



Assessment, Remediation, and Post-Remediation Verification of Mold in Buildings, 2nd edition

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Discusses exposure and hazard assessments, determination of requirements to allow for the reoccupancy of a building, and post-remediation verification methodologies and techniques.



Assessment, Remediation, and Post-Remediation Verification of **Mold in Buildings**

By AIHA's Law, Biosafety and Environmental Microbiology, and
Indoor Environmental Quality Committees



HEALTHIER WORKPLACES | A HEALTHIER WORLD

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1. INTRODUCTION

1.1 Purpose

This guideline describes the range of exposure assessment, hazard assessment, and re-occupancy post-remediation verification methodologies and techniques currently accepted and available for use by Competent Professionals (as defined in Section 1.5) to conduct assessments of mold growth in residential and commercial buildings.

1.2 Scope

This guideline is intended to:

- Be used by a Competent Professional investigating mold growth in residential and commercial buildings,
- Identify minimum actions required for a Competent Professional to properly inspect and sample for mold in buildings suspected of having excessive mold growth,
- Identify minimum actions required for a Competent Professional to properly establish specifications for remediation of mold contamination, and the re-occupancy post-remediation verification for buildings having excessive mold growth, and
- Be used by a Competent Professional to apply the most cost-effective measures to solve any particular excessive mold contamination problem. These measures would be aimed at reducing human exposures and adverse health effects in such a manner that mitigates and minimizes, to the extent practicable, recurring excessive mold contamination.

This guideline does **not** apply to:

- *Histoplasma capsulatum*, *Cryptococcus neoformans*, hanta virus, animal-derived pathogens or other highly infectious agents,
- *Escherichia coli* associated with sewage-contaminated “black water” events, and
- Healthcare facilities, their residents, individuals with compromised immune systems, or those with a medical condition that can be exacerbated by exposure to mold.

As used in this document:

Mold Assessment means an inspection, investigation, or survey of a dwelling or other structure to provide the owner, building manager, or occupant with information regarding the presence, identification, or evaluation of mold; the development of a mold management plan or remediation protocol; or the collection or analysis of mold samples.

Mold Remediation means the removal, cleaning, sanitizing, demolition, or other treatment, including preventive activities, of mold contaminated material or mold that was not purposely grown at a given location.

Mold Operations and Maintenance (O & M) Program means a program or system that is utilized in residential and commercial building maintenance programs to help in the prevention, identification and response to:

- Deterioration of building materials due to mold,
- Excessive water intrusion,
- Nuisance odors due to mold, and
- Excessive mold growth.

1.3 Basic Principles

AIHA believes that currently, there are basic principles to be followed for professionals conducting mold assessments. AIHA additionally believes that measures taken beyond such basic principles may also be appropriate as they are a matter of professional judgment. AIHA acknowledges that mold assessment of buildings is an emerging field, and there are professional disagreements on several issues.

Requests for mold assessments should be reviewed in the context of other potential environmental issues. Requests for these assessments are sometimes made because symptoms have been attributed to mold, when in fact the underlying cause of concern may be related to some other indoor environmental quality issue. When nonspecific symptoms are attributed to mold, professional judgment should include modification of the investigation strategy as needed, to appropriately consider non-mold indoor air contaminants and other environmental factors. However, possible mold contamination in a building should not be ignored and the Competent Professional should conduct an appropriate visual inspection of the building to identify locations of excessive mold growth.

The basic principles to be followed for Competent Professionals conducting mold assessments include:

1. Excessive mold growth in a living or workplace is undesirable, and should be appropriately addressed.
2. A thorough informed visual inspection of all areas of excessive mold growth is a key component of any successful initial mold survey.
3. Removal of visible mold growth from building materials is the preferred remediation technique.

4. Biocides are often ineffective in mold remediation and their use as a substitute for mold growth removal should be discouraged. The appropriateness of the use of biocides is a matter of professional disagreement. Despite effective disinfection, biocides may leave an allergenic residue when used as a sole treatment. Biocides may play an effective role as part of a remediation or O&M program for buildings with excessive mold growth.
5. Sampling for airborne mold as an initial investigative tool has some limitations. Results can be misleading and may provide an inaccurate assessment of current conditions. Mold spores are present in almost all indoor environments. In most cases, sampling for airborne mold spores as a sole initial investigative tool cannot conclusively distinguish between the normal background presence of such spores and the presence created by excessive mold growth. The application of professional judgment by a Competent Professional in the interpretation of such results is essential. The levels of airborne mold are subject to wide variability due to a multitude of external environmental and building conditions, creating a challenging environment for both sample collection and interpretation. For these reasons, sampling for airborne mold is discouraged as a primary or sole method of evaluation. However, air sampling can be a valid tool when used within a professional sampling strategy for the validation, verification or testing of exposure hypotheses.
6. At a minimum, a final post-remediation visual inspection of the remediated area should be performed. Appropriate sampling for mold such as bulk and air sampling, can also be used to evaluate remediated areas for quality control and re-occupancy purposes.
7. To avoid a conflict of interest, individuals should not have a stake in both the assessment and remediation firms working on the same project.

1.4 Assessment Tools

AIHA believes that there is a range of acceptable methodologies currently available for use by Competent Professionals in assessing residential and commercial buildings for excessive mold growth. These include, but are not limited to:

1. The results of bulk, wipe, and wall cavity samples may indicate the presence of mold. These methods may not contribute to the characterization of exposure to mold for building

occupants. Rather, they can merely identify the potential sources of mold exposure in a structure. The mere presence of any material, including mold, does not mean that exposure has occurred or will occur.

2. Contemporaneous indoor and outdoor air samples can assist in evaluating whether or not there is mold growth indoors affecting indoor mold spore levels. Air samples may also assist in evaluating the extent of potential indoor exposure. Results of bulk, wipe, and wall cavity samples may indicate the presence of mold, but may not contribute to the characterization of historical exposures for building occupants.

Recognized sampling and analytical methods should be used where sampling is conducted to identify the mold or assess potential mold exposures. It's AIHA's position that only laboratories accredited for the appropriate analyses by a nationally recognized accrediting authority, or an accrediting body recognized by the National Cooperation on Laboratory Accreditation (NACLA) or its equivalent should conduct mold analysis. Laboratories accredited by AIHA's Environmental Microbiology Laboratory Accreditation Program (EMLAP) meet this requirement.

AIHA doesn't believe it is currently possible to define, or set, a single occupational exposure level for mold, due largely to the current state of scientific study in this area. AIHA also does not believe it's possible for any single study to accurately delineate levels of exposure to mold or mold by-products that may be harmful to human health. In most healthy building environments, the airborne species of mold should be similar to, and the concentrations of mold should be less than, the ambient environment outside of the building. However, AIHA notes the variability and confounders associated with mold spore production make the choice of sample collection methodologies and subsequent analytical techniques very difficult, emphasizing the importance of the Competent Professional. In other words, the application of the identical sampling and analytical techniques in two different circumstances, which yield the same numeric result, can mean or identify very different potential exposures.

Widely published data available from the National Allergy Bureau (NAB) section of the American Academy of Allergy, Asthma and Immunology's (AAAAI) Aeroallergen Network may prove useful in understanding the potential natural variability of ambient mold spore sampling data. The Network regularly collects, counts, and reports mold spore levels at numerous certified locations in

North America. Thus the historical range and diversity of mold spores within a given region may be a consideration in the assessment of mold exposures in buildings. The Competent Professional is advised to consider these characteristics of the data in determining if, and how, to use this data in the assessment of mold in buildings.

1.5 Competent Professional

Only specifically qualified persons should be utilized for the design and management of mold assessments, directing others performing initial mold assessments, writing protocols for mold remediation, and conducting post-remediation inspections. These, or other such people would include, but not be limited to, Certified Industrial Hygienists (CIH) with education, training, and experience in the specific areas of science identified below and in Appendix 2. Teams conducting complex mold assessments should be multi-disciplinary in character. Appropriate experts, such as building scientists and physicians, should be added to an assessment team where the issues involved are beyond the expertise of a CIH. In those instances, the CIHs ability to help identify mold growth and contamination, and the potential level of exposure may help link the roles of the building scientist, who is focused on causation of water intrusion, and the physician, who is focused on potential health effects.

AIHA does not believe the skills necessary to conduct proficient mold assessments can be obtained through attendance at a training course held over a period of a few days. Combining education, the experience of working under the guidance of a Competent Professional, and demonstrating competency in specific areas of knowledge, is essential to developing the judgment necessary to recognize, evaluate, develop, and implement measures controlling mold exposures in a competent and responsible manner.

AIHA considers the following minimum qualifications and competencies necessary to define a Competent Professional: (See Appendix 2 for additional information.)

Minimum Qualifications:

- Bachelor of Science in industrial hygiene, environmental health, or an engineering, life science, chemistry, or physics discipline;
- Two years of experience under the direction of a CIH, Certified Safety Professional (CSP) and/or licensed Professional Engineer with significant experience in the following areas: building science, mold assessments, and exposure

assessment. At least one of the two years must involve the performance of Indoor Environmental Quality (IEQ) assessments.

Minimum Competencies:

In addition to the qualifications noted above, the Competent Professional should have competence (from education, training and experience) in the following areas:

- Exposure assessment
- Indoor Environmental Quality (IEQ)
- Heating, ventilating and air conditioning (HVAC)
- Microbial assessment and remediation
- Building science
- Legal/communication
- Microbiology/mycology
- Health effects

2. ASSESSMENT OF MOLD CONTAMINATION

A building assessment may be conducted when excessive mold contamination is suspected or occupant exposure to mold is alleged. An informed inspection is the first step in the assessment process, and forms the basis for an effective remediation, should that be necessary. The assessment is based on understanding and documenting the source(s) of water intrusion [or its impact(s)], such as staining, warping, or elevated moisture in building materials). Visible mold growth, the potential pathways for exposure, and the site-specific factors needed to define appropriate corrective measures are also parts of the assessment process.

Helpful information that should be obtained in order to conduct such an assessment includes:

- A history of past episodes of water leaks, high humidity levels and/or condensation, repairs, and complaints related to moisture,
- Structural and mechanical plans, and
- Information on health status of occupants.

2.1 Visual Inspection

The single most valuable investigative tool in a mold assessment is the determination of the presence of visible mold and/or excessive, unplanned moisture (past and present). Typically, the initial portion of the investigation is conducted during a building walk-through. A mold assessment should ideally include all surfaces in the building. Specific indicators to note during a mold assessment include suspect growth, musty odor, water damage, and dampness. The updated New York City Department

of Health (NYCDOH) Guidelines suggest N-95 disposable respirators as a minimum level of protection during mold remediation, not routine building assessment. A Competent Professional should apply professional judgment when requiring the use of respirators by assessors. In addition, any applicable local, state, and federal standards or regulations need to be followed.

During the walk-through, it's important that an individual under the direction of a Competent Professional gain entrance to areas that are normally considered to have limited access. This includes an investigation of a building's HVAC system. In the most basic consideration, this would include the physical examination of the HVAC system to determine if there are leaks, or locations where drain pans or other water collection points are allowing the buildup of stagnant water.

If visible mold is observed during the visual inspection, or if physical or visible indications (e.g., moisture, staining) suggest that mold may be present in areas inaccessible at the time of the initial walk-through ("hidden mold"), the Competent Professional should determine whether additional actions are appropriate. These actions may include gaining access to suspect areas including inside walls, ceilings, floors, and under wallpaper or carpeting near plumbing or other water sources, as well as destructive testing.

Any access holes should be cut with caution to prevent or minimize potential exposure to mold and other suspect materials known to be associated with building materials such as asbestos or lead. Precautions may include keeping occupants out of the area, protecting surfaces from contamination, cleaning the work area, and installing a temporary patch or seal.

The evaluation of the results of visual assessment, or the need for additional invasive assessment, should be based upon the judgment of the Competent Professional. Bulk or air sampling may also be used to support and enhance observations and findings from the assessment(s).

2.2 Assessment Tools

There are several assessment tools that can be used to assess restricted access spaces within a building. These include:

- **Moisture Meters and Detection Equipment:** Moisture meters and detection equipment are available in a variety of types. When properly used, they are valuable tools in locating substrates and building materials that may have excessively high levels of moisture.

- **Borescopes:** Borescopes can be useful in the visual examination of wall cavities and other restricted locations. Use of these fiber optic devices may allow quick visual assessment of interstitial building spaces in a non-destructive manner. However, all borescopes offer a restricted field of view, and it may be difficult to recognize visible mold contamination due to physical or optical limitations.
- **Wall Cavity Sampling Devices:** One method of assaying potential contamination in a suspect area through minimally invasive means is wall cavity sampling. It is important that the Competent Professional recognize the limitations of such sampling, including small sample size, and in some cases, a lack of correlation to actual conditions within the wall cavity and /or in the occupied portions of the building.

2.3 Bulk Sample Collection and Analysis

Once the presence of visible mold has been identified, the desired approach is typically to eliminate or control the unplanned source of moisture that allowed the growth, and removal or cleaning of the contaminated materials. Contaminated materials should be replaced when necessary. There are times, however, when it's advantageous to identify the genus or species of mold present. Such identification may help in assessing potential pathways for exposure, level of contamination, or defining remediation criteria.

The collection of bulk samples is relatively straightforward. As used in this document, bulk sampling refers to the gross collection of mold and/or substrate material. Steps should be taken to preserve the integrity of the sample, and to avoid cross contamination to the extent possible. Generally the use of sterile containers is desired, although dry samples may be transported in clean and dry containers.

Some of the acceptable collection and analysis methods of bulk sampling are:

- **Contact samples:** Loose particles may be collected by pressing a contact plate to a surface or applying an adhesive material to lift off sample material. Contact plates are special culture dishes or flexible containers with a meniscus of agar extending beyond the container's rim. Tape-lift samples may be collected using clear sticky tape or tape mounted on slides provided by the laboratory. The tape is then analyzed by direct examination through a microscope.
- **Wipe and surface-wash sampling:** Wipe sampling is a method by which a sterile fibrous

material such as a cotton swab used to wipe and collect surface mold. The swab is then placed in sterile water, cultured, and then analyzed by microscopy.

- **Micro-vac dust samples:** This method uses suction to vacuum particulate matter from a defined area (usually 1 ft²) typically of porous material such as carpet, the internal lining of an air handling unit, or the upper surface of ceiling tiles onto a filter cassette. The collected dust is then cultured for analysis.

Mold spores are ubiquitous, and the detection of spores alone by any of the above methods does not demonstrate mold contamination. A finding of mold contamination can be based on microscopic observation of hyphae or other fungal growth structures.

2.4 Air Sample Collection and Analysis

Whether or not air sampling for mold spores is an appropriate part of a building assessment is a matter of professional judgment to be made by a Competent Professional. When air samples are collected as part of a mold assessment, most situations dictate that a comparison be made between indoor and outdoor mold levels to help determine the extent of amplification, if any, in the indoor environment. Indoor and outdoor samples should be taken within the same time period. It is important that, to the extent possible, the outdoor samples taken represent the air entering the building. Competent Professionals must carefully consider the number of samples collected to allow for a reasonable comparison between indoor and outdoor environments. In some cases, air sampling can provide misleading information. As is the case with bulk sampling, air sampling must be accompanied by an informed visual inspection, including the visual examination of interstitial building spaces, which generally provides the best way to determine the extent, pathway, and potential amplification of mold growth.

Currently, a wide range of sampling methodologies are being employed for mold assessment. Sample analysis should follow analytical methods recommended by the AIHA, the American Conference of Governmental Industrial Hygienists (ACGIH), or other guidelines. The sample collection methods listed in this publication are intended to represent those that have been most widely accepted.

It's AIHA's position that only laboratories accredited to perform the appropriate analyses by a nationally recognized accrediting authority or an accrediting body recognized by NACLA or its equivalent should conduct mold assessment.

The references cited at the end of this document provide more information on air sampling devices and collection methods. Accepted methods are listed in the table 1.

In the case of any device used for the collection of culturable samples—living mold spores that are capable of growth—it's vital that individuals using the devices follow proper procedures with regard to media selection, refrigeration and storage of media, and refrigeration and shipment to the lab of collected samples.

2.5 Data Interpretation

Data interpretation often focuses on air sampling and data analysis. However, it must be emphasized that this effort comprises only one component of the overall mold assessment. A number of factors must be considered including:

- Elevated moisture readings or active water intrusion
- Environmental conditions during sampling
- Evidence or history of moisture intrusion, water staining, or damage
- Housekeeping practices
- Occupant sensitivity
- Other sampling data
- Outdoor air filtration
- Presence of mold genera/species commonly associated with water intrusion and/or mold contamination in buildings
- Presence of musty odors
- Presence of other allergens and contaminants
- Reported occupant health effects potentially attributed to mold exposures

Without a well-planned sampling strategy, and some predetermined decision criteria (hypotheses testing), interpretation of airborne mold spore concentration data is subject to possible mischaracterization of the environment being assessed. A Competent Professional should consider the following factors when interpreting air sampling data:

- There is a high natural variability of airborne mold spores.
- There is no precise formula to distinguish normal background levels from elevated airborne mold spore levels.
- There are no widely accepted evidence-based criteria that attribute a common set of adverse health effects to exposure to airborne mold (e.g., allergic reactions depend on individual sensitivity).
- Spore trap identifications can be inaccurate as there are currently no established norms.

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