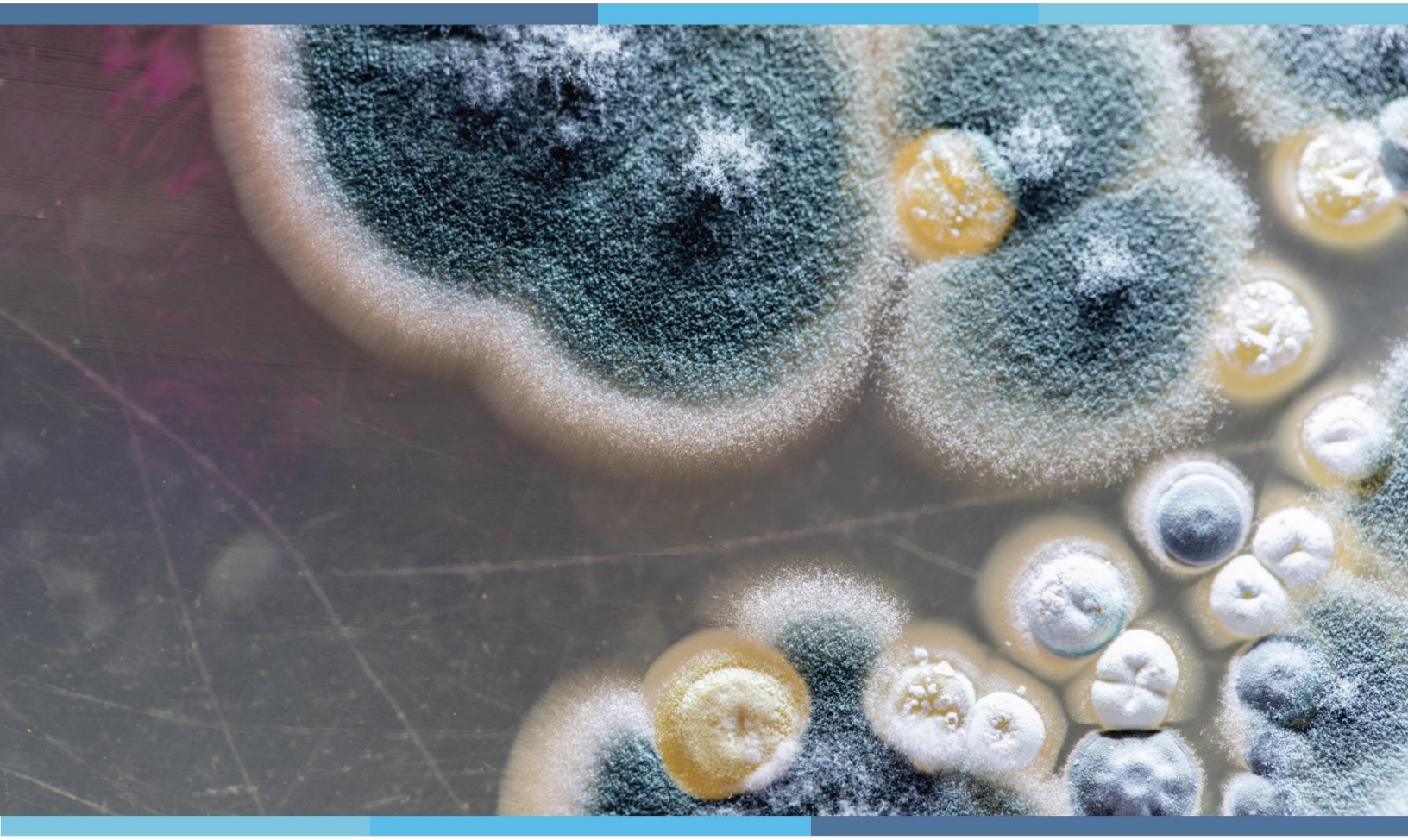
Mold Assessment Federal Testing Guidelines



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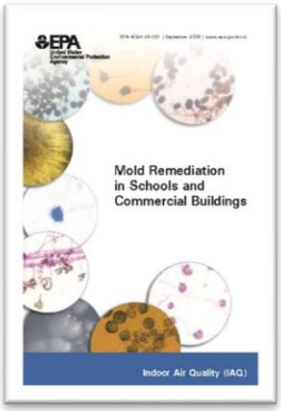
Free-Mold-Training.org • Gary Rosen, Ph.D.

HUD Mold Assessment

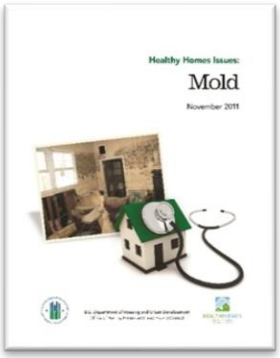
EPA Mold Remediation in Schools and Commercial Buildings

There are numerous federal agencies that base their mold remediation recommendations on the EPA's *Mold Remediation in Schools and Commercial Buildings* including the CDC, OSHA, FEMA and HUD.



Who is this EPA mold guidance written for? The document says:

> *"It has been designed primarily for building managers, custodians, and others who are responsible for commercial building and school maintenance. It should serve as a reference for potential mold and moisture remediators."*
>
> *"Using this document, individuals with little or no experience with mold remediation should be able to make a reasonable judgment as to whether the situation can be handled in-house."*
>
> *"It will help those in charge of maintenance to evaluate an in-house remediation plan or a remediation plan submitted by an outside contractor."*
>
> *"Contractors and other professionals who respond to mold and moisture situations in commercial buildings and schools may also want to refer to these guidelines."*



The focus of mold assessment in the EPA document is limited to visual methods, moisture measurements, and odor. Sampling / testing, they say, should be left to experienced professionals.

What guidelines are available from the federal government for these "experienced professionals" to use when an assessment needs to extend beyond the visual?

For Federal Guidance on mold assessment procedures, we can look to the U.S. Housing and Urban Development (HUD) *Healthy Homes Issues: Mold* Nov 2011, which provides a thorough literature review of the scientific basis for mold sampling / testing as of November 2011.

HUD cautions: "*Before the decision is made to sample, there should be a clear justification for the sampling. Sampling is most beneficial when used to augment a visual inspection or survey information, and to help address particular questions that derive from the inspection (e.g., the extent of contamination within a building).*"

While initial testing and sampling may at times not be necessary to determine the scope of work, post remediation verification (PRV) testing by mold professionals is mandatory. Mold professionals must ensure the remediation work has not compromised / cross-contaminated the indoor environment, which can only be reliably determined by post remediation air sampling of the indoor environment.
Culture testing to detect fast mold growth is important for Insurance work.

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Definitions

What do the terms “viable,” “non-viable,” “direct microscopic examination,” “spore trap” and “culturable sampling” mean?

Non-viable / dead mold spores are spores that are not capable of growing in contrast to **viable** / live spores that can grow and germinate.

Spore trap air sampling collects both viable and non-viable airborne mold spores by drawing air into air sampling cassettes that are then analyzed at the lab by Direct Microscopical Examination (DME). DME does not distinguish viable / live from non-viable / dead spores. Spore trap sampling is also referred to as sampling for “total spores” since sample results are reported as the total of both viable and non-viable spores.

Swabs collect surface samples for analysis either by DME or Culture Methods.

Culturable air or surface sampling collects both viable and non-viable spores onto a petri dish filled with growth media, on which the viable spores grow.

Mold assessors often test with spore trap air sampling rather than culturable air sampling for two main reasons: **(1)** spore traps are inexpensive, with fast, 24-hour turn-around time; and **(2)** spore traps, unlike culture samples, measure *both* non-viable as well as viable mold spores, which is important because both non-viable as well as viable mold spores can be irritants / allergenic.

For Insurance work the culture method is key. It shows that mold grows/grew in 24-48 hours triggering coverage.

HUD Reviewed Methods Used to Assess Mold in the Home

Surface and Bulk Sampling

Per HUD Healthy Homes:

> *“For routine initial assessments in which the goal is to identify possible mold contamination problems prior to remediation, it may be unnecessary to conduct surface sampling because decisions about appropriate remediation strategies can typically be made on the basis of a visual inspection [with the aid of moisture meters and / or infrared / thermographic (FLIR) cameras.]”*

Note: The HUD Healthy Homes document, though rather extensive, focuses only on initial assessment. It includes essentially nothing about Post Remediation Verification testing.

The presence of mold spores or growth on surfaces can be detected with surface sampling techniques such as tape-lift, Bio-Tape or swab samples, or by bulk sampling techniques whereby portions of materials are collected (e.g., sections of wallboard, pieces of duct lining, carpet segments, or return air filters).

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Surface & Bulk Sampling

Objective of Surface & Bulk Sampling

- To determine whether or not the visible stain, discoloration, etc. is indicative of mold growth at the sample location.
- To determine and identify the type of mold growth on the surface sampled.

Advantages and Disadvantages

- Advantages
  - Surface sampling is inexpensive and may be analyzed immediately (no incubation).
  - Surface sampling may reveal indoor reservoirs of spores that have not yet become airborne.
- Disadvantages
  - The presence of biological materials on a particular surface is not a direct indication of what may be in the air.
  - A mold professional should be able to determine if the substance that looks like mold growing on wet or previously wet surfaces is mold without testing.
  - Rarely will surface sampling provide value in terms of determining a remediation response (what kind of containment/ engineering control and where to put it).

Sampling Protocols

- Tape Sample
  - Use a piece of completely clear (not frosted) tape that is one or two inches in length and 3/4 inch (2 cm) wide. Handle it by the ends only.
  - Position the adhesive side of the tape over the suspect area and press firmly.
  - Remove the tape from the surface and place it onto a clean microscope slide, then place the microscope slides into a slide box or other protective container. If microscope slides aren't available, tape the tape sample directly onto the inside of a zip lock bag adhesive side down, folding over one end for easy removal by the analyst.
  - Do not fold the tape onto itself.
  - Another option is to use Bio-Tape.

- Bulk Sample
  - Remove a one or two square inch piece of the suspect material and place it inside a zip lock bag.
- Swab Sample
  - Swabs are the most popular method of taking mold surface samples. Must be used when the sampling area is difficult to reach, a bulk sample is not practical, or the surface is very wet, and a tape sample will not adhere to the area of concern.

Surface & Bulk Sampling

Lab Analysis

Mold spores or mold growth collected from surfaces or bulk samples are commonly analyzed directly under a microscope by DME (Direct Microscopic Examination).

Or, less commonly, surface samples are collected on and grown on nutrient agar (culture method).

Results from surface samples or bulk samples are reported differently by different laboratories. Surface / bulk sample results may be reported as spores/cm^2 or Usual / Unusual. Other reporting methods may be used as well.

Results from surface samples and lab DME are qualitative and descriptive. And do not indicate whether the observed fungal matter is viable (culturable or not.)

For Initial Assessment: For the HUD Healthy Homes publication, with its emphasis on initial mold testing and health, a major limitation of dust or bulk samples analyzed by DME is that DME does not measure whether the mold is growing.

Why is this a limitation? Per HUD: Although both live and dead mold can result in illness and / or irritation, the presence of mold *growth* is more strongly correlated with irritation / illness than is dead mold.

Keep in mind that the measurement of mold in dust or samples of source material does not measure exposure.

Since inhalation is the primary exposure pathway for molds, air sampling, not surface sampling, should therefore be used to estimate the likelihood of exposure.

For Post Remediation Verification (PRV) testing: Surface sampling is not a commonly used procedure for PRV mold testing since testing a small test area out of a much larger vicinity can never reliably rule out mold contamination.

Note: While the HUD Healthy Homes document solely focuses on initial testing, we need to include discussion of the application of testing to PRV.

Air Sampling. Non-Culturable

Air Sampling with Spore Traps.
Again, HUD cautions:

> *"As with surface sampling, for routine assessments in which the goal is to identify possible mold contamination problems prior to remediation, it may be unnecessary to conduct air sampling because decisions about appropriate remediation strategies can typically be made on the basis of a visual inspection [with the aid of moisture meters and/or infrared/ thermographic (FLIR) cameras.]"*

Per HUD: Air sampling may, however, be necessary in certain situations, including:

1. if an individual has been diagnosed with illness or irritation associated with fungal exposure through inhalation;
2. if it is suspected that the ventilation system is contaminated. Elevated levels of Pen/Asp spores throughout a home's indoor air is in general a good indication of mold contaminated ducting
3. if it is suspected that there are reservoirs of mold spores in old carpeting or house dust that may impact the ability to pass a post-remediation verification air test;
4. to determine by Post Remediation Verification testing that there has not been any cross-contamination of the air due to failed or careless mold remediation efforts.

It is important to note: Airborne mold particulates may include spores, toxin laden fungal fragments, aggregates of spores or fragments, or materials contaminated with fungal product. However, spore trap air sampling methods will only test for spores.
Spore trap sampling collects mold spores from the air onto small sticky slides inside the air sampling cassette (i.e., Air-O-Cell). Slides are removed at the lab and analyzed by Direct Microscopic Examination (DME).

Advantages of Spore Traps vs Culture Methods

- Spore trap samplers are capable of capturing a majority of [total] spores and particulate matter in the air. Consequently, it is possible to characterize problem environments where spores are present, but either are no longer viable, or are species that do not culture well. These are two situations where culturable sampling techniques, if used alone, may miss a potential Indoor Air Quality (IAQ) problem.
- Spore traps can also be used to quantify pollen, fiberglass, hyphal fragments, hair, skin cells, etc., present in the air.
- DME-analyzed spore traps measure the *total* spore amount, including both dead (non-viable) and viable spores as long as they are whole mold spores.
- Samples can be analyzed immediately. There is no lag time in comparison to culturing.

Air Sampling. Non-Culturable

Disadvantages

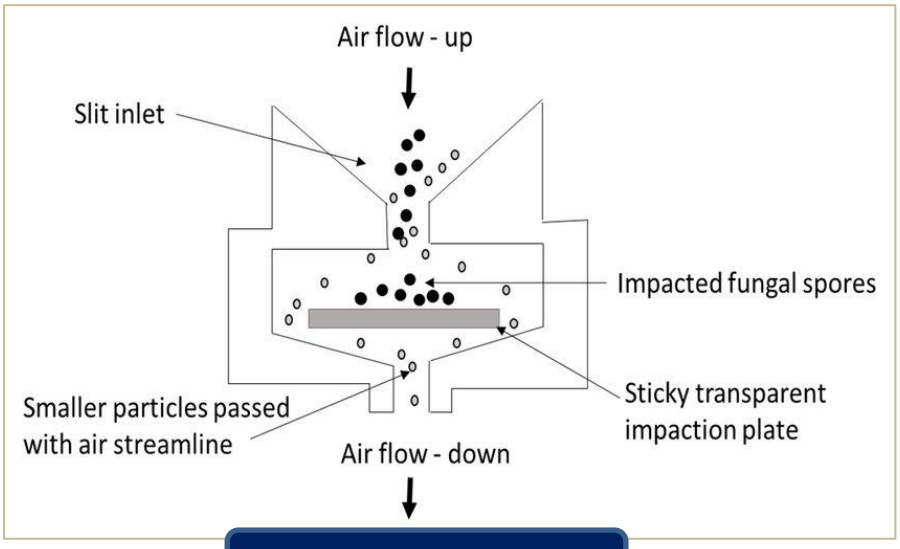
- While many mold spores have a unique morphology and are identifiable by DME, others are not and are more difficult to identify. These latter types must be counted in broader spore groups. In certain situations, this grouping may mask an Indoor Air Quality (IAQ) problem.
- Viability is not assessed. This is not critical to many situations.
- Only measures whole mold spores. Not fragments that can be more numerous and more irritating that whole spores.

Spore trap sample results are reported as spores per cubic meter of air (spores/m^3) as well as percentage of total.

Identifying individual **species** from, for example, penicillium, aspergillus or most other genus is not possible by DME. For that, it is necessary to culture the sample or use molecular/DNA methods for speciation.

However, speciation is rarely needed for either determining remediation response or for Post Remediation Verification (PRV) testing.

The vast majority of mold professionals perform air sampling using only the spore trap method. It is simple to sample, low cost, and has very a fast turnaround time (meaning the time it takes to receive results after submitting the samples to the lab) compared to culture air samples that must be incubated for about a week prior to analysis.



Spore Trap Mechanism

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Air Sampling Culture Testing

Air Sampling With Culture-Based Analysis

A less common, but nevertheless powerful method for testing air samples is by culture-based analysis.

Advantages of Culture-Based Analysis

- Culturable air sampling allows for speciation and the differentiation of two of the most common molds in water damage environments *aspergillus* from *penicillium* which spore traps cannot.
- Measures live / viable (fresh / new) spores and is indicative of mold growth. Per HUD, the best-established health effect of mold relates to the presence of *mold growth*

Disadvantages of Culture-Based Analysis

- Culturable air sampling methods require that the spores in the air are alive, survive the sampling process, germinate on the sampling media, and compete well with other species present on the growth media.
- Culturable sampling does not indicate the presence of non-culturable (dead) spores, which are also capable of producing allergies or other irritation.
- Culturable sampling requires a minimum of five to seven days for incubation after the sampling has taken place.

Culture-based air samples for mold are commonly collected by inertial impaction samplers. Examples of such samplers include Andersen, SKC BioStage, and Buck BioAire.

The culture-based sample collected on the impaction surface (petri dish filled with growth media) is incubated in the laboratory. The fungal colonies then are able to grow on the media are counted and identified by traditional microbiological methods (colony morphology, microscopical examination of spores and mycelial fragments, colony growth characteristics, etc.).

Andersen Impactor

Culture air testing is often going to be performed in addition to spore trap testing, not in lieu of.

Air Sampling Culture Testing

What follows is a typical step-by-step culture air sampling procedure:

- A known volume of air is drawn across a plate / petri dish inside an Andersen Impactor containing a growth medium (such as potato dextrose agar).
- Viable and non-viable spores are impacted on the plate / petri dish, with the live / viable spores growing / germinating.
- The Petri dishes are sent to the lab where they are incubated at elevated temperature a minimum of 5-7 days.
- The molds / fungi that germinate are then identified based on their physical characteristics (shape, size, color) and counted and identified down to the genus level or optionally to the genus and species level.
- Results are reported as colony-forming units (CFU) per cubic meter of air (CFU/m^3) along with the relative concentrations of each mold found.
- Typically, fungal species identification involves extra days or weeks of analysis to determine additional mold growth characteristics, and this involves extra cost as well as additional time for the species analysis.

Pre-Remediation Air Sample

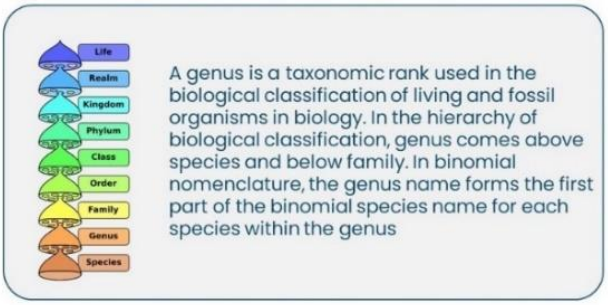
Post-Remediation Air Sample

There is no better method to "show" that a problem exists in the air, or that a prior air quality problem was resolved than with culture sampling. ***Seeing is believing.***

Genus vs Species

Genus and Species

On the previous pages, we mentioned that one can identify mold spores down to the genus as well as species level with culture testing.



What does genus and species level mean? The best way to explain is with an example:

Take the mold *Aspergillus versicolor*. Here *Aspergillus* refers to the genus and *versicolor* to the species.

Another important term is *Water Damage Indicator Molds / Spores*. This refers to molds that are typically found in a home that has current or recent water damage. Such molds are contrasted with molds that are in a home because they blew in or were tracked in from the outside.

Only when testing to both genus and species level can water damage indicator molds be identified.

Water damage indicator molds with only a few exceptions, are species of either the genus — *aspergillus* or the genus *penicillium*. See list below: Aspergillus and penicillium molds are in red.

Common Water Damage Indicator Molds

Stachybotrys chartarum ● Chaetomium globosum ● Cladosporium sphaerospermum ● Aspergillus versicolor ● Aspergillus unguis ● Penicillium variabile ● Aspergillus flavus ● Aspergillus penicillioides ● Penicillium crustosum ● Aspergillus niger ● Eurotium (A.) amstalodami ● Aspergillus fumigatus ● Penicillium corylophilum ● Aureobasidium pullulans ● Aspergillus ochraceus ● Penicillium brevicompactum ● Aspergillus sydowii ● Penicillium spinulosum

Knowing the genus and species of mold spores and / or whether the mold is viable or not is rarely of value to the mold remediator. Indeed, when the mold is gone, what kind of mold was there before remediation, and whether it was dead or alive, is largely irrelevant.

However, for insurance property damage coverage purposes after a water event, details about genus and species as well as the mold's viable / non-viable status can be crucial in determining timing and cause of loss.

Culture Testing for Insurance Claims

For insurance claims, knowing surface mold or airborne mold genus and species along with viability can be useful. Why? It can be helpful when answering questions about cause of loss and timing of loss. How so?

For four reasons:

1. Different species of mold grow at different rates. Knowing mold species can help with determining timing of the water exposure.
2. Some mold species need high levels of moisture / water (wet molds), while some can grow only with humidity (dry molds). Knowing the mold species can help determine cause of loss (water or humidity).
3. Speciation can help determine whether the mold is a water damage indicator mold (from indoor source) or an outdoor mold.
4. Viability can be used to determine timing of loss.
5. For instance, most of the sampled indoor airborne airborne mold is viable, then the mold spores did not come from the outdoors, since most mold spores outside are old / dead and not viable.
6. **Surface sampling of mold from the property is crucial. Show it grew/grows in 24-48 hours and triggered coverage.**

Elevated “live” airborne mold.

The rate / timing of surface mold growth (germination in days) is most valuable to determine coverage for an Insurance Claim. Use it to rule out denials based on"long tern damage" exclusions.

ERMI Mold Analysis

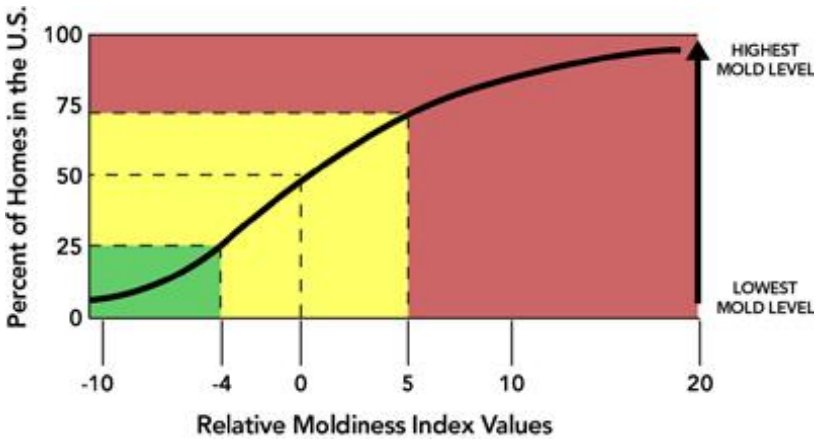
ERMI DNA Mold Analysis

What Is ERMI? The Environmental Relative Moldiness Index (ERMI) was developed by the U.S. Environmental Protection Agency, Office of Research and Development (ORD) as a research tool to investigate mold contamination in homes. The methodology is based on using mold-specific quantitative Polymerase Chain Reaction (PCR) to quantify 36 molds and calculate an index number for comparison with a database of reference homes.

How Does ERMI Work? The ERMI test involves the analysis of a sample of floor dust or air from a home. The sample is analyzed using mold-specific quantitative PCR, a highly specific DNA-based method for quantifying mold species. A simple algorithm is used to calculate a ratio of water damage-related species (water damage indicator molds) to common outdoor molds and the resulting score is called the Environmental Relative Moldiness Index or ERMI.

The EPA's ERMI consists of testing for 36 molds, broken down into two groups:

- **Group 1:** 26 species of molds that represent the species most associated with water-damaged environments (water damage indicator molds). It is however not an exhaustive list of water damage indicator molds.
- **Group 2:** 10 species that are considered common molds in homes that come from the outside air. These are not water-damage indicators.



The ratio of Group 1 to Group 2 can be used to classify an indoor environment as having elevated levels of water damage indictors or not. Elevated levels of Group 1 (water damage indicator molds) means that there has likely been and may still be water damage in the home.

Keep in mind that DNA testing, just like spore traps, counts both dead and live spores and therefore can provide no information as to the timing of the water damage.

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ERMI 36 Species

Group 1: Water Damage Molds	Group 1: Water Damage Molds	Group 2: Common Indoor Molds
1) Aspergillus flavus/oryzae,	14) Eurotium (Asp.) amstelodami	27. Acremonium strictum
2) Aspergillus fumigatus	15) Paecilomyces variotii	28. Alternaria alternata
3) Aspergillus niger	16) Penicillium brevicompactum	29. Aspergillus ustus
4) Aspergillus ochraceus	17) Penicillium corylophilum	30. Cladosporium cladosporioides1
5) Aspergillus penicillioides	18) Penicillium crustosum	31. Cladosporium cladosporioides2
6) Aspergillus restrictus	19) Penicillium purpurogenum	32. Cladosporium herbarum
7) Aspergillus sclerotiorum	20) Penicillium Spinulosum	33. Epicoccum nigrum
8) Aspergillus sydowii	21) Penicillium variabile	34. Mucor amphibiorum
9) Aspergillus unguis	22) Scopulariopsis brevicaulis/fusca	35. Penicillium chrysogenum
10) Aspergillus versicolor	23) Scopulariopsis chartarum	36. Rhizopus stolonifer
11) Aureobasidium pullulans	24) Stachybotrys chartarum	
12) Chaetomium globosum	25) Trichodermaviride	
13) Cladosporium sphaerospermum	26) Wallemia sebi	

Per HUD, the benefits of ERMI are:

- It is species specific, which allows assessment of mold species (speciation) suspected to be associated with health effects or environmental conditions.
- Unlike live culture analysis, it measures both non-viable and viable molds, which is important because non-viable molds are also potentially allergenic.
- It results in fewer “non-detects” than live culture analysis.
- It is apparently more reliable than live culture analysis because not all species may grow on the culture media, and because on culture media, fast-growing mold species may overtake slow-growing species.
- It finds higher concentrations than culture analysis, sometimes by orders of magnitude.
- It is quicker and easier than culture methods.
- *Detects mold micro-fragments in addition to mold and spores.*

One of the breakthroughs of DNA mold analysis is that it detects not only spores but also detects mold fragments — fragments can also contain mold DNA.

Why is detecting mold fragments important? Airborne mold fragments are invisible to traditional testing (spore traps and culture) but several studies have shown fragments are more numerous and a greater health risk to mold sensitive people than spores.

Therefore, DNA testing that measures airborne mold fragments, in addition to spores, has proven to be game changer for assessing mold exposure problems for mold sensitive occupants.

ERMI

Per HUD, drawbacks of ERMI testing are:

- The cited investigators found that results of PCR-analyzed settled-dust samples did not correlate with PCR-analyzed air samples.
- ERMI does not measure if spores are viable / live. [Therefore of limited value for insurance claims.]

For HUD Healthy Homes, the last limitation of ERMI —not measuring whether the mold is growing—is a critical limitation.

Again, with HUD's emphasis on mold and health, the best-established health effect of mold relates to the presence of mold growth. Not dead mold. As powerful as ERMI is, it is not a replacement for culture methods that not only provides mold speciation but also measures viability and the rate of mold growth.

Additionally, we offers our own assessment of several ERMI drawbacks:

- The cost is high; each sample is about $300.
- ERMI only analyzes 36 types of mold, while culture testing analyzes thousands.
- The sole focus of most assessors that perform DNA sampling is on DNA dust sampling and not air sampling.

Be advised that mold in pockets of dust does not reflect actual exposure from breathing mold.

Caution: Many mold assessors use the high values of mold DNA in dust (mold spores and mold fragments are a significant component of house dust) as a scare tactic to push expensive remediation.

Comparison of Different Mold Analysis Methods

	Spore Traps	Cultures	MSQPCR
Speed	Results available in 24 hours or sooner	5-10 Days	Results available in 24 hours or sooner
Identification	Genus level of all identifiable mold spores (No ID of Hyphae)	Genus and/or species level of viable spore-producing molds (No ID of Hyphae)	Genus and species level of client selected molds
Quantification	Spores	Colony Forming Units	Cells*
Accurancy	GOOD	BETTER	BEST
Viability	Cannot be determind	Can be determind	Cannot be determind
Sampling Time	Limited due to possibility of overloading sample	Limited due to possibility of overloading sample	No restrictions

ERMI vs HERTSMI-2

ERMI vs HERTSMI-2

Another form of DNA based mold analysis is HERTSMI-2. Here we compare to ERMI.

ERMI is a 36-panel procedure developed by the EPA for testing both air and dust.

HERTSMI-2 is a 5-panel proprietary (subset of ERMI) procedure prescribed by many doctors, but it is only defined for testing dust, not air; it does not measure exposure.

Again, keep in mind that mold in pockets of dust does not measure actual exposure (mold being inhaled). Finding mold in dust, which always comes back elevated, (since mold and mold spores are significant contaminants in household dust) is often used as a scare tactic to pay for expensive medical treatment or mold remediation when often not needed.

- Finding mold in dust does not help determine if there is significant mold exposure.
- Finding mold in dust does not help determine the source of exposure for the purpose of remediation.
- If there is mold in settled house dust, clean the dust. Swiffers or similar products work just fine.

Mold in dust? Clean the dust.
When there is no dust, there is no mold in the dust.

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Intrusive Inspections Per ASTM

Intrusive Inspections

Here, HUD's advice is based on sampling to aid *visual* inspection. But they do not define what a visual inspection for water damage is.

More helpful would be the American Society for Testing and Materials' (ASTM) D7338 *Standard Guide for Assessment of Fungal Growth in Buildings* June 2014. ASTM has done a good job defining that a visual inspection is not simply a surface inspection.

Per ASTM on Intrusive Inspection for Hidden Fungal Growth:

> *"Accessing covered surfaces or building envelope assemblies may be necessary where suspect fungal growth or moisture indicators are not visible or moisture pathways potentially impact materials susceptible to growth.*
>
> *Hidden fungal growth may be concealed in wall or ceiling cavities, on the exterior side of wall sheathing, under carpets, or behind vinyl wall coverings, baseboards, or vinyl base cove, and behind attached furniture. Access to such locations may involve cutting either a small hole for a boroscope or a larger hole for direct viewing (for example, using an inspection mirror and flashlight). Similarly, a section of carpet, baseboard, or wall covering may be pulled back to reveal building materials. In each case, materials should be removed layer by layer to reveal any concealed conditions. Visible discoloration patterns may help confirm sources for repair and surfaces for remedial measures."*

And per ASTM on the HVAC System:

> *"If applicable per the scope of work —The interiors of HVAC equipment in contact with ventilation air should be inspected for indicators of excessive moisture or suspect fungal growth… HVAC controls affecting humidification and dehumidification should be identified and located. Humidity control should be considered over the range of seasonal operations. All potentially significant moisture-related deficiencies in design, operation, or maintenance should be documented. The location and timing of negative pressure within the building, including air plenums, cavities and chases, may also be of interest in regard to moisture pathways."*

Finding mold in the HVAC system requires the help of specialists and is generally outside the scope of work of a most mold assessors or hygienists. This is unfortunate because, when it comes to occupant irritation, the problem is almost always contaminated ducts.

Note that air duct cleaners are non-licensed entities and, though they claim to clean ducting in homes, they generally do not. Typically, they only clean the grills and the inside of AC supply cans, but not the entire duct system.

Thresholds

Moldiness Thresholds

There is always some level of mold spores in the indoor air as mold spores are always present in the outdoor air that enters the home as people enter and exit.

However, there are no federal or state-level guidelines or thresholds as to what is elevated or not-elevated (problem level or not-problem level) indoor air. Whether a level of indoor mold is problematic or not is quite often more reflective of occupant sensitivity than of the precise indoor mold spore levels.

Eurofins Scientific, an international group of life sciences companies that provide a cross-industry, analytical testing services, offers an overview on the lack of industry-wide standardization:

No widely accepted standards exist for any type of fungal sampling (surface, dust, aerosol).

- In 1986, 1987, and 1989, the ACGIH (American Conference of Governmental Industrial Hygienists) published numerical guidelines. In 1999, they took them back.
- Scientifically valid numerical guidelines are unlikely to exist in the near future.
  Each case must be considered individually.
- Sampling data is unlikely to be used as the sole, or even primary, source on which to base recommendations.

Eurofins offers good advice. There is in fact no way to *measure* at what level of mold a mold sensitive person will be sick. However, one can determine if a home or office is making them sick or not by asking: Are you sick / irritated indoors but not outside or in other buildings?

It therefore follows that, if an occupant was irritated at home (but not outside), and then no longer reports any irritation in the home after remediation has occurred that is, while not quantitative, certainly the best measure of successful remediation.

As Eurofins notes, each case must be considered individually. Quantity of mold in the air that will cause irritation will vary depending on the person. Nonetheless, it is safe to say based on our experience that if the indoor air is essentially free of mold or mold fragments (spore traps < or = 100/200 spores per m^3), with no *stachybotrys* or *chaetomium* (toxic molds), there will be no irritation for even the most mold sensitive.

This ultra-low level goal for mold spores in the indoor air after remediation is likely to be unnecessary for healthy people, but often needed for the mold-sensitive.

Testing Activities

We can consider four different kinds of activities where mold testing may be warranted. While HUD *Healthy Homes* is focused only on the first activity "Health Concerns", we take a wider view:

- **Health Concerns:** Often the best method for testing is to listen to the client. Are they irritated in the home and not outside the home? Do they wake up with swollen sinuses, red eyes or scratchy throat? If the home is clean and dry, without old carpeting, use the process of elimination to investigate whether the irritation may involve the AC, AC closet or ducting where even a small amount of growth can result in significant exposure. In comparison, even a large amount of mold growth *within* walls or attics will not cause irritation because mold spores do not penetrate sheet rock.
  Here, Post Remediation Verification (PRV) clearance *testing* for the mold sensitive client is simple. After the AC/ducting has been refurbished to new by a certified specialist ask: Has the client's irritation in the home gone away? If so, pass. If not, no pass. No other testing required. An irritation-free home should be guaranteed for such work.
- **Real Estate Transactions:** Buyers want testing. Home inspectors take both spore trap air samples and surface samples. Buyers mistakenly think air testing will help determine if there is hidden mold in walls or ceilings but it cannot. Spores do not penetrate sheetrock. Air sampling can often find mold problems hidden in the AC and/or ducting that cannot readily be determined any other way.
- **Insurance Claims:** Insurance carriers want testing to prove that what looks like mold growing on water damaged materials is actually mold. Mold assessors generally take spore trap air samples and surface samples. This is of limited value.
  Swabs analyzed by Culture testing can show that mold starts/started to grow in 24-48 hours triggered coverage.
- **Obvious mold and / or water damage problem**: If a client calls with obvious water damage and likely mold inside the wall, say under a leaking window, there often is no reason to perform initial testing. Resources are best spent removing the mold rather than characterizing the mold. However, there should always be PRV testing to make sure the premises have not been left contaminated. For small jobs this should be performed by the remediator unless state law prohibits (as in New York, Texas). Florida law does not prohibit a mold remediator taking their own PRV testing.

Testing or not testing is a function of the type of water event. In some cases, such as with an obvious recent leak, testing may not serve a purpose. But while HUD cautions against relying on testing, testing is popular because it provides additional information beyond the visual inspection and is not expensive (except for ERMI DNA analysis).

Testing Variability

According to American Industrial Hygiene Association (AIHA) *FAQs-About-Spore-Trap-Air-Sampling-for-Mold-for-Direct-Examination-Guidance-Document:*

Q. What variables in environmental conditions can influence sample collection?

A. *"Variability in direct measurement is influenced both by the conditions of the sampling environment and by laboratory analyst-to-analyst variation. For the environment under evaluation, these considerations include conditions indoors and outdoors prior to and during the sampling. Some of these considerations are identified below:*

- *Type, operation, cleanliness and maintenance of the heating, ventilation and air conditioning (HVAC) system.*
- *HVAC outdoor air supply rate and building air exchange rate.*
- *Outdoor conditions, including season, weather, wind speed and wind direction.*
- *General cleanliness of the indoor space.*
- *Building envelope condition, such as windows or doors being open or closed.*
- *Type, density and activity of occupants.*
- *Processes and occupant use.*
- *Activity near the sampler prior to and during sample collection."*

For example per AIHA: *"Sampling and analytical error or uncertainty for spore trap samples is generally thought to be between 30 percent and 200 percent. Ideal samples with moderate spore loadings will have a sampling and analytical error closer to 30 percent, while samples with very high or very low concentrations of spores may have a sampling and analytical error closer to 200 percent. This analytical variability must be considered when comparing data from different samples."*

Mold sampling is by its nature not very precise.

Sample results are affected by the type of AC system, quality of air filter, overall cleanliness, and many other factors, even time of the day.

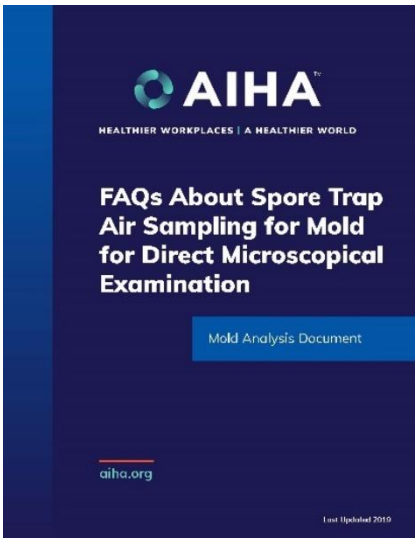
That sample results are highly variable does not mean that sampling is not inherently useful for many activities.

In general, what you need to know is whether: There is an indication of a mold problem or there is not.

Testing can often help answer this question even though testing is not inherently precise. It does not need to be.

Conclusions

In Conclusion: HUD *Healthy Homes* and AIHA *FAQs About Spore Trap Air Sampling* both strongly caution: Do not sample unless there is a hypothesis being tested and a sampling plan. From AIHA FAQs:



> *"Investigations for mold in indoor environments may include the collection of air [and/or surface] samples for direct microscopical examination for fungi, and/or culture-based fungal samples, [and / or ERMI / HERTMSI-2 sampling.]*
>
> *Such sampling requires clearly defined goals and a sampling plan before sample collection.*
>
> *Prior to collecting any samples for mold, the mold assessor should determine the purpose and relevance of the sampling, as well as ascertain the questions the sampling will answer.*
>
> *Sampling should be considered as a screening tool or as ancillary to a thorough [intrusive] visual inspection [aided by moisture measurements.]*
>
> *Testing results should confirm observations or otherwise support conclusions made based on the visual inspection.*
>
> ***In the absence of a thorough visual, intrusive inspection, air or surface sampling alone should not be used to support any definitive conclusions."***

HUD and AIHA both caution about the limitations of mold testing, and that the focus of a mold assessment should be visual assessment. Nevertheless, mold testing should be part of almost any mold inspection. Mold testing can usually provide additional information beyond the visual inspection and is not expensive (again with the exception of ERMI.)
So we test.
For example, unless one performs air testing, it is not possible to determine if the HVAC system is contaminated and releasing mold spores.
So we test.
Testing is also popular simply because experience indicates that clients expect testing be performed by a professional mold assessor as part of any mold inspection / investigation.
So we test.
For Insurance Claims we use culture testing to show mold grew fast and triggered coverage and to determine if it is a toxin producer.