Environmental Quality TFS Supplement

MOLD and MOISTURE BACKGROUNDER

Introduction

Indoor moisture problems occur in all climates throughout the United States and Canada. Common symptoms are mold, mildew and condensation. Molds (also known as fungi) are simple, microscopic organisms, found virtually everywhere, indoors and outdoors. To grow, molds require availability of moisture, a suitable temperature range, and a food source (such as leaves, wood, paper, and other building materials). Since many molds flourish in common building materials and at temperatures that humans find comfortable, moisture control is usually the most feasible option for limiting mold growth. Mold reproduction may occur through dispersal of mold spores which are very tiny and lightweight, allowing them to travel through the air. Mold growth can often be seen in the form of discoloration, ranging in color from white to orange and from green to brown to black.

Health Effects

Although it is common to find mold spores and other mold debris in indoor air, exposure to mold is not healthy for anyone inside buildings. Mold inside schools becomes a concern when the contamination is extensive. When airborne mold particles and spores are present in large numbers and are inhaled, they can cause allergic reactions, asthma episodes, infections, and other respiratory problems. People can also be exposed to mold through skin contact and eating.

Allergic reactions may be the most common health problem of mold exposure. Typical symptoms (alone or in combination) reported by people exposed to mold include:

- ❷ Respiratory problems
- ❷ Nasal and sinus congestion
- ❷ Dry, hacking cough
- ❷ Wheezing, and difficulty in breathing
- ❷ Sore throat
- ❷ Shortness of breath
- ❷ Eyes - burning, watery, reddened, blurry vision, light sensitivity
- ❷ Skin irritation
- ❷ Central nervous system problems (constant headaches, memory problems, mood changes)

Certain molds also produce toxins, called mycotoxins, that the mold produces to inhibit or prevent the growth of other organisms. Exposure to mycotoxins may present a greater hazard to occupants than that of allergenic or irritative molds. Mycotoxins and allergens are found in both living and dead mold materials, including spores. Therefore, moldy materials need to be removed, even after they are killed with cleaning solutions.

For some people, a relatively small mold exposure can cause health problems. For other people, it may take much more. The following individuals appear to be at higher risk for adverse health effects of molds:

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

Therefore, it is important to quickly identify and correct any moisture sources before mold and health problems develop.

Mold can also ruin carpet, furnishings, and finish materials, and cause structural damage to

a building by destroying the load carrying properties of wood. In addition, when wood goes through periods of wetting then drying, the wood can eventually warp and cause

walls/ceilings/floors to crack or become structurally weak.

Detection Of Mold

If you can see mold, or if there is an earthy or musty odor, you can assume that you have a mold problem. Allergic individuals may have the symptoms listed above. Look for areas of the building where water damage is likely, especially roofs, exterior walls, foundations, cooling equipment, and water pipes. Visible mold growth often is found underneath materials where water has damaged surfaces or behind walls. Look for discoloration and leaching from plaster. The basic rule is, "if you can see it or smell it" take steps to eliminate the excess moisture and to clean-up and remove the mold.

Testing is not recommended as the first step to determine if you have a mold problem. If a preliminary visual inspection doesn't reveal the problem, a thorough biological characterization by sampling in a space may be necessary. Sampling may also be necessary to demonstrate proper containment and the effectiveness of decontamination (clearance measurements). However, sampling, analysis, and interpretation are complex and costly. Airborne mold assessment requires sampling equipment not available to the general public. Standard assessment methods will vary depending on the type of material sampled. Refer to "Bioaerosols: Assessment and Control" from the American Conference of Governmental Industrial Hygienists (ACGIH) for more information.

SOLVING MOISTURE AND MOLD PROBLEMS

Unless the source of moisture is removed and the contaminated area is cleaned and sanitized, mold growth will reoccur. A procedure for dealing with an existing mold and moisture problem is outlined here:

1. Identify the causes of the moisture and mold problem, and the extent of the mold contamination
2. Develop a clean-up plan, to include:
   - Clean-up containment protocols
   - Worker protection protocols
   - Long-term moisture control solutions
3. Dry/Discard/Decontaminate
   - Dry the affected areas
   - Discard materials that are not worth saving
   - Decontaminate materials that can be saved
4. Implement repairs and program changes to prevent a recurrence

Understanding and Identifying Moisture Problems

Because mold growth is so dependent on a source of moisture, it is important to be able to understand and identify how moisture can enter and accumulate in buildings. In addition to causing mold growth, excess moisture can attract pests such as cockroaches and rodents, while humidity levels greater than 60% can foster mold growth, and levels greater than 50% can encourage dust mite proliferation.

Moisture problems are often identified by the appearance of visible dampness, stains, chalking on masonry materials, fogging and condensation on windows, sagging ceiling tiles, the sensations of moisture and odors, or measurements of elevated relative humidity levels. However, because many wetted areas may not be visible or apparent until considerable damage has occurred, it is advisable to conduct routine inspections of building and listen to staff complaints.

Liquid Water Entry

Some of the most obvious moisture problems are related to rain water entering a building due to leaks in the roof, or being driven into walls or through cracks and openings by wind or improperly aligned sprinkler systems. Poor drainage conditions can allow surface water and groundwater to enter along on-grade floors and through foundations. Plumbing leaks and flooding are other common causes of moisture problems, with the potential for wetting ceilings, walls, floors, and furnishings. Liquid water not only directly wets surfaces and materials, it can also evaporate and increase the amount of water vapor in the air.

Water Vapor

Water in the gas phase, often called water

vapor, can move along with air currents or through materials from wet areas with high concentrations of water vapor to dry areas with lower concentrations. Air can hold large amounts of water vapor -- the warmer the air, the more moisture it is capable of holding. These conditions often occur in outdoor air in hot, humid climates, and in indoor air when there are strong moisture sources (water leaks, steam leaks, locker room showers, improperly venting combustion equipment, etc.). Significant amounts of water vapor also can enter a building along with air from the soil, especially if soil and ground conditions permit easy air movement and there is a nearby source of ground water (water table, stream, lake, poor drainage).

For any temperature, relative humidity (RH) describes how 'full' of water vapor the air is. For example, air at 50% relative humidity contains approximately 50% of the moisture that it is capable of holding, while air at 100% relative humidity is considered to be 'saturated'.

Liquid water can be squeezed (condensed) out of air when the air comes near a cool surface (just like the water droplets that form on a glass of ice water on a humid summer day). This occurs more readily when the air is more humid (higher relative humidity) or when the surface is colder. The temperature of the surface when condensation occurs is called the 'dew point'. Condensation may be the most common cause of moisture problems in buildings.

When it is cold outside, the dew point is more easily reached on cool indoor surfaces such as exterior walls and concrete floors (even under carpeting) causing condensation to form and mold growth. Moisture problems and mold growth can be prevented by keeping interior surfaces from becoming cold (by adding heat or increasing insulation levels) or by lowering indoor relative humidity levels by controlling ventilation and moisture sources.

Condensation can also be a problem during warm weather when air conditioning creates cold spots in a building. When humid outdoor air comes into contact with the cold areas (for example, when the indoor air pressure is lower than outdoors), condensation and mold growth may be a result.

Containment and Worker Protection

Exposure to mold can occur during the cleaning stage and can be hazardous to the health of the workers and students and staff in the building. Mold counts in the air are typically 10 to 1,000 times higher than background levels during the cleaning of mold-damaged materials. The extent of the contamination usually determines the amount of containment and protection that is needed -- ranging from simple source containment to full containment with personnel trained to handle hazardous wastes.

During clean-up, a N95 particulate respirator (sometimes referred to as the TC-21C particulate respirator), approved by the National Institute for Occupational Safety and Health, should be worn. Respirators can be purchased at safety supply stores or some hardware and building supply stores may carry them. Workers may also need to wear rubber gloves, eye protection, and clothing that can be laundered or discarded afterward. Consider working with a qualified consultant, and contracting with a licensed contractor or professional to carry out the work.

Note that bleach, often used as a biocide, can irritate the eyes, nose, and throat, and it should never be mixed with ammonia. The working area should be ventilated well. The remediation should be conducted when the building is unoccupied -- special care should be taken when working in air ducts. Refer to the ACGIH's "Bioaerosols: Assessment and Control" for more specific guidance.

To minimize exposure to carbon monoxide, avoid using an unvented space heater, or a gasoline engine to power a pressure washer or generator indoors.

Cleanup And Removal Of Mold

Dry Affected Areas Quickly

If there are wet surfaces and materials, immediately (within 24 to 48 hours) begin to

thoroughly dry out the affected area using fans and dehumidifiers. If flooding or extensive water damage has occurred, it may be necessary to open wall and ceiling cavities to reduce drying time. Because some molds may release spores during periods of drying, containment of the contaminated area may be necessary. Be patient -- it may require six weeks or more for the drying process before installing new building materials (carpet, paint, sheet-rock). Allow inside of walls to dry thoroughly.

Remove and Discard

While drying is taking place, begin to clean up the contaminated areas. Porous materials (example: ceiling tiles, sheetrock, plaster, wood products, carpet/carpet pad) with mold contamination that cannot be eliminated by cleaning should be removed and discarded, using precautions to avoid mold exposure. Bag and discard moldy materials. If flooding occurred, remove and replace all sheetrock and insulation damaged by water up to at least 12 inches above the high water mark. You will need to visually inspect to see if you need to remove more than the 12 inches above the high water mark.

Clean and Decontaminate

Semi-porous materials (such as wood framing and trim, furniture) may be salvageable if the mold contamination has not penetrated the material too deeply or affected its structural soundness. Surface contamination on semi-porous and non-porous materials such as hard plastic, glass, metal, and even painted surfaces in good condition can often be removed by cleaning, and, if necessary, treatment with a dilute biocide solution.

Complete removal of all mold contamination on these surfaces requires thorough scrubbing of all contaminated surfaces (use a stiff brush to clean block walls) with a non-ammonia soap/detergent or a commercial cleaner in hot water. It is best to use an excessive amount of cleaning solution for this step. Rinse clean with water, using a wet-dry vacuum to collect excess water.

Consider the use of a biocide or sanitizing solution only if cleaning did not completely remove the mold and mold spores, and removal of materials was not possible. Sampling may be necessary to determine if cleaning, by itself, sufficiently removed the mold contamination. In any case, cleaning as a first step is important to make the biocide more effective. After cleaning, apply a sanitizing solution of 3/4-cup household bleach per gallon of water to the surface. If the mold has already started to grow back, try a stronger solution: 1-1/2 cup of bleach per gallon of water. Using bleach straight from the bottle will not be more effective. Bleach solution can be applied to large areas with a handheld garden sprayer. In case of flooding, be sure to thoroughly wet the studs, wall cavities, and floors. Avoid excessive run off. Use a wet-dry vacuum to collect extra bleach solution. Allow the bleach solution to dry naturally for a 6- to 8-hour period. The bleach solution should not be removed or dried quickly, extended contact time is important. Be sure to provide adequate ventilation during use of the sanitizing solution -- some individuals may have strong reactions to bleach exposure.

Mold Contamination in Air Duct Systems

Air duct systems can be constructed of bare sheet metal, sheet metal with an exterior fibrous glass insulation, sheet metal with an internal fibrous glass liner, flexible vinyl duct insulated with fiberglass, or made of entirely fibrous glass boards. If a building's air duct system has had water damage, first identify the type of air duct construction that it has. Bare sheet metal systems or sheet metal with exterior fibrous glass insulation can be cleaned and sanitized.

If the system has sheet metal with an internal fibrous glass liner or is made entirely of fibrous glass, the ductwork normally will need to be discarded. Underground air ductwork systems may need to be abandoned. For more information, contact the National Air Duct Cleaning Association (NADCA) or an air duct cleaning professional.

Keeping Buildings Dry

Because there are many different causes of moisture problems, solutions have to be tailored for each situation. The basic objectives are to eliminate all wet or damp areas, and to maintain indoor relative humidity in the range of 30% to 60%. Some general guidance includes:

Repair Rain Water Leaks
Rain water or snow melt can enter due to material failure or aging, or where materials join (e.g., an improper flashing detail at a roof-wall joint, no damp-proof course in a parapet wall). These areas should be routinely inspected and repaired, if necessary.

Improve Drainage
Drainage problems usually occur when the surrounding ground, parking, or walkways are not graded with a slope away from the building, or as a result of poor or failed drainage detailing (e.g., no capillary break beneath a slab-on-grade, damaged or poorly designed gutters and downspouts, clogged footing drains). Lawn sprinklers may also be improperly directed at building surfaces.

Repair Plumbing Leaks
Leaks from faucets, water supply pipes, sewer pipes, HVAC drip pan lines, etc., should all be repaired as soon as possible.

Minimize or Control Indoor Moisture Sources
Moisture from science laboratories, plants, locker room showers, cafeteria dishwashers, swimming pools, steam pipe leaks can be controlled or minimized by repair, or use of localized exhaust ventilation that removes moisture before it gets into other parts of the building. Where evaporative cooling systems are used, the equipment should be properly sized and maintained to control moisture build-up in the occupied spaces.

Restrict Moisture Movement
It is important to keep water vapor from entering building spaces or assemblies (e.g., walls, ceilings) where it might come in contact with a cool surface and condense. This can be accomplished through the use of vapor retarder films, wraps, and paints, and by controlling air pressure differences so that humid air cannot enter those potential problem areas. For basement or crawlspace areas with exposed soil, an impermeable ground cover should be installed over the soil to reduce the entry of moisture-laden soil air.

Eliminate Cold Surfaces/Improve Thermal Insulation
Adding thermal insulation to walls, ceilings, chilled pipes, and windows (in the form of storm windows or energy efficient replacement windows) can raise the temperature of those surfaces above the dew point, and avoid condensation. In some cases, it may be desirable to raise the temperature of a room or space during the winter to achieve the same result. Carpeting placed on concrete slab floors, especially in buildings with moisture sources below the floor, creates a condition where moisture condenses and remains trapped on the underside of the carpet, leading to an ideal environment for mold growth. During cooling season conditions, the cool supply air should not be directed onto walls, ceilings or other objects, nor should it be allowed to leak or escape into warm and humid spaces, such as wall cavities or attic and ceiling spaces.

Provide Adequate Outdoor Air Ventilation
If indoor moisture sources are unavoidable and relatively small (for example, from the normal metabolic processes of the staff and students), supplying properly conditioned outdoor air at the rates recommended by ASHRAE Standard 62 (TFS IAQ Coordinator's Guide, pages 10-12) will help to control indoor humidity levels. In hot, humid climates, the outdoor air may contain more moisture than the indoor air and will cause many problems unless the excess water vapor is not first removed by air conditioning equipment.

Dehumidify Spaces
Dehumidification equipment may be effective in reducing indoor relative humidity levels for those cases where other control measures are not practical. However, when poorly maintained, this equipment can be a breeding ground for mold, bacteria, and other organisms. Water storage pans and tanks should be periodically inspected and cleaned.

Follow-Up

If moldy odors or other evidence of mold contamination persist, continue to dry out the area and search for any hidden sources of mold. Do not assume that if the front side of a moldy surface has been cleaned that the backside is not moldy. Mold often grows under cabinets, inside walls (insulation), in carpet padding, and under vinyl wall coverings. Be particularly careful about recurring moisture problems which could trigger mold growth. If the area continues to smell musty, the area may have to be cleaned again. Continue to dry and ventilate the area. Don't replace flooring or begin rebuilding until the area has dried completely.

Ozone Air Cleaners

Because ozone is a strong oxidizing agent, some air cleaners produce ozone for use as a sanitizer and to eliminate odors. However, ozone is a lung irritant and can cause symptoms such as cough, chest pain, and eye, nose, and throat irritation. Although there are no air standards for ozone production from air cleaners, some ozone generators have been shown to generate indoor ozone levels above standards set for other purposes. **A recent study by the U.S. Environmental Protection Agency (EPA) demonstrated that ozone is not effective for killing airborne molds and fungi even at high concentrations (6 to 9 parts per million).** Health experts caution against introducing a lung irritant directly into an indoor environment. **For these reasons, the use of ozone air cleaners in any occupied space is strongly discouraged.**

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