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Restoring Documents After Water Damage

Working in the Creativity Age

Mold Testing: The Old, the New, the Useful

The Momentum of Measurement for Cleaning

Mold Testing

THE OLD, THE NEW, THE USEFUL

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The conversations about mold testing are always interesting, and the participants are almost always frustrated. Struggling homeowners who have been sick and are desperate to find out if mold is really the cause, restoration contractors who are upset because they have failed a post-remediation clearance and do not understand why, or doctors trying to find reliable indicators on the environmental side that correlate with health symptoms are all interested in sampling for mold.

Despite this common interest, there is often little that connects those scenarios because of the proliferation of sampling options for fungal and other biological contaminants in the past decade. Throw in substantial variations in analytical methods, as well as a lack of consensus identifying comparison criteria for the data that is generated from the samples, and you can begin to understand why confusion reigns in many parts of the mold remediation industry.

Different Types of Sampling

One of the first obstacles to anyone contemplating testing for fungal materials is choosing a sampling process. Should they collect air samples or surface samples? For air samples, does it make a difference if the air is outdoors, indoors, inside the contained work area or inside the wall cavity? If surface samples are to be collected, are swabs the appropriate medium, or should tape or vacuum samples be collected instead? Can we use a system that allows for direct-read analysis or is there a specific reason that we need to have cultured samples? Do side-by-side air samples—with one analyzed using optical microscopy and the other through cultured methods—really provide data that can be correlated?

Unfortunately, many individuals currently working in the mold inspection and remediation fields do not even know that these are

questions that should be considered before any sampling is undertaken. Instead, they collect the type of samples that:

- someone told them would be appropriate;
- they have collected in the past;
- fit the equipment they have; or
- seemed cool when they saw it at a conference or a supply store.

Once they get comfortable with a method and have some history with the type of data they receive, it becomes their standard regardless of whether it is the best sampling approach or even appropriate for specific uses. As Dr. Ritchie Shoemaker, a physician who specializes in treating patients who have been exposed to mold, notes, "No sampling can replace the skill of the experienced mold inspector in investigating mold problems."

What Question Are You Trying to Answer?

The first step in making intelligent choices related to mold testing is to follow a simple axiom: Do not collect a sample until you have clearly defined the question you want that test to help you answer. This is especially important if multiple parties will be reviewing the data. For example, if the remediation contractor is called to the home to help determine whether there is a water damage/fungal growth problem, he or she may choose to collect air samples to help identify which areas of the structure are impacted. However, homeowners hoping to use the air sample results to determine whether the indoor environment is impacting their health could easily be misled by information that, while

valuable for answering the contractor's question, may not be useful in addressing their concerns.

Even the proper testing process can be a source of problems if the data is being used to answer different questions. A common example of this scenario plays out every day with post-remediation air samples. If the question being asked is, "Has the mold remediation work inside the negative pressure containment been completed properly?" then the air samples should be collected with negative air machines and other engineering controls still in operation. In contrast, if the question that the air samples are meant to answer is, "Is the structure safe to reoccupy?" then all engineering controls that will not be in place when the occupants return should be shut off to represent normal conditions. In each case, air sampling can provide valuable data, but the conditions under which the samples are collected make all the difference.

As useful as they are, air samples are generally not the right choice if the question involves determining the cleanliness of contents. Assumptions are often made that if there is visible fungal contamination in the structure, there must be spore deposition on nearby objects. But how far does it extend? If the contamination is in the bathroom, do the contents of the connected master bedroom need to be cleaned? If a water source and fungal growth is in the basement, are the first-floor surfaces and contents contaminated? What about the second floor? Such questions are difficult to answer with air samples. Fortunately, many good techniques exist to collect surface samples.

How Will You Interpret the Results?

Having a specific question and choosing the appropriate sampling approach is still going to lead to frustration if the person collecting the samples does not have a clear understanding of how the results are going to be evaluated. Too often, individuals rely on the laboratory that conducts the analysis to interpret the results, frequently without taking the time to learn about their rating/ranking system.

We recently reviewed an inspection report for an office building in which a large number of air and surface samples had been collected. The investigator simply accepted the laboratory's determination as to whether samples were "elevated" or "normal," based strictly on a comparison of total spores outside versus inside. Using these simplistic criteria, most of the indoor samples looked fine compared to outdoors, so the inspector declared that there was no mold problem in the building. Unfortunately, this comparison of overall spore levels failed to point out that more than 40 percent of the indoor air samples were dominated by *Aspergillus/Penicillium*-like spores, while that same type of fungal material was absent from the outdoor comparison samples.

The inspector also failed to look for a correlation between air and surface samples. In this case, in 10 of the 11 rooms where elevated *Aspergillus/Penicillium*-like spores were recovered in air samples, tape samples from HVAC supply vents contained this same fungal material. Therefore, a review of the same data using two different comparison criteria resulted in completely opposite opinions. The original inspector did not think that a mold problem existed; another believed it was clear that mold contamination was present in different parts of the HVAC system.

ILLUSTRATION 1

ERMI samples utilize a special dust collection nozzle and a standard or HEPA filtered vacuum. The nozzle with the dust collection cup (the white part connected to the black hose) is slowly and repeatedly vacuumed over a precisely measured area of flooring.

These are not merely academic discussions. The initial rationale for the investigation was to determine if a mold-sensitized worker could safely reoccupy the building. Relying on the initial investigator's findings could create intensified health problems for the worker and significant legal liability for the building owners. The initial question was appropriate (Is there a mold contamination problem in the building?) and the sampling techniques were suitable (air and surface samples). However, the data interpretation process was not correct, leading to a completely erroneous conclusion.

Recommendations for Specific Situations

With this background information, let me offer some specific guidance in regard to mold testing in various situations. Remember, these suggestions reflect my study and experience and should be reviewed in the context of your particular situation. Still, they serve as a useful starting point for anyone who thinks that they have a need for sampling related to fungal materials or water-damaged buildings.

Utilize ERMI samples when evaluating whether conditions in a building are contributing to specific health problems.

ERMI stands for Environmental Relative Moldiness Index, a sampling and analytical process developed by the Environmental

Protection Agency (EPA). Following the recommended procedures, ERMI samples are collected by utilizing a vacuum with a special nozzle and filter arrangement. A 3-foot by 6-foot area of flooring is marked out in both the living room and primary bedroom. Dust is vacuumed from these marked areas as a single composite sample. **(See illustration 1 for an example of the ERMI sample collection equipment).**

Utilizing polymerase chain reaction (PCR), a relatively new analytical technique patented by the EPA, an ERMI dust sample is analyzed for 36 specific mold species. Twenty-six of these species are considered to be water-damage indicators, with the remaining 10 fungal types classified as common indoor molds. The results from the two categories of mold are compared using a statistical process so that a single ERMI value, ranging from -10 to 20 or more, is produced.

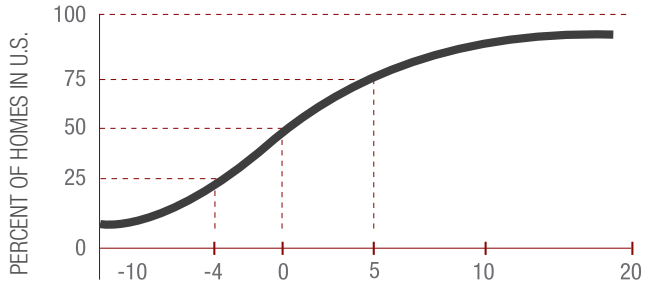

ILLUSTRATION 2

National "Environmental Relative Moldiness Index" – ERMI

Perhaps the most appealing thing about the ERMI samples is that the EPA has developed a comparison chart for the results, **as shown in illustration 2.** The score from a particular home is compared to the chart, which was developed based on an assessment of more than 1,000 homes to determine the "mold burden" in average homes compared to water-damaged structures.

Using the EPA system, a score of zero or less indicates that the mold burden in the house is average or better. A score of five or higher would be clear evidence that water damage and fungal growth were present in the home at some point.

Still, the ERMI process is not perfect, as it provides a historical perspective rather than one based on current conditions. Therefore, water damage and subsequent mold growth that developed a few weeks prior to the sampling may not be adequately identified by the floor dust samples. In addition, while the ERMI may answer the question for the owner as to whether the building is safe for an ill individual, an elevated score does not pinpoint the source(s) of the problem.

Consider interpreting ERMI sample results using the Hertsmi-2 criteria when deciding if a building is safe for re-occupancy by individuals with mold-related health problems.

The EPA rolled out the PCR analytical technique and background information related to ERMI samples to identify specific mold DNA more than five years ago. Since then, many creative ways to understand and utilize the data have been published.

One of the most useful criteria is the Hertsmi-2 (i.e., Hurts Me). A physician developed this scoring system, which looks at specific types of mold identified in the ERMI sample. Scoring values are assigned based on the concentration of five different types of mold that are prevalent in the homes of individuals with the most significant mold illnesses. As such, a quick and simple test is now available to answer a question that has long eluded both contractors and consultants: Is the building safe following a remediation effort?

ILLUSTRATION 3

A Wonder Air sampling pump and Zefon cassette collect a post-remediation sample through the isolation barrier that separates the work area from the unaffected part of the house.

Direct-read air samples are useful in building assessments to help identify fungal contamination sources.

Although there can be substantial variations over time, direct-read air samples (such as those collected on Air-O-Cell cassettes) are an important tool in identifying mold problem areas. Unless visible mold sources are evident, a 15-minute run time provides a better sense of possible problems in a building than five- or 10-minute samples. **(See illustration 3 for an example of a sample being collected for analysis by optical microscopy.)**

Of course, the sampling should be done with the support of information collected about the situation. What is the history of water damage? Is mold visible in the room where the sample is being collected or in adjacent areas? Are the occupants complaining of symptoms?

Cultured samples should be collected if an ill individual is trying to correlate his or her exposure to a particular environment.

Both air and surface samples must be cultured to identify biological constituents to the species level. If a building occupant has had blood work or other medical diagnosis that has identified a particular species of fungal contaminant or bacteria that could be from a water-damaged building, then the addition of samples that are grown in a Petri dish is important. Several products, including Via-Cell and Bi-Air sampling cassettes, allow a single sample to be collected, which can be analyzed either by direct microscopy or by culturing on an appropriate nutrient agar.

Wall cavity samples should be collected if the results of a visual inspection do not provide enough information to determine whether mold growth on the wall is a result of high humidity or some other water source.

The technology for sampling inside a wall leaving only a pencil-sized hole leaped forward with the introduction of the inner wall attachment for Air-O-Cell cassettes. Even wall cavities with fiberglass insulation can be reviewed using these devices, although walls with wet-blown cellulose or foam board are not good candidates for such sampling efforts. Patching after sampling can be minimized if the samples are collected behind rubber baseboard or from an existing opening in the wall surface.

If the goal of sampling is to gauge the effectiveness of remediation activity, post-remediation air samples should be collected with the engineering controls in place and operating.

Isolation barriers and HEPA-filtered negative air machines are utilized during mold remediation to ensure that airborne contaminants released during the remediation process do not cross-contaminate adjacent areas. Until there is documented evidence that the remediation has been successful, those engineering controls are critical to protecting the building and contractor. There is no other type of contaminant control procedure (radiation, asbestos, lead, etc.) where contractors are routinely told by consultants to jettison their planned safety efforts before they know that the work was completed properly. Such instructions generally indicate that the consultant is confused about what question he or she is trying to answer with the sampling data.

Use objective published criteria for evaluating the success or failure of post-remediation sample results rather than the subjective "professional judgment" of a particular consultant.

Regardless of who sets the post-remediation criteria, remediation contractors still bear substantial liability for the successful completion of their projects. Following bad advice is no excuse, even if the advice comes from someone who claims to be a professional. **Illustration 4 (below)** is an objective set of criteria that has

POST-REMEDIATION EVALUATION CRITERIA FOR MOLD CONTAMINATION

1 VISUAL INSPECTION
Were the specifications followed? Was the moisture source identified and corrected? Were the contents and debris removed? Was all visible mold removed? Was the work area white-glove dust free?

2 TOTAL SPORE CONCENTRATION
Is the total spore concentration less than 2,000 c/m^3 (typical of a normal fungal ecology)? If less than 800, go to Step 4.

3 COMPARISON TO MAKE-UP AIR SOURCE
Is the total spore concentration on the work area sample below that on the comparison sample?

Comparison sample collected from out-of-doors or inside building but outside work area, depending on location of containment entry point.

4 RANK/ORDER COMPARISON
Is the level of each fungal type (and hyphae) recovered from the work area less than 100 c/m^3 above the level of the same fungal type (and hyphae) on the comparison sample?

5 INDICATOR ORGANISMS
Were *Aspergillus/Penicillium*-like spores on the work area sample less than 200 c/m^3?

6 TARGET ORGANISMS
Was the work area sample free of target fungal types, both counted and observed?

Zero tolerance of Stachybotrys sp., Fusarium sp., Trichoderma sp., Memnoniella sp., Chaetomium sp.

ILLUSTRATION 4

been published in a peer-reviewed journal and reviewed by the Environmental Council of the Restoration Industry Association. It is a good choice for contractors conducting their own post-remediation *evaluation* sampling, as well as third-party post-remediation *verification*.

Use tape samples or microvacuum samples to determine if contents are contaminated by mold.

Collecting surface samples is simple when using products such as Bio-Tape. This flexible plastic microscope slide has sticky media on one end that can be pressed against any surface to collect a sample. It makes sampling easy on uneven surfaces, such as clothes or bedding.

Have surface samples analyzed so that the quantity of fungal spores is presented as a percentage of the sample area.

If laboratory results are determined as a percentage rather than a raw count, the following guidelines can be used to interpret the sample results:

Fungal Material	Usual Indication
≤ 1%	Normal fungal ecology
Between 1 and 3%	Indoor environment contaminated with settled spores that were dispersed directly or indirectly (Condition 2)
≥3%	Indoor environment contaminated with the presence of actual mold growth and associated spores (Condition 3)

Note that the presence of target spore types (*Chaetomium, Fusarium, Memnoniella, Stachybotrys,* and *Trichoderma*) is an automatic indication of fungal contamination, regardless of the percentage of spores.

Consider using field-portable sampling instruments to determine the cleanliness of surfaces and contents prior to final verification sampling.

ATP samplers, such as Bio-Reveal, identify the presence of any organic residue by reacting with the universal cellular enzyme adenosine triphosphate (ATP). ATP instruments have a long history of use in food-service and healthcare settings to determine the cleanliness of surfaces related to biological contaminants.

> "IT IS CRITICAL THAT ALL RESTORATION PROFESSIONALS HAVE A WORKING KNOWLEDGE OF MOLD SAMPLING AND DATA INTERPRETATION PROCESSES."

Such instruments provide numerical results that include fungal, bacterial, plant and animal residue. The fact that ATP tests are not specific to any one type of biological material is actually a benefit in the cleaning of contents. It makes sense that if the cleaning process has removed all biological materials, it certainly has removed the fungal constituents. An added benefit of using the Bio-Reveal instrument **(see illustration 5 below)** is that the manufacturer has completed extensive testing that allows it to offer guidelines for interpreting data for both water loss and mold projects.

Even if You Never Collect a Sample

This entire discussion may seem a bit academic to some restoration professionals, as they have been convinced that they should never do their own mold sampling. Even if that is true, it is critical that all restoration professionals have a working knowledge of mold sampling and data interpretation processes. The results from pre-work inspections and post-work verification sampling have such a direct impact on the success of a remediation project that contractors cannot afford to leave all the sampling decisions up to a third party.

Ultimately, the contractor has legal exposure on these projects. If done properly, mold testing can minimize that liability. Conversely, mold tests can increase a contractor's liability if they are selected, collected or interpreted poorly. As the saying goes, forewarned is forearmed.

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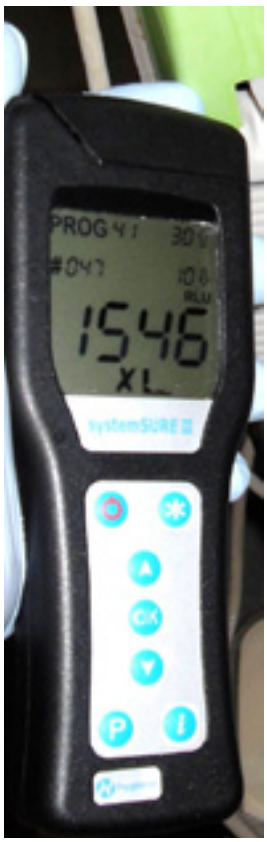

ILLUSTRATION 5