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Recommended Best Practices for Mold Remediation in Minnesota Schools

Environmental Health Division
Indoor Air Unit

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Acknowledgments

This guidance document draws on a number of previously published guidance documents, listed in Appendix B. In text referencing is not provided because MDH assumes the recommendations provided in the utilized guidance documents cannot be attributed solely to those specific authors.

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EXECUTIVE SUMMARY

The Minnesota Department of Health (MDH) developed this guidance at the request of the Minnesota Department of Education (MDE). It is a companion document to the MDH *Recommended Best Practices for Mold Investigations in Minnesota Schools* (Updated May 2014). These two documents were prepared to assist staff of Minnesota schools in identifying and correcting problems related to indoor mold contamination. The focus of this guidance is on practical, safe, and cost-effective methods to remove mold and associated contaminants. Planning and communication with staff, building users and parents are also emphasized since these are key components of the mold remediation process. While principles of moisture control are described, a detailed description of how to address moisture problems and restore moisture-damaged materials is beyond the scope of this document.

Mold problems in schools range from simple situations that can be handled by in-house maintenance or custodial staff, to extensive contamination that requires professional assistance to safely and successfully resolve. This document provides health protective advice for the variety of mold problems that school officials may face. The advice is deliberately general in nature and based on best practices, since there is potential for great variability from one problem to another. Consequently, MDH recommends that school officials read this guidance, and then adapt the advice most applicable to their circumstances to formulate site- and situation-specific plans for the remediation of their mold problem.

Topics covered include communication strategies, pre-remediation assessment of the problem and causes, determining the scope of the remediation project, use of administrative controls, contaminant removal considerations, and post-remediation evaluation. Detailed remediation procedures for three categories (“Minimal”, “Moderate” and “Major”) of mold problem severity are also provided. These may be used as stand-alone remediation procedures but should be adapted according to site- and situation-specific issues.

Minnesota schools officials are ultimately responsible for how such situations are addressed in their facilities. In this guidance document, MDH attempts to acknowledge this autonomy by providing flexible recommendations based on principles and processes as opposed to strict standards or prescriptive requirements. MDH staff are available to provide advisory assistance to schools.

1. INTRODUCTION

Mold contamination in the indoor environment is a complex issue. While scientific understanding about health effects and growth factors is evolving, there is currently considerable scientific uncertainty. Acknowledging this uncertainty, this guidance represents “best practices” advice that is general in nature for the types of situations many Minnesota school officials have struggled with recently.

There are no state or federal laws (as of June 2014) that specifically mandate how mold must be remediated. There are no consensus standards or laws about how much mold or what kind of mold is acceptable in a school or work place. Nevertheless, mold is a significant public health issue, and MDH has adopted a health-protective precautionary view that “no amount of visible mold growth is acceptable in occupied spaces”. It is prudent for school officials to make a reasonable and good faith effort to address mold problems following the recommendations provided in this document.

MDH considers all molds potentially harmful when they are allowed to grow indoors. Dead or dormant mold may also be harmful when breathed. Mold contamination of the indoor environment (including schools) has been linked to discomfort and health problems including allergy reactions, asthma symptoms, irritant effects, respiratory problems, and a variety of other non-specific health complaints. In addition to these potential health effects, remediation workers whom do not use appropriate personal protection may develop hypersensitivity pneumonitis or organic dust toxic syndrome. The longer mold is permitted to grow indoors, the greater the likelihood it may become airborne and cause adverse health effects. When not corrected effectively, mold problems can spread to previously unaffected areas, which may increase health risks to occupants.

Remediation of mold refers to the process of removing contamination coupled with steps to modify the indoor environment to prevent the recurrence of growth. In many cases it is necessary for the remediation process to include engineering controls and other protective measures to prevent or minimize potentially harmful exposures to workers and occupants. The objectives of any mold remediation project are:

- 1) Correct the underlying moisture problem;
- 2) Effectively and safely remove fungal contaminated material, including the mold contaminants in settled dust;
- 3) Control contaminants during remediation; and
- 4) Repair property damage and prevent future loss to building materials and contents.

While it is best to address the moisture problem first, this may not be possible. In cases where solving the moisture problem must be delayed, it is still prudent to remove the mold. However, the moisture problem must be addressed as soon as possible—otherwise mold growth will likely return.

School officials should ensure that remediation of contamination is planned and carried out carefully – especially when contamination is, or is suspected to be, extensive. When facing a suspected mold problem, school officials should consider the following:

- Are there immediate or likely health concerns?
- What is the extent of the problem?
- Are building materials structurally or functionally compromised?
- Can the moisture problem be remediated to prevent future mold problems?
- What are the school officials' liability concerns?
- What are the school officials' public relations concerns?
- What are the remediation options?

Since important details may vary from one situation to another, each mold problem can be uniquely complex. The ability to evaluate and respond to the many issues involved can also vary from school to school. Common sense and a considerable degree of judgment are necessary to determine how to best remediate a specific mold problem. Hence, this document intentionally allows school officials considerable flexibility in determining how to respond to mold problems within their facilities.

This document is organized into broad Sections 2 through 7 and appendices. The information is applicable to all but the very routine and small mold problems.

- Section 2 discusses communication first because this is one of the first things school officials must consider.
- Section 3 describes how to evaluate and use the investigative findings, highlighting the key issues described in "*Recommended Best Practice for Mold Investigation in Minnesota Schools*".
- Section 4 describes how to determine the scope of the problem and select the appropriate remediation methods. Detailed remediation procedures are located in Appendix A; these should be adapted to fit specific circumstances.
- Section 5 explains administrative controls that school officials may consider to limit worker and occupant exposure.
- Section 6 explains remediation practice considerations, such as seeking outside help, personal protective equipment, proper cleaning and removal methods, and the use of disinfectants. Most of these issues are summarized in the Appendix A.
- Section 7 discusses evaluating a remediation project's effectiveness, which should be determined when planning the remediation project.
- Appendices provide example remediation procedures, references to additional information and a glossary of terms that explains the critical terminology used in this guidance.

2. COMMUNICATION

When mold issues arise, school officials should expect staff, students, parents, teachers' unions, the media, or possibly the larger community to have a variety of questions. Underlying many such questions are concerns that need to be recognized and addressed. Open communication about health concerns can foster cooperation and early action vital to the efficient and successful resolution of mold problems. Without it, problems can be made worse and solutions delayed by frustration, anxiety, and distrust.

When a mold problem is perceived as a potential health threat (especially to children), it is predictable that people may become distrustful, anxious, and even openly hostile. This is especially true when parents feel that appropriate actions and safeguards are not being taken, that information has been withheld from them, or that their concerns are not being taken seriously. To manage expectations and prevent unnecessary anxiety, it is essential to effectively deliver complete and accurate information to affected stakeholders about the nature of the problem and the school officials' response. School officials should anticipate common questions and respond to all issues promptly and openly.

When mold problems are small and will likely be corrected through routine custodial practices, extensive communication efforts are often not necessary. However, due to the widespread attention recently given to mold, school officials should inform key stakeholders early whenever potential problems are noticed, such as water leaks, mold growth, or unusual complaints that could signal mold contamination. By acknowledging the existence of even simple problems and explaining how they will be handled, school officials can demonstrate their commitment to protecting building occupants. Early, proactive communication can avert rumors and the perception that information has been concealed.

When mold contamination is extensive, health concerns have been raised, or when remediation will disrupt normal school operations, school officials should develop a communication strategy and make sure it is followed. In all such cases it is critical to be open, honest, and direct. All findings regarding the problem should be fully and promptly shared with the community, especially interested members. It is best to create an opportunity for discussion of these findings. MDH has not identified any circumstances where information should be withheld when questions about mold in a school are raised.

The following are communication priorities:

1. Demonstrate that occupants' health and safety is of utmost concern and how potential risks are minimized;
2. Supply appropriate details of project goals, findings, and activities; and
3. Provide a mechanism for open, ongoing two-way dialogue between school officials and the affected groups or individuals including a means for occupants to share their observations and theories about problems and potential patterns.

Communication methods that some schools have used effectively include meetings (include question and answer opportunities), press releases, memoranda, postings, and flyers. The frequency of messages, methods of communication, and degree of formality should be based on the scope of the project and the audiences' needs and interests (if in doubt, over-communicate).

If possible, school officials should identify and attempt to include key stakeholders in the communication planning process, such as building staff, teachers, union representatives, students, parents, the medical community, and the media. These persons may help school officials anticipate and more fully understand the community's concerns. They may also help identify ways to reach the appropriate audiences and become a part of the communication network. When respected community members are involved and they help to explain the issues, additional trust and credibility may be gained, enhancing the effectiveness of the messages.

To ensure that information is consistent and accurate, school officials should identify a single point person to whom all requests for information about the remediation project are referred. For example, the district's designated Indoor Air Quality Coordinator may be a logical choice since all Minnesota public school districts must have such a Coordinator, and this person should be knowledgeable of how the district handles indoor air quality issues.

Remediation plan details should be made available to all affected parties early so that their concerns are understood and may be accommodated before work begins. Once remediation has begun, school officials should continue to provide updates to keep the interested community members abreast of progress and target completion dates.

3. EVALUATION OF INVESTIGATION FINDINGS

Correcting a mold problem requires understanding the extent of the problem and the underlying causes. In some cases, this is fairly simple, such as when an obvious moisture source has affected only a limited area resulting in easily observable visible mold. However, this can be difficult when the source(s) of moisture, their interaction with building conditions, or the location(s) of the growth are not readily apparent.

When the mold problem is relatively straightforward and can be corrected through routine custodial practices, it should be remediated as promptly as health and safety practices and procedures allow. When a complex mold problem exists, it is wise to carefully assess the problem thoroughly and objectively before beginning remediation. Resist temptation to address only the easiest, most obvious evidence of contamination without looking for hidden growth or reservoirs of contamination. To achieve a durable and effective solution, it is also imperative to understand the reason(s) for the moisture problem(s). Knowing the source of the excess moisture is vital to correcting it and preventing recurrence of the problem. Identifying the pathways the moisture may have taken can help locate hidden mold growth.

The success of remediating a large-scale mold problem ultimately depends on how well the moisture and contamination problem is understood. If planning the remediation relies heavily on reports of past investigations, the accuracy and completeness of those efforts should be objectively assessed. Review the findings of the reports and evaluate how completely the important issues were assessed. Do not assume that past findings necessarily reflect current conditions. Consider whether the conclusions and recommendations are logical in light of all available information, especially any recent findings. Several sections of the MDH guidance document "*Recommended Best Practices for Mold Investigations in Minnesota Schools*" may be helpful in critically reviewing investigation methods and reports.

Further investigative needs may be identified if critical factors to the remediation have not been examined adequately. When moisture problems or contamination are extensive, an informed and thorough inspection of the affected and possibly other related building areas and systems might be needed (including elements of the building envelope). An inventory should be made of all visibly moldy surfaces and materials that are water damaged. Consult "*Recommended Best Practices for Mold Investigations in Minnesota Schools*", or seek assistance from a professional with experience in assessing buildings for mold and moisture problems if further investigation is needed.

4. DETERMINING REMEDIATION SCOPE

After gaining a reasonable understanding about the extent of mold contamination and the source(s) of excess moisture, school officials should determine the scope of remediation best suited to the problem. School officials should consider site- and situation- specific details regarding the contamination severity as well as the nature of the underlying moisture problem, potential health and safety concerns related to remediation activities and the availability of district resources to correct the problems.

Table 1 presents subjective criteria to help school officials characterize the scale of mold contamination in their buildings. Three categories “Minor”, “Moderate”, and “Major” are used throughout this document to characterize the complexity of the contamination problem and the potential for exposure of building occupants. Persons responsible for planning the remediation should review and discuss the three criteria below (amount of mold growth, degree of contamination, and potential for releasing contaminants) to determine which category best describes the problem. Initially, the three criteria should be considered with roughly equal importance.

Table 1: Suggested Criteria for Determining Extent of Mold Problem

	Minimal	Moderate	Major
Amount of mold growth	Visible contamination of less than 10 ft ²	Contamination area between 10 -100 ft ²	Visibly contaminated area is over 100 ft ²
Degree of contamination	<ul style="list-style-type: none"> • Visible growth is scattered small colonies • Growth on easy to access, non-porous surfaces 	<ul style="list-style-type: none"> • Visible growth on porous or semi-porous materials is light & spotty • Non-porous materials are 50% covered with mold colonies • Possible hidden contamination 	<ul style="list-style-type: none"> • Heavy distribution of visible mold on any type of surface • Likely hidden contamination • Contamination may be well established (long-term water problem)
Potential for release of contaminants	<ul style="list-style-type: none"> • Surfaces can be easily cleaned in place. • Small items can be easily removed and bagged 	<ul style="list-style-type: none"> • Larger items need to be removed • Cleaning requires average force (ex. Scrubbing) 	<ul style="list-style-type: none"> • Aggressive force needed to clean or remove contaminated surfaces

Amount of mold growth refers to the surface area of the contaminated materials.

Degree of contamination takes into account the density of the mold growth and the type of

materials (porous, non-porous, semi-porous) supporting the growth. The potential for hidden mold growth should also be considered.

Potential for releasing contaminants refers to the amount of disturbance necessary to clean or remove the contaminated material. High amounts of disturbance or force can lead to the release of large numbers of mold spores.

If information is lacking to apply a category to one of the three criteria, it is prudent to assume the problem is “Major” until information is available to change that designation. If different categories are assigned to each criterion, it is prudent to apply the most cautious approach and pick the highest category. For example, if the amount of mold growth and degree of contamination are “Minimal” but the potential for releasing contaminants is “Moderate”, then MDH recommends designating the problem as “Moderate”.

It is crucial to remember if the moisture problem has impacted closed spaces and cavities, the extent of mold growth might be greater than what is visible from within occupied spaces. In such cases, destructive techniques may be used carefully to access and inspect inside surfaces of floor, wall, and ceiling cavities. Whenever there is information suggesting that additional contamination may be uncovered during remediation or investigation, increased contaminant control and personal protective measures should be used. Plans should be made flexible to allow for any necessary revision of the project’s scope, such as adjusting work practices and procedures if unforeseen contamination or other complications are encountered.

Other situation-specific issues may indicate a need for additional health and safety precautions during remediation. School officials must use their best judgment to anticipate if, and how, any additional factors may impact risks, affect perceptions of important stakeholders, or influence costs. The following are examples of such factors that may need to be considered:

- The skill and experience of the individuals who will perform the work;
- The presence of highly susceptible occupants or remediation workers¹;
- The duration and scope of the remediation project;
- The extent of public concern—it is prudent to treat the problem as a “Major” mold problem if distrust and anxiety has developed;
- Liability or other legal concerns; and
- The ability to control exposures through administrative or engineering controls.

To develop a remediation plan, school officials should read sections 4-7 and review the relevant example procedure in Appendix A. In addition, when “Major” contamination exists, MDH recommends skilled workers (preferably experienced and trained professionals) perform the bulk of the remediation work.

¹ Highly susceptible individuals include those with severe asthma, allergies and/or compromised immune systems. Immune-compromised individuals include uncontrolled diabetics, patients receiving therapy for organ transplants or cancer, and people with immune deficiency diseases such as advanced AIDS. A physician should be consulted about these issues.

5. ADMINISTRATIVE CONTROLS

Administrative controls are actions to protect building occupants by adjusting tasks and activities in ways that minimize exposure. Common examples include removing or relocating occupants and scheduling work during vacations, evening, or weekend hours. Practical and logistical considerations may also make it necessary to temporarily prohibit occupants from entering the work zone and possibly adjacent areas depending upon the nature and duration of the anticipated remediation project. If a medical or other health professional recommends the removal of certain individuals for health reasons, school officials should attempt to accommodate such advice whenever possible. School officials should make sure that the area occupants are being relocated to is more healthful than the area they were moved from.

For both health and practical reasons, administrative controls should be considered for any mold remediation project. School officials should consider the following questions to determine whether administrative controls are needed.

- How concerned are occupants about being near the remediation site?
- Is it likely that a lot of mold contaminants or construction dust will enter occupied areas?
- Are any occupants medically known to be susceptible to molds (medically recognized sensitivities of greatest concern are: asthma, mold allergy, compromised immune system and hypersensitivity pneumonitis)? Are there any credible reports by occupants of adverse health effects attributed to the mold problem?

When evaluating the need for administrative controls during a remediation project, school officials should initially apply the most protective approach. Such a precautionary approach is justified, especially if:

- the extent of the contamination problem has not been clearly identified; or
- there is less than ideal confidence in the engineering controls to be used during remediation work.

Following careful consideration of the control measures and other remediation practices that should minimize occupants' exposures, school officials may choose to relax the administrative precautions. For example, it is prudent to relocate susceptible occupants from areas adjacent to the mold remediation work area until it is verified that the work area is under appropriate containment (such as following measurements and visual observation of negative pressure relationships between the work area and adjacent occupied areas).

It is important to clarify that the most protective approach is not necessarily the evacuation of an entire school building. Most of the worst mold problems can be remediated while utilizing engineering controls of the affected areas and possible evacuation of occupants or susceptible individuals in directly adjacent areas, while maintaining normal operations in the rest of the building. However, school officials may choose to close a building in extreme cases. This might apply when the entire building is contaminated (or significant airborne contaminants cannot be controlled) and a medical professional has linked significant health effects to the mold problem.

School officials may consider closing a school for political or liability reasons, even though the availability of engineering controls and health-based scientific analysis does not warrant such an action.

Whenever occupants have been moved, school officials should anticipate questions about re-occupancy and safety after job completion. Post-remediation evaluation findings are necessary for making re-occupancy decisions. Communicating these findings is essential to provide peace of mind to the occupants. Implicit is the need to determine (in the planning phase) specific clearance indicators or criteria that will be used to evaluate the effectiveness of the remediation. It may be useful to include stakeholders in high profile or “Major” contamination problems, since this can help anticipate questions and concerns that may need to be addressed and to manage their expectations². After re-occupation, occupants should be informed about the process for reporting any future concerns to the appropriate school official(s) (e.g., the indoor air quality coordinator).

² It is understandable that school officials may be reluctant to involve certain stakeholders (such as certain affected parents or staff) because this may make discussions contentious and cumbersome. However, the views of these people will likely have to be addressed at some point. It is better to involve these people early on to minimize distrust and disappointment, and to minimize the likelihood of performing additional work to please certain groups.

6. REMEDIATION PRACTICES CONSIDERATIONS

Once the remediation scope, the communication strategy, and the administrative controls have been considered, school officials should review the various considerations for cleaning and removing the mold contamination. Appendix A of this document is an example step-by-step mold remediation procedure. School officials may want to consult this example and customize these procedures with the necessary site-specific details for their situation.

Remediation project plans should cover the following topics at a minimum:

1. remediation of excess moisture³;
2. identification of possible hazardous materials (such as lead and asbestos) in abatement areas⁴;
3. mold abatement practices and procedures;
4. health and safety precautions;
5. determination of project completion; and
6. repair and re-construction.

It is a best practice to develop detailed written project specification prior to starting any mold remediation project, especially when the problem is considered “major” or outside contractors are involved. The specification should clearly define the responsibilities of all parties involved in the project and state the requirements for removal, salvage, cleaning and abatement of hazards. Expectations and criteria for successful completion need to be stated. If measureable results are required, it is necessary to base all criteria on scientifically defensible data. (See section 7) Review the written project specifications with all workers prior to starting the project.

6.1: Deciding Whether to Use Outside Help

Once the nature and extent of the problem is understood, school officials have to decide whether school staff can adequately perform the remediation work or if outside assistance is needed. School staff can usually remediate “Minimal” problems, and, if experienced, school staff may also be capable of remediating “Moderate” problems. However, “Major” problems should typically be remediated by experienced professionals who have the appropriate expertise and equipment, to protect workers and occupants and contain remediation areas. In situations where district staff plans on completing the remediation work, it may be prudent to have a qualified professional review the mold problem and remediation plans.

Additional considerations before deciding to have school staff remediate a mold problem:

1. Individuals who are immune-compromised, severely asthmatic or suffering from hypersensitivity pneumonitis should avoid mold remediation work.
2. Employees are required under the MN Employee Right-to-Know Act (Minnesota Rules Chapter 5206) to receive training on potential health hazardous they may be exposed to

³ References to information about moisture damage restoration can be found in appendix B.

⁴ Further information about asbestos and lead is available from MDH at 651-201-4620

during the course of their employment. Without this training, school employees should not engage in remediation work.

3. If hazards such as asbestos or lead will be disturbed during remediation, a properly licensed professional must perform the work and follow appropriate regulations.
4. Certain fungi growing in areas with bat or bird droppings (*Histoplasma capsulatum* or *Cryptococcus neoformans*) have additional health concerns and require specific clean-up practices⁵. Extra precautions need to be taken in such situations.

6.2: Personal Protection

Physical disturbance of moldy materials can produce extremely high airborne levels of mold particles and contaminated dust. When handling moldy materials or working in the remediation area, people should be protected from being exposed to contaminants. After determining the scope of mold contamination, school officials need to determine what personal protective equipment is required for in-house staff performing mold remediation. While there are no legal respiratory protection requirements specific to handling indoor mold, there are OSHA requirements that an employer must follow if they mandate employees use personal protective equipment⁶. The chart below is a guide to *suggested* PPE based on the determined severity of the mold problem.

Table 2: Suggested Personal Protective Equipment for Mold Remediation

Minimal	Moderate	Major
<ul style="list-style-type: none"> • Gloves (nitrile, vinyl, etc.) • Goggles • N95 filtering face piece respirator (“dust mask” style) 	<ul style="list-style-type: none"> • Gloves • Goggles • N95 filtering face piece respirator OR half-mask respirator with HEPA filtration cartridges • Disposable overalls 	<ul style="list-style-type: none"> • Gloves • Goggles • Half-mask or full-mask respirator with HEPA filtration cartridges • Disposable clothing and foot coverings.

When applying disinfectants or strong cleaning agents it is necessary to select gloves that are resistant to chemicals, such as nitrile, neoprene, polyurethane or similar materials. Remediation workers should be instructed to always wash their hands after working with moldy materials in case spores are accidentally transferred to their hands.

⁵ See NIOSH Guidance Publication No. 2005-109, [Histoplasmosis- Protecting Workers at Risk](#). Website listed in Appendix B.

⁶ When employees wear respiratory protection, consult 29 CFR 1910.134 for mandated requirements related to written programs, fit testing and medical evaluations. In situations when employers DO NOT require respirator use, but an employer voluntarily dons an N95 respirator, the employer is still obligated to follow portions of the OSHA respiratory protection standard. Further information is available from the MN OSHA Workplace Safety Consultation Unit at 800-657-3776.

6.3: Contaminant Control

When creating a remediation plan, it is necessary to consider how workers will minimize and contain the release of mold particles to non-contaminated areas. Common ways contaminants are spread from worksites include foot traffic, the movement of contaminated materials or equipment and through air movement. When workers are remediating large amounts of mold growth or using destructive techniques, more stringent contamination control will be necessary.

Contaminated materials need to be handled in a manner that minimizes the disturbance of fungal particles. To prevent or minimize the dispersion of particles beyond the work area, containment and special cleaning practices are often necessary. This may include critical barriers (e.g., polyethylene sheeting), depressurization techniques (e.g., negative air pressure machines), dust suppression methods (e.g., damp wiping and HEPA vacuum cleaning) and decontamination procedures (e.g., showers, dirty rooms, clean rooms). Step-by-step recommendations are given in Appendix A. For further guidance on contaminant control, school officials should refer to the documents listed in Appendix B or seek advice from experienced mold remediation professionals.

In “Moderate” and “Major” problems, workers should “pre-clean” areas to minimize dispersion of contaminants while assembling engineering controls and applying aggressive force to contaminated materials. Pre-cleaning involves careful cleaning of easily accessible surface contamination with methods that can lift and capture fine dusts. Where possible affected materials should be enclosed in plastic and removed from the building using the shortest direct route leading to the outside of the building.

Containment should be designed according to the severity of the problem (see Section 4). During remediation of “Moderate” contamination, it may be adequate to enclose an area in plastic sheeting (a localized mini-enclosure or tent) and then bag and dispose contaminated items. In the case of “Major” contamination problems, physical isolation (total enclosure including at least one decontamination chamber) and depressurization may be necessary to separate work areas from non-contaminated spaces and the heating ventilation and air-conditioning (HVAC) system.

Depressurization of the work area is often used to ensure contaminants are confined within the work area. A pressure differential of > 5 Pa (0.02 inches water column), which is used for asbestos abatement, is usually adequate to contain airborne mold contaminants. In addition, remediation workers and project managers should routinely check to see that the separation barrier, typically plastic sheeting, billows inwards into the isolated area. The nozzle of one or more HEPA vacuums drawing from within a small containment area may provide adequate depressurization. When larger areas are isolated and a greater volume of air must be filtered, HEPA-filtered negative air machines are necessary.

6.4: Cleaning and Removal of Contaminated Materials

The primary goal of effective mold clean-up is to capture and remove contaminants from the building. Sometimes the material that the mold has grown on must also be removed. The following guidelines should be followed for determining which materials can be cleaned and salvaged versus which should be discarded.

Table 4: Suggested Mold Clean-Up Methods

Material	Example	Type of Damage	Clean-up Method
Porous Materials ⁷	Paper, Carpet, Wallboard, Upholstery, Ceiling Tiles, Insulation	Visible mold growth	Bag or wrap in plastic; Discard
		No evidence of mold	Clean with HEPA vacuum, launder or other methods to lift and capture dust. Remain vigilant for signs of future mold.
Semi-porous Materials	Solid wood furniture, engineered wood or composite products, brick, cement, resilient floor coverings	Little surface growth; Structurally sound	HEPA vacuum, damp cleaning with soap and water, disinfecting, drying. Remain vigilant for signs of future mold.
		Extensive fungal growth; Structurally compromised	Remove, bag in plastic and discard.
Non-porous materials	Metal, Ceramic Tile, Porcelain, Glass, Hard Plastic, Finished solid wood	Visible mold growth	HEPA vacuum, damp cleaning with detergent solution, and rapid drying.

6.5: Moisture Control

⁷ Interior lined ductwork is also considered porous. If ductwork lining is colonized by mold, it should be removed and the duct cleaned down to the bare metal or simply replace. See further discuss under the section “Heating, Ventilation and Air Conditioning (HVAC) Systems.”

The presence of excess moisture is the primary underlying cause of indoor mold growth. Identifying and correcting sources of excess moisture is vital to resolving mold problems and preventing their reoccurrence. The completion of a remediation job should include evaluation of steps taken to correct moisture problems and prevent their return.

If a catastrophic water problem (e.g. broken pipes, drain backup), it is essential to quickly correct the water source and to begin drying wet materials before mold growth can occur or spread. Building materials should be dried rapidly ideally in less than 48 hours, preferably less than 24 hours, to a moisture content that does not support mold growth. Prior to drying, check that there is no visible mold growth. Restorative drying methods can pressurize materials (such as wall cavities) allowing mold particles to spread to uncontaminated areas. As a precaution, fans and other devices that create airflow should no longer be used once visible mold appears, and drying should then proceed under more controlled conditions to avoid dispersing mold particles. Non-salvageable items that begin to show evidence of mold growth should be discarded promptly.

Understanding where excess moisture is located, along with what is causing the moisture and how it is entering the building can help staff assess the likelihood of finding future mold growth. Staff responsible for correcting and preventing mold problems should recognize that moisture in any of its phases (ice, water, and vapor) must be adequately controlled. For example, high relative air humidity may cause moisture to build-up on a material's surface. Moisture can also be absorbed into porous and semi-porous materials and may migrate under surface coverings, around furniture, and between components at joints. Understanding the moisture sources and dynamics involved in a particular situation may require professional assistance (see also Step 5 in MDH's "Recommended Best Practices For Mold Investigations in Minnesota Schools").

During the mold remediation project itself, it is necessary to control the use of water. For example, cleaning techniques should use water-based solutions sparingly and must include rapid drying practice following the cleaning steps. Power washing should be used as a last resort, and only on non-porous materials or concrete (cementitious materials) if the material can be dried quickly. Power washing should not be performed if vulnerable material, such as wallboard and sheet rock, might get wet. In addition, significant amounts of moisture can be introduced into air from open flame heaters. These heaters should be avoided in remediation areas.

Mold will likely grow again where moisture issues are not addressed adequately. School officials planning and carrying out mold remediation should consider how to ensure and document that moisture problems have been resolved. See Section 7 Post-Remediation Evaluation for details.

6.6: Cleaning of Remediation Equipment

Equipment used during remediation, such as respirators and protective clothing, may need careful cleaning depending on how much mold was released during cleaning. In the case of a "Minimal" Problem, tools and personal protective equipment can usually be adequately cleaned by damp wiping or washing with soap and water. With "Moderate" and "Major" problems, a

protocol for decontaminating workers and equipment should be developed⁸. In the case of “Major” problems, containment should be constructed to include a separate decontamination chamber. All equipment should be HEPA vacuumed, damp wiped, and bagged before they are removed from the work area. This includes cleaning tools, negative air machines, bags containing waste, outer clothing, respirators, gloves, and goggles. Workers should wear at least an N-95 respirator when cleaning or replacing HEPA filtered equipment components. At the end of the removal effort, all materials used for containment should be bagged and the area decontaminated as part of the final job site cleaning.

If hazardous materials such as lead or asbestos are also handled as part of the removal work, applicable regulatory work practices and procedures must be followed.

6.7: Waste Disposal

Mold contaminated materials are not classified as hazardous waste and can be disposed in a sanitary landfill. However, mold-contaminated waste that is not immediately disposed of should be stored securely (e.g., in a covered and posted waste container) and located away from high traffic areas, entrances, and fresh air intakes. Any hazardous materials removed must be kept separate from the non-hazardous waste, labeled appropriately, and disposed of according to applicable rules and regulations.

6.8: Heating, Ventilation and Air Conditioning (HVAC) Systems

In this document, the term HVAC system refers to the entire air distribution system from points where air enters the system to points of discharge. This may include return plenums (including ceiling plenums) and the mechanical room. The HVAC system(s) is relevant to mold remediation because it may be the source of mold growth or the route of disseminating mold particles from one area to another. Without regular inspection and proper maintenance of critical HVAC system components, dust, debris, and moisture may collect beyond the usual amounts expected. And since some HVAC system components may be inaccessible for periodic inspection, they are particularly susceptible to mold growth. Remediation of a school’s HVAC system is generally similar to those for other building components or systems, although additional precautions and hiring a professional may be necessary⁹.

Every mold investigation should include an evaluation of the HVAC system. In particular, the entire HVAC system should be assessed for its role in the moisture problem(s). In some cases, mold may be growing on the sound-proofing or damping material used to line interior air-stream surfaces of air-conveyance ducts. If such lining (or any other non-smooth or porous air-stream surface) is colonized by mold growth, it should be removed, discarded, and cleaned down to bare metal. Unit ventilators should not be overlooked as potential sites of mold contamination, since they are often poorly maintained and their operation hampered by misuse as storage areas.

⁸ See Appendix B resources for detailed contamination protocols.

⁹ For example, the NYC Department of Health and Mental Hygiene recommends constant negative pressure, airlocks and a clean changing room for HVAC contamination >10 ft².

The following HVAC system components should be inspected for growth, moisture, and relevant defects, and cleaned or replaced, as needed.

- Outdoor air intakes
- Filters
- Cooling coils, including evaporator fins
- Condensate pans, collectors and drains
- Humidifiers
- Air stream surfaces (baffles, dampers, include internal acoustical lining, fiberglass duct board, etc.)
- Blowers, fan components, and housings (supply, return and exhaust)
- Air distribution devices (registers, grilles, and diffusers)

MDH advises against the routine use of disinfectants and pesticides to “sanitize” ducts in school HVAC systems. (See also “Use of Disinfectants and Pesticides”) If cleaning and removal is done properly, disinfectant or pesticide application should be unnecessary. Furthermore, if organic materials (i.e., mold, dust, debris) are not removed first, it is unlikely that disinfectants or pesticides will achieve their intended level of killing. The health effects of such chemical use in HVAC systems are poorly understood, and improper application may lead to greater problems or complaints than the mold. Additionally, there are few such chemicals that can legally and practically be used in ductwork, and there is a lack of compelling evidence regarding their effectiveness in field applications¹⁰. If school officials choose to use chemicals in their HVAC system, MDH cautions that such agents should **never** be applied in an **operating** HVAC system, and the system’s manufacturer should be consulted prior to treatment to ensure compatibility.

MDH does not currently support the use of sealants or encapsulants as the primary remediation strategy to address mold problems in HVAC systems. There are important concerns about the toxicity and odors associated with sealants and encapsulants, and there are uncertainties about their long-term success in containing mold particles. While such a strategy is not a substitute for removing mold contamination or porous materials subjected to excess moisture, sealing or encapsulating colonized materials may be preferable to taking no action. If moldy materials are “locked down” in place, MDH recommends keeping a record to ensure appropriate care is taken to minimize the potential of future disturbance.

6.9: Use of Disinfectants and Pesticides

While usually unnecessary, disinfectants or pesticides may be used to try to kill any remaining mold following cleaning or material removal. Many conventional cleansers have disinfectant properties, such as household bleach, and are subject to limited regulations. Pesticides, on the other hand, are specifically regulated. Before using a disinfectant or pesticide, school officials should consider the following issues.

1. Whether the situation truly necessitate its use, or are other methods sufficient;
2. Whether the agent has been effective at controlling the target microbe, in schools, and on the

¹⁰ See the U.S. EPA’s publication 402-K-97-002, “Should You Have the Air Ducts in Your Home Cleaned?” The publication’s recommendations can also be applied to institutional buildings.

- same materials, when applied at levels that have negligible health risks;
3. Whether they are applying a disinfectant or pesticide; and
 4. If it's a pesticide, whether the agent will be applied by an experienced and licensed applicator, according to laws and safety guidelines.

It is very important to review the labels of any cleaning or chemical agent used to determine whether it is regulated as a pesticide. The term “biocide” refers to a legally defined group of pesticides used for managing microbial pests (such as mold). In Minnesota, pesticide applicators must have an antimicrobial commercial license to apply pesticides used to kill mold in schools. It is a common misconception to think that because a pesticide is “EPA registered” it is safe to use in variety of situations—pesticides are only registered for the specific use(s) described on the label. Contact the Minnesota Department of Agriculture for more information on pesticide regulations, applicator licenses, or other specific questions¹¹. If applicable, the school's integrated pest management plan should be followed. MDH further recommends making written records available to interested parties in the school and community, which detail any use of disinfectants or pesticides during the remediation.

MDH's primary concern is for occupants' and remediation workers' health and safety. Even when handled according to label instructions, any disinfectant or pesticide should be considered potentially harmful to people. Rightly or not, such agents may be blamed for health problems and odors. In addition, even if an agent does kill the mold, the agent does not usually destroy the allergens, irritants, or toxins that are present in the dead mold. Dead mold particles can still adversely affect health, so killing the mold without also removing the contaminants is not acceptable.

There may be situations in schools where use of a disinfectant or pesticide could be beneficial, but only after cleaning and removal efforts have removed visible mold growth. MDH recommends the use of disinfectants or pesticides if severely immune-compromised individuals¹² are expected to occupy or re-occupy a previously moldy area. These individuals are susceptible to infection with the living mold spores, so it can be useful to kill any residual mold that may still be present following cleaning and removal of moldy materials. A disinfectant may also be helpful on stubborn mold problems growing on non-porous or semi-porous surfaces that cannot be replaced (e.g., concrete blocks).

Standard household bleach (i.e., hypochlorite) is often used to clean and disinfect materials. Some hypochlorite solutions are regulated as pesticides. Bleach should not be used on materials that will corrode (e.g. stainless steel). For initial use, dilute the stock solution to yield a 0.25% hypochlorite solution¹³. Since many agents, including bleach, are rendered ineffective after

¹¹ To verify an individual holds a current ‘commercial pesticide applicator – anti-microbial’ license, visit the MN Department of Agriculture website: www2.mda.state.mn.us/webapp/lis/pestappdefault.jsp. Question can be directed to MDA at 651-201-6615.

¹² Immune-compromised individuals include uncontrolled diabetics, patients receiving immunosuppressive drugs, cancer treatments or people with immune deficiency diseases, such as advanced AIDS. Individuals should contact their physicians for more information.

¹³ If starting with a 5% bleach solution, mix 20 parts water to 1 parts bleach to obtain a 0.25% hypochlorite solution.

reacting with microbial contamination or other organic soiling, they should be applied only to previously cleaned surfaces using clean applicators (buckets, mops, sponges, etc.) or dedicated equipment. Apply the solution with a damp cloth and leave it on for a period of time according to the manufacturer's direction (some disinfectants should be left on for 10 minutes or less, while bleach is usually left on for 30 minutes). After disinfecting, the remaining chemical residue should be damp wiped from the treated surface with clean water, and the material should be dried quickly.

Working with bleach requires safety precautions. Never heat or combine bleach with ammonia-containing products, both will produce a toxic chlorine gas. Bleach should only be mixed with other chemicals if this is permitted on the label. Since bleach and most disinfectants and pesticides are volatile chemicals, they should only be applied when adequate ventilation and appropriate respiratory protection are used. When bleach is handled, the respiratory protection equipment used must be effective against inorganic vapors. In addition, protective gloves and eye protection should be used when handling bleach to avoid burns.

Treating moldy materials with disinfectants or pesticides can also complicate efforts to evaluate clean up. Treated materials may still release large numbers of mold particles that will not be measured by culture-based (i.e., viable) sampling and analytical methods. Evaluation of a remediation job should not rely solely on viable testing methods if disinfectants or pesticides were used. If viable sampling is used, it should be done after cleaning, but before disinfectant or pesticide application.

6.10: Use of Gas-Phase Ozone

Ozone-generating devices have been promoted to Minnesota schools as a solution to mold and other indoor air quality problems. There are significant concerns about applying ozone, a well-known respiratory health hazard, to occupied indoor environments. The limitations of using a disinfectant or pesticide described above apply to using ozone. As a general rule gas or vapor phase agents cannot effectively and safely remediate microbial building contamination—effective and safe application typically requires direct contact with the contamination. Because ozone may eliminate or mask odors, it can create the perception that the mold problem has been resolved. Yet research, including recent controlled laboratory studies, has confirmed that gas-phase ozone, applied at levels below health standards, is not effective at inactivating microbial contamination (including a variety of fungal organisms) on building materials or in air¹⁴. Consequently, MDH strongly opposes the intentional use of ozone to address school mold problems.

7. REMEDIATION EVALUATION

¹⁴ See the U.S. EPA's publication "Ozone Generators that are Sold as Air Cleaners".

After the mold remediation work is completed an evaluation of its effectiveness should be performed. At a minimum, school officials should verify and document that moisture problems were corrected and the contaminated area is ready for occupancy. Evaluation findings can also help restore the confidence of all stakeholders. School officials and their contractors may also desire an independent third party's evaluation as a way to provide some protection against potential future liability. School officials must decide who will do the evaluation, how the results will be used to demonstrate that remediation goals have been met, and what next steps will be taken if clearance criteria are not satisfied.

7.1: Remediation Goals

Clear and achievable goals should be set during remediation planning. All parties involved in the project should understand and agree upon the goals. It may be worthwhile for other stakeholders and affected parties to participate in setting goals, since they may better appreciate the costs and difficulties associated with expectations that are unrealistic and impractically strict. The ideal remediation goal is to restore the building to conditions in which occupants are free from health complaints or discomfort. It is, however, extremely difficult to achieve and maintain such a level of satisfaction given the many agents and conditions that can contribute to real and perceived indoor air quality problems and complaints. Some may demand that the goal should be a building free of all molds, but this is not possible or practical since spores will always be detectable in settled dust and in the air.

A reasonable remediation goal is to restore the building to normal conditions, reflected by: a lack of visible mold growth; a lack of mold odors; and appropriate control of moisture. Another goal in some cases may be to confirm, through testing, that the types and amounts of mold particles in the air or settled dust are similar in type and amount to what is present in unaffected and outdoor areas. Finally, remediation goals should also fit into a holistic approach to improving and maintaining indoor air quality through preventive maintenance, rather than simply reacting to problems.

7.2: Evaluation Criteria and Methods

Once goals for the remediation have been determined, evaluation criteria and methods can be selected. The methods and extent of evaluation should depend on several factors, especially the extent of the contamination problem and the community's concerns. For "Minimal" contamination cleaned by routine housekeeping, a sensory inspection alone should be adequate to judge project completion. When "Moderate" or "Major" contamination is present or health concerns have elevated the importance of the issue, a more thorough evaluation and communication of findings are advised.

Setting evaluation criteria involves determining ahead of time how much contamination may remain after remediation is complete -- in other words, deciding what indicators or measurable results will be considered evidence of an acceptable outcome or job "clearance". These criteria need to be set before remediation work begins. Setting clearance levels too low will impractically increase costs without additional practical benefit. Instead, the criteria should be

selected to show, in combination with other evidence and information about the remediation activities, that the remediated area was acceptably clean and dry at the time when the job was finished and that conditions that allowed mold growth were corrected. When using numerical criteria for clearance, it may be necessary to set material- and test method-specific criteria for interpreting testing results. This must be determined before the remediation work is begun and should ideally be understood and accepted by all key stakeholders.

7.2.1: Evaluation of Remediation Methods

The project manager should confirm with remediation workers that the previously determined remediation plan was followed. This should be confirmed during and after the remediation work by periodic inspections and closeout documents that should be included in the final report. School officials may wish to perform this task or delegate the responsibility to a contracted professional. The following are examples of some common problems that may be identified by the project manager.

- incorrect mixing of chemicals;
- inadequate pre-cleaning before moving large items from or erecting walls in remediation area;
- overloaded HEPA filters in vacuum cleaners and negative air machines, which no longer draw enough air;
- insufficient negative pressure established;
- loss of negative pressure (apparent on manometer readings);
- complacency regarding use of respirators; and
- not bagging materials and cleaning off surfaces before leaving containment area.

If significant inadequacies are revealed, proper remediation should be resumed before remediation activities continue.

7.2.2: Sensory Approach

The sensory approach should be used to evaluate all mold remediation efforts, from the most routine “Minimal” problems to “Major” problems. The sensory approach involves using senses of sight and smell to determine the presence or absence of conditions that support mold growth. Combined with evidence that effective methods for removing mold contaminants were used and moisture problems were addressed, the sensory approach offers a practical and common sense option for evaluating whether remediation goals have been met. Sensory criteria should include, at a minimum, that there is no visible mold growth, negligible dust, no moldy odors, and no apparent dampness.

One very important indicator of mold removal effectiveness is the overall cleanliness of the work site after job completion. The presence of any remaining visible mold colonies indicates that cleaning and restoration was not adequate. Moreover, the presence of dirt, moisture, debris, and dust should not be tolerated in remediated areas after project completion. Methods to document a sensory evaluation include written testimonials, photographs, white glove/black glove inspection

for dust, and confirmation by an independent third party. A white glove/black glove inspection involves allowing suspended matter time to settle, then wiping a finger over all or representative (previously determined) surfaces to demonstrate general cleanliness. In addition to the areas of contamination, areas that will underlie repaired or re-constructed structures should be assessed (cleared) before reconstruction, to verify contamination and moisture problems have been properly addressed.

7.2.3: Moisture Testing

In addition to the sensory approach, one common method to evaluate moisture control is to measure moisture levels of affected materials and surfaces and/or the indoor air relative humidity. Criteria for acceptable moisture levels in air or specific to certain materials should be established early in the project. These criteria can be used to verify that adequate drying has occurred before the replacement of damaged materials, refinishing, installation of surface coverings, or other re-construction efforts. In addition, they can be used to verify whether a moisture control method has been truly effective at controlling moisture. Equipment such as moisture sensors or detectors, thermo-hygrometers, and moisture meters may be used to evaluate drying progress and confirm moisture control. School officials should be familiar with moisture terms defined in Table 5 below. Moreover, they should expect contracted professionals who test for moisture to be very knowledgeable about these moisture concepts and their applications to moisture investigation and restoration¹⁵.

Table 5. Terms Used to Describe Water in Air and Materials¹⁶

Medium	Term	Definition
Air	Absolute Humidity	The ratio of the mass of water vapor to the mass of dry air
Air	Relative Humidity (RH)	The ratio of the amount of moisture held in air to the maximum amount that the air can hold for a specific temperature and pressure
Materials	Moisture content (MC)	The mass of moisture held in a material, measured as the mass water as a percentage of the dry mass of a material
Materials	Water activity (a_w)	The ratio of the amount of water in a material at a particular moisture content to the maximum amount of water air can hold at the same temperature and pressure.
Materials	Equilibrium RH (ERH)	The a_w expressed as a percentage

When verifying acceptable moisture levels it is preferable to compare moisture measurements to published acceptable moisture content (MC) values for a particular material relative to a benchmark water activity (a_w). As a rule of thumb, an a_w of less than 0.65 is ideal because this is typically the minimum amount of available water necessary for microbial growth. Microbial growth is limited at a_w up to 0.75. Note that a specific a_w value corresponds to very different measured MCs, depending on the material. For example, an a_w of 0.75 corresponds to about 20% MC for pine wood and 5% MC for concrete¹⁶. If published moisture content and

¹⁵ A complete discussion of moisture inspection and restoration is beyond the scope of this guide. School officials should refer to Appendix B for references.

¹⁶ From ACGIH Bioaerosols: Assessment and Control. See Appendix B for further information on moisture assessment and control, such as the ACGIH and IICRC references.

corresponding a_w are not available for a specific material, then background measurements from similar dry materials may be used for comparison to confirm a return to normal moisture levels. The use of relative humidity (RH) may be useful if measurements are taken directly next to the suspected material. However, RH measurements may fail to identify cold spots or local water intrusion that has caused a high localized a_w enabling mold growth.

7.2.4: Mold Testing

When done in a scientific manner, mold testing can provide useful information that complements the post-remediation evaluation approaches described above. However, before making the decision to use mold testing as a tool, school officials should familiarize themselves with the limitations, uncertainties and nuances of sampling to determine if testing will be a good investment of limited resources.

Limitations

There are a number of limitations to mold testing after a remediation project. As of June 2014, based upon the available science and lack of consensus standards, it is MDH's view that mold testing cannot answer questions such as "is there a safe level of mold" or "is the kind of mold present more harmful than others."¹⁷ Since there is no widely agreed upon criteria for acceptable mold levels, it is not advisable to compare mold testing results to any type of published "screening guidelines" to determine if levels of mold found in a school are "safe."

Currently, there is also no widely accepted testing protocol for mold, although a wide number of sampling methods exist¹⁸. Depending on the situation, material, collection and analysis method, there are limits to what can be detected. For example, viable samples will detect a portion live molds, but they will miss those molds that are dead or that don't grow on the agar used to incubate the sample. Sample results can vary dramatically depending on the time and location samples, and many samples are needed to account for this variability. Since a large number of samples are necessary, the cost of mold testing can be considerable.

Sampling and Data Interpretation

Because mold contamination is not always visible, mold testing can serve an important and necessary role in evaluating remediation when it is done in a scientific manner. Sampling can also be used to assess the possible spread of contaminants from a containment zone to adjacent areas during or after remediation. In cases involving extensive contamination or high profile situations, sampling has been used for post-remediation clearance when outside remediation contractors or consultants insist on testing. If sampling was done to investigate the problem, it may be prudent to test after the remediation because stakeholders may expect to see a significant decline in mold levels (however, changes in the molds' metabolic state or environmental

¹⁷ See MDH Fact sheet "Testing for Mold," available on the department's website.

¹⁸ Further information about mold testing is available in MDH's "Best Practices for Mold Investigation in Minnesota Public Schools", "Testing for Mold" and in Appendix B resources.

conditions can also affect measured mold levels).

MDH strongly recommends that mold testing only be done if the results can adequately answer a question with acceptable certainty. In general terms, the questions for post-remediation evaluation testing should be along the lines of “does the level of biological agents detected on this particular material indicate acceptable remediation?” or “does this environment contain more organisms than would normally be expected?” Depending on your question, different sampling methods are needed. If the question present is whether a material has returned to a normal mold level, then preference should be given to a sampling method that focuses on surface or dust levels. If a broader question is asked, such as whether mold levels in the overall environment are at a normal level, then typically three types of sampling should be used:

1. Spore trap screening of air for total mold (viable and non-viable)
2. Sampling air for viable mold levels; and
3. Sampling surfaces for viable mold.

If a school only has the resources for 2 out of the 3 methods, the MDH recommends aggressive spore trap and surface sampling. These methods are likely to yield more information about total fungal load or the location of contamination the viable samples alone.

All mold samples will be sent to a lab for analysis. The analytical method should be sensitive to low levels of a broad spectrum of environmental fungi, provide the level of taxonomic identification needed for the intended use of the data, and should not be so expensive to deter collecting an adequate number of samples. When the types and quantities of mold are essential for interpretation (for example, comparing amounts and types of mold in air samples to background or outdoor samples), MDH recommends using a laboratory accredited by the American Industrial Hygiene Association’s Environmental Microbiology Laboratory Accreditation Program (EMLAP) program.

As discussed before, there are no widely agreed upon standards for acceptable levels of mold. For this reason, a superior alternative to interpreting air samples results strictly according to a published guideline is to compare air fungal estimates from problem areas to those from similar suitable background areas (i.e., unaffected indoor area air levels and outdoor air levels). This comparative approach tries to determine if the concentrations and diversity of molds present in the remediated area are similar to the outdoor and unaffected indoor area air levels.

The following general principles should be used when interpreting comparison sampling results:

Air Samples

Comparison is only valid between samples taken at similar times on the same day and using the same sampling method (e.g. flow rate, duration, culture medium, etc.). Some variation in the total fungal levels and the presence or absence of a few types from one sample to the next is expected. Where relevant, indoor areas should be sampled and compared when building operations are similar, such as ventilation, open windows, cleaning and occupant activity level prior to and during sampling, and weather conditions. The following suggests acceptable mold

levels:

1. Total concentrations of mold (number of colony forming units and/or total spores detected per unit volume of air) in indoor samples should be similar to, or lower than outdoor and unaffected indoor area samples.
2. Indoor samples consistently contain types¹⁹ of mold present in the outdoor and unaffected indoor area samples.
3. Indoor samples are not dominated by types of mold (as a percentage of the total amount) unless the same types also dominate the comparable outdoor and unaffected indoor area samples.

Surface and Dust Samples

These should generally show similar levels and types of mold fragments expected on similar materials reported in the literature or measured on the same materials in unaffected indoor areas.

1. Total concentration of mold (number of colony forming units per unit area or gram of dust) in indoor samples should be similar to, or lower than, samples from the same kind of material in an unaffected area and/or what is reported for similar materials in the literature.
2. Samples should show a mixture of mold types – not dominated by a single type of mold unless unaffected area samples are also dominated by the same mold.
3. Microscopic examination of samples should indicate an absence of colony structures (spore producing structures and mycelial fragments) that indicate surface growth.

¹⁹ If sample results are to be interpreted by comparison to background levels, MDH suggest species level identification because this permits greater confidence in interpretation. However, due to cost, it may be adequate to distinguish and compare fungi at the genus level. Identification of many species requires viable sample techniques. The results should be called “presumptive.”

APPENDIX A: EXAMPLE STEP-BY-STEP REMEDIATION PROCEDURES

The following are examples of step-by-step procedures on contaminant removal, engineering controls and personal protection to be used when planning a remediation. These procedures are provided for instructional purposes—schools should prepare a site-specific procedure prior to undertaking any remediation project. Moisture control measures, crucial to solving any mold problem, are not addressed in these steps. Professional evaluation or remediation services may be necessary.

Practices and Procedures for “Minimal” Problem Remediation

Step 1. Select personal protective equipment.

- Respiratory protection capable of filtering particles down to 1 microns (a NIOSH approved N-95 filtering face piece respirator is recommended at a minimum);
- Eye protection (goggles that exclude fine particles); and
- Gloves (impervious to any cleaning products used).

Step 2. Determine if contaminated materials can be cleaned or whether they need to be discarded.

- Porous materials* (including drywall board, ceiling tile, insulation, unprotected “manufactured” or “processed” wood products, upholstered furniture, carpet and padding) that are contaminated with mold need to be removed from the building. This should include all materials and furnishings that have, or had: visible mold growth; strong mold odors; or remained wet for longer than *48 hours* and are not easily cleanable.
- Hard surfaced semi-porous materials* such as tile, finished wood products, cement, and concrete can often be left in place and cleaned, if they are structurally sound, would be very difficult to replace, lightly contaminated on the surface, and can be successfully cleaned.
- Non-porous materials* need to be thoroughly cleaned (includes metal, ceramic tile, porcelain, glass, hard plastics, highly finished solid wood items, and other hard smooth surfaces).

Step 3. Carefully clean mold contaminants by trapping or capturing as much of the visible mold growth as possible from accessible surfaces. Use component removal methods²⁰ where feasible; otherwise, select one or more of the following techniques.

- Vacuum all visible mold growth and materials surrounding the area of growth using a HEPA vacuum (*a standard shop vacuum is not adequate*); or
- Carefully and systematically damp wipe surfaces with soapy water to remove and capture surface growth (*work damp, not wet*); or
- Bag or contain porous contaminated materials and remove from the work area.

²⁰ Component removal techniques involve enclosing or sealing the surfaces of materials in plastic or other impermeable materials before removal. For example: wrapping, removing and disposing of entire sheets of wallboard in one piece.

- Step 4.** Perform a final cleaning and drying of non-porous surfaces, including surfaces surrounding discarded porous materials.
- Damp wipe the cleaned materials with clean water to remove any remaining contamination or soiling residue.
 - Manage run-off and leave surfaces as dry as possible after cleaning.
- Step 5.** Clean surrounding areas as needed.
- Step 6.** Perform post-remediation evaluation to determine the effectiveness of remediation work, and document the findings.
- Step 7.** Periodically inspect for moisture and visible mold growth.

Practices and Procedures for “Moderate” Problem Remediation

- Step 1.** Select personal protective equipment.
- Respiratory protection capable of filtering particles down to 1 microns (a NIOSH approved N-95 filtering face piece respirator may be sufficient. A HEPA filtered respirator (for example, P-100) is strongly encouraged, if available, or if heavy disturbance is likely.
 - Eye protection (goggles which exclude fine particles) if half-face respirator is used.
 - Protective covering (disposable or washable outer clothing, long sleeved tops, long pants, booties and head coverings).
 - Gloves (impervious to any chemicals used, and, if applicable, protective against sharp objects).
- Step 2.** Determine if the material(s) supporting surface mold growth can be cleaned or should be removed and discarded.
- Porous materials* (including drywall board, ceiling tile, insulation, unprotected “manufactured” or “processed” wood products, upholstered furniture, carpet and padding) that are contaminated with mold need to be removed from the building. This should include all materials and furnishings that have, or had: visible mold growth; strong mold odors; or remained wet for longer than *48 hours* and are not easily cleanable.
 - Hard surfaced semi-porous materials* such as tile, finished wood products, cement, and concrete can often be left in place and cleaned, if they are structurally sound, would be very difficult to replace, lightly contaminated on the surface, and can be successfully cleaned.
 - Non-porous materials* need to be thoroughly cleaned (includes metal, ceramic tile, porcelain, glass, hard plastics, highly finished solid wood items, and other hard smooth surfaces).

- Step 3.** Prepare parts of the work area, to minimize mold disturbance that will occur during containment set-up. Mold growth that such preparatory work would significantly disturb should be included in the containment area and cleaned after containment is erected.
- Remove easily accessible surface growth by HEPA vacuuming (*a standard shop vacuum is not adequate*) and damp wiping.
 - Clean areas and materials by HEPA vacuuming or damp wiping, such as
 - items that will be covered by critical barriers (e.g., air supply and return grilles);
 - surfaces that will become inaccessible once the containment is erected (e.g., flooring under a containment wall);
 - uncontaminated furniture and materials that will be removed from the work area (if this can be done without agitating the visible mold growth).
- Step 4.** Locally contain the affected area to minimize contaminant dispersal.
- Enclose areas of visible contamination and areas of suspected hidden growth with critical barriers (4-6 mm polyethylene sheeting or comparable non-permeable materials). The containment should be extended at least a few feet beyond areas of growth to ensure materials with heavy spore deposition are contained and to enable ease of remediation work. Critical barriers should block all openings so that mold particles cannot be carried outside the remediation area by air movement or through the mechanical ventilation system.
- Step 5.** Perform mold remediation activities, including detailed cleaning and/or removal of mold contaminated materials.
- *Porous materials:* wrap or bag the materials in plastic sheeting and discard in a secure disposal container. Clean surrounding non-porous materials, at least two feet beyond visible growth. Securely bag waste and dispose.
 - *Semi-porous materials:* remove if necessary, or thoroughly clean as described for non-porous materials, disinfect, and dry. For stubborn problems, consider using HEPA vacuum filtered sander, trisodium phosphate as a cleanser, or seal if the material can be kept dry.
 - *Non-porous materials:* clean using a repeatable pattern of motions moving downward and from the cleanest areas to the dirtiest (not random washing or visually based), to ensure all surfaces have been thoroughly cleaned. Don't use methods such as sweeping, dry dusting or brushing). Perform cleaning in the following order.
 1. HEPA vacuum slowly and carefully.
 2. Damp wipe with a water and an all-purpose non-ammonia based cleaner or detergent (*work damp not wet*).
 3. Once all surfaces have been dried from the initial cleaning, perform a second HEPA vacuuming in the opposite direction.
 4. Manage runoff and leave surfaces as dry as possible after cleaning.

- Step 7.** Decontaminate equipment and containment by thoroughly cleaning with a non-ammonia based all-purpose cleaner followed by application of a mild bleach solution.
- Step 8.** Disassemble containment materials.
- Step 9.** Initiate additional drying if needed.
- Step 10.** Clean surrounding area as needed.
- Step 11.** Perform post-remediation evaluation to determine the effectiveness of remediation work and document findings.
- Step 12.** Periodically inspect for the presence of excess moisture and/or return of mold growth before rebuilding or refurbishing. If growth reappears, the moisture problem typically has not been properly addressed or corrected. Perform further investigation to determine moisture problem, correct the moisture problem, and remediate mold growth.
- Step 13.** Re-construct and replace removed materials after moisture control has been achieved.

Practices and Procedures for “Major” Problem Remediation

- Step 1.** Select personal protective equipment. Workers should protect themselves with the following:
- Respiratory protection capable of filtering particles down to 0.3 microns. A full-face HEPA filtered respirator, such as a P-100 or powered air purifying respirator (PAPR), is strongly recommended;
 - Protective covering (disposable or washable outer clothing, long sleeved tops, long pants);
 - Eye protection (goggles which exclude fine dusts) if half-face HEPA respirator is used;
 - Anti-contamination garments; and
 - Gloves (impervious to any chemicals used and, if applicable, sharp objects).
- Step 2.** Determine if the material(s) supporting surface mold growth can be cleaned or should be removed and discarded.
- Porous materials* (including drywall board, ceiling tile, insulation, unprotected “manufactured” or “processed” wood products, upholstered furniture, carpet and padding) that are contaminated with mold need to be removed from the building. This should include all materials and furnishings that have, or had: visible mold growth; strong mold odors; or remained wet for longer than *48 hours* and are not easily cleanable.
 - Hard surfaced semi-porous materials* such as tile, finished wood products, cement, and concrete can often be left in place and cleaned, if they are structurally sound, would be very difficult to replace, lightly contaminated on the surface, and can be successfully cleaned.
 - Non-porous materials* need to be thoroughly cleaned (includes metal, ceramic tile, porcelain, glass, hard plastics, finished solid wood items, and other hard smooth surfaces).

- Step 3.** Prepare parts of the work area, to minimize mold disturbance that will occur during containment set-up. Mold growth that such preparatory work would significantly disturb should be included in the containment area and cleaned after containment is erected.
- Remove easily accessible surface growth by HEPA vacuuming (*a standard shop vacuum is not adequate*) and damp wiping.
 - Clean areas and materials by HEPA vacuuming or damp wiping, such as
 - items that will be covered by critical barriers (e.g., air grilles);
 - surfaces that will become inaccessible once the containment is erected (e.g., flooring under a containment wall);
 - uncontaminated furniture and materials that will be removed from the work area (if this can be done without agitating the visible mold growth).

- Step 4.** Contain work area and limit access to authorized personnel.
- Erect containment around the area of visible and suspected hidden mold growth, extending several feet beyond the affected area. This should be designed to seal off the contaminated area in an air-tight manner. An effective decontamination unit system should also be constructed for entering and exiting the remediation work area.
 - Isolate the air handling system from work zone by sealing off supply and return grills with plastic sheeting and duct tape. If the area being remediated is served by an HVAC system, it should be shut down prior to any remedial activities.
 - Use critical barriers (e.g., double layer of polyethylene and duct tape) to isolate the moldy area from clean occupied zones. Critical barriers should block all openings so that mold particles cannot be carried outside the remediation area by air movement or through the mechanical ventilation system.
 - Establish a negative air pressure differential of >5 Pa or >0.02 in. water column at all times between indoor areas external to the containment barriers and the enclosed remediation area. Establish negative pressure using HEPA-filtered ventilation equipment. Provide make up air and test or monitor containment for leakage.

- Step 5.** Perform mold remediation activities, including detailed cleaning and/or removal of mold contaminated materials.
- Porous materials:* wrap or bag the materials in plastic sheeting and discard in a secure disposal container. Clean surrounding non-porous materials, at least two feet beyond visible growth. Securely bag waste and dispose.
 - Semi-porous materials:* remove if necessary, or thoroughly clean as described for non-porous materials, disinfect, and dry. For stubborn problems, consider using HEPA vacuum filtered sander, trisodium phosphate as a cleanser, or seal if the material can be kept dry.
 - Non-porous materials:* clean using a repeatable pattern of motions moving downward and from the cleanest areas to the dirtiest (not random washing or visually based), to ensure all surfaces have been thoroughly cleaned. Don't use methods such as sweeping, dry dusting or brushing). Perform cleaning in the

following order.

1. HEPA vacuum slowly and carefully.
2. Damp wipe with a water and an all-purpose non-ammonia based cleaner or detergent (work damp not wet).
3. Once all surfaces have been dried from the initial cleaning. Perform a second HEPA vacuuming in the opposite direction.
4. Manage runoff and leave surfaces as dry as possible after cleaning

- Step 6.** Decontaminate equipment and containment by thoroughly cleaning with a non-ammonia based all-purpose cleaner followed by application of a mild bleach solution.
- Step 7.** Determine if use of disinfectants is needed or desirable (see Section 6.9 “Use of Disinfectants and Pesticides”). Carefully follow the directions provided with the disinfectant. A dilute bleach solution may be adequate. The solution should be applied by light misting or wiping on (avoid runoff); treat the entire area that supported visible growth. The surfaces should be kept damp with the solution according to the manufacturer’s recommendations. Allow to air dry. Wipe off residue.
- Step 8.** Clean surrounding area as needed.
- Step 9.** Allow or facilitate complete drying of all materials wet from excess moisture, cleaning activities, or disinfection solution. Dehumidifiers, fans, heat lamps and ventilation with dry warm air are among the methods that may be used to speed drying. Complete drying to normal levels may take days or weeks.
- Step 10.** Perform a thorough post-remediation evaluation and document work performed. Evaluate cleaning practices using previously identified evaluation methods to determine if clearance requirements have been satisfied.
- Step 11.** Once post-remediation criteria have been achieved, deconstruct containment and then remove air-handling equipment. Air-handling equipment should be left running until entire containment has been completely taken down and removed.
- Step 12.** Periodically inspect for the continuing presence of excess moisture and/or return of mold growth before rebuilding or refurbishing. If growth reappears, the moisture problem has not been corrected. Perform further investigation to determine moisture problem, correct the moisture problem, and remediate mold growth.
- Step 13.** Re-construct and replace removed materials after moisture control has been achieved.

APPENDIX B: MOLD REMEDIATION REFERENCES

The reference documents below describe various control measures for mold contamination. Schools may wish to consult these materials for further advice on mold clean-up and removal—particularly in unique situations such as HVAC contamination or widespread contamination. The MDH Best Practices documents are generally consistent with the guidelines below.

[Mold Remediation in Schools and Commercial Buildings](#). EPA 402-K-01-001, Reprinted September 2008.

[Guidelines on Assessment and Remediation of Fungi in Indoor Environments](#). New York City Department of Health and Mental Hygiene, November 2008.

[IICRC S500: Standard and Reference Guide for Professional Water Damager Restoration](#). Institute of Inspection Cleaning and Restoration Certification, Third Edition, April 2006.

[Bioaerosols: Assessment and Control](#). American Conference of Governmental Industrial Hygienists (ACGIH). 1999. Available for purchase by contacting ACGIH: www.acgih.org

[Assessment, Cleaning, and Restoration of HVAC Systems \(ACR 2013\)](#). National Air Duct Cleaners Association (NADCA) of Washington, DC, Eleventh Edition, 2013. Available on www.nadca.com

[Should You Have the Air Ducts in Your Home Cleaned?](#) EPA 402-K-97-002, October 1997. Available at www.epa.gov

[Fungal Abatement Safe Operating Procedure](#). University of Minnesota Department of Environmental Health & Safety, Revised January 2007. Available at www.dehs.umn.edu.

[Fungal Contamination in Public Buildings: Health Effects and Investigation Methods](#). Health Canada. Published 2004, Archived on June 24, 2013. Available at www.hc-sc.gc.ca

[Histoplasmosis- Protecting Workers at Risk](#). NIOSH Pub. 2005-109. December 2004. Available at www.cdc.gov.

[Ozone Generators that are Sold as Air Cleaners](#). U.S. EPA. Available at www.epa.gov.

APPENDIX C: MINNESOTA CONTACT INFORMATION

Minnesota Department of Health

Indoor Air Unit
P.O. Box 64975
St. Paul, MN 55164
phone: 651-201-4601
email: health.indoorair@state.mn.us

Minnesota Department of Education

Facilities and Technology/ School Finance
phone: 651-582-8779
email: mde.funding@state.mn.us

Minnesota Department of Labor and Industry

Minnesota Occupational Safety and Health Administration
Workplace Safety Consultation Unit
phone: 800-657-3776
email: osha.consultation@state.mn.us

Note: OSHA does not regulate mold in the workplace, but does regulate personal protection use, training, and other workplace practices associated with hazards.

Minnesota Department of Agriculture

Pesticide Licensing & Certification Unit
651-201-6615

APPENDIX D: GLOSSARY OF TERMS

AEROSOL: small liquid or solid particle, which can remain suspended in air for some time.

ALLERGEN: a substance (such as a mold spore) that can elicit an excessive immune response such as hay fever, rashes, sinusitis, or asthma symptoms.

AMPLIFIER: An item (material, substrate, etc.) that supports the active growth and proliferation (increase in numbers) of mold.

ANTIMICROBIAL: an agent used to suppress or retard microorganisms on direct contact (e.g., a fungistatic agent is used against fungi).

BIOAEROSOL: Airborne particles or matter of biological origin (derived from a live or formerly living organism). For example, mold spores or fragments of a mold growth that are suspended in the air.

CLEANING: The science and practice of controlling contaminants by locating, identifying, containing, removing and disposing of unwanted substances from the environment.

COLONY: A uniform mass of cells all derived from a single cell and which is growing on a solid surface. A colony is usually the smallest unit of mold that can be observed with the naked eye.

CONTAINMENT: Barriers, seals, air-locks, negative air filtration systems and other methods used to control the movement of airborne materials or agents and avoid secondary contamination. For example, plastic sheeting used to enclose a work area to prevent disturbed mold particles from drifting from the containment zone into adjacent or connected areas.

CONTAINMENT BARRIER: polyethylene sheeting (or other nonpermeable materials) used to completely seal off work area to prevent the airborne distribution of contaminants to areas outside the containment zone.

DETERGENT: A cleaning agent. Detergency refers to the ability to remove soil.

DISINFECTANT: Any agent that significantly reduces the numbers of undesirable or infectious microorganisms, but may not eliminate all (e.g., not all bacteria or fungi spores).

DISINFECTION: The elimination and destruction of microorganisms, which may allow for survival of some resistant organisms (e.g., bacterial endospores or fungal spores).

ENCLOSURE: The practice of attaching a rigid and durable barrier to building components, with all edges sealed for the purpose of permanently enclosing contaminants.

EQUILIBRIUM RELATIV HUMIDITY (ERH): The a_w of a material expressed as a percentage where $a_w = \text{equilibrium relative humidity}/100$. This can be estimated in the field by a relative humidity measurement at a material's surface using a hygrometer.

FUNGI: A biological kingdom of organisms that includes among many others, mushrooms, puffballs, yeasts, and molds. There are between 1000,000 and 10 million species of fungi.

FUNGISTATIC: A chemical agent incorporated into or applied onto a material to suppress or slow the growth of fungi on direct contact.

GENUS: A biological level of classification directly above the species level. In the practice of naming mold, the genus is indicated first and is capitalized (e.g., *Aspergillus* is the genus of the mold named, *Aspergillus fumigatus*). There often are many different species within a single genus. The plural form is genera.

HEPA: High efficiency particulate air. Capable of removal and capture of 99.97 % of dispersed particles greater than or equal to 0.3 microns in size. See the Dept. of Energy standard DOE-STD-3020-97 for details.

HEPA-FILTERED VACUUM: A high-efficiency particulate air filtered vacuum with a properly installed filter capable of collecting and retaining particulate matter 0.3 microns or larger at an efficiency rate of 99.97%.

HIDDEN MOLD: Mold growth on building materials or assemblies of building components that are obscured from the view of an observer within building spaces normally intended for occupancy. Common examples include contamination beneath carpeting or padding, behind fixed cabinetry or shelving units, in spaces above a drop ceiling, in air handling or distribution systems, or within a wall cavity.

HYPERSENSITIVITY PNEUMONITIS: (aka extrinsic allergic alveolitis). A syndrome characterized by inflammation of the lungs, caused by inhalation of certain allergens. Typically occurs in the occupational setting following the repeated inhalation of very high levels of an allergen(s), including mold allergens (e.g., farmer's lung).

METABOLITE: A chemical produced by the metabolism of a living organism; produced by enzymatic action.

MICROBE: a microorganism, including types of fungi and bacteria that are usually not visible to the naked eye. Indoor biological contamination can include other microbes in addition to mold, and this may affect the remediation strategy.

MICRON: A unit of measure equal to one millionth (10^{-6}) of a meter; also known as a micrometer and written as "Im". Approximately equal to 1/25,000 inch.

MOISTURE CONTENT: The mass of moisture held in a material, relative to the material. Measured as the mass of water as a percentage of the dry mass of a material. Expressed as a percentage $[(\text{wet mass} - \text{dry mass}) (100)]/(\text{dry mass})$, or in terms of mass of water over material volume. Moisture content can be measured in the field using a moisture meter that is appropriate and calibrated for the material. Different moisture content values can be tolerated, depending on the material, before mold growth occurs.

MVOCs: Microbial Volatile Organic Compounds: chemicals that can be produced by actively growing molds and bacteria, which are released as gases into the air and are responsible for the characteristic moldy or musty odor .

MYCOTOXIN: A harmful substance produced by a fungus, which affects the structural or functional integrity of cells or tissues. Mycotoxins are usually found in the spores, filamentous structures, and/or the surrounding growth material.

MYCOLOGIST: A microbiologist who studies or has “expert” knowledge of fungi.

NADCA: National Air Duct Cleaners Association. Trade group that publishes the standard Assessment, Cleaning, and Restoration of HVAC Systems (ACR-2002).

NEGATIVE PRESSURE: An atmosphere created in an enclosure such that the air pressure within the enclosure is less than that outside the enclosure resulting in the tendency for airborne particles to be drawn in rather than out.

NIOSH: National Institute for Occupational Safety and Health

ODTS: Organic Dust Toxic Syndrome (same disease as humidifier fever; also referred to as silo unloader’s disease and pulmonary mycotoxicosis). Illness characterized by chest tightness, flu-like symptoms, and possibly other symptoms following a single very heavy microbial exposure (including mold). Such extreme conditions are rarely found in homes, schools, or offices.

PATHOGENIC: A microbe capable of causing disease by direct contact, typically through infection. The molds most often regarded as pathogenic are those most frequently known to cause opportunistic fungal infections, primarily among immune-compromised individuals (e.g., *Aspergillus fumigatus*). A microbe that produces toxins that cause disease in the absence of the microbe is not defined as pathogenic.

POROUS: Strictly defined, porous refers to the ability of a material to allow fluids to pass through (permeability to liquids or gases). For the purposes of this document, porous materials are items that absorb moisture (liquid water or humidity). Examples include wood products, paper products, fabric, carpet and pad, plasterboard, drywall, insulation, and ceiling tiles. In contrast, non-porous materials include Formica, vinyl, plastic, glass, some tile, metal and many other similar hard surfaced durable or sealed materials.

PROPAGULE: Particles that are capable of germinating and producing a colony (for example, mold spores or fragments of hyphae).

PROTECTIVE CLOTHING: Garments worn by workers to keep gross contamination from contacting skin surfaces and reaching underlying clothing layers.

RELATIVE HUMIDITY (RH): A ratio quantifying the actual amount of water present in air to the maximum amount of water that air (at the same temperature) is capable of holding; this ratio is expressed as a percentage. Warmer air has a greater capacity to hold water in the vapor form than does cooler air.

REMEDICATION: The spectrum of measures intended to correct a problem and restore the environment to a useable state. For the purposes of this document, MDH regards mold remediation as any combination of activities which: a) remove indoor mold growth and mold-contaminated materials, b) eliminate and prevent excess moisture that allows growth, and c) rebuild or refurbish.

SANITIZER: An agent with cleansing and antimicrobial properties that reduces or inhibits microbial growth.

SPECIES: The next most specific level of biological classification below genus. In the practice of naming mold, the species follows the genus and its first letter is always written in the lower case (e.g., fumigatus, in *Aspergillus fumigatus*).

SPORE: A specialized reproductive cell. Mold spores are individually microscopic and many are very buoyant. As such, they readily stay suspended in the air and can be dispersed by air movement. Some spores of mold and bacteria may be highly resistant and able to survive adverse environmental conditions.

STERILIZE: Kill or inactivate all microorganisms.

STERILANT: An agent or process used to sterilize a surface or media.

TAXONOMY: An orderly system for classifying and naming living organisms based upon how closely groups or individuals are related. See also **GENUS** and **SPECIES**.

TOXIC: Toxic refers to the inherent ability of a substance to cause harm to living cells or biological tissues.

TOXIGENIC: An organism that can produce one or more toxins. Examples of fungi that can produce toxins under certain conditions include the certain species of *Aspergillus*, *Penicillium*, *Fusarium*, *Trichoderma*, *Memnoneniella*, and *Stachybotrys chartarum* (note other species may also produce toxins).

VIABLE: Able to reproduce under appropriate conditions (the opposite of non-viable). Some mold testing methods only detect molds that will grow on the specific culture medium used-- molds that are non-viable or don't grow on that medium will be missed. Some mold spores can remain viable for many years.

WATER ACTIVITY (a_w): A physical-chemical concept that describes the moisture in a solid material and can be used to express the availability of free moisture for the growth of microorganisms. It is expressed as a decimal fraction less than or equal to 1; where a material's water activity is 1.0 when it is saturated. There is no direct field technique to measure water activity and it can only be related to moisture content for a specific material (see **EQUILIBRIUM RELATIVE HUMIDITY**).