the lung tissue.

## *Stachybotrys chartarum (atra)*

This group of molds can thrive on water damaged, cellulose-rich material in buildings such as sheet rock, paper, ceiling tiles, insulation backing, wallpaper, etc. In the majority of cases where *Stachybotrys* is found indoors, water damage has gone unnoticed or ignored since it requires extended periods of time with increased levels of moisture for growth to occur. Stachybotrys is usually black and slimy in appearance. Events of water intrusion that are addressed quickly tends to support the growth of more xerophilic fungi such as *Pencillium* and *Aspergillus*.

*Stachybotrys* is another fungi that has the ability to produce mycotoxins, ones that are extremely toxic, suspected carcinogens, and immunosuppressive. Exposure to these mycotoxins can result through inhalation, ingestion, and dermal exposure. Symptoms of exposure include dermatitis, cough, rhinitis, nose bleeds, cold and flu-like symptoms, headache, general malaise, and fever.

## *Cladosporium spp.*

These genera of mold are pigmented dark green to black in the front, and black on the reverse with a velvety to powdery texture. One of the most commonly isolated from indoor and outdoor air, *Cladosporium spp.* are found on decaying plants, woody plants, food, straw, soil, paint, textiles, and the surface of fiberglass duct liner in the interior of supply ducts.

There are over 30 species in the *Cladosporium* genus. The most common are *C. elatum, C. herbarum, C. sphaerospermum,* and *C. cladosporioides.* These fungi are the causative agents of skin lesions, keratitis, nail fungus, sinusitis, asthma, and pulmonary infections. Acute symptoms of exposure to *Cladosporium* are edema and bronchiospasms, and chronic exposure may lead to pulmonary emphysema.

## *Fusarium spp.*

A common soil fungus and inhabitant on a wide array of plants, this fungi is often found in humidifiers and has been isolated from water-damaged carpets and a variety of other building materials. Human exposure may occur through ingestion of contaminated grains and possibly through the inhalation of spores. *Fusarium spp.* are frequently involved with eye, skin, and nail infections. More severely it can produce hemorrhagic syndrome (alimentary toxic aleukia) in humans which is characterized by nausea, vomiting, diarrhea, dermatitis, and extensive internal bleeding.

Several species can produce the trichothecene toxins which target the circulatory, alimentary, skin, and nervous systems. Vomitoxin is one such tricothecene mycotoxin that has been associated with outbreaks of acute gastrointestinal illness in humans. Zearalenone is another mycotoxin produced by *Fusarium.* It is similar in structure to the female sex hormone estrogen and targets the reproductive organs.

## *Penicillium spp.*

These fungi are commonly found in soil, food, cellulose, grains, paint, carpet, wallpaper, interior fiberglass duct insulation, and decaying vegetation. *Penicillium* may cause hypersensitivity pneumonitis, asthma, and allergic alveolitis in susceptible individuals.

The genus Penicillium has several species. The most common ones include Penicillium chrysogenum, Penicillium citrinum, Penicillium janthinellum, Penicillium marneffei, and Penicillium purpurogenum.

This fungi has been isolated from patients with keratitis, ear infections, pneumonia, endocarditis, peritonitis, and urinary tract infections. Penicillium infections are most commonly exhibited in immunosuppressed individuals. For example, P. marneffei is a fungus abundant in Southeast Asia that typically infects patients with AIDS in this area. Infection with P.marneffei is acquired via inhalation and initially results in a pulmonary infection and then spreads to other areas of the body (lymphatic system, liver, spleen, and bones), and is often fatal. An indication of infection is the appearance of papules that resemble acne on the face, trunk, and extremities.

Penicillim spp. do have the ability to produce mycotoxins. The mycotoxin known as Ochratoxin A, which is nephrotoxic and carcinogenic, may be produced by Penicillium verrucosum. Verrucosidin is another mycotoxin produced by this fungus that exhibits neurotoxity. Penicillic acid is another mycotoxin that is nephrotoxic (causes kidney and liver damage).

## *Mycotoxins*

During the digestion of substrates, fungi secrete enzymes into nutrients in order to break down complex compounds into simpler compounds that can be taken up by the fungi and used as nutrition. These digested nutrients produce secondary metabolic byproducts called mycotoxins that are released to give the fungi a competitive edge over other microorganisms and fungi. Unfortunately, mycotoxins can also be incredibly toxic to humans causing a variety of responses including cold/flu-like symptoms, sore throats, headaches, nose bleeds, fatigue, diarrhea, dermatitis, and immune suppression. Some mycotoxins may also be carcinogenic and teratogenic. Molds that have been known to potentially produce these toxins are *Acremonium, Alternaria, Aspergillus, Chaetomium, Cladosporium, Fusarium, Penicillium,* and *Stachybotrys.*

Even though these molds may potentially produce mycotoxins, they will not do so unless specific environmental conditions exist. Currently, it is unknown exactly what conditions promote the growth of mycotoxin production and more scientific research needs to be conducted on this topic for it to be fully understood.

***Types of Mycotoxins***

**Aflatoxin**. This mycotoxin is primarily produced by *Aspergillus species.* It is one of the most potent carcinogens known to man and has been linked to a wide array of human health problems. The FDA has established a maximum allowable level of total aflatoxin in food commodities of 20 parts per billion (ppb) and the maximum level for aflatoxin in milk products is 0.5 ppb.

**Ochratoxin**. This mycotoxin is primarily produced by species of *Penicillium* and *Aspergillus*. It can be damaging to the kidneys / liver, and it is a suspected carcinogen. There is also evidence supporting it's role in impairing immune system function.

**Tricothecene.** The toxin is produced by *Stachybotrys spp*. and *Fusarium spp* and has even been indicated as a potential agent for use as a biological weapon. One of the more deadly mycotoxins, if it is ingested in large amounts it can severely damage the entire digestive tract and cause rapid death due to internal hemorrhaging. It has also been implicated in human disease such as infant pulmonary hemosiderosis.

# Mold Test Kit Review

## Note on Mold Testing:

Mold tests **by themselves cannot give you the full picture** of the mold problem in your house or building. When combined with other evaluation methods you can better determine the extent of the problem.

Since they can be expensive, and **usually tell you only what you already know**, it is usually best to find the source of excessive moisture and to try fixing it before resorting to a mold test.

Some techniques identify what species of molds are present. This can be helpful since some mold species pose a greater health risk than others.

## Air vs. Surface Sampling Techniques

Mold tests can be divided into two categories: air and surface. If you find it necessary to perform a mold test (e.g. for legal purposes), then it would be advisable to take at least one surface sample and one air sample.

The reason is, in some situations, you may have mold growing on surface, yet it has not reached a point where it is releasing very many mold spores into the air. In which case, air sampling alone would provide results that did not accurately portray the extent of mold growth.

Or, you may have a situation where, in your random surface sampling, you did not sample a surface where mold was growing (or at least not at a significant level), but mold colonies throughout other parts of the home had reached a point where they were releasing substantial amounts of mold spores into the air. In this case, your surface sampling would not give you and accurate picture of the problem.

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## Reviews of Various Mold Tests

**Anderson N-6 Bioaerosol Sampler:**

This is a single stage petri plate impacter that consists of an aluminum device held together by 3 spring clamps and is sealed with O-ring gaskets. A high volume of air is drawn through the sampler causing multiple jets of air to direct airborne particles toward the surface of the agar collection plate. This will lead to biological growth if any microorganisms are present in the air that is sampled. A short collection period (3-5 minutes @ 28.3 lpm) should be used to prevent the plates from being overgrown by microorganisms. The sampler should be disinfected with isopropyl alcohol between each use and you don not want to use media that's expired, has visible cracks, or possible contamination.
***Pros:*** Results relate directly to airborne exposures; qualitative and quantitative results; it is possible to speciate; specific organisms can be targeted since various types of media are available; results can be compared to bulk, tape, or swab results in order to find amplification sites.
***Cons:*** Expensive; time consuming for sampling and analysis; only isolates viable (living) organisms; some fungi may overgrow others leading to an unclear picture about what is present; media has a short shelf-life; and the samples are perishable if not handled properly and carefully.

**Spore Trap:**

This indoor air quality sampler is a particulate sampling cassette, Zefon Air-O-Cell Cassette, designed for rapid collection and analysis of a wide range of airborne aerosols including mold spores, pollen, insect parts and skin fragments. These types of samples are used to detect for total spore counts. It is useful for rapid analysis of airborne contaminants in IAQ testing, allergy testing and flood restoration monitoring.
***Pros:*** Media is easy to store and has a long-shelf life; results are semi-quantitative and relates directly to airborne exposure; rapid analysis of results.
***Cons:*** Differentiation between viable and non-viable organisms is difficult; can't sample for bacteria; there is large lab to lab variation in analysis of results; and cannot speciate.

**Bulk/Surface Samples:**

These types of sample are applicable when there is visible contamination of building materials such as drywall, flooring, insulation, wood, etc. Materials are collected then sent directly to a lab for microbial identification. Bulk/ surface sampling is useful in verification of remediation.
***Pros:*** Inexpensive; rapid spore count identification; can be quantitative; able to differentiate between viable and non-viable microorganisms; possible to culture and then speciate.
***Cons:*** Destructive of building materials; may expose occupants during collection; results do not relate directly to airborne exposures; may not be the source of contamination.

**Wallchecks:**

Wallchecks evaluate concealed spaces without being destructive.
***Pros:*** Results are qualitative and quantitative; media is easy to store and has a long shelf-life, results relate directly to spacial contamination and to the contamination of the air behind the wall, cabinet space, etc; rapid analysis of results.
***Cons:*** Differentiation between viable and non-viable is difficult; cannot collect samples for bacteria; lab to lab variation in results is great; cannot speciate; the lack of dilution ventilation may cause high levels for results that are not representative of the problem.

**Swab/Tape Sampling for Building Surfaces:**

A swab sample is collected with a sterile cotton "Q-tip" applicator that has been moistened with sterile growth media. The area to be swabbed should be performed by a person wearing sterile latex, surgical gloves and the cotton head of the applicator is

broken off into the growth solution vial. The vial and swabbed applicator sent to a lab for plate culturing and counting.
***Pros:*** Inexpensive; non-destructive; rapid analysis for spore counts; results can be quantitative and cultured for speciation; sampling can be performed on irregular surfaces.
***Cons:*** Results do not relate directly to airborne exposures; fungal structures may be damaged during collection causing identification of the mold to be less accurate; spores may germinate before lab analysis; may miss presence of organisms in porous materials; and sample collection does not work well on dry surfaces.

**The ProLab Mold Test Kit:**

Offers three (3) different types of sampling methods, depending on your application needs:

*Method 1:* taking a sample from a visual growth area. The same as bulk/surface sampling (covered above).

*Method 2:* taking a 10 minute grab air sample of the HVAC system. This is done by placing a petri dish over a register, closing all other registers, and turning the HVAC system fan on and sampling for 10 minutes. Close the plate up and allow it to incubate for a couple of days.

*Method 3:* taking an air sample using a settling plate technique. This is simply done by placing an open petri dish somewhere in a room for like an hour, closing it up, and allowing the plate to incubate for a couple of days.

***Pros:*** Results may relate to airborne exposures; qualitative results; it is possible to speciate; results can be compared to bulk, tape, or swab results in order to find amplification sites: Methods 2 & 3 are beneficial for finding mold in the HVAC system.

***Cons:*** Time consuming for analysis; only isolates viable (living) organisms; some fungi may overgrow others leading to an unclear picture about what is present; and the samples are perishable if not handled properly and carefully; would not be quantitative since it does not employ using a specified flow rate, therefore you cannot calculate a quantity in a sample of air.

## Health Risks from "Toxic" Mold

Molds (sometimes referred to as black molds, even though mold can come in a variety of colors) can cause a wide array of adverse responses in humans depending on the type and quantity that is present. However, these are not the lone factors when considering the health affects to mold exposure. Since dose and human response can be highly individualistic, the sensitivity of the person exposed is also an important consideration. For example, infants and young children, the immune-compromised, and the elderly are at an increased risk of experiencing adverse health effects related to mold exposure.

There are many routes of exposure to molds including dermal contact, ingestion, and inhalation. The health risks associated with mold exposure include, but are not limited to: allergic reactions, irritation associated with volatile organic compounds (VOCs), invasive disease, mycotoxicosis.

### Allergy

Allergic reactions are elicited when a substance such as mold that is not harmful in itself causes an immune response in susceptible individuals. The most common symptoms of an allergic response to increased levels of mold range from runny noses, itchy-watery eyes, coughing, sneezing, and throat irritation to more severe symptoms caused by chronic conditions such as sinusitis and asthma.

### Irritation

Fungi produce Volatile Organic Compounds during the process of degrading substances to obtain nutrition. The VOCs are the cause of the typical “moldy/musty” commonly associated with fungal contamination indoors. Exposure to high levels of VOCs may irritate the mucous membranes and the central nervous system leading to symptoms of headaches, decreased attention span, difficulty in concentration, and dizziness.

### Invasive Disease

This type of disease is uncommon. It is an opportunistic infection caused by exposure to microorganisms that don’t normally produce disease in healthy individuals, but affects those persons with abnormally functioning immune systems. For example, those with HIV/AIDS or those receiving immunosuppressive drugs such as transplant or chemotherapy patients. Some common fungi that have been associated with invasive disease are *Aspergillus*, *Cladosporium*, *Mucor*, and *Rhizopus*.