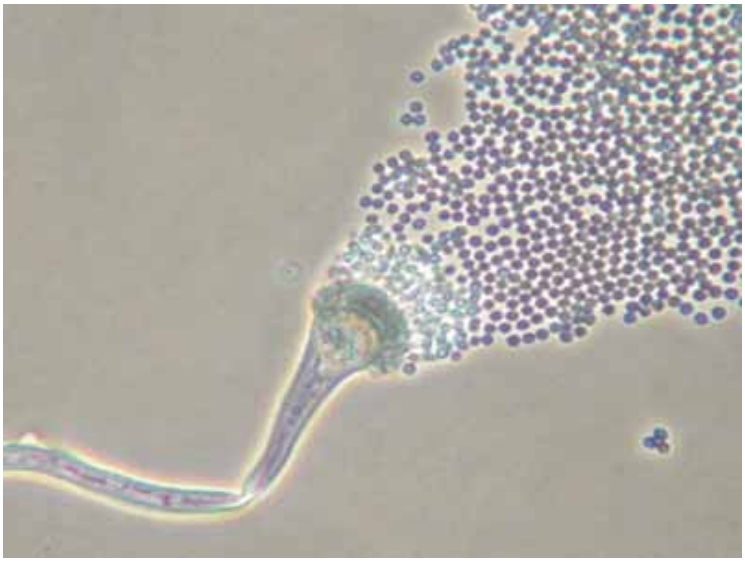
How To Perform A Mold Inspection

By Ben Gromicko



The purpose of the textbook is to define and teach good practice for conducting a mold inspection of a building. The student will learn how to find and report mold growth that may exist in a building using a visual examination and mold sampling of the building. The textbook is designed primarily for residential home inspection professionals. Public health and environmental health professionals who are involved with mold issues may be interested in this textbook. Building managers, custodians, remediators, contractors, and other professionals who respond to mold problems may also want to refer to this textbook.

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Objective:

The student will learn: what mold is; the IAC2 Mold Inspection Standards of Practice; health effects related to mold exposure; what mold needs to grow; how to perform a visual examination of a building to find mold; the IAC2 Mold Sampling Decision Chart; the IAC2 Mold Sampling Procedures; proper use of tools, equipment and PPE; hypotheses development; building science and moisture; sampling devices and procedures; documentation of work; laboratory result interpretation; mold remediation; report writing; preventing mold growth. Dr. Shane, chief mycologist at Pro-Lab®, is a guest contributor of the content in this textbook.

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Overview

The purpose of the textbook is to define and teach good practice for conducting a mold inspection of a building. The student will learn how to find and report mold growth that may exist in a building using a visual examination and mold sampling of the building. The student will learn: what mold is; the IAC2 Mold Inspection Standards of Practice; health effects related to mold exposure; what mold needs to grow; how to perform a visual examination of a building to find mold; utilizing the IAC2 Mold Sampling Decision Chart; IAC2 Mold Sampling Procedures; proper use of tools, equipment and PPE; hypotheses development; building science and moisture; sampling devices and procedures; documentation of work; laboratory result interpretation; mold remediation; report writing; preventing mold growth.

It is designed primarily for residential home inspection professionals. Public health and environmental health professionals who are involved with mold issues may be interested in this textbook. Building managers, custodians, remediators, contractors, and other professionals who respond to mold problems may also want to refer to this textbook.

Disclaimer

EPA does not regulate mold or mold spores in the air. There are no federal or state threshold limit values for inspectors to use when interpreting results of mold spores in the indoor environment. There are no federal or state requirements for inspectors in the sampling of mold. Research of the most accepted, best industry practices have been complied in an effort to develop this textbook for mold inspection training.

Please note that the text is based provide simple guidelines; some professionals may prefer other inspection and sampling methods. This textbook does not cover all situations; it does not reference all research and information sources; and it does not review all potentially useful methods, procedures, or protocols. The absence of a method, standard, or technique from this textbook does not indicate or imply that it is not effective or important.

Research on mold and on its health effects continues. This textbook does not describe all of the potential health effects related to mold exposure; it provides only an overview. For more detailed information, consult a health professional or your state or local health department.

This textbook is based largely upon the following sources:

- New York City Department of Health (2000) Guidelines on Assessment and Remediation of Fungi in Indoor Environments. New York New York: New York city Department of Health
- United States Environmental Protection Agency. A Brief Guide to Mold, Moisture, and Your Home [EPA 402-K-02-003]
- United States Environmental Protection Agency. Mold Remediation in Schools and Commercial Buildings [EPA 402-K-01-001, March 2001]
- Biological Pollutants in Your Home [CPSC Publication #425]
- United States Environmental Protection Agency. Indoor Air Quality in Public Buildings: Volume II.
- Investigating and Remediating Mold in Minnesota Public Schools and Recommend Best Practices for Mold Investigations in Minnesota Schools, November 2001, Environmental Health Division, Indoor Air Unit, PO Box 64975, St. Paul, MN 55164-0975
- United States Environmental Protection Agency. Introduction to Mold and Mold Remediation for Environmental and Public Health Professionals. July 2008.
- Molds in the Environment, Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333, U.S.A.
- California Department of Health Services, Indoor Air Quality Info Sheet, Mold In My Home: What Do I Do?, June 2006.

Section 1
Types of Mold Inspections

This textbook categorizes two types of mold inspections. One type is the Complete Mold Inspection. The other type is the Limited Mold Inspection.

- Complete Mold Inspection
- Limited Mold Inspection

Complete Mold Inspection

The complete mold inspection is performed by an IAC2 certified mold inspector.

The complete mold inspection is performed in accordance with the Mold Inspection Standards of Practice of the International Association of Certified Indoor Air Consultants (www.IAC2.org).

The inspector shall perform:
- a non-invasive visual examination of the readily accessible, visible, and installed systems and components of the building listed in the IAC2 Mold Inspection Standards of Practice.
- at least three air samples for mold growth (one indoor and two outdoor) at the building according to the IAC2 Mold Sampling Procedures

The inspector shall report:
- moisture intrusion,
- water damage,
- musty odors,
- apparent mold growth, or
- conditions conducive to mold growth.
- results of a laboratory analysis of any mold samplings taken at the building.
- any system or component listed in the Standards of Practice that were not visually examined and the reason(s) they were not inspected.

Unless the inspector and client agree to a limitation of the inspection, the inspection will be performed on the primary building and parking structure.

A Complete Mold Inspection includes:
- Visual examination of entire building, its systems and components
- At least three air samples (Refer to IAC2 Mold Sampling Procedures)

Limited Mold Inspection

The limited mold inspection is performed by an IAC2 certified mold inspector.

The limited mold inspection is performed in accordance with the Mold Inspection Standards of Practice of the International Association of Certified Indoor Air Consultants (IAC2), with one exception. The exception is a limitation of the non-invasive visual examination of the building.

The limited mold inspection does not include a visual examination of the entire building as required by the IAC2 Standards, but is limited to a specific area of the building identified and defined by the inspector and agreed to by the client.

The inspector and client prior to the inspection shall agree to the limitation of the visual examination. As a result, potential sources of mold growth in other areas of the building may not be inspected.

The inspector shall take at least one mold sampling. A carpet, swab, tape, or an air sampling shall be taken by the inspector to send to a laboratory for analysis.

The limited mold inspection is a fast and affordable way to confirm the existence of mold and, if possible, determine the type of mold present in a specific, defined area of the building.

An example of a limited mold inspection: The inspector's client requests a limited mold inspection to be performed. The scope is specifically limited to the under-floor crawlspace of the building. Only the crawlspace will be inspected including a non-invasive examination of the crawlspace. At least one mold sample will be taken, typically a tape sample if apparent mold is visible.

A Limited Mold Inspection includes:

- Limitation of the visual examination to a specific, defined area of the building
- At least one sampling

Section 2
IAC2 Mold Inspection Standards of Practice

In the previous section we learned about two types of mold inspections. A mold inspection requires the inspector to perform according to a standard. The following is the IAC2 Mold Inspection Standards of Practice.

An updated version of the IAC2 Mold Inspection Standards of Practice is available at http://www.iac2.org/sop.php. These standards are subject to change as more credible information about fungal contaminants becomes available. The standards may be updated at any time. It is the inspector's responsibility to know the standards and apply them.

IAC2 Mold Inspection Standards of Practice

Table of Contents

1.0 Scope

1.1 The purpose of this standard is to provide standardized procedures to be used for a mold inspection. There are two types of mold inspections described in the IAC2 Mold Inspection Standards of Practice:

(1) Complete Mold Inspection (Section 2.0)

(2) Limited Mold Inspection (Section 4.0)

1.2 Unless the inspector and client agree to a limitation of the inspection, the inspection will be performed at the primary building and attached parking structure. Detached structures shall be inspected separately.

1.3 A mold inspection is valid for the date of the inspection and cannot predict future mold growth. Because conditions conducive to mold growth in a building can vary greatly over time, the results of an inspection (examination and sampling) can only be relied upon for the point in time at which the inspection was conducted.

1.4 A mold inspection is not a home (property) inspection.

1.5 A mold inspection is not a comprehensive indoor air quality inspection.

1.6 A mold inspection is not intended to eliminate the uncertainty or the risk of the presence of mold or the adverse effects mold may cause to a building or its occupants.

2.0 Complete Mold Inspection

2.1 The inspector shall perform:

- a non-invasive visual examination of the readily accessible, visible, and installed systems and components of the building listed in Section 3.0 Standards of Practice
- temperature and humidity measurements according to Section 3.8
- mold samplings according to Section 4.0 Mold Sampling Procedure

2.2 The inspector shall report:

- moisture intrusion,
- water damage,
- musty odors,
- apparent mold growth, or
- conditions conducive to mold growth;
- results of a laboratory analysis of any mold samplings taken at the building; and
- any system or component listed in Section 3.0 Standards of Practice that were <u>not</u> inspected and the reason(s) they were not inspected.

3.0 Standards of Practice

3.1 Roof

I. The inspector shall inspect from ground level or eaves:

A. The roof covering.
B. The roof drainage system, including gutters and downspouts.
C. The vents, flashings, skylights, chimney and other roof penetrations.

II. The inspector is not required to:

A. Walk on any roof surface.
B. Predict the service life expectancy.
C. Perform a water test.

3.2 Exterior and Grounds

I. The inspector shall inspect from the ground level:

A. The cladding, flashing and trim.
B. Exterior doors, windows, decks, stoops, steps, stairs, porches, railings, eaves, soffits and fascias.
C. The exterior grading surrounding the building perimeter.

II. The inspector is not required to:

A. Inspect underground drainage systems.

3.3 Basement, Foundation, Crawlspace, and Structure

I. The inspector shall inspect:

A. The foundation, basement, or crawlspace including ventilation.

II. The inspector is not required to:

A. Operate sump pumps with inaccessible floats.
B. Inspect for structural defects not related to mold growth or moisture intrusion.

3.4 Heating, Cooling and Ventilation

I. The inspector shall inspect:

A. The air handler, circulating fan, and air filter.
B. The condensate pump.
C. Readily visible ductwork.
D. Representative number of supply and return air registers.
E. The central humidifier.
F. The central air conditioning unit.

II. The inspector is not required to:

A. Inspect the air conditioning coils if not readily accessible.
B. Inspect the condensate pan if not readily accessible.
C. Test the performance or efficiency of the HVAC system.

3.5 Plumbing

I. The inspector shall inspect:

A. The main water line.
B. Water supply lines.
C. Drain, waste, and vent pipes.
D. Hot water source.
E. Fixtures such as toilets, faucets, showers and tubs.

II. The inspector is not required to:

A. Test the showers and tubs by filling them with water
B. Test whirlpool tubs, saunas, steam rooms, or hot tubs.

3.6 Attic, Ventilation & Insulation

I. The inspector shall inspect:

A. Insulation.
B. Ventilation of attic spaces.
C. Framing and sheathing.

II. The inspector is not required to:

A. To move, touch, or disturb insulation.
B. Inspect for vapor retarders.
C. Break or otherwise damage the surface finish or weather seal on or around access panels and covers.

3.7 Interior

I. The inspector shall inspect:

A. The walls, ceilings, floors, doors and windows.
B. The ventilation in the kitchen, bathrooms and laundry.
C. Whole-house ventilation fans

3.8 Humidity and Temperature

I. The inspector shall measure (at the inspector's discretion):

A. Humidity of any room or area of the building.
B. Temperature of any room or area of the building.

4.0 Mold Sampling Procedure

The IAC2 Mold Sampling Procedures are located at http://www.IAC2.org. Refer to these standards prior to performing any sampling.

I. Closed-Building Conditions

A. Windows on all levels and external doors should be kept closed (except during normal entry and exit) during the sampling period according to the IAC2 Mold Sampling Procedures.

II. Air Sampling

A. The inspector shall perform two (2) outdoor samples according to IAC2 Mold Sampling Procedures. These samples are the control (or background) samples for comparison with the indoor sample(s).

B. The inspector shall perform at least one (1) indoor sample according to the IAC2 Mold Sampling Procedures. Additional indoor air samples may be performed at the discretion of the inspector.

III. Surface Sampling

A. The inspector shall perform at least one (1) surface sampling according to the IAC2 Mold Sampling Procedures. Additional surface samples may be performed at the discretion of the inspector.

5.0 Limited Mold Inspection

The limited mold inspection does not include a visual examination of the entire building, but is limited to a specific area of the building identified and described by the inspector. As a result, moisture intrusion, water damage, musty odors, apparent mold growth, or conditions conducive to mold growth in other areas of the building may not be inspected.

5.1 The inspector shall describe:

- the room or limited area of the building in which the Limited Mold Inspection is performed

5.2 The inspector shall perform:

- a non-invasive visual examination of the readily accessible, visible, and installed systems and components located the room or area described in Section 5.1

- at least one (1) surface sampling according to the IAC2 Mold Sampling Procedures. Additional surface samples may be performed at the discretion of the inspector.

5.3 The inspector shall report:

- moisture intrusion,
- water damage,
- musty odors,
- apparent mold growth, or
- conditions conducive to mold growth; and
- results of a laboratory analysis of any mold samplings taken at the building

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6.0 Limitations & Exclusions

6.1 Limitations:

I. These Standards of Practice apply only to residential buildings with four or fewer dwelling units.
II. The mold inspection is not a warranty, guarantee, or insurance policy.
III. The mold inspection is not technically exhaustive.
IV. The mold inspection will not identify concealed or latent conditions or defects.
V. The mold inspection will not identify mold growth not readily visible at the time of the inspection.
VI. The scope of a mold inspection does not include future conditions or events
VII. The scope of a mold inspection does not include hidden mold growth or future mold growth.

6.2 Exclusions:

I. The inspector is not required to report:
    A. The condition of any system or component that is not readily accessible
    B. The condition of any system or component that is not in the IAC2 Standards of Practice.
    C. The service life expectancy of any system or component.
    D. The size, capacity, BTU, performance, or efficiency of any component or system.
    E. Compliance with codes, regulations or installation guidelines.
    F. The presence of evidence of rodents, animals, insects, wood destroying insects and pests.

II. The inspector is not required to:
- A. Determine the presence of hidden mold by physical examination or sampling.
- B. Report replacement or repair cost estimates.
- C. Lift carpeting or padding.
- D. Inspect any other environmental issue.
- E. Determine the cause or reason of any condition.
- F. Perform a geotechnical, structural, geological evaluation.
- G. Move any personal items or other inspection obstructions, such as, but not limited to: insulation, throw rugs, furniture, floor or wall coverings, ceiling tiles, window coverings, equipment, plants, ice, debris, snow, water, dirt, foliage, or appliances.
- H. Dismantle, open, or uncover any system or component.
- I. Enter or access any area, crawlspace, or attic space, which, in the opinion of the inspector, may be unsafe or may risk personal safety.
- J. Do anything that may be unsafe or dangerous to the inspector or others or damage property according to the opinion of the inspector.
- K. Determine the insurability of a property.

II. The inspector is not required to operate:
- A. Any system that is shut down.
- B. Any system that does not function properly.
- C. Any system that does not turn on with the use of normal operating controls.
- D. Any shut off water or fuel valves or manual stop valves.
- E. Any electrical disconnect or over current protection devices.
- F. Any irrigation or sprinkler systems.

7.0 Definitions

7.1 **Accessible**: Can be approached or entered by the inspector safely, without difficulty, fear or danger.
7.2 **Apparent Mold**: visible growth with characteristics of mold, which cannot be confirmed by the inspector without the benefit of sampling. The term “mold growth” is interchanged in this textbook with “fungal growth” and “microbial growth.”
7.3 **Complete**: Comprehensive in scope or purpose.
7.5 **Areas of Concern**: Areas of moisture intrusion, water damage, musty odors, visible apparent mold growth, and conditions conducive to mold growth.
7.4 **Component**(s): A permanently installed or attached fixture, element or part of a system.

7.5 **Condition**(s): The visible and conspicuous state of being of an object.
7.6 **Dismantle**: To open, take apart or remove any component, device or piece that would not typically be opened, taken apart or removed by an ordinary occupant.
7.7 **Due Diligence**: The degree of care and caution required by the circumstances of a person.
7.8 **Dwelling Unit**: A complete place to live including a kitchen and bathroom.
7.9 **Household** Appliances: Kitchen and laundry appliances, room air conditioners, and similar appliances.
7.10 **Invasive**: To probe, dismantle or take apart a system or component.
7.11 **Interior**: The area(s) of a building where people have access and are included in the condition space of the building.
7. 12 **Limited**: Not comprehensive in scope or purpose.
7. 13 **Microbial**: Microscopic organism such as mold.
7. 14 **Normal Operating Controls**: Devices such as thermostats that would be operated by ordinary occupants, which require no specialized skill or knowledge.
7.15 **Occupants**: Tenants, persons, or entities each of which uses a portion of the building.
7.16 **Readily Accessible**: An item or component is readily accessible if, in the judgment of the inspector, it is capable of being safely observed without movement of obstacles, detachment or disengagement of connecting or securing devices, or other unsafe or difficult procedures to gain access.
7.17 **Report**: A written communication (possibly including digital images) of conditions seen during the inspection.
7.18 **Representative Number**: At least one in a particular room or area.
7.19 **Sampling**: The collection of air, surface, or carpet samples for analysis.
7.20 **Shut Down**: Turned off, unplugged, inactive, not in service, not operational, etc.
7.21 **Inspect**(ed): To visually look at readily accessible systems and components safely, using normal operating controls and accessing readily accessible panels and areas in accordance with these Standards of Practice.
7.22 **Inspector**: One who performs an inspection.
7.23 **System**(s): An assembly of various components to function as a whole.
7.24 **Technically Exhaustive**: A comprehensive and detailed examination beyond the scope of a mold inspection which would involve or include, but would not be limited to: dismantling, specialized knowledge or training, special equipment, measurements, calculations, testing, research, analysis or other means.
7.25 **Unsafe**: A condition in a readily accessible, installed system or component, which is judged to be a significant risk of personal injury during normal, day-to-day use. The risk may be due to damage, deterioration, improper installation or a change in accepted residential construction standards.

Section 3
What Is Mold?

In the previous sections we learned about the types of mold inspections and the IAC2 Standards. Now let's learn about mold and what it is.

Molds are organisms that may be found indoors and outdoors. They are part of the natural environment and play an important role in the environment by breaking down and digesting organic material. Molds are neither plants nor animals. They are part of the kingdom Fungi.

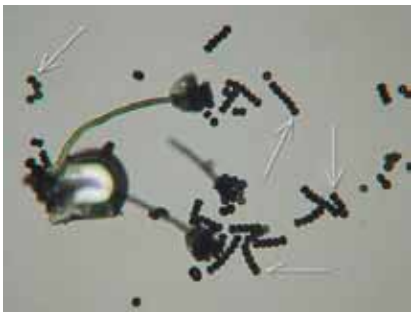
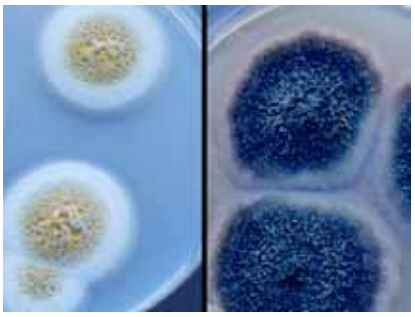
Mold is Fungi

The diagram to the right demonstrates the position of fungi among other living organisms.[10] Fungi are not plants. Fungi are not animals. Fungi belong to a kingdom of their own. Plants convert carbon dioxide directly into carbohydrates for food. Animals and fungi must find complex carbon in the environment for food. While animals ingest the food and degrade it internally, fungi excrete chemicals (enzymes) into the environment that degrade the complex carbon into soluble form.

Fungi do not make their own food they way that green plants do. Fungi get nourishment from other living organisms. The main role of fungi in the ecosystem is to break down dead materials, such as dead leaves, trees, insects, and animals. The same enzymes that assist fungi in breaking down dead materials are the same fungi that can damage wooden components in a building. Molds can damage food, stored goods, and building materials of houses.

Yeast, mold, mildew, and mushroom are terms that are commonly used to refer to fungi. Mold is essentially a description of fungi growing on surfaces (like the black substance on a moldy

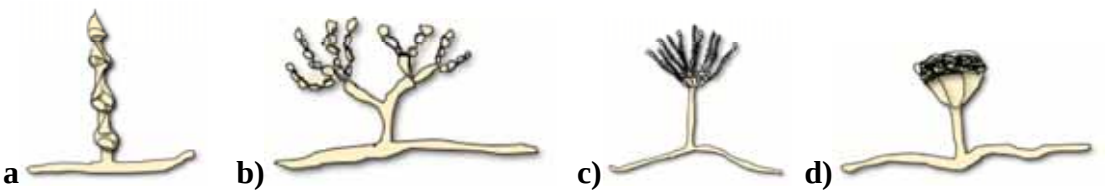
shower wall). Mold and mildew often refer to the same fungi. All mold is fungi; not all fungi is mold.


Molds come in many colors including white. "Black mold" is not a species or specific kind of mold, and neither is "toxic mold." Sometimes the news media use the terms "*toxic mold*" and "*black mold*" to refer to molds that may produce mycotoxins or for a specific mold, *Stachybotrys chartarum*. Molds that produce mycotoxins are often referred to as toxigenic fungi.

Molds can multiply by producing microscopic spores (2 - 100 microns [µm] in diameter), similar to the seeds produced by plants. Many spores are so small they easily float through the air and can be carried for great distances by even the gentlest breeze. The number of mold spores suspended in indoor and outdoor air fluctuates from season to season, day to day, and even hour to hour.

No one knows how many species of fungi exist, but estimates range from tens of thousands to perhaps three hundred thousand or more. Some of the common indoor molds are Penicillium, Aspergillus, Cladosporium, and Alternaria.



a) Alternaria b)Cladosporium c)Penicillum d)Stachybotrys

Mold is Everywhere

Mold spores are ubiquitous; they are found both indoors and outdoors. Mold spores cannot be eliminated from indoor environments. Some mold spores will be found floating through the air

and on settled dust; however, they will not grow if moisture is not present.

Why Be Concerned?

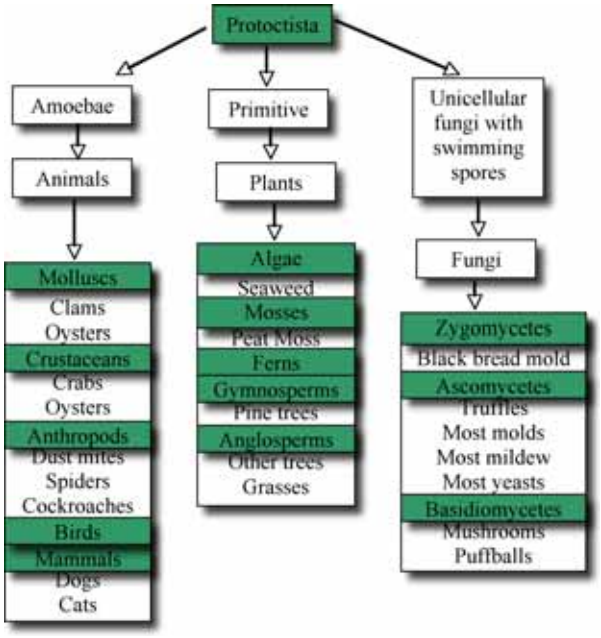
Mold is not usually a problem indoors—unless mold spores land on a wet or damp spot and begin growing. As molds grow they digest whatever they are growing on. Unchecked mold growth can damage buildings and furnishings; molds can rot wood, damage drywall, and eventually cause structural damage to buildings. Mold can cause cosmetic damage, such as stains, to furnishings. The potential human health effects of mold are also a concern. It is important, therefore, to prevent mold from growing indoors.

There are three (3) reasons why there should be a concern about fungi in the indoor environment:

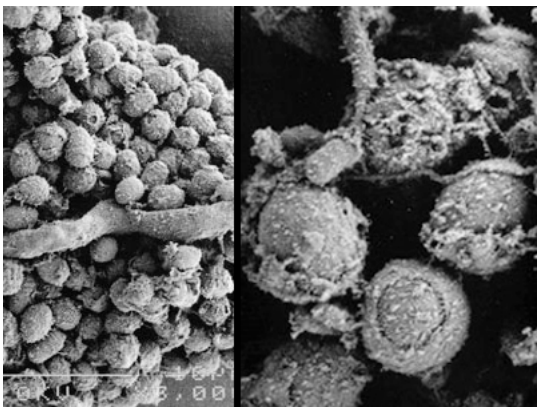
1) potential health effects of exposure to fungi and their byproducts;
2) the effect of fungal contamination on the structural integrity of a building; and
3) the negative aesthetic effects fungi can produce both visually and on the human olfactory systems.[9]

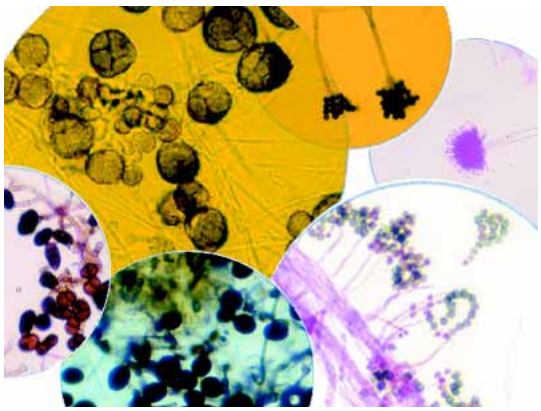
Although the issue of whether exposure to indoor fungi causes adverse health effects is controversial, there is no doubt that a seriously mold-contaminated building can suffer structural damage and that a foul-smelling, fungus-filled building is aesthetically unpleasing. Controversies about health effects aside, the latter two reasons are sufficient to merit a complete mold inspection and remediation when an environment is found to have fungal contamination.

People who have concerns about structural damage or the aesthetic effects of indoor fungi should seek the services from a certified mold inspector. People who have concerns about health effects of mold exposure should seek the counsel of a health care professional.



Section 4
Physical Characteristics of Mold





The structures of fungi vary widely. Some fungi have rigid cellular walls that are made of chitin. Chitin is resistant to breakdown as compared to the cellulose that makes up the cellular walls of plants. Spores can survive a very long time in harsh conditions until the environment is suitable for growth.

A mold has like long, threadlike strings of cells called hyphae. Hyphae form into a tangled mass called mycelium. (The mycelium growth is the fuzzy stuff on bread.) The strings that grow down into the bread are the mycelium, which is not seen. The whole fungus body is called a thallus. Spores are produced in large numbers. They are located on the hyphae.

Fungi grow well in moist, dark areas, but can be found wherever organic material is available. Molds can grow on a variety of surfaces, including paint, jet fuel, wallpaper, glass, and stainless steel. Moisture is necessary for mold growth. Moisture may come from the air and from the material upon which they grow. If the environment becomes very dry, fungi survive by going dormant or by producing spores that resist drying out.

Fungi can spread via the tiny spores through the air. When a spore lands upon a surface that is moist and has material that can be used for food, it germinates and begins to grow. Hyphae grow out of the spores. Some grow up to the air. Spores are produced on the hyphae that grow upwards, above the food material. Spores can then be blown by the wind and spread to new areas.

A change in the humidity level can increase spores in the air. A high relative humidity (RH) can burst the moist, swollen cells of the mold body that form spores. This is true for Penicillium and

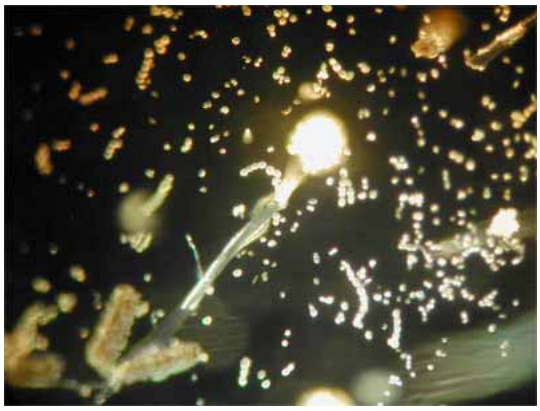
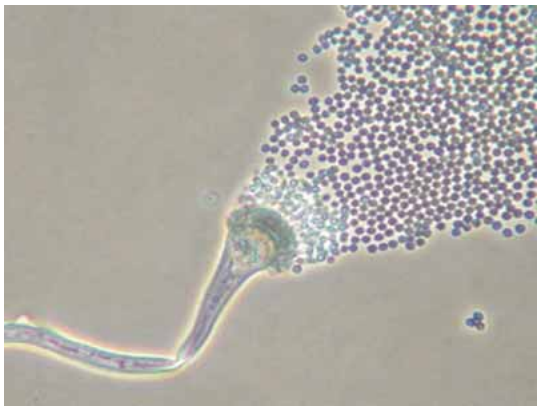
Aspergillus, two very common indoor molds. Foot traffic, carpet vacuums, or increased ventilation increases the number of airborne mold spores.

Some hyphae grow down into the food material. Cells of the hyphae produce chemicals. Those chemicals break down the material (fruit, paper, wood) into food that the fungus can absorb.

Most of the mold body is the hyphae that is buried in the food material and is out of sight. What is visible is the part of the mold body that produces spores.

Section 5
Health Effects And Mold

- Symptoms
- Infections
- Mycotoxins
- ODTS and HP
- PPE
- Contaminants

Inhalation exposure to mold indoors can cause health effects in some people. Molds produce allergens (substances that can cause allergic reactions), irritants, and in some cases, potentially toxic substances or chemicals (mycotoxins). Inhaling or touching mold or mold spores may cause allergic reactions in sensitive individuals. Mold does not have to be alive to cause an allergic reaction. Dead or alive, mold can cause allergic reactions in some people.

There are different types of people who can be affected by mold more severely and sooner than others. They are infants, children, elderly people, individuals with respiratory conditions and sensitivities such as allergies and asthma, persons having weakened immune systems (for example, people with HIV infection, chemotherapy patients, organ transplant recipients).

Sensitive people should avoid areas that are likely to have mold, such as compost piles, cut grass, and wooded areas.

Allergic reactions to mold in buildings do occur for many sensitive people. However, there is no conclusive evidence that proves mold in a building directly causes human health illnesses. More research is needed. Mold research is continuous. Mold-related exposure and human health is a complex and emerging science.

Symptoms of Mold Exposure

There are many symptoms of mold exposure. Current evidence indicates that allergies are the type of diseases most often associated with molds. [4] An allergic reaction is the most common symptom that could include wheezing and difficulty in breathing.

Inhalation of fungal spores, fragments (parts), or metabolites (mycotoxins and volatile organic compounds) from a wide variety of fungi may lead to or exacerbate immunologic (allergic) reactions, cause toxic effects, or cause infections. [3]

Repeated or single exposure to mold, mold spores, or mold fragments may cause non-sensitive individuals to become sensitive to mold, and repeated exposure has the potential to increase sensitivity. Allergic responses include “hay fever”-like symptoms such as headache; sneezing; runny nose, red eyes, and skin rash (dermatitis). Molds can cause asthma attacks in people with asthma who are allergic to mold. Fungi in buildings may cause or exacerbate symptoms of allergies, especially in persons who have a history of allergic diseases (such as asthma and rhinitis).[3] In addition, molds can irritate the eyes, skin, nose, throat, and lungs of individuals whether or not they are allergic to mold. Other symptoms include nasal and sinus congestion; burning, watery, red eyes; sore throat; dry cough; and skin irritation.

These and other symptoms may be associated with exposure to mold. But all of these symptoms may be caused by other exposures or conditions unrelated to mold growth. Therefore, it is important not to assume that, whenever any of these symptoms occurs, mold is the cause.

The effects of mold exposure can be acute or chronic. An acute effect is an immediate, severe reaction to a large exposure. A chronic effect may take days, months or years to manifest and usually comes from small, repeated exposures.

If a person experiences these symptoms only when occupying a particular building, then that person may possibly be experiencing symptoms of mold exposure.

There are four important indoor allergenic molds. They are Penicillium, Aspergillus, Cladosporium, and Alternaria. Alternaria and Cladosporium are outdoor molds that can be found indoors if the doors or windows of a building are left open and the spores are carried by air currents.

For more detailed information on mold and its health effects, consult a health professional. You may also wish to consult your state or local health department.

As a certified mold inspector, you should not offer medical advice to your clients. People with health problems that may be related to mold should seek a physician trained in occupational, environmental, or allergy medicine. Tell your client to consult with a health care provider regarding any health problems they might be experiencing.

Infections

Only a small group of fungi have been associated with infectious disease. Aspergillosis is an infectious disease that can occur in immune-suppressed persons. [3] Health effects in this population can be severe. Several species of Aspergillus are known to cause Aspergillosis. The most common is Aspergillus Fumigatus. Exposure to this common mold, even to high concentrations, is unlikely to cause infection in a healthy person.

Breathing in mold may also cause hypersensitivity pneumonitis, an uncommon disease that resembles bacterial pneumonia. In addition, mold exposure may result in opportunistic infections in persons whose immune systems are weakened or suppressed.

There are fungal infections that can affect healthy people. They are pathogenic fungi sometimes found inside a building: Blastomyces (which inhabit decaying wood), Coccidioides (found in South Western United States), Cryptococcus (in bird droppings), and Histoplasma (in bat droppings). People, without adequate personal protection equipment (PPE), who come in contact with bird or bat droppings, such found in attics, could be at very high risk. People with compromised immune systems can be seriously affected by fungal infections.

Exposure to fungi associated with bird and bat droppings (Histoplasma capsulatum and Cryptococcus neoformans) can lead to health effects, usually transient flu-like illnesses, in healthy individuals. Severe health effects are primarily encountered in immune-compromised persons. [3] People with chronic lung illnesses, such as obstructive lung disease, may develop mold infections in their lungs. [4]

Mycotoxins

As molds grow, some (but not all) of them may produce potentially toxic byproducts called mycotoxins under some conditions. [1] Some of these molds are commonly found in moisture-damaged buildings. Exposure to mycotoxins can occur from inhalation, ingestion, and skin contact. More than 200 mycotoxins from common molds have been identified, and many more

remain to be identified. The amount and types of mycotoxins produced by a particular mold depends on many environmental and genetic factors.

No one can tell whether a mold is producing mycotoxins just by looking at it.

Many fungi, including species of Aspergillus, Penicillium, Fusarium, Trichoderma, Memnoniella, and Stachybotrys Chartarum, can produce potent mycotoxins, some of which are identical to the compounds produced by Stachybotrys Chartarum.[3] Mycotoxins are fungal metabolites that have been identified as toxic agents.

There are studies that suggest an association between Stachybotrys Chartarum and pulmonary hemorrhage/hemosiderosis in infants, generally those less than six months old. [3]

Toxic substances (mycotoxins) can enter a human body through inhalation, ingestion, or skin absorption. The effects of the toxic substance depend upon the chemical or material, the concentration, the route of entry, and the duration of exposure.

Smoking, alcohol, medication, gender, existing health problems are factors that can influence the effects of a toxic substance entering a body.

Some mycotoxins are known to affect people, but for many mycotoxins little health information is available. Research on mycotoxins is ongoing.

ODTS and HP

Mold inspectors and mold remediators can be at risk of developing Organic Dust Toxic Syndrome (ODTS) or Hypersensitivity Pneumonitis (HP). ODTS may occur after a single heavy exposure of dust contaminated with fungi and produces flu-like symptoms. It differs from HP in that it is not an immune-mediated disease and does not require repeated exposures to the same causative agent. A variety of biological agents may cause ODTS including common species of fungi. [3] HP may occur after repeated exposures to an allergen and can result in permanent lung damage. [3]

PPE

There have been reports of linking health effects in office workers to offices contaminated with moldy surfaces and in residents of homes contaminated with fungal growth. [3] Symptoms such as fatigue, respiratory ailments, and eye irritation were typically observed in these cases.

Occupants and workers inside buildings can reduce their exposure by proper use of personal protective equipment (PPE), including respirators (minimum N-95), gloves, protective clothing, and goggles. Personal cleanliness and habits are important to reducing exposure for remediation workers.

Contaminants

Although mold is frequently found in damp buildings, it is not the only potential contaminant — biological contaminants other than mold, and non-biological contaminants are often present and may also cause health effects. Damp buildings may attract rodents and other pests. Damp or wet building components and furnishings may release chemicals indoors.

Potential contaminants in damp or wet buildings include bacteria, dust mites, cockroaches and other pests, as well as chemicals emitted by damp building materials and furnishings. For more information on damp buildings and health effects, see the 2004 Institute of Medicine Report, *Damp Indoor Spaces and Health*, published by The National Academies Press in Washington, DC, and available on the Web.

Section 6
What Mold Needs to Grow

In previous sections we learned what mold is. Now let's understand what mold needs to grow. That knowledge will help guide inspectors to the best locations in a building to find growth.

Most of the mold found indoors comes from outdoors, because mold spores can easily float on gentle air currents. If the spores land on suitable organic material inside a building, mold can begin to grow. But mold needs certain things in order to grow and survive.

Mold needs (1) moisture and (2) food.

Moisture

Mold does not need a lot of moisture to grow. A little condensation, in a bathroom or around a window sill, for example, can be enough. Common sites for indoor mold growth include bathroom tile and grout, basement walls, and areas around windows and sinks. Common sources of water or moisture include roof leaks, condensation due to high humidity or cold spots in a building, slow leaks at plumbing fixtures, humidification systems, sprinkler systems, and floods.

Mold has been found to germinate, grow, and produce spores in as little as 24 hours after water damage occurs.

Indoor relative humidity (RH) should be between 20% and 40% in the winter and less than 60% the rest of the year. [6] Some experts recommended that the indoor humidity levels in general should be between 40% and 60%.[4]

Moisture is the most important factor influencing mold growth indoors. Controlling indoor moisture helps limit mold growth. Moisture control is the key to mold control.

Food

Besides moisture, mold needs nutrients, or food, to grow. Mold can grow on virtually any organic substance. Most buildings are full of organic materials that mold can use as food, including paper, cloth, wood, plant material, and even soil. Molds secrete digestive fluids that decompose the substrate, making nutrients available. Mold can digest some synthetic materials such as adhesives, pastes, and paints.

Molds can grow on inorganic material such as concrete, glass, and metal, because it can grow on the dirt or dust that is present on the surface of those materials.

In most cases, temperature is not an issue; some molds grow in warm areas, while others prefer cool locations such as bread stored in a refrigerator.

Mold grows well in an environment at 40º to 100º Fahrenheit. (And the pH is usually between 3 and 8.) Some mold species have been found in hot springs with water temperatures above 120ºF.

Often, more than one type of mold can be found growing in the same area, although conditions such as moisture, substrate, and temperature may favor one species of mold over another.

Section 7
Building Science in Relation to Moisture and Microbial Growth

Microorganisms can be found in the air inside a building, on a surface inside a building (like on the floor, ceiling, wall, or furniture), and inside the HVAC system of a building. Many of these microorganisms come from outside. They come from decaying organic matter or moist earth.

Microorganisms can enter the a building by floating with outdoor air that enters the building, or they can travel on people and animals who bring them inside.

Microorganisms might be present on the building materials as the structure is being constructed. Oftentimes, inspectors will find building materials lying on the ground at a new-construction site. These materials absorb moisture and dirt. These materials may support mold growth inside the building, after construction has completed.

Mold growth is not desirable in a building and must be prevented. There are three reasons to prevent fungal growth inside a building: (1) potential health effects of exposure to fungi and their byproducts; (2) the effect of mold contamination on the structural integrity of the building; and (3) the negative aesthetic effects fungi can produce both visually and on the human olfactory systems. [9]

Moisture, Temperature, Food, and Time

There are four factors involved with mold growth. The following conditions are necessary for mold growth to occur on surfaces:

- temperature range above 40°F and below 100°F
- mold spores

- nutrient base (most surfaces contain nutrients)
- moisture

Human comfort constraints limit the use of temperature control. Spores are almost always present in outdoor and indoor air, and almost all commonly used construction materials and furnishings can provide nutrients to support mold growth. Dirt on surfaces provides additional nutrients. It is virtually impossible to eliminate all nutrients. Therefore, moisture control is the most important strategy for reducing mold growth.

Moisture is the primary factor in controlling fungal growth (mold growth) in a building. Temperature, food, and time are other factors. [12] Air temperature inside a building that is suitable for occupants is also good for mold growth. Most buildings are kept between 65 and 75°F. This temperature range is suitable for mold growth. Some fungi can thrive in temperatures as cold as 15°F and as hot as 122°F.

A building is comprised of an abundant supply of nutrients for mold growth. Fungi have been shown to colonize on drywall, wood paneling, wallpaper, ceiling tiles, carpeting and pads, furniture, insulated ductwork, and other building components where the fungi break down the materials for food or use the dust that has collected upon a surface as a nutrient source. Temperature, food, and time cannot be managed so as to control microbial growth, but moisture can. Moisture is the controlling factor. Once moisture intrusion into a building takes place, mold can start growing in little time. Fungi have been show to be capable of germination, growth, and sporulation in as little as 24 hours after water damage occurs. [13]

Building Science

To understand how to find mold growth and prevent mold growth in a building, inspectors must study and understand building science. Building science in relation to mold is the study of the building dynamics related to moisture intrusion. Buildings are dynamic environments affected by geographic location, season, weather conditions, HVAC system design and operation, moisture intrusion, pest colonization, and human activities. [13] Building dynamics continually change and affect the conditions for mold growth.

Moisture Content

Moisture content (MC) is often expressed as a percentage (100 x (wet mass – dry mass)) ÷ (dry mass) or in terms of the amount of water in a certain volume (lbs/ft^3).

Mold requires moisture to survive, so protecting lumber and wood structures from moisture will prevent mold growth. Mold growth can be limited if the MC of wood can be kept below 20%. Below a 17% MC of wood, virtually no microbial growth will occur on even the most susceptible materials. Southern Pine dimensional lumber is typically kiln-dried to maximum 19% MC or less. The moisture content will be identified on the grade stamp. Keep in mind, moisture content is related directly to particular substrates or materials. Microbial growth is limited when the MC of gypsum board is below 0.6%, brick is below 0.8%, wallpaper is below 10.5%, and concrete is below 5%. [13] There was a study that showed a moisture content greater than 5% permitted growth of Penicillium glabrum and Aspergillus versicolor on ceiling tiles in a laboratory. [14]

Molds and mildew are fungi that grow on the surfaces of objects, within pores, and in deteriorated materials. They can cause discoloration and odor problems, deteriorate building materials, and lead to allergic reactions in susceptible individuals, as well as other health problems.

Mold growth does not require the presence of standing water; it can occur when high relative humidity or the hygroscopic properties (the tendency to absorb and retain moisture) of building surfaces allow sufficient moisture to accumulate. Relative humidity and the factors that govern it are often misunderstood. This section is intended to give building inspectors an understanding of the factors that govern relative humidity, and to describe common moisture problems and their solutions.

Relative Humidity

Understanding relative humidity in a building is essential to controlling mold growth. Relative humidity (RH) is a ratio (expressed as a percentage) of the amount of moisture in air to the maximum amount the air can hold. Warm air can hold more moisture than cool air. RH is a factor in determining how much moisture is present in a room, but it is the available moisture in a substrate (not the RH of the room's air) that determines if mold can grow or not.

Many sources recommend maintaining RH in living spaces below 60% to limit microbial growth. By keeping RH below 60%, one may assume that moisture content in building materials would be low. However, this assumption may be false because mold grows on surfaces and in building materials, not in the air. Therefore, it is the RH in the air adjacent to the surface, not the ambient RH, that must be lowered in order to control mold growth. Measuring a room with a RH at or below 60% may mean that the building materials are fairly dry, but it does not the possibility of mold growth because local cold spots and water intrusion may allow the RH of the air adjacent to the surface to exceed 70%. [13]

Moisture meters are essential for inspectors; they enable inspectors to identify damp areas that would otherwise not be evident. Infrared thermography cameras are praised for their ability to detect moisture that is not readily visible.

Water enters buildings both as a liquid and as a gas (water vapor). Water, in its liquid form, is introduced intentionally in bathrooms, kitchens, and laundries and accidentally by way of leaks and spills. Some of that water evaporates and joins the water vapor that is exhaled by building occupants as they breathe or that is introduced by humidifiers. Water vapor also moves in and out of the building as part of the air that is mechanically introduced or that infiltrates and exfiltrates through openings in the building shell.

A lesser amount of water vapor diffuses into and out of the building through the building materials themselves.

The sketch [13] illustrates locations of moisture entry and how all those entry paths can add to the moisture gain of the building.

The ability of air to hold water vapor decreases as the air temperature is lowered. If a unit of air contains half of the water vapor it can hold, it is said to be at 50% relative humidity (RH). As the air cools, the relative humidity increases. RH rises as the air cools, because cooler air has a lower moisture-holding capacity, increasing the risk of condensation in walls.

If the air contains all of the water vapor it can hold, it is at 100% RH, and the water vapor condenses, changing from a gas to a liquid. It is possible to reach 100% RH without changing the amount of water vapor in the air (its “vapor pressure” or “absolute humidity”); All that is required is for the air temperature to drop to the “dew point.”

Relative humidity and temperature often vary within a room, while the absolute humidity in the room air can usually be assumed to be uniform. Therefore, if one side of the room is warm and the other side cool, the cool side of the room has a higher RH than the warm side.

The highest RH in a room is always next to the coldest surface. This is referred as the “first condensing surface,” as it will be the location where condensation first occurs, if the relative humidity at the surface reaches 100%. It is important to understand this when trying to understand why mold is growing on one patch of wall or only along the wall-ceiling joint. It is likely that the surface of the wall is cooler than the room air because there is a void in the insulation or because wind is blowing through cracks in the exterior of the building.

The chart [13] shows a relative humidity reading taken in a room will only give an accurate indication of the actual amount of moisture present if a temperature reading is taken at the same time. The chart below shows that air at 70°F and 40% RH contains approximately 0.006 pounds of moisture per pound of dry air (as indicated by the bold line), while air that is at 50°F and 40% RH contains approximately 0.003 pounds of moisture per pound of dry air (as indicated by the dashed line). Although both are at 40% RH, the 70°F air contains roughly twice as much moisture as the 50°F air.

Condensation in Cold Climates

The basic idea in controlling condensation due to vapor migration is to prevent warm moist-laden air from contacting cool surfaces. In cold climates, condensation can occur within an exterior wall of a building when warm, moist indoor air flows outward. This warm, moist air cools as it nears the outer boundary of the exterior wall. RH rises as the air cools (because cooler air has a lower moisture-holding capacity), increasing the potential for condensation forming in the walls.

To control condensation in a building exterior wall in cold climates:

- Install insulation to prevent large temperature differences between air and surfaces.
- Install air or vapor barriers on the warm side of the building envelope.

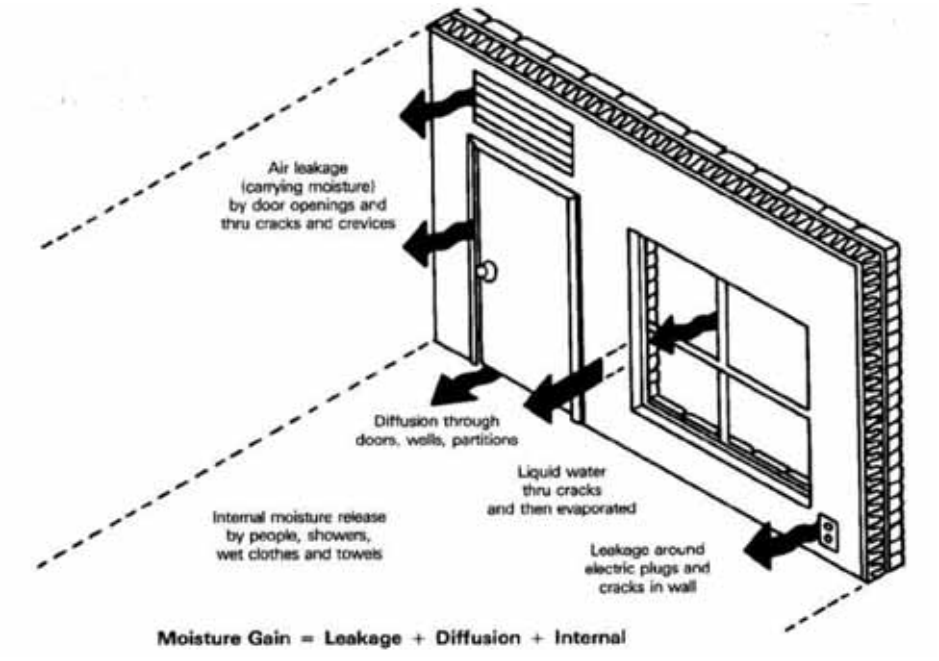
- Use ventilation to reduce indoor moisture levels below levels that allow condensation to occur.

Condensation in Hot and Humid Climates

To control condensation in a building exterior wall in hot, humid climates:

- Install insulation to prevent large temperature differences between air and surfaces.
- Install air or vapor barriers on the exterior-side of the building envelope.
- Avoid impermeable vinyl or other wall coverings and use permeable paints and wall coverings on the interior surfaces of the exterior walls.
- HVAC systems should be producing net positive pressures on the inside of the building with respect to the outdoors to avoid entry of outdoor air inwards
- Try to avoid cooling interior spaces below the average, monthly, outdoor, dew-point temperature for the climate in which the building is located. [13] In some areas this may not be possible.

Many buildings incorporate vapor barriers in the design of their walls and floors. Vapor barriers must be located and installed properly or the building may have moisture problems. A vapor barrier is a layer of material that slows or prevents the absorption or release of moisture from or into a wall or floor. Vapor barriers can prevent damp or wet building materials from drying quickly enough to prevent mold growth.



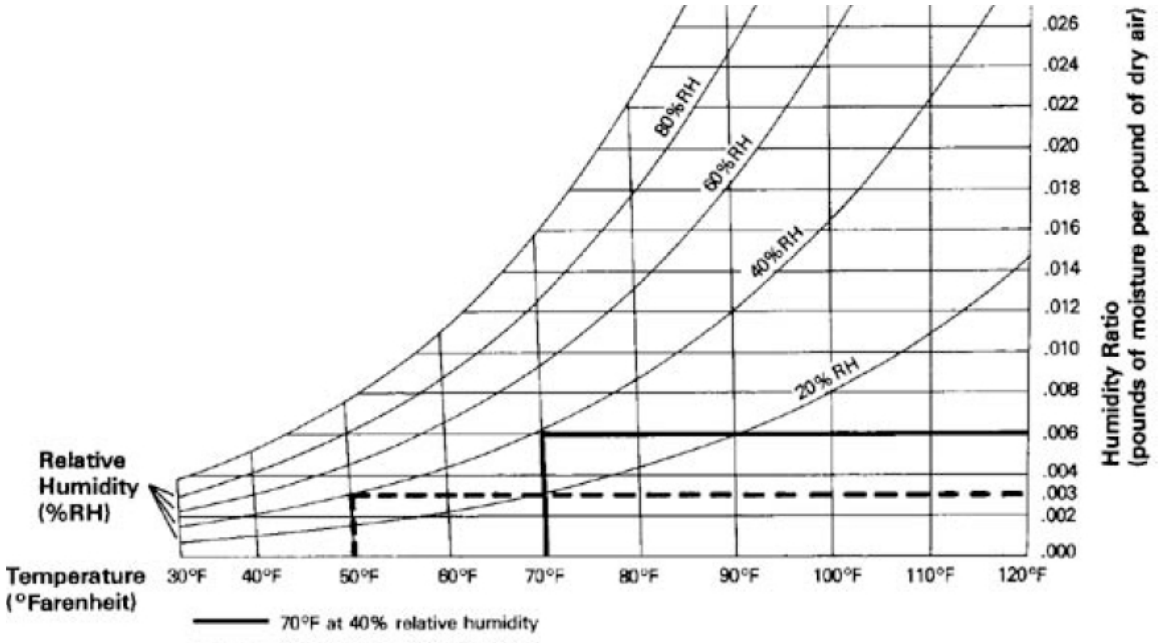
How To Perform a Mold Inspection
By Ben Gromicko

Humidifiers

Moisture from humidifiers may support microbial growth on wet surfaces where moisture can condense during cold weather. Humidifiers that discharge small droplets of water from a reservoir of water are prone to supporting mold growth. Moisture accumulation inside a dirty ductwork creates a suitable environment for mold growth. The reservoir of the humidifier is usually contaminated in some degree. Humidifiers should be considered as potential mold growth sources.

Windows

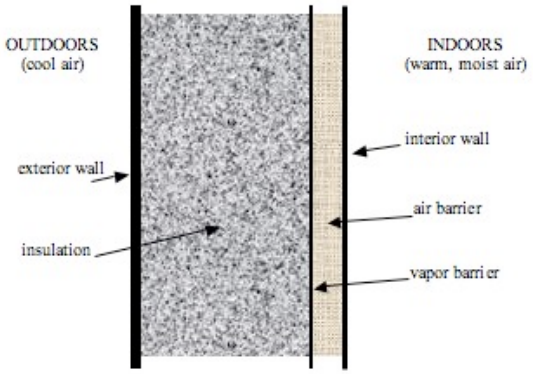
In winter, windows are typically the coldest surfaces in a room. The interior surface of a window is often the first condensing surface in a room. Condensation on window surfaces has historically been controlled by using storm windows or insulated glass to raise interior surface temperatures. The advent of higher performance glazing systems has led to a greater incidence of moisture problems in heating climate building enclosures, because the buildings can now be operated at higher interior vapor pressures (moisture levels) without visible surface condensation on windows. In older building enclosures with less advanced glazing systems, visible



condensation on the windows alerted occupants to the need for ventilation to flush out interior moisture (so they opened the windows).

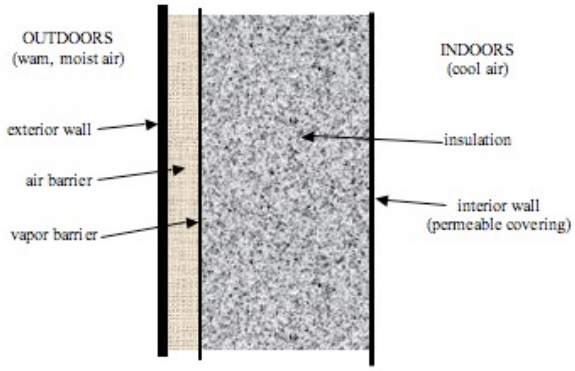
RH and Temperature

Mold is commonly found on the exterior wall surfaces of corner rooms in cold climate locations. An exposed corner room is likely to be significantly colder than adjoining rooms, so that it has a higher relative humidity (RH) than other rooms at the same water vapor pressure. If mold growth is found in a corner room, then relative humidity levels next to the room surfaces are above 70%. However, is the RH above 70% at the surfaces because the room is too cold or because there is too much moisture present (high water vapor pressure)?



The amount of moisture in the room can be estimated by measuring both temperature and RH at the same location at the same time. Suppose there are two cases. In the first case, assume that the RH is 30% and the temperature is 70°F in the middle of the room. The low RH at that temperature indicates that the water vapor pressure (or absolute humidity) is low. The high surface RH is probably due to room surfaces that are “too cold.” Temperature is the dominating factor, and control strategies should involve increasing the temperature at cold room surfaces.

In the second case, assume that the RH is 50% and the temperature is 70°F in the middle of the room. The higher RH at that temperature indicates that the water vapor pressure is high and there is relatively large amount of moisture in the air. The high surface RH is probably due to air that is “too moist.” Humidity is the dominating factor, and control strategies should involve decreasing the moisture content of the indoor air.



Section 8
Finding Mold in Buildings


We know what mold is, and we know what mold needs to grow. Now let's learn how and where to find mold in a building.

A building can become a perfect place for mold growth when the building has construction flaws, systems or components that are damaged or inoperable, or delayed maintenance. Any part of a building that allows moisture to enter into the building materials creates the potential for mold growth. Wooden components, drywall, carpeting, plaster, wallpaper, and many other building materials provide fertile conditions for mold growth when they are wet. Water-damaged materials provide sites for mold growth.

Approximately 31% of all residential homes in the U.S. have some type of water damage every year. Where there is water damage, there may be mold growth. When a home has mold growth there may be a large financial burden to correct the problem as well as a serious health risk.

Use Your Eyes

A visual inspection is the most important initial step in identifying a possible mold contamination problem. [3]

A certified mold inspection includes a non-invasive visual examination of the readily accessible, visible, and installed systems and components listed in the IAC2 Mold Inspection Standards of Practice, and at least one sampling for mold growth according to the IAC2 Mold Sampling Procedures.

The inspector shall report moisture intrusion, water damage, musty odors, apparent mold growth, or conditions conducive to mold growth.

Look for mold growth (may appear cottony, velvety, granular, or leathery and have varied colors of white, gray, brown, black, yellow, and green). Mold often appears as discoloration, staining, or fuzzy growth on the surface of building materials or furnishings.

General Guide to Performing an Examination: [14]

- The general grading of the ground around the perimeter of the building. Look for unusual or problematic conditions. The ground should be sloped away from the building.
- Examine the downspouts and discharge of the roof water. Examine storm water collection systems. Examine swales or drainage areas, or drainage systems. No standing water should be observed for more than 12 hours after a rain storm.
- The exterior siding materials and building envelope should be inspected carefully. Flashing details should be proper. Trim around windows and doors should be water-tight. Check sealant condition. Inspect for weep holes where required. Note the condition of the siding and trim.
- The roof system shall be inspected carefully. Check for damage or worn or deteriorated areas. Flashing details need to be installed properly. Observe any patching or repairs.
- Inside the building, check the walls, ceilings, and floors. Pay attention to paint surfaces. Look for patching and repairs. Look for water stains. Find water marks. Note odors and smells. Measure the humidity levels. Measure for wet, damp, or moist areas.
- Inspect the bathrooms and toilet rooms. Run water at all the fixtures. Check for water leaks or signs of prior water leaks and repairs. Check the exhaust fans and where they discharge. Check for microbial growth around the bath fans, the toilet, and inside the sink cabinet. Bathroom carpeting can support mold growth.

- In the kitchen, all the appliances and fixtures should be operated and inspected. Look for water stains and leaks under the sinks inside the cabinets. Check the area inside the sink cabinet for microbial growth. Check for water dripping from the dishwasher or refrigerator. The exhaust fan should be discharging outside. Check the area around the exhaust fan and the filtering system for microbial growth.
- Check humidifiers for mold. Note the method of how any dehumidifier is discharging the collected water.
- Inspect condensation or drip pans underneath air conditioning coils. Mold is often found on the coil fins themselves. There should not be standing water in any collection pans.
- Enter crawlspaces and check for humidity and moisture. Ventilation and insulation problems often support mold growth in under-floor crawlspaces. Exposed dirt floors should be sealed with a vapor barrier. Check for condensation on plumbing pipes and uninsulated ductwork passing through nonconditioned spaces.
- Basements should be inspected for moisture intrusion and water penetration problems and water damage. Check for efflorescence on masonry walls. Carpeting an uninsulated basement concrete floor is not recommended. Check sump pumps and their discharge. Check perimeter drainage channels or trenches.
- Check for leaks and condensation at all visible plumbing pipes and lines. Check the hot water source for leaks, drips, or discharge.
- Examine the fire sprinkler system, its valves, pipes, and sprinkler heads, for leaks or drips.
- Enter and examine accessible attic spaces. Check for properly installed and adequate ventilation and insulation.
- Examine enclosed structures around spas, whirlpools, swimming pools, saunas, or other areas witch high humidity levels.
- Check the dryer exhaust vents.
- Examine the proper ventilation of the exhaust of all combustion appliances, including the fuel-fired heating system and hot water source.

Smell for Odors

Search for areas of noticeable moldy, musty odors. You may suspect mold, even if you can't see it, if a building smells moldy. [1] You may suspect hidden mold if you know there has been a water problem in the building and its occupants are reporting health problems. [1]

Some compounds produced by molds have strong smells and are volatile and quickly released into the air. These compounds are known as microbial volatile organic compounds (mVOCs). Because mVOCs often have strong or unpleasant odors, they can be the source of the "moldy odor" or musty smell frequently associated with mold growth.

mVOCs are small molecules that don’t tend to settle out on carpet and other surfaces as do mold spores. They can pass through walls, allowing them to spread throughout the inside of buildings. However, like mycotoxins and enzymes, they can’t be transmitted very far outside when exposed to sunlight. Therefore, their presence inside of buildings is direct evidence of active or recently active mold growth. [5]

A moldy odor suggests that mold is growing in the building and should be investigated. The health effects of inhaling mVOCs are largely unknown, although exposure to mVOCs has been linked to symptoms such as headaches, nasal irritation, dizziness, fatigue, and nausea. More research is needed to determine whether there are any human health effects from non-occupational indoor exposures to mVOCs.


Check for Conditions

A visual examination of a building includes reporting conditions conducive to mold growth. The following is a list of conditions that are conducive to mold growth. This list is for information purposes only. It is not all-inclusive. Certain physical conditions may exist at a property that are not listed here. Certain activities or procedures that are beyond the scope of a standard inspection may be warranted at the discretion of the inspector.

- water or moisture intrusion at carpeting in the corner of a below-grade basement
- any building system or component that may contribute to a moisture problem
- standing water
- water damage
- puddles of water
- water stains
- flooding
- over-watering potted plants
- water inside a sump pump bucket
- water inside a perimeter drainage channel
- condensation problems
- indoor humidity that is too high
- indoor surfaces that are too cold
- moisture movement through basement walls and slab
- carpeting that was wet
- negative grading
- downspouts not discharging far enough away from the building

- clogged or inoperative gutter system
- dripping water valves
- steam radiators
- missing vapor barrier
- leaking gutters
- roof leaks
- plumbing leaks
- overflow of water from tubs, sinks, or toilets
- firewood stored indoors
- the use of a humidifier
- defects in systems or components that may allow water or moisture penetration
- a roof covering in deteriorated condition
- improperly installed flashing
- defects in the plumbing system such as a leaking dishwasher appliance
- the HVAC system including a dirty air filter and a clogged condensate drainage
- improper discharge of exhaust from the clothes dryer, bath fan, or kitchen fan
- inadequate venting of kitchen and bath humidity
- improper venting of combustion appliances
- failure to vent clothes dryer exhaust outdoors (including electric dryers)
- line drying the laundry indoors
- house plants – watering them can generate large amounts of moisture
- loosely secured toilets with leaking wax rings or seals
- irrigation sprinkler systems that are not spraying efficiently
- condensing moisture on air-conditioning ducts and windowpanes
- crawlspaces with exposed dirt floors
- inadequately ventilated spaces such as an attic space with its vents blocked by insulation
- fire suppression sprinkler head that is dripping water
- non-insulated ductwork inside non-conditioned space


Ask Occupants

You may suspect hidden mold if you know there has been a water problem in the building and its occupants are reporting health problems. [1] If the building occupant states noticeable odors, musty smells, or elevated humidity levels in any room of the building, there may exist conditions favorable to mold growth. If allergic reactions or symptoms are experienced inside a particular area of the building, mold growth may be present.

Check Moisture Intrusion

Moisture intrusion includes ground water intrusion, surface water intrusion, water intrusion originating from inside the building (such as from a plumbing leak), and condensation.

Look for active moisture intrusion into the building. Look for signs of excess moisture or water damage. Sampling for mold is recommended if water or moisture penetration is visually evident during an examination, because mold can grow in moist environments.

A moisture meter shall be used during a mold inspection. There are many different types of moisture meters. The most basic moisture meter is essential to a complete mold inspection. Moisture meters can provide qualitative information but may not indicate the actual amount of water available to microorganisms for growth.

Moisture measurements should be taken in every room or area of the building of concern at the discretion of the mold inspector. Not all rooms and areas have to be measured.

Moisture problems can have many causes. Some moisture problems have been linked to changes in building construction practices since the 1970s. These practices led to buildings that are tightly sealed but, in some cases, lack adequate ventilation. Without adequate ventilation, moisture may build up indoors and mold may grow.

A building must be properly designed for climate, site location, and use, and its design must be accurately followed during construction or the building may have moisture control problems.

Delayed or insufficient maintenance can lead to moisture problems in buildings. Undiscovered or ignored moisture problems can create an environment in which mold can grow. Moisture problems in temporary structures, such as portable classrooms, are also frequently associated with mold problems.

Common moisture problems include:

- Leaking roofs.
- Leaking or condensing water pipes, especially pipes inside wall cavities or pipe chases.
- Leaking fire-protection sprinkler systems.
- Landscaping, gutters, and down spouts that direct water into or under a building.
- High humidity (> 60% relative humidity).
- Unvented combustion appliances such as clothes dryers vented into a garage. (Clothes dryers and other combustion appliances should be vented to the outside.)
- Under-floor crawlspace with exposed dirt floor.

Some moisture problems are not easy to see. For example, the interiors of walls where pipes and wires are run (pipe chases and utility tunnels) are common sites of mold growth. Mold is frequently found on walls in cold corners behind furniture where condensation forms.

Other possible locations of hidden moisture, resulting in hidden mold growth are:

- poorly draining condensate drain pains inside air handling units.
- porous thermal or acoustic liners inside duct work.
- roof materials above ceiling tiles.
- the backside of drywall (also known as gypsum board, wallboard, or SHEETROCK®) or paneling.
- under carpeting and pads
- behind wallpaper
- under vinyl flooring
- inside sink cabinets
- under furniture
- behind stored items placed near an exterior wall or on a cold floor

Condensation Inside HVAC Ducts

An increase (up to 90%) in the relative humidity of air downstream of cooling coils is a natural result of the energy transfer between the air and the coils. Moisture may condense on cool surfaces in contact with this damp air or may “wick” off cooling coils. Particles (soil, organic matter, and microorganisms) not removed by the filter system can collect on surfaces within HVAC systems. Such organic matter may support microbial growth under wet or damp conditions. Inspectors should sample surfaces inside HVAC systems if microbial growth is suspected and needs to be confirmed. [13] Any surfaces within supply air ducts that can accumulate dirt can be a place for mold growth if adequate moisture is present.

Humidifiers

Reservoirs for humidification devices that use recirculated cold water are always microbially contaminated to some degree. [13] They should always be considered as potential mold sources.

Check Humidity

Relative humidity (RH) measurements should be taken in all areas of the building that have conditions that have lead to moisture intrusion, water damage, musty odors, apparent mold growth, or conditions conducive to mold growth.

Sometimes, humidity or dampness (water vapor) in the air can supply enough moisture for mold growth. Indoor relative humidity (RH) should be kept below 60 percent — ideally between 30 percent and 50 percent, if possible. [1]

Low humidity may also discourage pests (such as cockroaches) and dust mites.

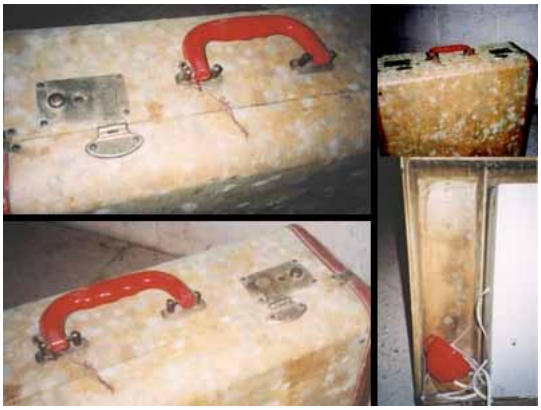
Humidity levels can rise in a building as a result of the use of humidifiers, steam radiators, moisture-generating appliances such as dryers, and combustion appliances such as stoves. Cooking and showering also can add to indoor humidity.

One function of the building heating, ventilation, and air conditioning (HVAC) system is to remove moisture from the air before the air is distributed throughout the building. If the HVAC system is turned off during or shortly after major cleaning efforts that involve a lot of water, such as mopping and carpet shampooing or cleaning, the humidity may rise greatly, and moisture or mold problems may develop.

Condensation can be a sign of high humidity. When warm, humid air contacts a cold surface, condensation may form. (To see this, remove a cold bottle of water from a refrigerator and take it outside on a hot day. Typically, condensation will form on the outside of the bottle.)

Intrusion of humid outdoor air could result in chronic condensation on windows, perimeter walls, or other cool surfaces.

Humidity can be measured with a humidity gauge or meter; models that can monitor both temperature and humidity.



Check Temperature

The mold inspector in all areas where there is moisture intrusion, water damage, apparent mold growth, musty odors, or conditions conducive to mold growth should take temperature measurements. Mold tends to grow well in temperatures ranging from 32 to 104 °F.

Could Be Hidden

In most cases, finding indoor mold growth may not be obvious. Mold does not need light to grow: it can grow in dark areas and on hidden surfaces, such as the backside of drywall, wallpaper, and paneling; the top side of ceiling tiles; and the underside of carpets and pads. Possible locations of hidden mold also include damp areas behind walls and in crawlspaces, inside pipe chases and utility tunnels (areas in walls where water and other pipes are run), on acoustic liners in ventilation ducts, and on roof materials above ceiling tiles.

Investigating hidden mold can be difficult. It requires a professional with experience in inspecting for water and moisture problems. Being a certified home inspector is the best qualification to perform a thorough mold inspection. Certified home inspectors are trained to locate and identify moisture intrusion, condensation, and humidity problems. Certified home inspectors are trained in building science, which is needed to investigate moisture intrusion and conditions conducive to mold growth. For information about training to become a certified home inspector, visit http://www.nachi.org.

Investigating hidden mold requires caution since disturbing moldy areas may spread mold throughout the building. Operating air handlers, for example, can send high levels of dust and mold into the air and circulate it throughout the building.

Personal protective equipment (PPE) is not always needed when looking for mold, but it should always be available. If mold might be released into the air, inspectors should use PPE to reduce exposure.

Maintenance Personnel of Large Buildings

A key step when looking for mold in a building is to determine whether there has been a water leak. Maintenance personnel are frequently among the first to know when moisture problems have occurred. In some cases, management or health and safety personnel will have been notified. Either way, touring the building with maintenance or other personnel involved with the water problem may be helpful.

Inspect Crawlspaces

Under-floor crawlspaces should be included when examining a building. (A white, soluble fibrous material on the soil of the crawl space may be alkaline salts, not mold, indicating moisture has been a problem and suggesting that the area should be more extensively inspected.)

Keep in mind that mold levels in confined spaces such as a crawlspace are likely to be high, so PPE should be selected accordingly.

Crawlspaces where relative humidity (RH) is high are common sites of hidden mold growth, particularly if the crawlspace has a bare earth floor. The soil will wick moisture, through capillary action, from moist to dry areas. The relative warmth of the crawl space will dry the soil by evaporation, adding this moisture to the air in the crawlspace where it can cause mold to grow. Also, in areas where the water table is high and weather conditions are suitable, ground water may enter a crawlspace.

The moisture that accumulates in a crawl space may also enter another part of the building and contribute to mold growth there. Moisture can pass from a crawl space into a building through cracks in walls, floors, and ceilings.

Crawlspaces should be designed specifically to avoid moisture problems.

Inspect HVAC

The building's air-handling system should be inspected to determine whether it is moldy. Moisture may collect in the ventilation system due to poor condensate pan drainage, poor roof drainage, or high humidity in the ventilation ducts. In some cases, water may enter the ventilation ducts from a leaky pipe. A contaminated ventilation system may spread mold spores throughout the building and should be considered a high priority for investigation and repair. Ventilation system mold contamination should be mitigated as soon as possible in a manner that does not expose building occupants to dust and mold spores.

Filters may become damp during the air-conditioning season. Microorganisms may grow on a damp filter itself or on collected dust. Mold sampling of the material accumulated on the filter may distinguish between a normal accumulation of material of biological origin on a filter and actual microbial growth (mold). [13]

Mold growing near the intake to an HVAC system likely indicates ventilation humidity problems. An HVAC system that is part of an identified moisture problem may also be a site of mold growth. Experience and professional judgment should be used when working with the HVAC system; consult a professional if needed.

If the HVAC system has insulation on the inside of the air ducts, and the insulation gets wet or moldy, it should be removed and replaced because the material cannot be cleaned effectively.

Look for:

- Standing water under the cooling coils of air handlers.
- Condensate pans could have excessive water in them.
- Make sure the drain pans slope toward the drain and the drain is flowing freely.
- Make sure ducts are properly sealed and insulated in all non-air-conditioned spaces so moisture due to condensation does not enter the system and the system works as intended. To prevent condensation, the heating and cooling system must be properly insulated.
- Check proper installation, proper maintenance of any in-duct humidification equipment according to the manufacturer's recommendations.

- Check the air filters. Dampness may be found on the filters. Microbial growth may be found on the filters.
- The cooling coils could be dirty and conducive to microbial growth.
- Dampness and microbial growth on the acoustical lining
- Poorly maintained humidifier units with stagnant water.
- Surface deposits, rust, or microbial growth on the air supply registers.

Return Air Registers

Mold spores that are released in one room of a residential building may be circulated to other parts of the building. The mold spores may settle on dirt or dust that is located anywhere in the duct system through which the air travels. These spores could become moistened by the circulating air, especially if there is a humidifier operating in the building. An inspector should check the return air registers for indications of visible apparent mold growth. A lack of maintenance and cleaning of the ducts can be a reason for suspecting microbial growth inside the ductwork.

Consult the EPA guide Should You Have the Air Ducts in Your Home Cleaned? (see the Resource List in Section 29). Although this publication focuses on ducts in homes, the information it contains is applicable to other building types.

A window air conditioner could have a dirty filter or grille. There could be standing water inside the unit. There could be moisture dripping from the bottom of a window unit, evidenced by moisture damage at the bottom corners of the window opening and directly below the unit.

Check the Structure

Molds gradually destroy whatever they grow on, so preventing mold growth also prevents damage to building materials and furnishings. If a mold and moisture problem goes unaddressed long enough, structural damage is likely to result. For example, if a roof is allowed to leak long enough, molds can weaken floors and walls by feeding on the wet wooden, load-bearing components.

When mold is suspected of causing major material damage to the structural integrity of a building, a structural engineer or other professional with relevant expertise should be consulted.

Carpeting

Bathrooms and basements should not be carpeted. [4] Carpeting installed on uninsulated concrete floors at ground level is of particular concern because of the potential for dampness, condensation, and mold growth.

Check Other Areas of Mold Exposure

The following are areas of high mold exposure usually: Antique shops, greenhouses, saunas, farms, mills, construction areas, flower shops, where lawn grass is being cut, and summer cottages.

Measure Small, Medium, or Large

The size and extent of the apparent mold problem should be measured. Mold contamination generally can be divided into small (less than 10 square feet of mold), medium (10-100 square feet of mold), and large jobs (more than 100 square feet of mold). [2] A remediation manager should be consulted for medium jobs. An experienced health and safety professional should be consulted in remediation projects and on large or complex jobs.

Use IAC2

Finding mold in buildings involve performing a non-invasive visual examination and mold sampling according to a standard. The IAC2 Mold Inspection Standards of Practice can be used as a guide to perform a mold inspection.

Use Computer Software

Finding mold in buildings requires documentation of work. A computer software program to document findings and write the inspection can be utilized. The software used for the textbook was created by HomeGauge®.

HomeGauge® makes it easy to create professional reports and print them onsite or deliver them online. HomeGauge® comes standard with templates for many different types of property inspections, including single family homes, multi-family, commercial buildings, condos, mold, four point inspections, new construction phases, and also includes support for the Texas (TREC) format. In addition, you can create your own templates for just about any type of inspection you may need to perform. HomeGauge® offers free technical support and also tips on marketing your inspection business. For more information go to http://www.homegauge.com.

Section 9
Inspection Tools and Personal Protection Equipment (PPE)


Eyes

The most important equipment to use during an examination of a building for mold growth is your own eyes and nose. A visual examination of the building is required; sampling alone is almost useless.

Nose

Check for odors. Air sampling may be necessary if the presence of mold is suspected (for example, musty odors), but cannot be identified by a visual examination.[3] Musty, moldy odors likely indicate mold growth.

Flashlight

A good flashlight is essential.

Borescope

Some investigators use borescopes to look for mold growth behind walls without significantly damaging the drywall. A borescope may be useful when there is moisture intrusion, water damage, apparent mold growth, musty odors, or conditions conducive to mold growth, and the full extent of the problem is not ascertainable.

The borescope is commonly used when moisture penetration is apparent at a wall, and there is a desire to understand the extent of the moisture problem in the wall cavity. Mold may be behind a finished wall or above a finished ceiling. With a borescope, an inspector can view the wall cavity without significant removal of or damage to the finished wall or ceiling. Written permission must be attained from the property owner prior to using a borescope, because one or more holes through the finished wall or ceiling will need to be drilled. The use of a borescope is beyond the IAC2 Standards of Practice.

Moisture Meter

A mold inspector should use a moisture meter to find wet areas. Wherever there is moisture, dampness, or wetness, there may be mold growing. Mold can grow instantly. It does not take 24 or 48 hours, or a few days to grow. Mold growth can be instant wherever there is moisture intrusion, [12] including but not limited to, ground water intrusion, roof leaks, condensation, and plumbing leaks.

These meters measure the moisture in many types of building materials (substrates). They also can monitor the process of drying these materials. A moisture meter typically has a thin probe that can be inserted into the material to be tested or pressed directly against its surface. Moisture meters can be used on carpet, wallboard, wood, brick, and concrete. Because mold often grows where moisture is high, a moisture meter can help an inspector locate hidden areas of mold growth.

IR camera

An infrared camera can be used to detect moisture penetration that may not be visible to the

human eye. An infrared camera is an inspection tool with many applications. It is a non-invasive instrument that can give clues to conditions that are behind the apparent, visible surface of a wall, floor, or ceiling.

Humidity

An inspector is should measure the humidity when performing an examination of the building. High humidity in a building can lead to mold growth, so humidity gauges are very useful. When high humidity levels are measured inside a particular area or room in a building, that measurement may indicate hidden mold growth. Further evaluation is needed when high humidity levels are measured and mold growth is not visible.

There are measurement tools that measure both humidity and air temperature. The tool may have an infrared device for non-contact temperature measurements.

Digital Camera

A digital camera should be used to take pictures of all the sampled surfaces. A digital picture should be taken of all of the areas of moisture intrusion, water damaged components, apparent mold growth areas, rooms with musty odors, and any other system or component of the building that may be attributing to mold growth.

Other Inspection Tools and Equipment

- Mask/respirator. Full-face for remediation work. Lower-face or full-face can be used for inspections. Respirators are used to protect your lungs and your eyes. Do not use a dust mask or something inexpensive.
- Work suit. Full-body, long sleeves (protection from hazards including simple abrasion).
- Pockets (to carry inspection tools, leaving your hands free)
- Knee pads (protection from rocks, water, debris, nails, concrete)
- Protective gloves, cloth or latex. Not too loose that your finger can’t be used to take a picture with your camera.
- Duct tape. For sealing the sleeves and legs of the work suit.
- Digital picture camera. With fresh batteries, and carry extra batteries. Used for documenting inspection restrictions and conditions observable on the day of the inspection.
- Protective cloth cap or hardhat
- Different shoes worn just for working in a moldy environment
- Shoe covers

- Probe or poker
- Screwdriver or hand tools. Hand tools could be used for probing or knocking. Decayed or damaged wooden components sound different than those that are sound and solid.
- Flashlight with fresh batteries. Use rechargeable batteries. Carry extra batteries into the crawlspace.
- Laser pointer
- Headlight or headlamp. Can be used as a backup to a flashlight. Can be used as the primary light source. Headlamps keep your hands free.
- Extra batteries
- Non-contact voltage detector beeper instrument. To check electrical wires and their condition. Oftentimes, an inspector will discover loose, disconnected, live wires hanging from the crawlspace ceiling.
- Work light. Work lights have the advantage over flashlights by flooding the space with light. And a work light does not require the use of hands.
- GFCI-protection. Use GFCI-protection especially if you are using a work light with an extension cord. Many extension cords have integrated GFCI-protection devices.
- Extension cord. Make it a heavy-gauge cable. At least 14-gauge should be used; 12-gauge wire is better. Make sure the cord is plugged into a properly wired and grounded receptacle.
- Carpet for cleanliness. Use the carpeting to stand upon after exiting a crawlspace or attic, particularly if the access is an interior opening and the space is muddy.
- A note and a business card. If you are working in a vacant house, leave a note and a business card somewhere in the entry area - to alert people entering the house of your location and the reason for your presence.
- GFCI tester. Test all electric receptacles prior to using them.
- Measuring tape
- Moisture meter. A moisture meter should be used to confirm what is visually observed.
- Moisture gauge. A moisture gauge should be used to confirm what is felt as a musty, muggy, or moisture-laden air.
- Infrared thermography camera. There are various ways to use this technology. It can be applied to discovering moisture penetration that cannot be seen with the human eye. It needs a good holster or carrying bag to offer padded protection.

Personal Protection Equipment (PPE)

- PPE
- Respirators





We learned about inspection tools and equipment. Now let's go over PPE and respirators.

Mold inspectors are subject to exposure to a variety of hazards, including insects, wildlife, construction debris, abrasions, dust, asbestos, lead, bioaerosols, and mold spores. Since mold spores can enter the inspector's body through touch, ingestion, and inhalation, PPE is very important to an inspector.

PPE stands for personal protection equipment. The use of personal protective equipment (PPE) should be considered during a mold inspection. PPE protects against the hazards of working inside a mold-contaminated area of a building by limiting exposure. The use of PPE is needed when mold is disturbed and likely to become airborne during a surface sampling. It may be unavoidable to have mold spores released into the air during an inspection or remediation. Airborne spores can pose a health threat when they are inhaled.

Diseases or allergic reactions to mold may manifest when the mold spores enter through the respiratory system. Therefore, a respirator for a mold inspector is commonly used. The primary

function of PPE is to avoid inhaling mold and mold spores and to avoid mold contact with the skin and eyes. There are many different types of respirators. The selection of respirator depends upon the job scope, contamination conditions, and the requirements of the work to be done. The respirator is an important piece of PPE.

Personal and professional judgment should be used when selecting PPE.

Attention to the health of the inspectors, workers, and occupants are essential at all times. Care must be taken to ensure everyone's safety.

The Occupational Safety and Health Administration (OSHA) regulates the use of PPE equipment in work areas. OSHA requires the use of PPE for working in moldy environments, especially remediation work. Anyone using respirators and other PPE in the workplace must be trained, must have a medical clearance, and must be fit-tested by a trained professional. Note that all Occupational Safety and Health Administration (OSHA) requirements must be met.

To insure a safe work environment for everyone performing inspections and remediation work, efforts to protect against exposure to mold contamination must be taken. A mold-contaminated building can be a dangerous place in which to work. Good work practices and safety procedures must be followed to prevent or effectively limiting mold exposure.

Hand Protection

There are many types of gloves available for inspections and remediation work. There are gloves that are chemical resistant, cotton, canvas, puncture resistant, disposable latex, and leather. Thick work gloves are best when bagging debris and materials. Rubber glove can protect from electrical hazards. Leather gloves protect from abrasion and cuts. For mold inspections, disposable latex gloves are recommended, but not necessary. A mold sampling can be performed according to sampling protocols without wearing gloves. [12]

Gloves protect the skin from contact with mold. They also protect the skin from potentially irritating cleaning solutions. Long gloves that extend to the middle of the forearm are recommended when disturbing mold. The material from which gloves are made should be suited to the type of materials being handled. If you choose to use a biocide in remediation work, such as chlorine bleach, or a strong cleaning solution, gloves should be made from natural rubber, neoprene, nitrile, polyurethane, or polyvinylchloride (PVC). If a mild detergent is being used, ordinary household rubber gloves are suitable. The routine use of biocides is not recommended.

Foot Protection

Boots can provide protection from a variety of hazards and environmental or work conditions. For maximum protection, boots should have rubber soles. Shoe covers are needed to prevent transfer of contamination to clean work areas or back home.

Eye Protection

Eye protection should be worn during an inspection where mold is visually evident. Airborne mold spores, particles, and materials can enter the body through the eye. Goggles, safety glasses, and eye shields are readily available. Safety glasses or goggles that have open vent holes are not acceptable. A full-face respirator provides eye protection. A lower-face respirator does not. It is important to choose the proper type of eye protection, since most work-related eye injuries are related to wearing the incorrect type of protection.

Head Protection

Any job that involves construction, demolition, or building requires wearing a hard hat. Mold remediation work involves hazards that can be prevented by wearing head protection. Inspection work is no exception. There are different types of hard hats and head protection. There are hard hats, bump caps, face shield adapters, and face shield visors. Each type of head protection gear is designed for protection against specific hazards. Class A helmet is for general purpose. Class B helmet is for electrical work. Class C helmet is designed for comfort; they are lightweight and offer limited protection. There should be label inside of the helmet showing the manufacturer's name, ANSI standard, and class.

Respirators

Respirators protect inspectors and remediation workers from inhaling airborne mold, mold spores, and dust. Three types of respiratory protection are described: minimum, limited, and full. Only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) should be worn during mold remediation. These respirators must be used according to any applicable Occupational Safety and Health Administration (OSHA) regulations.

Use minimum PPE when cleaning up a small area affected by mold (less than 10 square feet total). Minimum PPE includes gloves, goggles/eye protection and an N-95 respirator. An N-95 respirator covers the nose and mouth, filters out 95 percent of airborne particulates, and is available in most hardware stores. It does not provide eye protection.

Limited PPE includes the use of half-face or full-face air purifying respirators (APRs) equipped

with P100 filter cartridges. These respirators have inhalation and exhalation valves that filter the air and ensure it is free of mold particles. The P100 filters do not remove vapors or gases, and the half-face APRs do not protect the wearer's eyes. Limited PPE may be warranted when the total surface area affected by mold is between 10 and 100 square feet. Professional judgment should be used to make the final determination about whether to wear limited PPE.

Full PPE includes a full-face, powered air-purifying respirator (PAPR). It is recommended when more than 100 square feet of mold is found, when high levels of airborne dust or mold spores are likely, or when intense or long-term exposures are expected. A powered air-purifying respirator uses a blower to force air through a P100 filter. The filtered air is supplied to a mask that covers the wearer's face or a hood that covers the entire head. Positive pressure within the hood prevents unfiltered air from entering through penetrations or gaps. Individuals must be trained to use their respirators before they begin remediation.

Protective Clothing

Inspectors entering an under-floor crawlspace should wear protective clothing. Protective clothing is recommended for medium and large remediation projects. It prevents the transfer and spread of mold to clothing and eliminates skin contact with mold. When limited protection is warranted, disposable paper coveralls can be used. When full protection is required, a body suit of breathable material, such as TYVEK® , and mold-impervious disposable head and foot coverings should be used. All gaps, such as those around ankles and wrists, should be sealed. (Many remediators use duct tape to seal clothing.)

Personal Protective Equipment (PPE)

- Minimum: Gloves, N-95 respirator, goggles/eye protection
- Limited: Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection
- Full: Gloves, disposable full body clothing, head gear, foot coverings, full-face respirator with HEPA filter

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Respirators

A human respiratory system can only endure a small amount of exposure to toxic gases, fumes and particles. Some inhaled chemicals will destroy portions of the lungs. Chemicals in the lungs can be absorbed into the bloodstream where tissues and organs can be affected. Respirators can filter gases, vapors, and particles in the air.

The Occupational Safety and Health Administration (OSHA) regulate the use of respirators in a workplace. OSHA states that all respirators must be (1) approved, (2) color coordinated according to the known hazards, and (3) individually fitted.

Respiratory protection should be used when the concentration of airborne substances exceed a specific exposure limit. There are several exposure limits that can be used to determine the requirement of a respirator. They include OSHA Permissible Exposure Limits, NIOSH Recommended Exposure Limits, and ACGIH Threshold Limit Values.

If none of these are used for mold inspection work, then other published data may be used since there are no mold spore exposure limits for inspectors defined by those three national groups. It is up to the mold inspector to decide when, where, and what type of respirator to use (if at all).

An outline of an OSHA requirement for a minimal acceptable program is listed below:

- A written standard operating procedure governing respirators.
- Respirators are selected based upon the hazards to which the worker will be exposed.
- The worker shall be trained on how to use a respirator properly.
- Respirators shall be regularly cleaned, maintained and inspected.
- The work area shall be inspected to maintain good working conditions.

The selection of a proper respirator depends on:

- The nature of the hazards.
- The nature of the work or activity in the hazardous area.
- The location of the hazardous area in relation to a safe area having clean, breathable air.
- The length of time of exposure to hazards.
- The effectiveness of the respirator.
- The individual fit of the respirator.

There are respirators that purify (filter) the air. They could have filters (for particulates), cartridges (for gases and vapors), or canisters (large capacity “gas masks”). They require that the oxygen level be greater than 19.5%.

There are respirators that supply breathable air. They can be a self-contained breathing apparatus, supplied-air respirator, or a combination of the two.

Filtering disposable face mask

A particulate N95 respirator is an air purifying respirator used to provide protection in dusty, non-oil based environments, including sanding, bagging, and grinding. It is lightweight in

construction. It has a crimpable nose clip to provide a customized fit. This type is not recommended for mold inspectors.

Lower-face or half-mask respirator

A lower-face respirator has a face-sealing flange and chin holder. It has a head harness. The cartridges are disposable. The filters are job/hazard specific. The filters are readily available and easy to replace. It does not provide full protection.

Full-face respirator

The full-face respirator has dual cartridge attachments. There is a full field of vision provided. It has a sealing flange and a head harness. It provides the greatest protection. This mask is best for mold remediation work and mold inspection work. A mold inspector particularly inside a crawlspace should wear a respirator. [12]

In mold remediation of heavily contaminated areas, a powered air purifying respirator or a supplied-air respirator may be needed for maximum protection. A self-contained breathing apparatus may be used too.

Filters and cartridges

Organic vapors produced by mold spores can be filtered. The cartridges are color-coded black for identification.

There are two classifications for respiratory hazards in relation to filters and cartridges. They are (1) particulates and (2) vapors and gases. Particulates can be filtered by mechanical means. Vapors and gases are filtered by absorbents that react chemically with them. To effectively remove both hazards, a respirator will combine both mechanical filter and chemical sorbents.

There are three levels of filter effectiveness. “95” rating is 95% effective. “99” rating is 99% effective. “100” rating is 99.97% effective.

The service life of a filter or cartridge depends upon:

- Sorbent quality
- Exposure conditions
- Relative humidity
- Temperature
- Concentration of the contaminant

- Type of gas or vapor
- Presence of other hazards or particulates

OSHA requires testing the fit on the individual for all tight-fitting respirators. Fit testing is required for the first-time use and then annually afterwards. Each make, model, and size of tight-fitting respirator should be fit-tested. The wearer may actually breathe contaminated air unless the air passes effectively through the filter or canister (or air supply system). It is imperative that all respirators fit properly.

Be Safe

Safety is very important for all types of jobs including inspections and remediation work. Take the proper precautions to keep your work environment safe, train yourself in safety procedures, and wear PPE.

Section 10
Hypotheses

- Null Hypothesis
- Damaged Building Hypothesis
- Aesthetic Hypothesis
- Affected Health Hypothesis
- That Which is Visible is Mold Hypothesis
- An Example

A similar approach to gaining knowledge is shared by all scientific disciplines. The scientific method involves observing empirical evidence and drawing inferences from it. One school of thought holds that sampling can only disprove a hypothesis, and an inspector can never prove a cause-effect relationship. An alternative understanding of the basis of scientific knowledge is that all inspectors begin with a set of prior beliefs or assumptions. For example, an inspector may begin an examination of a building with an underlying assumption that there exist numerous undiscovered deficiencies in the building. Progress is made as hypotheses (based upon prior beliefs) are tested by collecting data, which either supports or refutes the hypotheses and underlying beliefs.

Before any sampling takes place, an inspector should develop a set of hypotheses that address the concerns of the inspector's client. A hypothesis is a proposition set forth as an explanation for the specific observation or condition experienced. A hypothesis is often used to guide the inspection (a working hypothesis) and can be accepted as highly probable in the light of established facts.

Hypotheses concerning the suspected role of fungal (mold) exposure on adverse effects should be developed BEFORE any mold sampling takes place. The inspector and client should agree to the hypotheses and agree upon how they should be addressed.

The inspector needs to gather information, develop hypotheses, test the hypotheses, and make recommendations based upon all available information gathered.


Gather Information

Gathering information involves asking the client about their concerns about mold; the reasons why they are requesting a mold inspection; and what relevant information they intend to receive from an inspection. Setting expectations with the client is part of this information gathering process.

There are generally three (3) types of CONCERNS clients may express about mold growth in a building:

1) client is concerned about the potential health effects of exposure to fungi and their byproducts;
2) client is concerned about the effect of mold contamination on the structural integrity of the building; and
3) client is concerned about the negative aesthetic effects fungi can produce both visually and on the human olfactory systems. [9]

Although the issue of whether exposure to indoor fungi causes adverse health effects is controversial, there is no doubt that a seriously mold-contaminated building can suffer structural damage, and that a foul-smelling, fungus-filled building is aesthetically unpleasing. Controversies about health effects aside, the latter two concerns are sufficient to merit a complete mold inspection and remediation when an environment is found to have fungal contamination.

People who have concerns about structural damage or the aesthetic effects of indoor fungi should seek the services from a certified mold inspector. People who have concerns about health effects of mold exposure should seek the counsel of a health care professional.

There are generally eight (8) questions that can be answered by a visual examination and mold sampling of a building:

1) Is there water intrusion in the building?
2) Are there water damaged components in the building?
3) Are there musty, moldy odors in the building?
4) Is there any visible apparent mold?
5) Is that which is visible actually mold?
6) Are there indications of hidden mold growth?
7) Are there conditions conducive to mold growth?
8) What should be done if mold growth is discovered?

To address these concerns, hypotheses, and questions accurately, a visual examination must be performed to a standard, mold samples must be taken according to procedures, laboratory analysis must be included, and proper documentation must be made. Proper collection, handling, and documentation of a mold sample are all required for a conclusive, credible report. All inspection procedures should be followed carefully and precisely. Poor handling can lead to mistakes, errors, and liability exposure.

Develop Hypotheses

There are generally four (4) types of HYPOTHESES about fungi in an indoor environment that can be developed by the inspector and the client:

1) there is no mold growth in the building (null hypothesis);
2) health is being affected by mold exposure (health affected hypothesis);
3) structural damage is caused by mold growth in the building (damaged building hypothesis); and
4) a musty odor indicates mold growth (aesthetic hypothesis).

Null Hypothesis

An inspector should approach a mold inspection without bias towards finding mold. It is reasonable to assume that a building does not have a mold growth problem. If the client does not have any concerns, then the inspector should assume that there are no mold growth problems in the building (null hypothesis). The inspector should approach the mold inspection with an unbiased opinion, without any presumption of mold problem existing in the building. An

assumption that there is no mold growth in the building should be made prior to performing a mold inspection. That way, if an actual mold problem is found at the building, it will be unexpected. Legally, it is a stronger argument that a mold inspector initiated a mold inspection without bias, without a presumption that a mold problem existed in a building. If your client does not express a particular concern about mold in the building, then make the null hypothesis, assume that there is no mold in the building prior to performing the inspection. [12]

Damaged Building Hypothesis

If damage to the building were suspected to be caused by fungal contamination, then a reasonable hypothesis would be that mold is present and the harming the building.

Aesthetic Hypothesis

Another hypothesis is that stains and odors are caused by the presence of mold.

Affected Health Hypothesis

Health effects of indoor mold exposure may depend on the types of mold that are in the building. [6] Under certain circumstances, such as when litigation is involved, the source of the mold is unclear, or health concerns are a problem, you may consider sampling as part of your site evaluation. [1]

Concerns about health effects are more complicated because they involve a chain of hypotheses: mold has to be present, the affected person must be exposed to mold, the affected person must be sensitive to the exposure, and the exposure must cause the symptoms. Since that chain of hypotheses are very difficult (if not impossible) to prove during a mold inspection, then an inspector should apply the statements and conclusions made by credible sources (health

professionals, the EPA, state health departments, indoor air quality associations, and others in the industry) who comment upon mold standards and guidelines in relation to health affects. An inspector should make good use of them as relevant, suitable, or pertinent in interpreting laboratory results and making recommendations to their clients.

The purpose of a non-invasive visual examination is to report moisture intrusion, water damage, apparent mold growth, musty odors, and conditions conducive to mold growth.

Determination of patient sensitivity to fungi and the assessment of the relationship between that sensitivity and symptoms should be determined by health care professionals guided by the results of the mold sampling taken by a mold inspector. [8] It is not the inspector's responsibility to correlate mold in a building to their client's health.

That Which is Visible is Mold Hypothesis

According to the Environmental Protection Agency (EPA), "in most cases, if visible mold is present, sampling is unnecessary." An inspector may object to that statement, because of the assumption that what is present is actually mold. There may be many inspectors who are comfortable in making that assumption.

"That which is visible is mold" is a statement based upon assumption. Apparent mold growth cannot be confirmed as actual mold growth by visual examination only.

The only way to actually know that what is visible is actually mold is through sampling. If neither you nor your client need to confirm that what you see is actually mold, you need not sample. However, there may be others (affected by the findings of the inspector's report) who

will request proof or validation of the visual findings.

The term “visible mold” applies to what appears only on the surface, not to what is borne out by professional examination, scientific sampling, and confirmation by laboratory analysis.

The use of the term “visible mold” should not be used in reference to *actual* mold growth. The term “visible apparent mold” is accurate.

Don’t guess. It is an inspector’s due diligence to act or perform with care and accuracy. Reporting “the presence of visible mold” for a professional inspector should be based upon fact or evidence rather than possibly inaccurate assumptions about surface appearances.

Not everything that looks like mold is mold. Paint on the backside of drywall or wood may look like mold growth. Alkaline crystals on soil or concrete walls may look like mold, but, unlike mold, they are usually water-soluble. Carpet stains also may look like mold. Spider webs, fine dust, paint spray, dried mud, and water stains may all give the appearance of mold growth. The inspector whom reports the existence of mold growth based upon the discovery of something that appears to look moldy may be in error. It may be mold; it may not. Error comes with guessing.

Most microbiology laboratories need only a little of the suspected mold on a clear strip of sticky tape to determine, using a microscope, whether it is actually mold or something that looks like mold. Sampling may help locate the source of the mold contamination, identify some of the mold species present, and differentiate between mold and soot or dirt. [1]

Test Hypotheses

Test the hypotheses by collecting and analyzing all relevant information about the building, its systems and components, by performing a non-intrusive visual examination and taking multiple mold samples. The mold sampling should be in alignment with the client’s concerns about mold. In an attempt to conserve time, money and resources, the amount, type and location of samples should directly address the hypotheses that have been developed by the inspector and the client.

Make Recommendations

After finding apparent mold growth, the goal is confirm that it is in fact mold. To report mold growth with care and accuracy is through sampling by a certified inspector and analysis by a laboratory. Sampling should be conducted if mold is suspected. After confirming mold growth at high or elevated concentration levels inside the building, then cleaning up and/or removal of the mold growth and contaminated building materials should be recommended. There are

several sources to refer to when making mold remediation recommendations. See Section 19.

An Example of a Hypothesis

The following is an example of a hypothesis an inspector can use as a guide. After speaking with the client, the inspector develops a null hypothesis stating, “There is no mold growth at the building that could affect the health of the occupants, cause structural damage, or produce odors. And there are no conditions conducive to mold growth.”

While performing a non-invasive visual examination of the building, the inspector finds visible apparent mold growth on the drywall of a non-load bearing wall in the basement near the hot water source.

Additional assumptions (hypotheses) are made (by the inspector):

1) the apparent mold growth is in fact actual mold growth;
2) enough moisture exists in this area of the building to support mold growth;
3) mold spores from this growth area are floating in the air (the breathing zone) of the rooms in which the building occupants dwell; and
4) the mold may affect the health of those exposed.

The inspector determines that further evaluation is needed in order to find the source of moisture in the building that is supporting the apparent mold growth. (The use of a moisture meter or other device can provide an objective indication of the amount of moisture in a building material.) A closer examination of the area and the use of a moisture meter by the inspector results in discovering significant moisture coming from a dripping temperature and pressure relief valve of the hot water tank. The wall material is discovered to be wicking moisture up from the floor where the water drip is located.

The inspector determines that a surface sampling is needed to confirm the existence of actual mold growth. The inspector determines that air sampling is needed to address the concern that mold spores may affect the health of those exposed.

A surface mold sampling of the apparent mold growth area is taken. The result of the surface mold sampling confirms that the visible apparent mold is in fact actual microbial growth (mold). Ultimately, the presence of microbial growth, which is only possible if water is available, provides evidence that sufficient moisture was present. [13]

Multiple air samples are taken. (The biological agents of interest are fungal allergens, but detection of fungal spores is often used to indicate allergen presence. [13]) The results of the air

sampling confirms that there are elevated levels of mold spores in the air of the basement as compared with the control samples taken outside the building.

The initial hypothesis that there is no mold growth at the building that could affect the occupants health, cause structural damage, or produce odors; and there are no conditions conducive to mold growth was disproved and found to be false. The evidence outlined in support of the three assumptions or additional hypotheses (that the apparent mold growth is in fact actual mold growth; enough moisture exists to support mold growth; and mold spores are floating in the air) are sufficient to conclude that the source of excessive moisture in the basement should be corrected and the water-damaged (mold-contaminated) wall material should be replaced. The fourth assumption about health should not be directly commented upon by the mold inspector. A recommendation to consult with a health care professional should be made in relation to connecting mold exposure to health effects.

There was in fact moisture intrusion and mold growth in the building; and since there was an elevated concentration of mold spores measured in the air, the potential for health effects caused by mold exposure exists.

Information about health effects related to mold exposure and recommendations to remediate the mold problem in the building are provided to the client in the mold inspection report.

Another Example of a Hypothesis

An inspector makes the hypothesis that there is not a mold growth problem inside the HVAC ductwork system (null hypothesis).

Air samples are taken before and after the HVAC system is turned on. Air samples show a

significantly lower concentration of mold spores in the air before the HVAC system was turned on than when after it was turned on and operated for 15 minutes.

The sampling results may be convincing that there is a mold growth problem inside the ductwork, and mold spores are being distributed and circulated throughout the building when the HVAC system is turned on.

Section 11
Sampling Devices

Bioaerosol Impaction Sampler

A single-stage bioaerosol impaction sampler is an aluminum device held together by three spring clamps and sealed with o-ring gaskets.

The impactor stage contains 400 precision-drilled holes. When air is drawn through the sampler, multiple jets of air on the stage direct any airborne particles toward the surface of the agar collection surface. To ensure sample integrity, the EMS E6 must be used with a pump capable of 28.3 liters per minute.

Reuter Centrifugal Sampler

With centrifugal samplers, the principle of collection is centrifugation. It involves the creation of a vortex in which particles with sufficient inertia leave the airstreams to impact upon a collection surface such as a semisolid agar medium. After the sampling is finished, the agar strip is then sent to a laboratory for analysis. The most frequent example of such a device is the Reuter centrifugal air sampler.

Airborne Particle Counters

Airborne particle counters (APC) are hand-held, battery-operated instruments that also measure temperature and relative humidity. An airborne particle counter has four parts: the sensor, pump, battery, and electronics. The pump draws about 0.1 cubic feet per minute of air.

This device does produce a sample that requires laboratory analyzation. It only identifies the size of particles that are airborne. The APC measures two-particle size ranges simultaneously, 0.5 and 5.0 microns. Some measure four size ranges of particles simultaneously, 0.3, 0.5, 1.0, and 5.0 microns. Some

airborne particle counters have three sampling modes and can display data in particles per cubic foot, particles per liter, and total particles. The sample count and sample interval times can be user-programmed. The date, time, and particle counts for up to 200 locations are stored in memory for later on-screen review or downloading to a printer or personal computer.

Air-O-Cell®

The *Air-O-Cell*® is a unique air sampling cassette specifically designed for the rapid collection of a wide range of airborne aerosols including mold spores, pollen, insect parts, skin cell fragments, fibers (e.g. asbestos, fiberglass, cellulose, clothing fibers, etc.) and inorganic particulate e.g. ceramic, fly ash, copy toner, etc.). The *Air-O-Cell*® collects both viable and non-viable sample specimens, providing a much broader overview of potential allergens contaminants than conventional sampling techniques.

The *Air-O-Cell*® operates upon the principle of inertial impaction. Particulate laden air is accelerated as it is drawn through the cassettes tapered inlet slit and directed towards a small slide containing the collection media, where the particles become impacted, and the air flow continues out the exit orifice. The adhesive nature of the collection media prevents the collected particulate from blurring or being washed off during the laboratory staining process, and eliminates sample loss from vibration during handling and shipment.

After sampling is completed, the cassettes are sent to a laboratory, where the slides are removed and direct microscopic analysis can be immediately performed. The collection media is compatible with a wide range of biological stains and refractive index oils, allowing direct quantitative analysis of organic and inorganic particulate.

The *Air-O-Cell*® can be used with any standard off-the-shelf area sampling pump capable of drawing 15 LPM open flow. The small compact size makes *Air-O-Cell*® suitable for use in confined or restrictive spaces.

With its proprietary engineered design, ease of use, and compatibility with typical everyday area sampling pumps, its easy to see how the *Air-O-Cell*® cassette is setting the new standard in IAQ sampling and analysis.

BioCassettes

BioCassettes are similar to *Air-O-Cell*® in regard to the pump and tubing. The difference between the two is that *BioCassettes* use an agar base surface to collect the sample to allow it to grow. Anything that touches or comes in contact with the agar plate will contaminate the sample and a new sample will be required.

Z5 Sampling Cassette

The five-liter by five-minute air sampling cassette made by ZEFON. The Z5 sampling cassette is a cost effective, first-line mold-screening tool that efficiently and reliably collects mold. It can be easily used by home inspectors to get preliminary information on whether a mold problem may exist and further investigation is warranted.

The Z5 is a spore trap impactor that uses slit impaction as the collection mechanism. This method is an industry recognized and reliable method that allows superior mold spore collection. Advantages to the Z5 are (1) The slit impaction collection method the Z5 uses is the most reliable and industry recognized method for superior mold collection; (2) Quick 5 x 5 sampling (5 LPM for 5 minutes); (3) Works with any pump set at a flow of 5 LPM; and (4) Manufactured by Zefon International, an ISO 9001:2000 certified manufacturer and industry leader in the design and manufacture of air sampling equipment.

The Z5 standard operating procedures are: (1) Remove the caps from both ends of the Z5; (2) Attach the vinyl tubing from pump to bottom of the Z5 (where round cap was inserted); (3) Turn pump on; (4) Calibrate pump before each use making sure that the bottom of the stainless steel ball in the flow meter is sitting above the 5 liter line marker; (5) Listen for suction; (7) Run pump for 5 minutes.

AC/DC IAQ Pump

This pump is designed for mold inspectors who do not want to carry around extension cords. This pump runs on AC or DC power to give you the versatility to sample anywhere with out having to carry extension cords or search for power. It has a quick 2-hour fully charged time. This pump can run for up to 3 hours of performance between charges. It has a built-in rotameter, a quick release tubing attachment, a built-in digital countdown timer, and a rechargeable 12-volt battery. It can be charged when operating in AC mode. It has a HEPA filter exhaust system. It is about 15 pounds in weight.

BUCK Libra Plus LP-7

This pump range is 3 to 7 LPM to allow applications of the Miro5 MicroCell spore trap impactor cassette. A special 5-minute timer in the Main Menu allows for a rapid start-up for samplers. Additional applications of the Libra Plus air sampling pump is to draw air contaminants in through a sampling media such as 25 and 37 mm filter cassettes, to gauge personnel exposure to gases, vapors, particulates, aerosols, etc.

The sampler consists of a pump contained in a Lexan case, exclusive and proprietary electronic circuit board for flow control, an LCD display with 2 lines of 16 characters, a single diaphragm pump mechanism and a rechargeable nickel metal hydride battery pack. Other features of the Libra Plus include elapsed time, flow rate and accumulated volume. The built in timer count down the sampling time and automatically turn off the pump. All data is saved and cleared for next sample under the MENU.

Features: Built-in 5 minute countdown timer; Flow compensation for filter plugging and battery voltage; Compact, rugged and quiet; No tools required to change flow rates; Battery pack rechargeable while attached or separately; Stainless steel belt clip with built-in tripod connector; One-hour rechargeable batteries and optional run triple packs; High impact case, antistatic and RFI shielded; Auto-restart within one minutes of a flow fault; Flows up to 5 LPM for special cyclone requirements; High backpressure capable for 25 mm 0.45 u asbestos filters; Built-in washable stainless steel 100 micron filter; Displays elapsed time, accumulated volume and flow rate; Accuracy +/- 5% of display reading or pump flow faults; Count down timer up to 40 hours, turns off pump; and a Key pad lock system.

Megalite Air Pump

Air pump with rotameter, deluxe heavy duty case, and built-in flow control valve; lightweight; 3-30 lpm rate; 10 Feet of vinyl tubing; HEPA filter.

Rotary Vane Pump

This lightweight, low maintenance, rotary vane sampler is specifically designed to be used for not only asbestos and spore trap cassettes, but will work with impactors (adjustable flow range 3-30 LPM). It comes complete with six feet of vinyl tubing, inline filters, muffler jar, feet, handle and built-in switch. Weighs 9.9 lbs.

Zefon Bio-Pump®

The Zefon Bio-Pump® is a portable, battery powered pump that provides the simplest and most convenient way to sample with Air-O-Cell® cassettes at a flow rate of 15LPM. Features: Portable, battery powered, uses Air-O-Cell® cassettes. Programmable timer allows unattended operation. Long-lasting battery. Quick-charge battery charger included. Nothing to prepare or clean. Just place the cassette on the pump, set the time and go.

Wall Sampling Attachment

The Air-O-Cell™ inner wall sampler provides these features in a simple tubing attachment that works in conjunction with Air-O-Cell™ cassettes.

Biosis Slide with Mailer

Individually packaged with slide mailers. Used for Allergenco & Biosis samplers. No possibility of cross contamination.

Bio-Tape™

Bio-Tape™ provides a sampling method used for the determination of possible microbial, bioaerosol, and inorganic dust contamination in a simple, standardized way. It provides the ability to quickly take a sample and measure the relative degree of contamination. It is especially useful when sampling valuable or non-transportable materials and is very effective on smooth areas of concern.

Carpet Cassettes

Carpet cassettes are designed for the collection of fibers and particulate from carpets and other dusty areas. Carpet testing will give you historical data of previous mold contamination. Cassettes use a 1" piece of tubing with a 45-degree bevel fitted to the inlet port, and come preloaded with .45µ & 5.0µ MCE filter and support pad Carpet Sampling Cassette, chain of custody form and lab fee included.

Culture Swabs

Culture swabs are easy to use for visual surface sampling. Convenient containers are included which can be used for storage and transport.

Section 12
Air Sampling

- Take Air Samples When
- Comparison
- Closed-Building Conditions
- HVAC System
- Air Sampling Location
- Outdoor Air Sampling
- Sampling Results


Inspectors collect air samples in order to test hypotheses about indoor environments. Air samples can detect and quantify the presence of mold spores, identify the release of mold spores into the air from mold growth sources, aid in assessing human exposure to the mold spores, and to monitor the effectiveness of control measures or remediation of mold.

A primary way of testing for mold growth (or collecting bio-particulates) and answering concerns addressed by the hypotheses developed is by air sampling.

To answer the concerns or hypotheses that have been developed (for example, mold is present and the harming the building), it is necessary to assume that spores or fungal byproducts travel from sources of mold growth to living spaces and other areas of the building. The most direct way to identify paths through which spores move is to measure their concentration in the air along airflow pathways. Air sampling can identify potentially damaging mold, even when mold growth is not readily visible.

An inspector may be able to establish that a plausible or demonstrable exposure pathway exists by taking and interpreting multiple air samples.

Air samples are made by the use of a pump that pulls air through a collection device. The device catches mold spores out of the air. The sample is sent to a laboratory. A microscope is used to count the mold spores.

Take Air Samples When

Use the IAC2 Mold Inspection Standards of Practice, the IAC2 Mold Sampling Procedures, and the IAC2 Mold Sampling Decision Chart to assist in deciding when and where to take samples in a building.

In general, take air samples when a non-invasive visual examination of the building yields:

- moisture intrusion,
- water damage,
- musty odors,
- apparent mold growth, or
- conditions conducive to mold growth.

When such conditions exist, at least one interior air sample shall be taken by the mold inspector.

Two Outdoor Samples

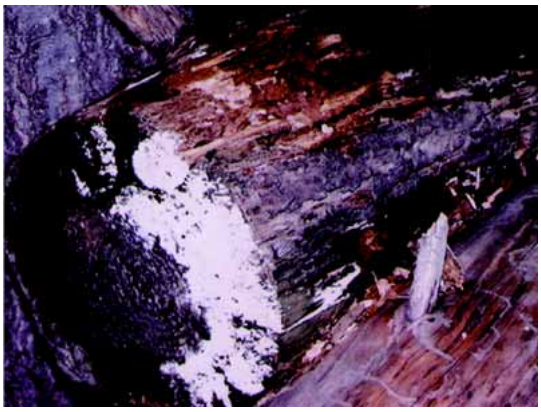
In general, an inspector shall take two outdoor air samples of the highest quality general air to be used as control samples (or background samples). If possible, one sample should be located on

the windward-side of the building (the side facing the point from which the wind blows), and the other should be located on the leeward-side of the building (the side sheltered from the wind).

The outdoor sampling should begin soon after arriving at the property, assuming that the weather is clean and calm. It is better for an inspector to perform the outdoor sampling while the weather is favorable than to wait. The outdoor conditions may change drastically during the examination and sampling of the building interior.

The sampling device located on the windward-side of the building should be positioned so as to face the wind directly. The sampling device should point towards the wind, in the direction of the point from which the wind is blowing. The sampling device should be three to six feet (3-6 ft.) from the ground surface (breathable space). Typically the device is about 10 feet away from the front entry door. The idea is to have both outdoor samples located in areas where the devices will collect a representative sampling of the air that may enter the building through the entry door or nearby open windows (the openings on the sides of the building).

If there is a main ventilation component of the building that draws into the building fresh air from outside, sampling should be performed ten feet (10 ft.) feet from that intake. The sampling should be performed at least ten feet (10 ft.) from the most frequently used entrance to the home. Sampling should not be performed under an overhang, soffit or eave; carport; porch roof, or any other roof or overhead structure. The air sampling devices should be kept at least ten feet (10 ft.) away from all openings, air intakes, registers, exhaust vents, vent pipes, ventilation fans, etc.



HVAC System

Air sampling at the HVAC system may be necessary if there is suspicion from a visual examination that the ventilation system may be contaminated (apparent mold growth on the

coils, central humidifier, filter, or supply registers). The purpose of such air sampling is to assess the extent of apparent contamination throughout a building.[3] It is preferable to conduct sampling before and during the operation of the HVAC system.

At least one air sample shall be taken at an air supply register. Ideally, there would be at least three samples similarly situated, but financial or time constraints may limit the number of samples that can be taken. The air sample should be taken near an air supply register, with the sampling device oriented so that air from the register directly enters the sampling device.[13] A gentle or vigorous mechanical agitation of the ductwork (a bump or shake) is appropriate.[13]

Comparison

An air sample should be taken when apparent mold growth is visible. An air sample can be taken for other reasons, including moisture intrusion, water damage, a musty odor, or conditions conducive to mold growth. Samples of the indoor air and the outside air should be taken for comparison.

- There should not be any mold inside the house that is not found outside.
- The concentration of mold inside a home should not be higher than the concentration of mold outside.

Health effects of exposure to indoor mold may depend on the types of mold present.[6]

Keep in mind that mold spores in the air being sampled can vary greatly in relation to the life cycle of the mold, atmospheric and environmental conditions, and the amount of ventilation. There are seasonal and diurnal variability in airborne mold at an indoor residential environment.

Air sampling may be necessary if the presence of mold is suspected (for example, musty odors), but cannot be identified by a visual examination.[3] The purpose of such air sampling is to determine the location and/or extent of mold contamination. All mold spores have a source, and identifying the source is the goal.

Because the outdoor sample is the control, and it is used to compare with the indoor sample, the samples should be collected as close as possible in time and under the similar conditions. Air samples should be collected at the same air flow rate, for the same duration of time, near the same height above the floor in all rooms that are sampled indoors, and using the same type of collection device.

- Similar times and conditions


Closed-Building Conditions

Indoor air sampling should be made under closed-building conditions. Closed-building conditions are necessary for in order to stabilize the air that may contain mold spores or mVOCs, and to increase the reproducibility of the air sampling and measurement.

Windows on all levels and external doors should be kept closed (except during normal entry and exit) during the sampling period. Normal entry and exit include a brief opening and closing of a door, but--to the extent possible--external doors should not be left open for more than a few minutes.

In addition, external-internal air exchange systems (other than a furnace) such as high-volume, whole house and window fans should not be operating. However, attic fans intended to control attic and not whole building temperature or humidity should continue to operate. Combustion or make-up air supplies must not be closed.

Normal operation of permanently installed energy recovery ventilators (also known as heat recovery ventilators or air-to-air heat exchangers) may also continue during closed-building conditions. In houses where permanent radon mitigation systems have been installed, these systems should be functioning during the air sampling period.

Closed-building conditions will generally exist as normal living conditions in northern areas of the country when the average daily temperature is low enough so that windows are kept closed. Depending on the geographical area, this can be the period from late fall to early spring.

Air sampling should not be conducted during unusually severe storms or periods of unusually high winds. Severe weather will affect the sampling and analysis results in several ways.

First, a high wind will increase the variability of airborne mold spore concentration because of wind-induced differences in air pressure between the building interior and exterior. Second, rapid changes in barometric pressure increase the chance of a large difference in the interior and exterior air pressures, consequently changing the rate of airborne mold spores being sucked into the building. Weather predictions available on local news stations can provide sufficient information to determine if these conditions are likely.

Air Sampling Location

Indoor air sampling should be performed near the center of each room or area of the building that has moisture intrusion, water damage, apparent mold growth, musty odors, or conditions conducive to mold growth.

If there are no areas of concern, then one air sampling should be made near the HVAC return (if that is available.) Otherwise, at least one indoor air sample should be taken in the most lived-in common room, such as the family or entertainment rooms. More than one indoor air sampling can be taken at the discretion of the inspector.

An indoor air sampling should only take place in a livable space in the building. Sampling in areas such as closets, under-floor crawlspaces, unfinished attics, storage or utility rooms, or inside the HVAC system is prohibited. The air collection device should be at head height (about three to six feet above the floor surface).

Inside the building, the air pump sampling should run for 10 minutes. If there is a lot of indoor activity, then the air pump sampling should be reduced to 5 minutes. If there is an active source of dust, such as construction or cleaning, then the air sampling time should be reduced to 1 minute.

- 10 minutes



Weather Conditions

On a Chain-of-Custody form, the weather conditions shall be recorded. The weather conditions should be clean and calm. High winds may affect the quality of the sampling, including the comparison between indoor and outdoor smpling.

- Clean and calm

On a clean windless day, air pump sampling should run for 10 minutes. When the outdoor air is something other than clean and windless, then the time of the sampling should be reduced to 5 minutes or less. A breeze, the mowing of grass, nearby construction, and dusty air all affect the sampling conditions.

- 10 minutes

Air pump sampling should not take place outdoors if it is raining. If possible, you should wait for at least two (2) hours after the rain has stopped before taking an air pump sample. Alterations or adjustments to the normal procedure or locations of taking air pump samples, particularly for the control sample, must be recorded in a Chain-of-Custody.

- No rain

Air pump sampling should not take place when the outdoor air temperature is below 32° Fahrenheit. All air sampling should take place when the air temperature is above freezing.

- Above freezing

If the ground is completely covered with snow, outdoor air pump sampling should not be performed. A partial covering or a light dusting of snow is acceptable.

- No snow covering

Air Flow Rate

There are many different types of air pumps, measurement meters, and spore collectors that can be used for an air sample at a mold inspection. The air pump should be adjusted to collect air at a flow rate that is recommended by the manufacturer. The result of an air pump sample is recorded in spores per meter cubed (spores/m^3). If the air flow rate is too fast, the spores will bounce off the collector plate or slide and will not stick. If the airflow rate is too slow, the spores float around the collector plate or slide and will not stick.

Rotameters are air flow meters that provide field accuracy in an easy-to-read instrument. The principle of operation is simple: air flow passes through a vertical, tapered tube and pushes a small ball or float having a diameter slightly less than the smaller tube end. As the little ball rises, the clearance between the ball and the tube wall increases. The ball becomes stationary when the diameter of the tube is large enough to allow the total airflow past the ball. The flow rate is determined by reading the number on the tube at the middle position of the stabilized ball.

Limits of the Sampling

Keep in mind that sampling provides information about a building as it existed at the time it was inspected. The results may not represent conditions at a time in the past or future. Changes in the kinds, concentrations, and proportions of mold spores in the air can be rapid and substantial.

Section 13
Air Sampling Procedure

1) The sampling equipment must be protected, clean, and properly maintained at all times. The sampling device shall be clean, free from dirt or debris prior to starting a sample. If re-usable collection devices are used, then they shall be handled and cleaned prior to use in accordance with the manufacturer's recommendation. The re-usable collection device may need to be cleaned with an alcohol swab prior to use. The collector may re-usable and have sticky slides already prepared, or the collector may be a one-time-use self-contained device.

2) Slides, cassettes, and one-time-use devices should be stored in cool, dry environments. The slides must be protected from direct sunlight. Sampling devices (slides, swabs, cassettes, tapes) older than one year should not be used.

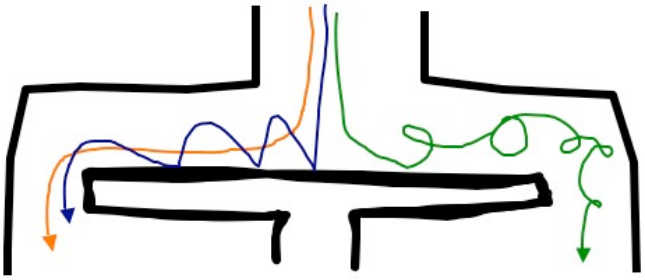
3) Set the air collector at a normal breathing height, which is about 3 to 6 feet above the ground level or floor surface. A tripod is typically used to set the collector height. The outdoor control sample should be taken at the same height at the indoor sample.

4) Calibrate the flow of the pump. Do not attach the sampling device (cassette) on the tubing yet. Measure the flow rate of the pump with a rotameter that has been calibrated to a standard. Make sure that the flow rate is set to the manufacturer's recommendation. For example, an Air-O-Cell cassette flow rate is 15 liters of air per minute. The pump should be calibrated regularly (once a day). A record of calibrations should be kept in a log work book.

5) After calibration, securely attach the tubing of the pump to the sampling device (cassette). Turn on the pump. Start sampling. Record start time.

6) After turning on the air pump, check the airflow rate. The flow rate should not vary. A flow change greater than five percent (5%) requires a new air sample to be taken. All air samples must have the same volume.

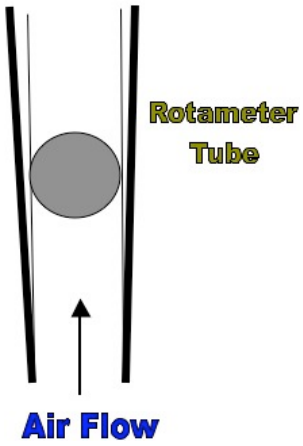
7) A digital time controller on the equipment is highly recommended. Examine the collector. There should not be an overload on the slide. There should be a fine trace, hardly visible to the human eye, of dust and spores on the slide. A slide that has an easily visible trace on it may be unreadable. If that is the case, the environmental conditions may need improvement or a new sampling location may be needed. If a slide is heavy, a new sample should be taken.



8) Remember, all air samples must have the same volume.

9) Record the time that the pump stopped. Mark the sampling device with a unique sampling number. Record that information on the Chain-of-Custody.

10) Place slides in a protective carrying case. Or close the collector if a cassette is used. This protects the slides. Prevent cross contamination. A new sample must be taken, if a slide is accidentally touched, smeared, or contaminated, because it will be unreadable.



11) Calculate the volume by multiplying the liters of air pumped by the number of minutes. An example of the calculation is 20 liters of air pump multiplied by 10 minutes equals 20 liters per minute equals 200 liters (20L x 10 minutes = 200 L).

Section 14
Procedures for Surface Sampling

Surface sampling can provide information regarding whether the visible apparent mold is in fact actual microbial growth (mold) or not, measure the relative degree of the mold contamination, and can serve to confirm that the sampled mold growth may be producing mold spores in the air.

Surface sampling is not destructive to building materials or surfaces when performed properly. For example, it may be possible to collect samples of fungal growth from the surfaces of valuable furnishing or materials of historical interest without damaging the original items. [13]

Loose particles can be collected by pressing a contact plate to a surface or applying an adhesive material to lift off the visible apparent mold growth.

Because there is direct contact with and disturbance of the mold contaminated area, PPE is recommended, including gloves and a respirator rated as N-95 or higher.

Use the IAC2 Mold Sampling Decision Chart to assist in deciding when and where to take samples in a building.

Swab Sampling

A swab comes inside a plastic tube container. The cellulose swab is moistened with a liquid preservative stored in an ampoule at one end of the tube container. Any bacteria collected with the swab are transferred via the swab into a tube. The tube is sent directly to a laboratory for analysis.

A swab provides immediate determination of the presence of fungal spores as well as what types of fungi are present.

Take Swab Samples When

Take swab samples when a non-invasive visual examination of the building yields:

- moisture intrusion,
- water damage,
- apparent mold growth,
- musty odors, or
- conditions conducive to mold growth.

A swab sample should be taken when apparent mold growth is visible. A swamp sample can be taken for other reasons, including moisture intrusion, water damage, a musty odor, or conditions conducive to mold growth.

Benefits

There are benefits to using a swab sample. The swab sampling is inexpensive. It can be performed quickly. The swab sampling of a surface indicates all molds present in that particular sampled area. The swab sampling may reveal indoor reservoirs of spores that have not yet become airborne.

There are many manufacturers of swab sampling systems. Each manufacturer may have different ways of taking a sample with their particular swab system. In general, an inspector will typically hold the tube container so that the ampoule with the liquid preservative is at the top. You pinch the plastic tube so the liquid will flow down onto the swab. To remove the moistened swab, you pull on the cap. Rub and roll the wet swab over a one-inch square area of the apparent mold growth. The swab should collect visible apparent mold. Insert the swab back into the tube. Secure the cap.

Each Sample

A unique sample number should be recorded for each swab sample. Write the number on the tube itself. The Chain-of-Custody document should have the sample number, location, date, and time of the sampling.

Each Room

Take the sample in each room or area where there is visible apparent mold.

Each Color

If there is apparent mold growth with different colors in the room or area, take a sample of each different colored mold. The different colors may indicate different mold types.

Each Substrate

If mold is visible on different substrates or building materials such as wood, drywall, or wallpaper, then a sample from each different material is recommended.

Tape Sampling

A tape system provides a quick way to sample visible mold. A tape-lift system is the most common surface sampling technique. It can be used instead of a swab sample. Many samples can be collected in a short period of time. Samples that show hyphae fragments and reproductive structures can provide proof of mold growth.

One of the most popular tape sampling products is the Bio-Tape™ system. There are many advantages of using tape lift systems such as the Bio-Tape™ instead of using regular tape. Bio-

Tape™ is easier to handle, the tapes are individually numbered, it requires less laboratory preparation time, and the slides are flexible and will not break.

The sampling result is not quantitative. The presence of fungi can be confirmed, genera can be identified, and possibly a semi-quantitative estimation of the amount of each genus can be determined.

The procedure to using a tape lift system such as Bio-Tape™ are as follows:

(1) Remove the slide from the mailer;
(2) Record the sample number and all other identification information prior to taking the sample;
(3) Peel off the protective liner from the slide to expose the adhesive;
(4) Place the slide with sticky side down on the contaminated area being sampled;
(5) Press down gently and make contact. Excessive pressure is not necessary;
(6) Lift the slide from the surface and place back into the slide mailer. Do not replace the protective liner;
(7) Record all information on the Chain-of-Custody document, including property address, date, time, and sample number;
(8) Mail the sample to the laboratory.

PPE

Because there is direct contact with and disturbance of the contaminated area, PPE is recommended, including gloves and a respirator rated as N-95 or higher.

Each Sample

A unique sample number should be recorded for each tape sample. The Chain-of-Custody document should have the sample number, location, date, and time of the tape sampling.

Each Room

Take the tape sample in each room or area where there is visible apparent mold.

Each Color

If there is apparent mold growth with different colors in the room or area, take a tape sample of each different colored mold. The different colors may indicate different mold types.

Each Substrate

If mold is visible on different substrates or building materials such as wood, drywall, or wallpaper, then a tape sample from each different material is recommended.

Carpet Sampling

A carpet tends to contain a history of any mold that has been growing in the building. The carpeting sampling is performed to reveal previous mold problems. A carpeting sampling can also reveal undetected mold growth that may have been covered over or cleaned up. Choose an area that is not heavily walked upon, an area with little traffic. Do not sample under furniture.

An air pump and a carpet-sampling cartridge are used to vacuum a small area of the carpet. The cartridge should be inserted as deep into the pile of the carpet as possible. If a carpet has not been cleaned thoroughly prior to a sampling, a carpet can easily hold evidence of a mold problem in the house. Even after cleaning, there can be mold spores discovered deep in the carpet.

Set up the air pump, a rotameter and a carpet cartridge connected with tubing. The airflow of the pump should be set to 15 liters per minute. Sample an area equal to 4 inches by 4 inches (4” x 4”). Sample a clean area of the carpet. If you see visible dirt collecting on the filter, a new sample must be performed. Take a sample until a visible trace appears on the filter in the cartridge, but for no more than 10 minutes (10 min. maximum).

Bulk Sampling

Bulk or surface samples may be needed to be collected to identify specific fungal contaminants as part of a medical examination if occupants are experiencing symptoms which may be related to fungal exposure or to identify the presence or absence of mold if a visual inspection is unclear (discoloration or staining for example).[3]

Small pieces of carpet, drywall, or other porous building materials may be collected and mailed to a laboratory for analysis. It is typically unusual for an inspector to have permission to remove pieces of building material. Normally a swab sample is performed instead of a bulk sample. Use a respirator and gloves when handling moldy bulk material. Mail to the laboratory only small

pieces of material in airtight plastic bags. Double bag the sample for safety during shipping and handling. The bag should be marked with unique sampling numbers. Document the information on the Chain-of-Custody.

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mVOC Canister Sampling [5]

A canister-based method has been developed for detecting microbial Volatile Organic Compounds (mVOCs) in air. MVOCs have been determined to be an indicator of mold growth because their presence is associated with actively growing mold. Sampling for mVOC's can be used to detect hidden sources of mold. MVOCs have been sampled using sorbent tubes but limited sample flow rates require the tube samples to be collected over one or more hours. Canisters can be filled in just a few seconds, providing faster means of screening an indoor environment for mold.

Data correlating the concentration of mVOCs to hazardous mold levels has been shown that below 8 ug/L of total mVOCs most people will not have any allergic reaction; between 8 and 30 ug/L some people may have moderate allergic reactions; and at levels above 30 ug/L there will be very probable allergic reactions.

Wall Sampling

If you suspect that there is a mold problem within a wall of a building, then a wall sampling can be performed. Written permission from the property owner must be obtained prior to sampling since this is a destructive procedure. Wall sampling is beyond the IAC2 Standards of Practice.

A collector device is used to sample the air within the wall interior, the wall cavity air.

The sample is collecting air of a wall cavity (a non-livable space), and therefore should not be used in comparison to a control sample or other samples. The air pump may collect a large amount of air that is equivalent to other samples, but it may be actually pulling air from other places in addition to the wall cavity.

The sample of the wall interior can be taken by inserting a tube in a small hole or gap near an electric wall receptacle or wall switch is located. There is sometimes a gap or open space visible

around the box after the cover plate is removed. Or a hole can be drilled at that location. Or a hole could be drilled at the bottom of the finished wall with the property owner's permission.

Wait a minute or two before inserting the collection tube in the wall to allow any dust to settle. The air pump is turned on for one to two minutes at a flow rate of 15 liters per minute. This rate is low to prevent sucking in debris.

The collector device can be a carpet-sampling cartridge or a spore-sampling device.

After the sampling is complete, the tube and the sampling device in front of the cassette are considered contaminated. They should be cleaned with a water and alcohol solution or discarded.

Viable (or Culturable) Sampling

Mold inspectors typically do not use viable sampling in their inspections.

A special air pump can be used to collect an air sample. Any mold spores in the sample can be deposited directly onto a culture plate. Under ideal conditions, molds take approximately 7 days to germinate and grow mold spores. If mold is collected and cultured in a controlled laboratory environment, the species of the mold may be identified; the number of mold colonies that develop on the plate can be counted. This identification process is referred to as viable testing. It takes longer than non-viable testing, since 7 days of culturing takes place. Viable testing may not identify dead mold spores or fragmented parts of hyphae, which may cause health problems or allergic symptoms. Viable testing can be expensive.

Viable or culturable sampling refers to collecting mold spores in such a method that allows the spores to grow. The laboratory analyzes the samples while they are living or growing. That allows the laboratory to accurately determine the exact type of species and genus.

Viable spore sampling is more time consuming than a tape-lift sampling system, because it depends on fungal growth.

The equipment to capture live mold varies. A typical sampling method is to use a device that combines a sample collector, such as a cotton swab or plastic loop, with a stabilization media for transport.

The viable sampling can be used to identify species.

It captures mold spores using inertia and impacting the mold particles onto an agar plate. The mold spores grow on the plate. The sample is sent to a laboratory. The sample requires freezing or refrigeration to be shipped to the laboratory. The sample needs to reach the laboratory within 24 hours after collection. The laboratory should be consulted about the proper collection and shipping methods prior to taking any samples. The laboratory uses a microscope to provide an accurate identification and count of the mold.

A viable (or culturable) sample can be collected using nutrient agar or it can be collected using inert media and prepared for culture at the laboratory. The sample is incubated for several days to allow cell growth and replication into visible colonies. The entire colony, not just the spore, is used for identification, allowing the lab to make a more precise, accurate identification of mold types and species. Aspergillus flavus, Aspergillus versicolor, Aspergillus fumigatus, Aspergillus niger are examples of viable testing in the identification of *species*. An example of non-viable testing by the laboratory would be the determination of the Aspergillus mold. The viable testing will exactly identify the type *and* species being Aspergillus *flavus*. Penicillium and Aspergillus has about 150 species. Stachybrotys has about 15 species.

Not all of the viable fungi that collect onto an agar will grow during incubation. As a result, the laboratory will tend to underestimate the number of total mold spores that are present. A significant percentage of the fungi will not grow because of the growing conditions. Some molds will not grow very slowly or not at all on the agar. They mold spores collected may be present, but they won't be identified or counted. Take Stachybotrys as an example, because Stachybotrys needs cellulose to grow. If a Malt Extract Agar is used for sampling, and the laboratory does not identify any Stachybotrys in the sample, that may mean that Stachybotrys is present, but the MEA did not support its growth.

It is vital to understand how the laboratory identifies and counts mold in collected samples. Identifying and counting a particular type of fungi relates to the type of viable sampling devices being used. To be accurate and efficient, you must choose the correct type of viable sampling devices in order for the laboratory to identify and count the type of fungi that you wanted to sample.

If you want to make sure that you are collecting a suspected presence of Stachybotrys, then contact the laboratory and determine what type of agar to use that will support collecting viable samples and growth. The better way to identify Stachybotrys is to simply use a non-viable

collection sample, because Stachybotrys spores are very distinctive and can be easily identified by the laboratory under the microscope. It does not require a viable sample collection.

Non-Viable Sampling

Mold inspectors typically use non-viable sampling in their inspections. A non-viable sample is directly examined under a microscope. The mold spores are identified and counted. Other particulates are examined and identified based upon physical features, such as fibers, skin cells, hyphae fragments. Their spores alone cannot identify some molds, such as Aspergillus and Penicillium. They are reported as a group. For example, the Aspergillus/Penicillium group or the Periconial/Myxomycetes group.

For viable or culturable sampling, the air pump needs to be able to draw at least 28 liters per minute. A rotameter can be used to measure the airflow.

If a mold sample is collected at an on-site inspection and later observed under a microscope, then the identification process is called non-viable testing. During this type of sampling, a vacuum pulls air past a slide with a sticky surface. The slide catches dust and debris floating in the air. Swabs may be used to collect samples when there is visual evidence of mold. The species is not identified. Non-viable testing is quicker than viable (as short as 24 hours). Non-viable testing is less expensive. Analysis includes all mold spores and hyphae fragments. Comparison of indoor and outdoor air samples may indicate elevated levels inside the building.

Section 15
Do NOT Sample for Mold

Do not sample for mold when a person occupying the building is under a physician's care for significant health effects attributed to mold exposure. A mold inspector should not be in conflict or dispute with a health professional by confirming or denying the absence or presence of mold and the discussing the potential health impact from mold exposure. Consultation by a health *expert* should be recommended.

Do not sample for mold when there is litigation being considered or in progress in relation to mold in the building. The testimony of an *expert* should be recommended.

Do not sample for mold when your health or safety are in danger.

Do not sample for mold in a commercial or public building if you are a residential home inspector. IAQ specialists or experts in the field of *commercial or public building* inspections should be recommended, rather than a *residential home inspector* trained in performing mold inspections.

Section 16
General Outline for Performing an Inspection

1. Scheduling an inspection is the first step to performing a successful mold inspection. When scheduling a mold inspection with a client, be sure they understand completely what services are available and in which inspection they are interested. Setting expectations is very important when speaking to a potential client about your mold inspection services. Provide to your clients readily available information about mold and your mold inspection, and any documents that relate to the inspection including the IAC2 Mold Inspection Standards of Practice, your company's mold inspection agreement, and a sample report. Having a company website with all pertinent information and downloadable documents related to the inspection service is a highly affective means of communication.

2. Ask for the proper spelling of your client's name, their current address, and contact phone number and email address. Ask for the property address where the inspection will be performed. Set a date and time of the inspection. Request that the client attend the inspection. Get information about gaining access to the property, including the owner's name and contact information. Confirm the type of mold inspection that is being ordered by your client and the fee of the inspection.

3. Prepare all your inspection documents prior to the inspection, including filling in your client's information on all of the documents. If the house is in the process of a real estate transaction, ask for any type of information disclosure document provided by the owner (seller) of the property. There are several computer software companies that provide inspectors the ability to create customized documents, templates, inspection checklists and reports. Be sure to prepare the inspection agreement and the chain-of-custody document.

4. Arrive at the inspection 15 minutes early. Meet, greet, and show proper identification to anyone present. If the owner of the building available, ask the following seven (7) questions: (1) Are you aware of any active water penetration/intrusion at the building? (2) Has there ever been of any prior experiences with moisture or water problems in the building? (3) Are you aware of any possible mold growth (or mold) in the building? (4) Has the property ever been inspected or tested for mold growth (or mold)? (5) Are any occupants in the building presently experiencing or have any occupants ever experienced their health affected by asthma, allergies, breathing problems, or mold growth (or mold)? (6) Are any occupants in the building under a physician's care for significant health

effects attributed to mold exposure? (7) Is there any litigation being considered or in progress in relation to mold in the building?

5. Explain to your client what your inspection includes, what is within and beyond the scope of the mold inspection. Review the inspection agreement, allow plenty of time for your client to read and understand the agreement, have your client sign the agreement, take the original, and give them a copy.

6. Ask your client about their concerns with the building and the apparent condition(s) of its systems and components. Ask your client if they are aware of or suspect any conditions that have lead to moisture intrusion, water damage, or conditions conducive to mold growth or the actual existence of mold growth. Develop hypotheses that can be answered by a visual examination or sampling.

7. Perform a non-invasive examination of the building's visible and readily accessible systems and components in accordance with the IAC2 Mold Inspection Standards of Practice.

8. Document your examination utilizing notes, sketches, checklists, digital pictures, and/or computer software.

9. Take mold samplings (air and/or surface) according to the IAC2 Mold Inspection Decision Chart and the Procedures for Air and Surface Sampling.

10. When you leave the building, make sure it is in the same condition as it was when you arrived. Pick up all trash that may have come from using the mold collection devices, including wrappers, tape, and gloves.

11. Thank your client. Inform them of the average turn-around time of the laboratory results and when your inspection report will be available.

12. Review all samples and identification numbers. Make sure all samples are properly labeled, identified, and in your possession. Complete the chain-of-custody document for the laboratory.

13. Send the samples to the laboratory for analysis. Typically this requires an overnight mailing.

14. Retrieve your laboratory analysis report.

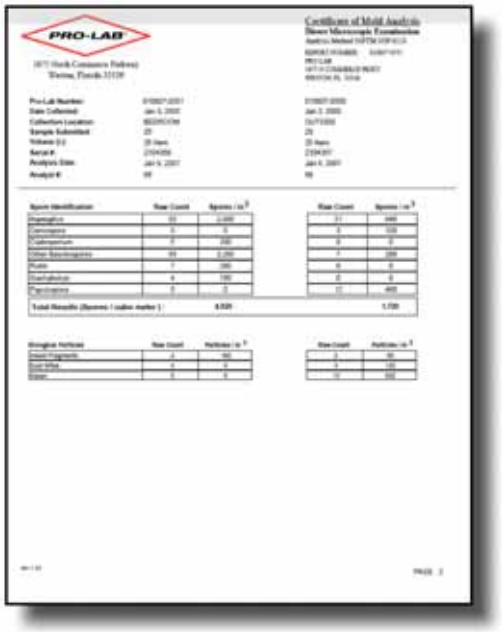
15. Prepare your inspection report for your client. The inspection report may include your letterhead, a description of the type of mold inspection that was performed, the scope of the mold inspection, a summary of the inspection written in simple language that your client can understand, the actual report from the laboratory, any digital photos taken during the inspection, and directions to attain additional information.

16. Deliver the report to your client and be available for questions and assistance.

Section 17
Interpretation of Laboratory Results

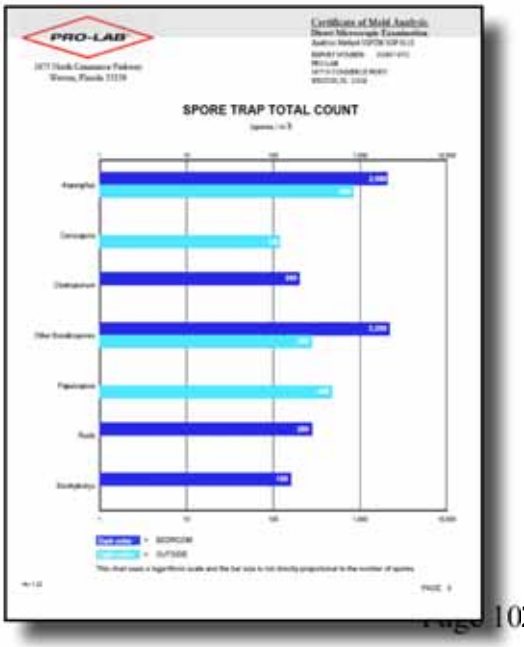

PRO-LAB

Certificate of Mold Analysis


PRO-LAB

Certificate of Mold Analysis

A laboratory report should include the laboratory's letterhead and bear the signature of a quality assurance manager of some type. A laboratory report typically consists of three parts. The first part contains the identification of the mold spores collected. Page 2 is a table listing spore identifications and counts. Page 3 contains a colored bar chart identifying spores and counts.


PRO-LAB

Certificate of Mold Analysis

SPORE TRAP TOTAL COUNT


PRO-LAB

Certificate of Mold Analysis

The second part contains general characteristics of mold with respect to the most common impact on human health. Many genera of molds have species with varying characteristics.

This report from Pro-Lab contains very good general information about indoor air quality testing, mold testing methods, data interpretation, and symptoms of mold exposure. This information continues from pages 4 to 8.

On page 9 there is a list of references and resources if the receiver of the laboratory report would like further information.

The third part of the laboratory report will include a concluding report summary. The summary from the Pro-Lab is located on page 10 of this sample report.

Every laboratory report should indicate whether the analysis suggests that unusual mold conditions exist or not. This determination is based upon the type of mold detected in the samples. For air pump samples, the type of mold as well as the inside and outside counts are considered.

This report states, “One or more of the samples in this report indicate the presence of elevated indoor mold spores or colonies for these specific locations only. Professional advice will be necessary to determine the appropriate actions to take to correct the conditions indicated.”

Guidelines for Interpreting Laboratory Results

There have been studies of mold in homes that have provided new information about what is “normal” or “unusual” in a healthy home. [11] Every building has mold, but deductions may be made about whether a particular building has “unusual” conditions or levels that may necessitate further investigation. Air samples should be evaluated by means of comparison (i.e., indoors to

outdoors) and by fungal type (e.g., genera and species).[3] In general, the levels and types of fungi found should be similar indoors as compared to the outdoor air.[3] Differences in the levels or types of fungi found in air samples may indicate that moisture sources and resultant fungal growth may be problematic.[3]

Simple Confirmation
The information expected from contact surface samples is often simple confirmation that the collected material was biological in nature or that the biological growth can be ruled out.[13]

Mold Growth Inappropriate
Many fungi produce allergens. Some fungi produce toxins. Fungal growth in buildings is not desirable. Fungal growth may cause health problems for building occupants. Mold growth in a building is inappropriate and should be removed. Steps should be taken to correct conditions that led to the mold growth so that it does not occur again.

Visible apparent mold that is confirmed by a surface sampling to be actual fungal growth (mold) is evidence of indoor contamination. Air sampling may indicate indoor fungal growth that is either visible or possibly hidden.

Visible apparent mold, mold-damaged materials, and moldy odors should not be present in a healthy building.[1] When a swab, carpet, tape, or bulk sample contains spores of any mold, then the report should indicate that “unusual” conditions exist.

Health Effects
It is not the mold inspector’s responsibility to establish that exposure to mold spores occurs or that exposure is a health hazard to their client. Information on cause-effect relationships between biological materials and illness is not currently available.

Should Be Similar
The kinds and concentrations of mold and mold spores in a building should be similar to those found outside.[1] In cases in which a particularly toxic mold species has been identified or is suspected, a more cautious or conservative approach to remediation is indicated.[2]

If an air sampling shows that the types and concentrations of mold in indoor air samples are not similar to those in local outdoor air, then there is a mold problem in the building. If the indoor concentration levels exceed the outdoor levels or when the types of mold inside differ from those outside, then there is a mold problem in the building.[1]

Once the mold problem is identified and the mold remediation is complete, then the type of mold

and the concentration levels of mold should be similar. After remediation, the types and concentrations of mold in indoor air samples should be similar to those in local outdoor air. [1]

Elevated Indoor Levels
When an air pump sample of a building interior contains more mold spores than an outdoor air sample, then the report should indicate that “elevated” conditions exist at the building, and the levels may necessitate further investigation.

Sampling Results
Hypotheses should be answered. Mold inspectors should consider the results of sampling (surface and air) in conjunction with the building’s condition to decide if the information supports the hypotheses that have been developed and if the information warrants a recommendation for mold remediation.

In general, immediate remediation is needed for microbial growth found on materials that are in direct contact with indoor air or subject to disturbance that might release biological particles, as well as for materials that building occupants may contact directly. [13]

If sampling cannot be done properly and enough samples to answer the client’s concerns cannot be taken, then it is preferable not to sample at all. Inadequate sample plans may generate misleading, confusing, and useless results. Samples should be analyzed according to the analytical methods recommended by the American Industrial Hygiene Association (AIHA), the American Conference of Governmental Industrial Hygienists (ACGIH), or other professional guidelines. (See the Resource List.)

Keep in mind that air sampling for mold provides information only for the moment when the sampling took place. For someone without experience, sampling results will be difficult to interpret. Experience in interpreting results is essential.

Section 18
Threshold Limit Values (TLV) and Guidelines

The Threshold Limit Value (TLVs) refer to air concentrations of substances and represent conditions under which it is believed that people may be repeatedly exposed day after day without adverse health effects. [13] There is not sufficient information available. There are no mandatory limits against which inspectors can compare measurements of air or surface sampling concentrations related to health effects to mold exposure. Data on the range of inhalation exposures to mold are limited and the methods that inspectors use to collect and analyze microbial growth (mold) vary widely. Even if limits were set, they would be arbitrary standards because the data on the cause-and-effect of mold exposure on which to base mold exposure limits are few and inconsistent. The problem lies in the fact that biological exposures are often very complex mixtures of variable composition. Qualitative and quantitative information about mold (biological) exposure and health effects is often imprecise because biological material (other than those intended to be sampled) may also be present and responsible from some of the health symptoms manifested by the exposed person.

Although the issue of whether exposure to indoor fungi causes adverse health effects is controversial, there is no doubt that a seriously mold-contaminated building can suffer structural damage, and that a foul-smelling, fungus-filled building is aesthetically unpleasing. Controversies about health effects aside, the latter two concerns are sufficient to merit a complete mold inspection and remediation when an environment is found to have fungal contamination.

People who have concerns about structural damage or the aesthetic effects of indoor fungi should seek the services from a certified mold inspector. People who have concerns about health effects of mold exposure should seek the counsel of a health care professional.

Section 19
Mold Inspection Report

Every mold inspection report should contain information in a format that is useful to the person who needs the results. The following information should be included in a mold inspection report. [9]

Scope of work
The scope of work should list all of the hypotheses (concerns) and a description of the sampling done to test them. It should refer to the IAC2 Mold Inspection Standards of Practice.

Property Information
This should include the property address, size, age, number of occupants, and the date of the inspection. The weather conditions should be included as well.

Visual Examination
The systems and components of the building that is inspected should be listed here. Each system and component inspected should be identified with a description. The report should include any moisture intrusion, water damage, apparent mold growth, musty odors, and conditions conducive to mold growth. A summary of the visual examination should be listed.

Sampling
The instruments and devices used in the collection of samples should be listed and described. The sampling locations and areas of the building should be recorded.

Laboratory Results
A summary of the laboratory results could be written in the report. Interpretation of the results and recommendations should be confined to those that are supported directly by data obtained during the visual examination. Determination of patient sensitivity to fungi and the assessment of the relationship between that sensitivity and symptoms should be determined by health care professionals guided by the results of the mold sampling taken by a mold inspector. [10] It is not the inspector's responsibility to correlate mold in a building to their client's health.

Section 20
Remediation

Mold should not be permitted to grow and multiply indoors. [6] Problems associated with mold have been around since recorded history. As we can read in the Bible, the method in dealing with mold has changed very little for thousands of years. Solving mold problems still requires fixing the source of moisture and removing any contaminated components.

Leviticus 14:39-47: *The priest shall come again on the seventh day and shall look; and if the disease has spread in the walls of the house, he shall command that they take out the diseased stones and cast them into an unclean place outside the city. He shall cause the house to be scraped within round about and the plaster or mortar that is scraped off to be emptied out in an unclean place outside the city. And they shall put other stones in the place of those stones, and he shall plaster the house with fresh mortar. If the disease returns, breaking out in the house after he has removed the stones and has scraped and plastered the house, then the priest shall come and look, and if the disease is spreading in the house, it is a rotting or corroding leprosy in the house; it is unclean. He shall tear down the house--its stones and its timber and all the plaster or mortar of the house--and shall carry them forth out of the city to an unclean place. Moreover, he who enters the house during the whole time that it is shut up shall be unclean until the evening. And he who lies down or eats in the house shall wash his clothes.*

Leviticus 13:47-50: *The garment also that the disease of leprosy [symbolic of sin] is in, whether a wool or a linen garment, whether it be in woven or knitted stuff or in the warp or woof of linen or of wool, or in a skin or anything made of skin, if the disease is greenish or reddish in the garment, or in a skin or in the warp or woof or in anything made of skin, it is the plague of leprosy; show it to the priest. The priest shall examine the diseased article and shut it up for seven days.*

Dry Quickly

Dry items before mold grows, if possible. Mold can grow instantly if there is adequate temperature, moisture, and food provided.

To dry carpet and backing within 48 hours, remove water with a wet vacuum, pull the carpet and pad off the floor, and dry them using a fan to blow air over them. A dehumidifier can be used to reduce the humidity in the room where the carpet and backing are drying, while fans can be used to accelerate the drying process.

Water can be removed from concrete or cinder block surfaces with a water-extraction vacuum.

Using dehumidifiers, fans, and heaters also can accelerate the drying. Hard surface flooring (such as linoleum, ceramic tile, and vinyl) should be vacuumed or damp wiped with a mild detergent and allowed to dry. They should be scrubbed clean, if necessary. If the under-flooring is wet, it should be dried using a vacuum or by exposing it to the air.

Non-porous, hard surfaces such as plastics and metals should be vacuumed or damp wiped with water and mild detergent, and then allowed to dry. Scrubbing may be necessary to thoroughly clean the surfaces. Water should be removed from upholstered furniture with a water-extraction vacuum. Fans, dehumidifiers, and heaters may be used to accelerate the drying process. Completely drying upholstered furniture within 48 hours may be difficult, so if the piece is valuable, you may consider consulting a restoration or water-damage professional who specializes in furniture.

Drywall, also known as gypsum board or gypsum wallboard, may be dried in place if there is no obvious swelling and the seams are intact. Otherwise, removal is necessary. The wall cavity is the most difficult area to dry, and it should be ventilated if drywall is left to dry in place.

(Drywall is not made out of boards of wood; traditionally, drywall is made of the mineral gypsum with a layer of heavy paper on the outside and inside. Commercial gypsum boards and drywall are also available with a variety of outside layers and coatings. According to the U.S. Geological Survey, a typical new home contains more than 7 metric tons of gypsum.)

To clean water-damaged window drapes, follow the manufacturer's laundering or cleaning instructions.

To clean wooden surfaces, remove moisture immediately and use dehumidifiers, fans, and gentle heat to dry them. (Be very careful when applying heat to hardwood floors.) Treated or finished wood surfaces can be cleaned with mild detergent and clean water, then allowed to dry. Wet paneling should be pried from the wall for drying.

Some water-damaged items, including ceiling tiles, cellulose and fiberglass insulation, drywall and gypsum board, and books and papers, may have to be discarded. If valuable or important books, documents, or other items are moldy or water damaged, you may wish to consult a restoration, water damage, or remediation expert.

These guidelines are for damage caused by clean water. If you know or suspect that the water is contaminated with sewage, or with chemical or biological pollutants, then OSHA requires PPE and containment. An experienced professional should be consulted if you or your remediators do not have expertise remediation in contaminated water situations. Do not use fans until you have

determined that the water is clean or sanitary.

Assess Mold Problem

Before planning a remediation effort, the size and extent of the mold problem and any continuing moisture problems should be assessed. Remediation generally can be divided into small (less than 10 square feet of mold), medium (10-100 square feet of mold), and large jobs (more than 100 square feet of mold).[2] A remediation manager should be selected for medium or large jobs. You may choose to involve an experienced health and safety professional in remediation projects, particularly on large or complex jobs.

Questions to consider before starting remediation include:
• Are there existing moisture problems in the building?
• Have building materials been wet more than 48 hours?
• Are there hidden sources of water, or is the humidity high enough to cause condensation?
• Are the building occupants reporting musty or moldy odors?
• Are the building occupants reporting health problems?
• Are building materials or furnishings visibly damaged?
• Has maintenance been delayed or has the maintenance plan been altered?
• Has the building been remodeled recently, or has its use changed?
• Are consultations with health professionals indicated?

Remediation Plan

The highest priority in a remediation is to protect the health and safety of the building occupants and the remediation workers. Remediation plans vary according to the size and complexity of the job. They may require updating if circumstances change or more extensive contamination is

discovered.

The remediation plan should include:
Whether containment will be required.
What level of PPE will be used.
How the water or moisture problem will be fixed so the mold problem does not recur.
How the moldy building materials will be removed to avoid spreading mold.

Mold Remediation Procedures

A variety of methods are available to remediate damage to buildings and furnishings caused by moisture control problems and mold. The procedures selected depend on the size of the moldy area and the type of contaminated materials. Budget may also be a concern. The methods presented in this section outline one approach; some professionals may prefer to use other methods. If possible, remediation activities should be scheduled during off-hours, when building occupants are less likely to be affected.

Cleanup methods may include:

Wet Vacuum

Wet, or water-extraction, vacuums are designed to collect water. They can be used to remove water that has accumulated on floors, carpets, and hard surfaces. Wet vacuums should be used only when materials are still wet, otherwise they may spread mold spores. Wet vacuums alone will not dry carpets. Wet carpets must be pulled up and dried, then reinstalled. The carpet padding also must be dried. The tanks, hoses, and attachments of wet vacuums should be thoroughly cleaned and dried after use because mold and mold spores may stick to their surfaces.

Damp Wipe

Mold can generally be removed from hard surfaces by wiping or scrubbing with water and detergent. Always follow the cleaning instructions on product labels. Surfaces cleaned by damp wiping should be dried quickly and thoroughly to discourage further mold growth. Porous materials that are wet and have mold growing on them may have to be discarded. Because mold will infiltrate porous substances and grow on or fill in empty spaces or crevices, completely removing mold can be difficult, if not impossible. Mold can also cause staining and other cosmetic damage.

HEPA Vacuum

High-Efficiency Particulate Air (HEPA) vacuums are recommended for the final clean up of remediation areas after materials have been thoroughly dried and contaminated materials have been removed. HEPA vacuums are also recommended for cleaning up dust that has settled outside the remediation area. When changing the vacuum filter, workers should wear PPE to prevent exposure to mold that has been captured in the vacuum. (See Lesson 4 in Chapter 6 of this textbook.) The filter and contents of the HEPA vacuum must be disposed of in well-sealed plastic bags. Care must be taken to ensure that the new filter is properly seated on the vacuum so there are no leaks.

Throw Away Damaged Materials

Mold-contaminated building materials that cannot be salvaged should be double-bagged in 6-mil or thicker polyethylene bags. The bagged materials usually can be discarded as ordinary construction waste. Packaging mold-contaminated materials in sealed bags before removing them from the containment area is important to minimize the spread of mold spores throughout the building. Large items that have heavy mold growth should be covered with polyethylene sheeting and sealed with duct tape before being removed from the containment area.

Biocides

Biocides are substances that can destroy living organisms. The use of a biocide or a chemical that kills organisms such as mold (chlorine bleach, for example) is not recommended as a routine practice during mold cleanup. There may be instances, however, when professional judgment indicates their use (for example, when immune-compromised individuals are present). In most cases, it is not possible or desirable to sterilize an area; a background level of mold spores will remain, but these spores will not grow if the moisture problem has been resolved. If disinfectants or biocides are used, always ventilate the area and exhaust the air to the outdoors. Never mix chlorine bleach with other cleaning solutions or with detergents that contain ammonia because toxic fumes could be produced.

Please note: Dead mold is allergenic and may cause allergic reactions and other health effects in some individuals, so it is not enough to simply kill the mold. It must also be removed.

Floods

Buildings that have been heavily damaged by floodwaters should be assessed for structural integrity and remediated by experienced professionals. Please note that the information covered in this textbook was developed for inspecting water damage and moisture/mold conditions

caused by clean water (not flood water, sewage, or other contaminated water). Visit the EPA's website at http://www.epa.gov/mold/flood, which has an EPA Fact Sheet: Flood Cleanup - Avoiding Indoor Air Quality Problems.

During a flood cleanup, the indoor air quality in your home or office may appear to be the least of your problems. However, failure to remove contaminated materials and to reduce moisture and humidity can present serious long-term health risks. Standing water and wet materials are a breeding ground for microorganisms, such as viruses, bacteria, and mold. They can cause disease, trigger allergic reactions, and continue to damage materials long after the flood.

Buildings that have been heavily damaged by floodwaters should be assessed for structural integrity and remediated by experienced professionals.

Please note that the guidelines covered in this textbook were developed for damage caused by clean water (not flood water, sewage, or other contaminated water). See the Resource List, which includes the EPA Fact Sheet: Flood Cleanup - Avoiding Indoor Air Quality Problems, for more information.

Section 21
Remediation of Large Areas


For large or complex mold remediation jobs (over 100 square feet of mold growth), you may consider hiring professionals who have experience working on large mold remediation projects, particularly since extensive containment and PPE may be needed. Be sure to check references and ensure that the professional has experience working in mold remediation situations. Remediators should follow EPA mold remediation guidance or other government or professional remediation guidance. Building occupants need to be informed about what is going to happen, when it will happen, and how they may be affected.

Containment should be designed to prevent the movement of mold spores from one area of the building to another. This effort usually requires full containment using double layers of polyethylene sheeting and fans to create negative air pressure. A decontamination chamber or airlock should be used to separate the clean areas from the contaminated areas during entry into and exit from the remediation area. The entryways to the airlock from the outside and from the airlock to the main containment area should consist of a slit with covering flaps on the outside surface of each entry. Contaminated PPE, except respirators, should be sealed in bags while inside the containment exit chamber. Workers should wear respirators until they are in the uncontaminated area, where the respirators can be removed. Disposable respirators can be thrown away and re-usable respirators can be put into a bag for cleaning. Full PPE may also be necessary during these operations and may consist of protective clothing and full-face or powered air purifying respirators (PAPR) with HEPA filters. Protective clothing should include head and foot coverings with all gaps sealed with duct tape or the equivalent.

Section 22
Remediation in HVAC Equipment

Mold remediation involving a heating, ventilation, and air conditioning (HVAC) system should be done only by professionals experienced in working with HVAC systems. Professionals may have several different methods and techniques for approaching HVAC remediation. As with the rest of a mold remediation project, professional judgment is required when working with HVAC systems, and professionals may use materials, methods, and techniques not mentioned in this textbook.

An HVAC system found to be contaminated with mold should be turned off and not used until the system has been remediated; using a mold-contaminated HVAC system may spread mold throughout the building and increase the exposure of building occupants. (There may be some exceptions or instances when all or part or the HVAC system can be run, based on professional judgment, if there is no risk of increasing occupant or worker exposure). If possible, the HVAC system should be remediated during off hours when the building is not in use.

Effective containment of the area served by the ventilation system is important to avoid the spread of mold and mold-contaminated materials. All intakes and supply vents should be sealed with plastic and tape, and negative air pressure should be maintained in work areas. (A fan can be used.) Contaminated porous materials in the HVAC system should be bagged and removed. Materials that can be cleaned should be vacuumed with a HEPA vacuum or cleaned with a moist cloth and detergent solution. All items should be dried promptly.

If you consider duct cleaning, first consult EPA's guide *Should You Have the Air Ducts in Your Home Cleaned?*

Section 23
Remediation of Confined Spaces

Confined spaces include pipe chases (areas within and under buildings where steam and utility pipes are run) and valve pits (areas below grade that contain utility shut-off valves). Working in confined areas presents numerous challenges. Movement and communication are difficult and, if a problem arises, immediate exit from the area may be impossible.

The air in some confined spaces may be contaminated or low in oxygen, posing significant health risks for workers. Efficient rescue of an injured worker may be difficult or impossible. Poor lighting may result in increased injuries. Because exposures may be greatly magnified in a confined space, workers must use a higher level of PPE than they would when working in a more accessible area.

Worker safety must be carefully considered when deciding whether to use disinfectants or biocides because confined spaces may increase the potential for exposure. In general, work in confined spaces should be conducted only by trained professionals who have the equipment required by OSHA to deal with the inherent dangers in this type of environment.

Before remediating mold in a confined space, the area should be evaluated for atmosphere and toxic substances. If there is any chance of low oxygen, the area should be tested using the appropriate equipment. The testing equipment should be kept on site and used periodically to ensure an adequate oxygen supply.

If the area is sealed off from the rest of the building to prevent the spread of mold spores, oxygen testing should be conducted again after the area has been sealed. A frequent contaminant in crawlspaces and pipe chases of older buildings is asbestos; other chemicals such as natural gas and solvents can also be found in some of these spaces. These materials must be identified and dealt with properly to prevent worker exposure.

Once the hazards have been identified, procedures for working in the confined space should be included in the remediation plan. Special consideration should be given to who will be allowed into the area, how communications will be maintained, what materials can be taken into or used in the space, and what safety equipment is necessary. Only individuals trained in the hazards associated with that space should be allowed to enter. An attendant should be posted outside of the confined space area to summon help if necessary. The area should be well lit so that work can be conducted efficiently and injuries avoided.

In conducting the mold remediation, every effort should be made to keep dust and mold out of

the air. This can be done by using moist techniques, such as a damp cloth or pad, for mold removal and by bagging the material in the confined space for later removal. Mold levels are likely to be high in a confined space, so PPE should be selected accordingly. Most cases will require full PPE, including skin and eye protection, and full respiratory protection using a full-face respirator or a powered air purifying respirator (PAPR) with a HEPA filter. The presence of asbestos may require other PPE for workers as well as monitoring and medical evaluation.

Section 24
Containment

The goal of containment is to limit the spread of mold throughout the building in order to minimize the exposure of remediators and building occupants to mold. The larger the contaminated area, and the greater the possibility that someone will be exposed to mold, the greater the need for containment. Although, in general, the size of the contaminated area indicates the level of containment required, the final choice of containment level should be based on professional judgment.

Heavy mold growth in a small area, for example, could release more mold spores than lighter growth in a relatively large area. In this case, the smaller contaminated area may warrant a higher level of containment.

Two types of containment are described in EPA's mold remediation guidance: limited and full. Limited containment is generally used for areas involving between 10 and 100 square feet of mold contamination. Full containment is used when areas larger than 100 square feet are to be remediated or in cases where it is likely that mold could be spread throughout the building during remediation.

Maintaining the containment area under negative pressure will keep contaminated air from flowing into adjacent, uncontaminated areas and possibly spreading mold. A fan exhausted to the outside of the building can be used to maintain negative air pressure. If the containment is working, the polyethylene sheeting of the containment area should billow inward on all surfaces. If it flutters or billows outward, containment has been lost, and the problem should be found and corrected before remediation continues.

Depending on the situation, professional remediators may choose to use a variety of containment methods not described in detail here. For example, a remediator repairing a large building with extensive mold damage in the walls may choose to remove the outside layer of the wall and work inward, relying on appropriate containment to ensure mold is not spread throughout the building.

Or, to limit the amount of mold that gets into the air, a remediator may apply sticky-backed paper or covering to a moldy wall component before removing it.

Limited Containment

Limited containment consists of a single layer of 6-mil fire-retardant polyethylene sheeting enclosing the moldy area. Access to the contained area is through a slit entry covered by a flap

on the outside of the containment area. Limited containment is generally recommended for areas involving 10 to 100 square feet of mold contamination.

In small areas, the polyethylene sheeting can be secured to the floor and ceiling with duct tape. In larger areas, a frame of steel or wooden studs can be built to hold the polyethylene sheeting. Epoxy can also be used to fasten the sheeting to the floor or ceiling.

All supply and air vents, doors, and pipe chases in the containment area must be sealed with polyethylene sheeting to minimize the spread of mold and mold spores to other areas of the building. Stairs should also be sealed if a riser is missing or open. (A pipe chase is an enclosure through which pipes are run; a riser is the upright piece of a stair step, from tread to tread.)

Heavy mold growth on ceiling tiles may affect HVAC systems if the space above the ceiling is used as a return air plenum. In such cases, containment would be installed from floor to ceiling deck. The filters in the air-handling units serving the affected area may have to be replaced once the remediation is complete.

Full Containment

Full containment is recommended for the clean up of mold-contaminated surface areas of more than 100 square feet and when intense or long-term exposures are expected. It is also recommended if it appears likely that the occupant's space would be further contaminated if full containment were not used because high levels of airborne dust or mold spores are likely. Full containment requires double layers of polyethylene sheeting to create a barrier between the moldy area and other parts of the building. A decontamination chamber or airlock—an area with doors between the contaminated area and the clean area—should be built for entry into and exit out of the remediation area.

The entryways from the outside into the airlock and from the airlock into the containment area should be slits covered by flaps on the outside surface. The chamber should be large enough to hold a waste container and allow a worker to put on and remove Personal Protective Equipment (PPE). All contaminated PPE, except respirators, should be placed in a sealed bag while in this chamber.

Respirators should be worn until remediation workers are outside the decontamination chamber.

Section 25
Completing Mold Remediation

How do you know when you have finished remediation?

Ultimately, it is a judgment call. People should be able to occupy or work in the building without health complaints or physical symptoms. The most important action, if mold growth is to be controlled in a building, is to eliminate the source of moisture that caused the mold problem. No matter how good the mold cleanup is, if the water problem is not solved, mold will return.

Therefore, determining whether moisture in the building is being controlled is key in assessing the effectiveness of the remediation effort. If moisture is not being controlled, even removing all the mold growing in the building will be only a temporary solution.

A visual inspection of the area that has been remediated should show no evidence of present or past mold growth. There should be no moldy or musty odors associated with the building, because these odors suggest that mold continues to grow. If mold or moldy odors are present in the building, the remediation has not been effective.

Keep in mind that remodeling, cleaning, and construction may have introduced new building materials or chemicals capable of causing upper respiratory irritation that, in some individuals, may mimic the symptoms caused by exposure to mold.

How Do You Know When You Have Finished Remediation/Cleanup?

1. You must have completely fixed the water or moisture problem.
2. You should complete mold removal. Use professional judgment to determine if the cleanup is sufficient. Visible mold, mold-damaged materials, and moldy odors should not be present.
3. If you have sampled, the kinds and concentrations of mold and mold spores in the building should be similar to those found outside, once cleanup activities have been completed.
4. You should revisit the site(s) shortly after remediation, and it should show no signs of water damage or mold growth.
5. People should be able to occupy or re-occupy the space without health complaints or physical symptoms.
6. Ultimately, this is a judgment call; there is no easy answer.

Bioaerosol Sampling

Bioaerosol sampling (air sampling for mold or other biological contaminants) usually is not

necessary to determine remediation effectiveness. In fact, bioaerosol sampling may be less effective at determining the success of remediation than visual and sensory surveys of the area.

Although sampling may be of some help in judging remediation effectiveness, remember that a negative sampling report must not be used in place of a visual survey. Factors such as barometric pressure, inside and outside temperatures, activity levels, and humidity may dramatically reduce or increase the spore levels within a building. Air sampling for mold provides information on what was in the air only for the moment when the sampling occurred. It is important, therefore, that sampling not replace visual inspection.

Communicate When You Remediate

Communication with building occupants is essential for successful mold remediation. Some occupants will naturally be concerned, and their concern may increase if they believe information is being withheld. The status of the building investigation and remediation should be openly communicated, along with information on known or suspected health risks.

Small-scale remediation will not usually require a formal communication process, but do be sure to take individual concerns seriously and consider whether formal communication is required. Managers of medium or large remediation efforts should make sure they understand and address the concerns of the building occupants and communicate clearly what has to be done. Depending on the situation, communication, communication strategies, and communication issues may also be handled by others such as building owners, school principals, and public relations specialists. Some organizations or buildings may have a communications strategy that can be used, or they may wish to develop a comprehensive strategy.

Communication techniques may include regular memos and meetings with occupants (with time for questions and answers). The communication techniques used will depend on the scope of the remediation and the level of occupant concern. Tell the occupants about the size of the remediation project, the activities planned, and the schedule. Send or post regular updates on the remediation's progress. Send or post a final memo when the project is completed or hold a final meeting. Try and resolve issues and occupant concerns as they come up. When building wide communications are frequent and open, remediation managers can spend more time resolving the mold problem and less time responding to occupant concerns.

Communication is especially important if occupants are relocated during remediation. When deciding whether to relocate occupants, consider the size of the area affected, the extent and types of health effects exhibited by the occupants, and the potential health risks associated with debris and activities during the remediation. Be sure to ask about, accommodate, and plan for

individuals with asthma, allergies, compromised immune systems, and other health concerns. Smooth the relocation process and give occupants an opportunity to participate in resolving the problem by clearly explaining the disruption of the workplace and work schedules. Notify individuals of relocation efforts in advance, if possible.

Special communication strategies may be warranted when treating a mold problem in a school. Teachers, parents, and other affected groups should be notified as soon as significant issues are identified. Consider holding a special meeting so parents can learn about the problem and ask questions of school authorities, particularly if it is necessary or advisable to vacate the school during remediation.

In some cases, particularly when large areas are contaminated with mold or complaints run high among teachers or students, it may be a good idea to hire a remediation professional who can provide expert information to concerned parents and teachers, as well as do the remediation work. Often, giving parents and teachers access to a professional early in the investigation and remediation process will reduce their concern during the latter stages of the remediation. It is important that the best information available be provided to everyone who might be affected by the investigation and remediation.

Communicate When You Remediate

• Establish that the health and safety of building occupants are top priorities.
• Demonstrate that the occupants' concerns are understood and taken seriously.
• Present clearly the current status of the investigation or remediation efforts.
• Identify a person whom building occupants can contact directly to discuss questions and comments about the remediation activities

Please note: EPA does not regulate mold or mold spores in the air. EPA does not certify mold remediators or inspectors.

Section 26
Preventing Mold Growth

Keep the building and furnishings dry. When things get wet, dry them quickly (24-48 hours). Perform routine maintenance, cleaning, and repairs. The key to mold prevention is moisture control. Water entry into buildings or building crawl spaces should be controlled. If water enters a building through a leaking roof or because of a flood or accident, it should be removed immediately and affected areas should be dried out.

Hidden Areas

Special attention should be given to areas that are hidden, but that might have gotten wet. Areas behind walls and in ceilings, crawl spaces, and attics are frequently overlooked and not dried carefully. In general, all wet areas should be completely dried within 48 hours to prevent mold from growing.

Routine Maintenance is Important

A number of items frequently involved in mold problems should be checked and maintained routinely. Furnace humidifiers must be cleaned regularly to prevent mold and bacterial growth. Ducts in which humidifiers are installed should also be checked to ensure water has not leaked into the furnace or filter areas. Stand-alone humidifiers should be cleaned very frequently to ensure that they are not moldy. Special attention should be paid to any filters in the humidifier because they can become moldy and the humidifier can spread spores throughout the area. Carpeted areas around the humidifiers should also be monitored for wetness. Humidifiers should be set to produce less than 60 percent relative humidity in the building. Relative humidity greater than 60 percent is likely to result in condensation in the building, which can lead to mold growth.

HVAC systems should be checked routinely because mold in a ventilation system may be spread throughout the building. Drain or condensate pans should also be checked routinely because they can become reservoirs for mold and bacteria if not installed and maintained properly. These pans are designed to remove water produced by cooling hot air from the ventilation system. If the pans do not drain, or are not cleaned frequently, they may allow water to enter the HVAC system and contaminate the ventilation ducts in the building. The pans themselves may also grow mold and allow mold spores to be spread throughout the building. Filters for the HVAC system also should be kept dry and changed frequently.

Toilet and bathroom areas should be carefully monitored for water and plumbing leaks. Rippling wall coverings, cracked drywall tape, peeling paint, and other signs of water damage should be

investigated quickly. These signs frequently indicate that water has leaked, and hidden mold growth and damage are likely. Water seepage into crawl spaces or basements should also be stopped quickly to ensure that mold will not grow, and measures such as the installation of sump pumps or a regrading of the area around the building should be considered to prevent future leaks. Any areas that smell moldy or musty should also be investigated to ensure that water has not entered and mold is not growing.

Buildings should be located, landscaped, built, and renovated with consideration for the climate. A building that is not suited to the climate can have moisture problems. Buildings inevitably will get wet, both inside and out, and they must be allowed to dry or mold will grow in them. Selection and location of building materials and furnishings can also be made with mold prevention in mind. In frequently damp or wet areas, more mold-resistant materials can be used; for example, some woods are more resistant to mold than particleboard or pressed board.

Mold Prevention Tips

- Moisture control is the key
- Keep the building clean and dry. Dry wet or damp areas within 48 hours.
- Fix leaky plumbing and leaks in the building envelope as soon as possible.
- Watch for condensation and wet spots. Fix the sources of moisture problems as soon as possible.
- Prevent moisture due to condensation by increasing surface temperature or reducing the moisture level in air (humidity). To increase surface temperature, insulate or increase air circulation. To reduce the moisture level in air, repair leaks and increase ventilation (if outside air is cold and dry), or dehumidify (if outdoor air is warm and humid).
- Keep heating, ventilation, and air conditioning (HVAC) drip pans clean, flowing properly, and unobstructed.
- Vent moisture-generating appliances, such as dryers, to the outside where possible.
- Maintain low indoor humidity, below 60 percent relative humidity (RH), ideally 30 percent to 50 percent, if possible.
- Perform regular building and HVAC inspections and maintenance as scheduled.
- Don't let foundations stay wet. Provide drainage and slope the ground away from the foundation.
- If you are not experienced with home/building repairs you may want to consult a professional when making repairs, or for assistance with mold-prevention-related changes to your home/building.

--For large buildings: Use EPA's I-BEAM software to help manage indoor air quality. Routine maintenance and repairs reduce the likelihood of a mold problem in the building. (See the

Resource List)
--For schools: Use the EPA IAQ (Indoor Air Quality) Tools for Schools guidance.

Section 27
Pollen and Mold Counts

The American Academy of Allergy Asthma and Immunology (AAAAI) organized the Aeroallergen Monitoring Network, which has compiled pollen and mold counts for more than 30 years. The network was established to further the science of allergy, and to contribute to the information available to physicians for the diagnosis and treatment of allergic disease.

The Network has reported pollen and mold spore counts to the public and the media since 1992 through the National Allergy Bureau, a service established by the AAAAI. Member stations report pollen and mold counts to the NAB, which releases reports to interested media outlets and to the public through the AAAAI web site (www.aaaai.org/nab). Results are reported as total tree pollen, grass pollen, weed pollen, and mold spore counts per cubic meter with comments about their relative amounts. This information allows allergy sufferers and their physicians to correlate symptoms and causing agents.

Accurate forecasts of future counts would allow people to adjust activities on days with predicted high counts. Forecasting involves having accurate counts from previous years at the involved site and taking into account meteorological data.

Researchers involved with the network are working on such predictive models, but want to prove their reliability before making such predictions available to the public. Until reliable forecasts are available, people with symptoms will have to rely on trends in recent high pollen counts to alert them to take appropriate precautions regarding avoidance.

Section 28
Vital Documents

- A Work Ledger
- IAC2 Mold Inspection Standards of Practice
- Mold Inspection Agreement
- IAC2 Mold Sampling Decision Chart
- Ten Questions to Ask the Building Owner
- Chain-of-Custody

A Work Ledger

A work ledger is a small book used by an inspector during a visual examination and a sampling.

During a visual examination of a building, notes can be written down in the ledger and then transferred to the inspection report at a later time. Answers to questions asked of occupants could be during the examination could be quickly jotted down and recorded. Sketches of the floor plans of the building can be documented.

During a sampling, records of sampling location, sampling time, sample identifications. The air pump shall be calibrated on a regular basis. Pump calibrations should take place once on every day that you have an inspection to perform, preferably in the morning before any air sampling takes place. [12] The data of the calibration should be recorded in the ledger. This ledger is a legal document that can be of great value if there are any legal investigations about your mold inspections. The first two questions someone might ask a mold inspector during a legal investigation may be, “When do you calibrate you air pump machine? Can you prove it?”

Clear and complete records of where a sampling took place; what type of sampling device was used; when the pump turned on and off; what the air flow rate was at the time of the inspection; and unique identification of the sampling devices are necessary to compile an accurate report and to respond to possible litigation.

Sampling information a mold inspector may desire to record in the ledger may include the following:[13]

- Collector’s name
- Date and time of the sample collection
- Address of the building
- Sample identification number
- Sample type (air, surface, bulk)

- Sample collection site (marked on a map or sketch, or a photograph of the site with equipment in place)
- People present at the time of the inspection
- Sample transportation method and conditions, sample storage conditions
- Type of analysis requested
- Date and time samples were received at the laboratory
- Sample device name or type
- Sampling pump identification numbers
- Sampling air flow rate, sampling start and stop times, volume of air collected
- Indoor and outdoor air temperature, relative humidity, moisture readings
- Weather conditions, wind direction and general velocity
- Temperature of the air, temperature of the substrate

IAC2 Mold Inspection Standards of Practice

Table of Contents

1.0 Scope

1.1 The purpose of this standard is to provide standardized procedures to be used for a mold inspection. There are two types of mold inspections described in the IAC2 Mold Inspection Standards of Practice:

(1) Complete Mold Inspection (Section 2.0)
(2) Limited Mold Inspection (Section 5.0)

1.2 Unless the inspector and client agree to a limitation of the inspection, the inspection will be performed at the primary building and attached parking structure. Detached structures shall be inspected separately.

1.3 A mold inspection is valid for the date of the inspection and cannot predict future mold growth. Because conditions conducive to mold growth in a building can vary greatly over time, the results of an inspection (examination and sampling) can only be relied upon for the point in time at which the inspection was conducted.

1.4 A mold inspection is not a home (property) inspection.

1.5 A mold inspection is not a comprehensive indoor air quality inspection.

1.6 A mold inspection is not intended to eliminate the uncertainty or the risk of the presence of mold or the adverse effects mold may cause to a building or its occupants.

2.0 Complete Mold Inspection

2.1 The inspector shall perform:

- a non-invasive visual examination of the readily accessible, visible, and installed systems and components of the building listed in Section 3.0 Standards of Practice
- temperature and humidity measurements according to Section 3.8
- mold samplings according to Section 4.0 Mold Sampling Procedure

2.2 The inspector shall report:

- moisture intrusion,
- water damage,
- musty odors,
- apparent mold growth, or
- conditions conducive to mold growth;
- results of a laboratory analysis of any mold samplings taken at the building; and
- any system or component listed in Section 3.0 Standards of Practice that were <u>not</u> inspected and the reason(s) they were not inspected.

3.0 Standards of Practice

3.1 Roof

I. The inspector shall inspect from ground level or eaves:

A. The roof covering.

B. The roof drainage system, including gutters and downspouts.
C. The vents, flashings, skylights, chimney and other roof penetrations.

II. The inspector is not required to:
A. Walk on any roof surface.
B. Predict the service life expectancy.
C. Perform a water test.

3.2 Exterior and Grounds

I. The inspector shall inspect from the ground level:
A. The cladding, flashing and trim.
B. Exterior doors, windows, decks, stoops, steps, stairs, porches, railings, eaves, soffits and fascias.
C. The exterior grading surrounding the building perimeter.

II. The inspector is not required to:
A. Inspect underground drainage systems.

3.3 Basement, Foundation, Crawlspace, and Structure

I. The inspector shall inspect:
A. The foundation, basement, or crawlspace including ventilation.

II. The inspector is not required to:
A. Operate sump pumps with inaccessible floats.
B. Inspect for structural defects not related to mold growth or moisture intrusion.

3.4 Heating, Cooling and Ventilation

I. The inspector shall inspect:
A. The air handler, circulating fan, and air filter.
B. The condensate pump.
C. Readily visible ductwork.
D. Representative number of supply and return air registers.
E. The central humidifier.
F. The central air conditioning unit.

II. The inspector is not required to:
A. Inspect the air conditioning coils if not readily accessible.
B. Inspect the condensate pan if not readily accessible.
C. Test the performance or efficiency of the HVAC system.

3.5 Plumbing

I. The inspector shall inspect:
- A. The main water line.
- B. Water supply lines.
- C. Drain, waste, and vent pipes.
- D. Hot water source.
- E. Fixtures such as toilets, faucets, showers and tubs.

II. The inspector is not required to:
- A. Test the showers and tubs by filling them with water
- B. Test whirlpool tubs, saunas, steam rooms, or hot tubs.

3.6 Attic, Ventilation & Insulation

I. The inspector shall inspect:
- A. Insulation.
- B. Ventilation of attic spaces.
- C. Framing and sheathing.

II. The inspector is not required to:
- A. To move, touch, or disturb insulation.
- B. Inspect for vapor retarders.
- C. Break or otherwise damage the surface finish or weather seal on or around access panels and covers.

3.7 Interior

I. The inspector shall inspect:
- A. The walls, ceilings, floors, doors and windows.
- B. The ventilation in the kitchen, bathrooms and laundry.
- C. Whole-house ventilation fans

3.8 Humidity and Temperature

I. The inspector shall measure (at the inspector's discretion):
- A. Humidity of any room or area of the building.
- B. Temperature of any room or area of the building.

4.0 Mold Sampling Procedures

I. Closed-Building Conditions

A. Windows on all levels and external doors should be kept closed (except during normal entry and exit) during the sampling period according to the IAC2 Mold Sampling Procedures.

II. Air Sampling

A. The inspector shall perform two (2) outdoor samples according to IAC2 Mold Sampling Procedures. These samples are the control (or background) samples for comparison with the indoor sample(s).

B. The inspector shall perform at least one (1) indoor sample according to the IAC2 Mold Sampling Procedures. Additional indoor air samples may be performed at the discretion of the inspector.

III. Surface Sampling

A. The inspector shall perform at least one (1) surface sampling according to the IAC2 Mold Sampling Procedures. Additional surface samples may be performed at the discretion of the inspector.

5.0 Limited Mold Inspection

The limited mold inspection does not include a visual examination of the entire building, but is limited to a specific area of the building identified and described by the inspector. As a result, moisture intrusion, water damage, musty odors, apparent mold growth, or conditions conducive to mold growth in other areas of the building may not be inspected.

5.1 The inspector shall describe:

- the room or limited area of the building in which the Limited Mold Inspection is performed

5.2 The inspector shall perform:

- a non-invasive visual examination of the readily accessible, visible, and installed systems and components located the room or area described in Section 5.1
- at least one (1) surface sampling according to the IAC2 Mold Sampling Procedures. Additional surface samples may be performed at the discretion of the inspector.

5.3 The inspector shall report:

- moisture intrusion,

- water damage,
- musty odors,
- apparent mold growth, or
- conditions conducive to mold growth; and
- results of a laboratory analysis of any mold samplings taken at the building

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6.0 Limitations & Exclusions

6.1 Limitations:

VIII. These Standards of Practice apply only to residential buildings with four or fewer dwelling units.

IX. The mold inspection is not a warranty, guarantee, or insurance policy.

X. The mold inspection is not technically exhaustive.

XI. The mold inspection will not identify concealed or latent conditions or defects.

XII. The mold inspection will not identify mold growth not readily visible at the time of the inspection.

XIII. The scope of a mold inspection does not include future conditions or events

XIV. The scope of a mold inspection does not include hidden mold growth or future mold growth.

6.2 Exclusions:

I. The inspector is not required to report:

L. The condition of any system or component that is not readily accessible

M. The condition of any system or component that is not in the IAC2 Standards of Practice.

N. The service life expectancy of any system or component.

O. The size, capacity, BTU, performance, or efficiency of any component or system.

P. Compliance with codes, regulations or installation guidelines.

Q. The presence of evidence of rodents, animals, insects, wood destroying insects and pests.

II. The inspector is not required to:

A. Determine the presence of hidden mold by physical examination or sampling.

B. Report replacement or repair cost estimates.

C. Lift carpeting or padding.

D. Inspect any other environmental issue.

E. Determine the cause or reason of any condition.

F. Perform a geotechnical, structural, geological evaluation.
R. Move any personal items or other inspection obstructions, such as, but not limited to: insulation, throw rugs, furniture, floor or wall coverings, ceiling tiles, window coverings, equipment, plants, ice, debris, snow, water, dirt, foliage, or appliances.
S. Dismantle, open, or uncover any system or component.
T. Enter or access any area, crawlspace, or attic space, which, in the opinion of the inspector, may be unsafe or may risk personal safety.
U. Do anything that may be unsafe or dangerous to the inspector or others or damage property according to the opinion of the inspector.
V. Determine the insurability of a property.

II. The inspector is not required to operate:
A. Any system that is shut down.
B. Any system that does not function properly.
C. Any system that does not turn on with the use of normal operating controls.
D. Any shut off water or fuel valves or manual stop valves.
E. Any electrical disconnect or over current protection devices.
F. Any irrigation or sprinkler systems.

7.0 Definitions

7.1 **Accessible**: Can be approached or entered by the inspector safely, without difficulty, fear or danger.
7.2 **Apparent Mold**: visible growth with characteristics of mold, which cannot be confirmed by the inspector without the benefit of sampling. The term “mold growth” is interchanged in this textbook with “fungal growth” and “microbial growth.”
7.3 **Areas of Concern**: Areas of moisture intrusion, water damage, musty odors, visible apparent mold growth, and conditions conducive to mold growth.
7.4 **Complete**: Comprehensive in scope or purpose.
7.5 **Component**(s): A permanently installed or attached fixture, element or part of a system.
7.6 **Condition**(s): The visible and conspicuous state of being of an object.
7.7 **Dismantle**: To open, take apart or remove any component, device or piece that would not typically be opened, taken apart or removed by an ordinary occupant.
7.8 **Due Diligence**: The degree of care and caution required by the circumstances of a person.
7.9 **Dwelling Unit**: A complete place to live including a kitchen and bathroom.
7.10 **Household** Appliances: Kitchen and laundry appliances, room air conditioners, and similar appliances.

7.11 **Invasive**: To probe, dismantle or take apart a system or component.
7.12 **Interior**: The area(s) of a building where people have access and are included in the condition space of the building.
7. 13 **Limited**: Not comprehensive in scope or purpose.
7. 14 **Microbial**: Microscopic organism such as mold.
7. 15 **Normal Operating Controls**: Devices such as thermostats that would be operated by ordinary occupants, which require no specialized skill or knowledge.
7.16 **Occupants**: Tenants, persons, or entities each of which uses a portion of the building.
7.17 **Readily Accessible**: An item or component is readily accessible if, in the judgment of the inspector, it is capable of being safely observed without movement of obstacles, detachment or disengagement of connecting or securing devices, or other unsafe or difficult procedures to gain access.
7.18 **Report**: A written communication (possibly including digital images) of conditions seen during the inspection.
7.19 **Representative Number**: At least one in a particular room or area.
7.20 **Sampling**: The collection of air, surface, or carpet samples for analysis.
7.21 **Shut Down**: Turned off, unplugged, inactive, not in service, not operational, etc.
7.22 **Inspect**(ed): To visually look at readily accessible systems and components safely, using normal operating controls and accessing readily accessible panels and areas in accordance with these Standards of Practice.
7.23 **Inspector**: One who performs an inspection.
7.24 **System**(s): An assembly of various components to function as a whole.
7.25 **Technically Exhaustive**: A comprehensive and detailed examination beyond the scope of a mold inspection which would involve or include, but would not be limited to: dismantling, specialized knowledge or training, special equipment, measurements, calculations, testing, research, analysis or other means.
7.26 **Unsafe**: A condition in a readily accessible, installed system or component, which is judged to be a significant risk of personal injury during normal, day-to-day use. The risk may be due to damage, deterioration, improper installation or a change in accepted residential construction standards.

InterNACHI Mold Inspection Agreement

A mold inspection agreement of InterNACHI (International Association of Certified Home Inspectors) is available at http://www.nachi.org/moldagreement.htm. The mold inspection agreement is as follows:

Mold Inspection Agreement

This is an Agreement ("Agreement") between _____ ("INSPECTION COMPANY") and the undersigned client ("CLIENT"), collectively referred to herein as the "PARTIES." CLIENT agrees to employ the INSPECTION COMPANY to perform a mold inspection as set forth herein.

1. Address: The address of the property to be inspected:_____

2. Fee: The fee for the inspection service is $ _____ and is based on a single visit to the property. The inspection is not technically exhaustive. The fee charged for this inspection is substantially less than that of a technically exhaustive inspection.

3. Purpose: The purpose of the inspection is to attempt to detect the presence of mold by performing a visual inspection of the property and collecting samples to be analyzed by a laboratory.

4. Scope: The scope of the inspection is limited to the readily accessible areas of the property and is based on the condition of the property at the precise time and date of the inspection and on the laboratory analysis of the samples collected. Mold can exist in inaccessible areas such as behind walls and under carpeting. Furthermore, mold grows. As such, the report is not a guarantee that mold does or does not exist. The report is only indicative of the presence or absence of mold. As a courtesy the INSPECTION COMPANY may point out conditions that contribute to mold growth but such comments are not part of the bargained for report.

5. Report: The CLIENT will be provided with a written report of the INSPECTION COMPANY's visual observations and copies of the results of the laboratory analysis of the samples collected. The INSPECTION COMPANY is not able to determine the extent or type of microbial contamination from visual observations alone. The report will be issued only after the laboratory analysis is completed. The report is not intended to comply with any legal obligations to disclosure.

6. Exclusivity: The report is intended for the sole, confidential and exclusive use and benefit of the CLIENT and the INSPECTION COMPANY has no obligation or duty to any other party. INSPECTION COMPANY accepts no responsibility for use by third parties. There are no third party beneficiaries to this agreement. This Agreement is not transferable or assignable. Notwithstanding the foregoing, the CLIENT understands that the INSPECTION COMPANY may notify the homeowner, occupant, or appropriate public agency of any condition(s) discovered that may pose a safety or health concern.

7. Limitation of Liability: It is understood the INSPECTION COMPANY and the laboratory are not insurers and that the inspection, laboratory analysis and report shall not be construed as a guarantee or warranty of any kind. The CLIENT agrees to hold the INSPECTION COMPANY and their respective officers, agents and employees harmless from and against any and all liabilities, demands, claims, and expenses incident thereto for injuries to persons and for loss of, damage to, destruction of property, cost of repairing or replacing, or consequential damage arising out of or in connection with this inspection.

8. Limitations Period: Any legal action arising out of this Agreement or its subject matter must be commenced within one year from the date of the Inspection or it shall be forever barred. The CLIENT understands that this limitation period may be shorter than the statute of limitations that would otherwise apply.

9. Litigation: The parties agree that any litigation arising out of this Agreement shall be filed only in the Court having jurisdiction in the County in which the INSPECTION COMPANY has its principal place of business. If INSPECTION COMPANY is the substantially prevailing party in any such litigation, the CLIENT shall pay all legal costs, expenses and attorney's fees of the INSPECTION COMPANY in defending said claims. The CLIENT further agrees that the International Association of Certified Home Inspectors, Inc. ("Association") is not a party to this Agreement, and any action against it or its officers, agents or employees allegedly arising out of this Agreement or INSPECTION COMPANY's relationship with the Association must be brought only in the District Court of Boulder County, Colorado. If the Association substantially prevails in any such action, the CLIENT shall pay all legal costs, expenses and attorney's fees of the Association in defending said claims.

10. Severability: If any court having jurisdiction declares any provision of this Agreement to be invalid or unenforceable, the remaining provisions will remain in effect.

11. Entire Agreement: This Agreement represents the entire agreement between the PARTIES. No statement or promise made by the INSPECTION COMPANY or its respective officers, agents or employees shall be binding.

CLIENT has carefully read the foregoing, understands it, and voluntarily agrees to it.

CLIENT (Date)

IAC2 Mold Sampling Decision Chart

Condition	Swab Sampling	Tape Sampling	Interior Air Sampling	Outdoor Air Sampling	Carpet Sampling	Wall Sampling
Visible apparent mold.	*Yes (or a tape sampling).*	*Yes (or a swab sampling).*	*Yes. In the area(s) of the building with visible apparent mold growth.*	*Yes. Two outdoor samples (one windward; one leeward).*	*Possibly. At the discretion of the inspector.*	*No.*
No visible apparent mold, but there are visible condition(s) conducive to mold growth.	*Yes (or a tape sampling). At water stains, water damage, areas of moisture, or other areas at the discretion of the inspector.*	*Yes (or a swab sampling). At water stains, water damage, areas of moisture, or other areas at the discretion of the inspector.*	*Yes. In the area(s) of the building with condition(s) conducive to mold growth.*	*Yes. Two outdoor samples (one windward; one leeward).*	*Yes. In the area(s) of the building with condition(s) conducive to mold growth.*	*Yes. At the wall with condition(s) conducive to mold growth. With permission from owner. Destructive.*
No visible apparent mold. No visible conducive conditions.	*No.*	*No.*	*Yes. Near HVAC return duct (if available). Otherwise, at least one sampling in the most lived-in common room such as the family or entertainment rooms.*	*Yes. Two outdoor samples (one windward; one leeward).*	*Possibly. In front of sofa. Alongside bed.*	*No.*

Refer to IAC2 Mold Sampling Procedures prior to performing any sampling.
Refer to IAC2 Mold Inspection Standards of Practice prior to performing any visual examination.

Ten Questions to Ask

If the an occupant or the owner of the building is available, ask the following ten (10) questions:

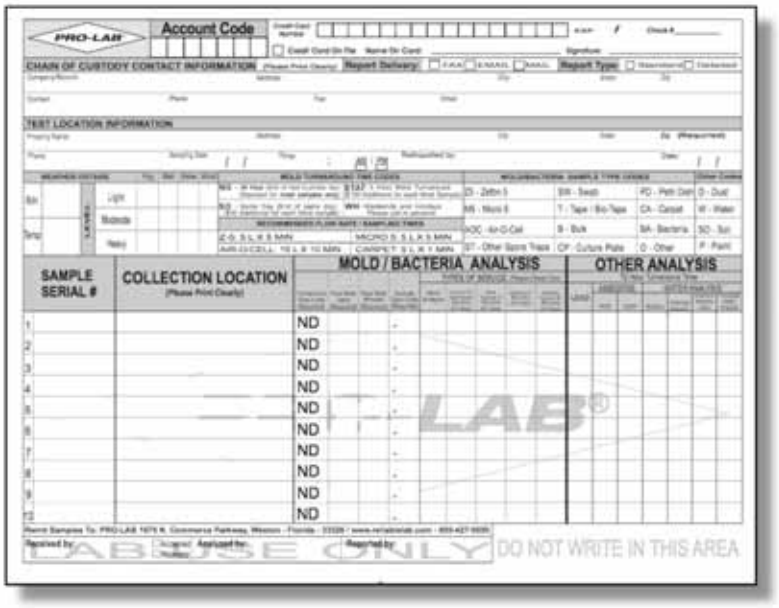
(1) Are you aware of any active water penetration/intrusion in the building?
(2) Has there ever been any prior experiences with moisture or water problems in the building?
(3) Are there any active plumbing leaks?
(4) Have there been any plumbing leaks that have been repaired?
(5) Are there any areas of the building that have a musty odor?
(6) Are you aware of any apparent mold growth (or mold) in the building?
(7) Has the property ever been inspected or tested for mold growth (or mold)?
(8) Are any occupants in the building presently experiencing or have any occupants ever experienced their health affected by asthma, allergies, breathing problems, or mold growth (or mold exposure)?
(9) Are any occupants in the building under a physician's care for significant health effects attributed to mold exposure?
(10) Is there any litigation being considered or in progress in relation to mold in the building?

Chain-of-Custody

It is essential to document you work when performing an environmental inspection and sampling. A mold inspection is meaningless if the work cannot be traced through a Chain-of-Custody document that identifies the date, address, sampling method, and sampling location. The Chain-of-Custody can be considered as a legal document. It must be properly and accurately completed. It must be filled out legibly; an unreadable or incomplete document can be a legal liability.

The purpose of a chain-of-custody document for samples are (1) to ensure that filed and laboratory personnel do not lose track of or exchange samples, (2) to prevent tampering with samples, (3) to track mishandling that might compromise a sample's integrity, and (4) to qualify laboratory results as evidence in legal cases. [13]

The following is the Chain-of-Custody document from Pro-Lab®:



Each sample must be marked with a unique identification number that matches in the Chain-of-Custody document.

Air sample volumes must be calculated and recorded. The laboratory requires this information in order to calculate spores per cubic meter.

Shipping samples to the laboratory overnight is typically preferred. The laboratory should be consulted about the proper collection and shipping methods prior to taking any samples.

IAC2 Mold Sampling Procedures

Table of Contents

1.0 General Comments

- Use the IAC2 Mold Sampling Decision Chart and the IAC2 Standards of Practice to assist in deciding when and where to take samples in a building.
- Samples of the indoor air and the outside air should be taken for comparison. There should not be any mold inside the house that is not found outside. The concentration of mold inside a home should not be higher than the concentration of mold outside.
- Keep in mind that mold spores in the air being sampled can vary greatly in relation to the life cycle of the mold, atmospheric and environmental conditions, and the amount of ventilation. There are seasonal and diurnal variability in airborne mold at an indoor residential environment.
- Air sampling may be necessary if the presence of mold is suspected (for example, musty odors), but cannot be identified by a visual examination.[3] The purpose of such air sampling is to determine the location and/or extent of mold contamination. All mold spores have a source, and identifying the source is the goal.
- Because the outdoor sample is the control, and it is used to compare with the indoor sample, the samples should be collected as close as possible in time and under the similar conditions. Air samples should be collected at the same air flow rate, for the same duration of time, near the same height above the floor in all rooms that are sampled indoors, and using the same type of collection device.

2.0 Air Sampling Procedure

- The sampling equipment must be protected, clean, and properly maintained at all times. The sampling device shall be clean, free from dirt or debris prior to starting a sample. If re-usable collection devices are used, then they shall be handled and cleaned prior to use in accordance with the manufacturer's recommendation. The collector may re-usable and have sticky slides already prepared, or the collector may be a one-time-use self-contained device.
- Slides, cassettes, and one-time-use devices should be stored in cool, dry environments. The slides must be protected from direct sunlight. Sampling devices (slides, swabs, cassettes, tapes) older than one year should not be used.
- Set the air collector at a normal breathing height, which is about 3 to 6 feet above the ground level or floor surface. A tripod is typically used to set the collector height.
- Calibrate the flow of the pump. Do not attach the sampling device, cassette or collector on the tubing yet. Measure the flow rate of the pump with a rotameter that has been calibrated to a standard. Make sure that the flow rate is set to the manufacturer's recommendation. For example, an Air-O-Cell cassette flow rate is 15 liters of air per minute. The pump should be calibrated regularly (once a day). A record of calibrations should be kept in a work ledger or logbook.
- After calibration, securely attach the tubing of the pump to the sampling device or collector. Turn on the pump. Start sampling. Record start time.
- After turning on the air pump, check the airflow rate. The flow rate should not vary. A flow change greater than five percent (5%) requires a new air sample to be taken. All air samples must have the same volume. A digital time controller on the equipment is highly recommended.
- Examine the collector. There should not be an overload on the slide. There should be a fine trace, hardly visible to the human eye, of dust and spores on the slide. A slide that has an easily visible trace on it may be unreadable. If that is the case, the environmental conditions may need improvement or a new sampling location may be needed. If a slide is heavy, a new sample should be taken.
- Remember, all air samples must have the same volume. Refer to manufacturer's recommendations about sampling time and volume for each type of sampling device.
- Record the time that the pump stopped. Mark the sampling device with a unique sampling number. Record that information on the Chain-of-Custody.
- Place slides in a protective carrying case. Or close the collector if a cassette is used. A new sample must be taken, if a slide is accidentally touched, smeared, or contaminated, because it will be unreadable.
- Calculate the volume by multiplying the liters of air pumped by the number of minutes. An example of the calculation is 20 liters of air pump multiplied by 10 minutes equals 20 liters per minute equals 200 liters (20L x 10 minutes = 200 L).

2.1 Weather Conditions

2.1.1 General Comments

- Air sampling should not be conducted during unusually severe storms or periods of unusually high winds. Severe weather will affect the sampling and analysis results in several ways.
- First, a high wind will increase the variability of airborne mold spore concentration because of wind-induced differences in air pressure between the building interior and exterior. Second, rapid changes in barometric pressure increase the chance of a large difference in the interior and exterior air pressures, consequently changing the rate of airborne mold spores being sucked into the building. Weather predictions available on local news stations can provide sufficient information to determine if these conditions are likely.

2.1.2 Clean and Calm

- On a Chain-of-Custody form, the weather conditions shall be recorded. The weather conditions should be clean and calm. High winds may affect the quality of the sampling, including the comparison between indoor and outdoor sampling.

2.1.3 No Rain

- Air pump sampling should not take place outdoors if it is raining. If possible, you should wait for at least two (2) hours after the rain has stopped before taking an air pump sample. Alterations or adjustments to the normal procedure or locations of taking air pump samples, particularly for the control sample, must be recorded in a Chain-of-Custody.

2.1.4 Above Freezing

- Air pump sampling should not take place when the outdoor air temperature is below 32° Fahrenheit. All air sampling should take place when the air temperature is above freezing.

2.1.5 No snow covering

- If the ground is completely covered with snow, outdoor air pump sampling should not be performed. A partial covering or a light dusting of snow is acceptable.

2.1.6 Ten Minutes

- On a clean windless day, air pump sampling should run for 10 minutes. (Be sure to refer to the manufacturer’s recommendation.) When the outdoor air is something other than clean and windless, then the time of the sampling should be reduced to 5 minutes or less.

A breeze, the mowing of grass, nearby construction, and dusty air all affect the sampling conditions.

2.2 Outdoor Air Sampling

The air sampling shall be conducted in accordance with the Air Sampling Procedure (located in previous Section 2.0).

2.2.1 General Comments

- In general, an inspector shall take two outdoor air samples of the highest quality general air to be used as control samples (or background samples).
- The outdoor sampling should begin soon after arriving at the property, assuming that the weather is clean and calm. It is better for an inspector to perform the outdoor sampling while the weather is favorable than to wait. The outdoor conditions may change drastically during the examination and sampling of the building interior.

2.2.2 Windward and Leeward

- If possible, one outdoor sample should be located on the windward side of the building (the side facing the point from which the wind blows), and the other should be located on the leeward-side of the building (the side sheltered from the wind).
- The sampling device located on the windward side of the building should be positioned so as to face the wind directly. The sampling device should point towards the wind, in the direction of the point from which the wind is blowing. The sampling device should be three to six feet (3-6 ft.) from the ground surface (breathable space). Typically the device is about 10 feet away from the front entry door. The idea is to have both outdoor samples located in areas where the devices will collect a representative sampling of the air that may enter the building through the entry door or nearby open windows (the openings on the sides of the building).

2.2.3 Ten Feet

- If there is a main ventilation component of the building that draws into the building fresh air from outside, sampling should be performed ten feet (10 ft.) feet from that intake.
- The sampling should be performed at least ten feet (10 ft.) from the most frequently used entrance to the home.
- The air sampling devices should be kept at least ten feet (10 ft.) away from all openings, air intakes, registers, exhaust vents, vent pipes, ventilation fans, etc.

2.2.4 Nothing Overhead

- Sampling should not be performed under an overhang, soffit or eave; carport; porch roof, or any other roof or overhead structure.

2.3 Closed-Building Conditions

- Indoor air sampling should be made under closed-building conditions. Closed-building conditions are necessary for in order to stabilize the air that may contain mold spores or mVOCs, and to increase the reproducibility of the air sampling and measurement.
- Windows on all levels and external doors should be kept closed (except during normal entry and exit) during the sampling period. Normal entry and exit include a brief opening and closing of a door, but--to the extent possible--external doors should not be left open for more than a few minutes.
- In addition, external-internal air exchange systems (other than a furnace) such as high-volume, whole house and window fans should not be operating. However, attic fans intended to control attic and not whole building temperature or humidity should continue to operate. Combustion or make-up air supplies must not be closed.
- Normal operation of permanently installed energy recovery ventilators (also known as heat recovery ventilators or air-to-air heat exchangers) may also continue during closed-building conditions. In houses where permanent radon mitigation systems have been installed, these systems should be functioning during the air-sampling period.
- Closed-building conditions will generally exist as normal living conditions in northern areas of the country when the average daily temperature is low enough so that windows are kept closed. Depending on the geographical area, this can be the period from late fall to early spring.

2.4 HVAC Sampling

The air sampling of the HVAC system shall be conducted in accordance with the Air Sampling Procedure (Refer to previous Section 2.0).

2.4.1 General Comments

- Perform air sampling at the HVAC system if there is suspicion that the ventilation system may be contaminated (for example, if there is visible apparent mold on the coils, central humidifier, filter, return or supply registers).
- The purpose of such air sampling is to assess the extent of apparent contamination throughout a building. [3]
- It is preferable to conduct sampling before and during the operation of the HVAC system.

2.4.2 One Air Sampling

- At least one air sample shall be taken at an air supply register. Ideally, there would be at least three samples similarly situated, but financial or time constraints may limit the number of samples that can be taken. The air sample should be taken near an air supply register, with the sampling device oriented so that air from the register directly enters the

sampling device. [13] A gentle or vigorous mechanical agitation of the ductwork (a bump or shake) is appropriate. [13]

- Additional samples may be performed at the discretion of the inspector.

2.5 Indoor Air Sampling

2.5.1 General Comments

- An indoor air sampling should only take place in a livable space in the building. Sampling in areas such as closets, under-floor crawlspaces, unfinished attics, storage or utility rooms, or inside the HVAC system is prohibited.
- The air collection device should be at head height (about three to six feet above the floor surface).

2.5.2 Areas of Concern

- In each room or area of the building that has moisture intrusion, water damage, apparent mold growth, musty odors, or conditions conducive to mold growth, one (1) air sample should be taken near the center of that room or area.

2.5.3 No Areas of Concern

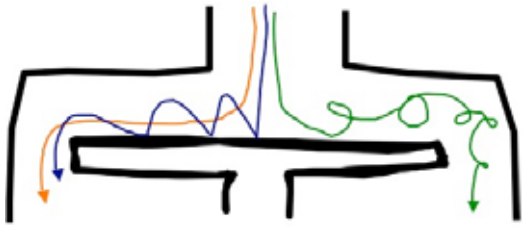
- If there are no areas of concern and there is an HVAC system installed in the building, then one air sampling should be made near the HVAC return (for each HVAC system).
- If there are no areas of concern and there is no HVAC system installed in the building, then one (1) indoor air sample should be taken in the most lived-in common room, such as the family, living, or entertainment room (The location shall be determined at the discretion of the inspector). Refer to previous Section 2.4 HVAC Sampling.
- Additional indoor air samples may be taken at the discretion of the inspector.

2.5.4 Ten Minutes

- Inside the building, the air pump sampling should run for 10 minutes. If there is a lot of indoor activity, then the air pump sampling should be reduced to 5 minutes. If there is an active source of dust, such as construction or cleaning, then the air sampling time should be reduced to 1 minute.

2.6 Air Flow Rate

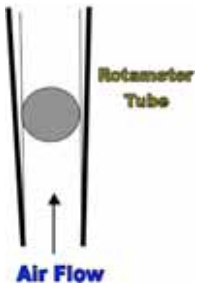
- There are many different types of air pumps, measurement meters, and spore collectors that can be used for an air sample at a mold inspection. The air pump should be adjusted to collect air at a flow rate that is



recommended by the manufacturer of the collection device. The result of an air pump sample is recorded in spores per meter cubed (spores/m^3).

- If the air flow rate is too fast, the spores will bounce off the collector plate or slide and will not stick. If the airflow rate is too slow, the spores float around the collector plate or slide and will not stick.

2.7 Rotameter



- Rotameters are air flow meters that provide field accuracy in an easy-to-read instrument. The principle of operation is simple: air flow passes through a vertical, tapered tube and pushes a small ball or float having a diameter slightly less than the smaller tube end. As the little ball rises, the clearance between the ball and the tube wall increases. The ball becomes stationary when the diameter of the tube is large enough to allow the total airflow past the ball. The flow rate is determined by reading the number on the tube at the middle position of the stabilized ball.

3.0 Surface Sampling Procedures

3.1 General Comments

- Surface sampling can provide information regarding whether the visible apparent mold is in fact actual microbial growth (mold) or not, measure the relative degree of the mold contamination, and can serve to confirm that the sampled mold growth may be producing mold spores in the air.
- Use the IAC2 Mold Sampling Decision Chart and the IAC2 Mold Inspection Standards of Practice to assist in deciding when and where to take samples in a building.

3.2 Swab Sampling Procedure

3.2.1 General Comments

- A swab comes inside a plastic tube container. The cellulose swab is moistened with a liquid preservative stored in an ampoule at one end of the tube container. Any bacteria collected with the swab are transferred via the swab into a tube. The tube is sent directly to a laboratory for analysis.
- A swab provides immediate determination of the presence of fungal spores as well as what types of fungi are present.

3.2.2 Areas of Concern

- Inspector shall take at least one (1) swab sample when a visual examination of the building yields moisture intrusion, water damage, apparent mold growth, musty odors, or conditions conducive to mold growth. Additional sampling may be performed at the discretion of the inspector.

3.2.3 Sampling Procedure

- In general, an inspector will typically hold the tube container so that the ampoule with the liquid preservative is at the top. You pinch the plastic tube so the liquid will flow down onto the swab. To remove the moistened swab, you pull on the cap. Rub and roll the wet swab over a one-inch square area of the apparent mold growth. The swab should collect visible apparent mold. Insert the swab back into the tube. Secure the cap.

3.2.4 Each Sample

- A unique sample number should be recorded for each swab sample. Write the number on the tube itself. The Chain-of-Custody document should have the sample number, location, date, and time of the sampling.

3.2.5 Each Room

- Take the sample in each room or area where there is visible apparent mold.

3.2.6 Each Color

- If there is apparent mold growth with different colors in the room or area, take a sample of each different colored mold. The different colors may indicate different mold types.

3.2.7 Each Substrate

- If mold is visible on different substrates or building materials such as wood, drywall, or wallpaper, then a sample from each different material is recommended.

3.3 Tape Sampling Procedure

3.3.1 General Comments

- A tape system provides a quick way to sample visible mold. A tape-lift system is the most common surface sampling technique. It can be used instead of a swab sample. Many samples can be collected in a short period of time. Samples that show hyphae fragments and reproductive structures can provide proof of mold growth.
- One of the most popular tape sampling products is the Bio-Tape™ system. There are many advantages of using tape lift systems such as the Bio-Tape™ instead of using regular tape. Bio-Tape™ is easier to handle, the tapes are individually numbered, it requires less laboratory preparation time, and the slides are flexible and will not break.
- The sampling result is not quantitative. The presence of fungi can be confirmed, genera can be identified, and possibly a semi-quantitative estimation of the amount of each genus can be determined.

3.3.2 Tape Sampling Procedure

The procedure to using a tape lift system such as Bio-Tape™ is as follows:

- Remove the slide from the mailer;
- Record the sample number and all other identification information prior to taking the sample;
- Peel off the protective liner from the slide to expose the adhesive;
- Place the slide with sticky side down on the contaminated area being sampled;
- Press down gently and make contact. Excessive pressure is not necessary;
- Lift the slide from the surface and place back into the slide mailer. Do not replace the protective liner;
- Record all information on the Chain-of-Custody document, including property address, date, time, and sample number;
- Mail the sample to the laboratory.

3.3.3 PPE

- Because there is direct contact with and disturbance of the contaminated area, PPE is recommended, including gloves and a respirator rated as N-95 or higher.

3.3.4 Each Sample

- A unique sample number should be recorded for each tape sample. The Chain-of-Custody document should have the sample number, location, date, and time of the tape sampling.

3.3.5 Each Room

- Take the tape sample in each room or area where there is visible apparent mold.

3.3.6 Each Color

- If there is apparent mold growth with different colors in the room or area, take a tape sample of each different colored mold. The different colors may indicate different mold types.

3.3.7 Each Substrate

- If mold is visible on different substrates or building materials such as wood, drywall, or wallpaper, then a tape sample from each different material is recommended.

3.4 Carpet Sampling Procedure

3.4.1 General Comments

- A carpet tends to contain a history of any mold that has been growing in the building. The carpeting sampling is performed to reveal previous mold problems. A carpeting sampling can also reveal undetected mold growth that may have been covered over or cleaned up. Choose an area that is not heavily walked upon, an area with little traffic. Do not sample under furniture.
- A household vacuum machine and a carpet-sampling cartridge are used to vacuum a small area of the carpet. The cartridge should be inserted as deep into the pile of the carpet as possible. If a carpet has not been cleaned thoroughly prior to a sampling, a carpet can easily hold evidence of a mold problem in the house. Even after cleaning, there can be mold spores discovered deep in the carpet.

3.4.2 Set Up

- Insert the nylon filter into the collector nozzle. It should snap in place. Attach the device to the vacuum hose securely. An adapter may be needed. If the attachment is loose, use duct tape to make a tight connection.

3.4.3 Sampling

- Choose a 6-foot by 3-foot sampling area in front of the sofa or large chair where occupants spend a lot of time. Vacuum this area thoroughly. Next select a 6-foot by 3-foot area in a bedroom along side a bed. Remove filter. Place into a bad the came with the unit. Mail it to the laboratory.

Section 29
Glossary of Terms

AIR HANDLING UNIT (AHU): Equipment that includes a blower or fan, heating and/or cooling coils, and related equipment such as controls, condensate drain pans, and air filters. Does not include ductwork, registers or grilles, or boilers and chillers.

ALLERGEN: A substance, such as mold, that can cause an allergic reaction.

ANTIMICROBIAL: Agent that kills microbial growth (i.e., chemical or substance that kills mold or other organisms). See "Biocide" and "Fungicide."

BIOLOGICAL CONTAMINANTS: 1) Living organisms, such as viruses, bacteria, or mold (fungi), 2) the remains of living organisms, or 3) debris from or pieces of dead organisms. Biological contaminants can be small enough to be inhaled, and may cause many types of health effects including allergic reactions and respiratory disorders.

BIOCIDE: A substance or chemical that kills organisms such as mold.

BOROSCOPE: An optical probe, inserted through a small hole drilled into a wall, that lets an investigator inspect a small portion of the wall without causing extensive damage.

BUILDING ENVELOPE: Elements of the building, including all external building materials, windows, and walls, that enclose the internal space.

CEILING PLENUM: Space between a suspended ceiling and the floor above that may have mechanical and electrical equipment in it and that is used as part of the air distribution system. The space is usually designed to be under negative pressure.

FUNGI: A separate kingdom comprising living things that are neither animals nor plants. The kingdom Fungi includes molds, yeasts, mushrooms, and puffballs. In this textbook, the terms fungi and mold are used interchangeably.

FUNGICIDE: A substance or chemical that kills fungi.

HEPA: High efficiency particulate air (filter).

HVAC: Heating, ventilation, and air-conditioning system.

HYPERSENSITIVITY: Great or excessive sensitivity.

HYPERSENSITIVITY PNEUMONITIS: A group of respiratory diseases that cause inflammation of the lung (specifically granulomatous cells). Most forms of hypersensitivity pneumonitis are caused by the inhalation of organic dusts, including molds.

MOLD: A group of organisms that belong to the kingdom Fungi. In this textbook, the terms fungi and mold are used interchangeably.

mVOC (microbial volatile organic compound): A chemical made by mold that is a gas at room temperature and may have a moldy or musty odor.

MYCOTOXIN: A toxin produced by a mold.

NEGATIVE PRESSURE: A condition that exists when less air is supplied to a space than is exhausted from the space, so the air pressure within that space is less than that in surrounding areas. Under this condition, if an opening exists, air will flow from surrounding areas into the negatively pressurized space.

PLENUM: Air compartment connected to a duct or ducts.

PRESSED WOOD PRODUCTS: A group of materials used in building and furniture construction that are made from wood veneers, particles, or fibers bonded together with an adhesive under heat and pressure.

REMEDIATE: Fix.

SPORE: The means by which molds reproduce. Spores are microscopic. They vary in shape and range from 2 to 100 microns in size. Spores travel in several ways: passively moved by a breeze or water drop, mechanically disturbed (by a person or animal passing by), or actively discharged by the mold (usually under moist conditions or high humidity).

TOXIGENIC: Producing toxic substances.

See also Indoor Air Quality, Glossary of Terms: http://www.epa.gov/iaq/glossary.html

Section 30
Resource List

EPA Mold Homepage - links to EPA mold documents and non-EPA resources
www.epa.gov/mold

EPA Resources
A Brief Guide to Mold, Moisture, and Your Home
www.epa.gov/iaq/molds/moldguide.html

Biological Contaminants
www.epa.gov/iaq/biologic.html

Fact Sheet: Flood Cleanup - Avoiding Indoor Air Quality Problems
www.epa.gov/iaq/pubs/flood.html

Hurricane Response 2005
www.epa.gov/Katrina

Hurricane Information
www.epa.gov/naturalevents/hurricanes.html

Indoor Air Quality (IAQ) Home Page
www.epa.gov/iaq

Indoor Air Quality Building Education and Assessment Model (I-BEAM)
www.epa.gov/iaq/largebldgs/ibeam_page.htm

IAQ in Large Buildings/Commercial Buildings
www.epa.gov/iaq/largebldgs

IAQ Tools for Schools
www.epa.gov/iaq/schools

Mold Remediation in Schools and Commercial Buildings
www.epa.gov/iaq/molds/mold_remediation.html

Regulating Antimicrobial Pesticides
www.epa.gov/oppad001

Should You Have the Air Ducts in Your Home Cleaned?
www.epa.gov/iaq/pubs/airduct.html

U.S. EPA IAQ Clearinghouse
Phone: (800) 438-4318 or (703) 356-4020 (live operator during business hours)
Fax: (703) 821-8236
E-mail: iaqinfo@aol.com
Free indoor air-related documents, answers to indoor air quality (IAQ) questions, listing of state IAQ contacts and EPA regional contacts.

Section 31
Notes and References

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Section 32
Acknowledgements

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- Dr. John Shane, chief mycologist for Pro-Lab®
- Mr. Will Decker, InterNACHI member. www.deckerhomeservices.com
- My wife and my three little girls for their love and patience

REVIEW QUESTIONS

Section 6
1. The most important factor influencing mold growth is _____.
a) Temperature
b) Light
c) Moisture or water
d) Organic matter

Section 5
2. Molds have the potential to cause health effects such as allergic reactions.
a) True
b) False

Section 5
3. Personal Protective Equipment (PPE) is worn in order to limit mold exposure. Minimum PPE for mold remediation includes _____.
a) A helmet and gloves
b) Safety glasses and protective shoes
c) An N-95 respirator, gloves, and goggles.

Section 8
4. Water-damaged furnishings and building components should be dried within 24-48 hours to prevent mold growth.
a) True
b) False

Section 3
5. Mold cannot be eliminated from indoor environments. Some mold spores will be found floating through the air and in dust; however, they will not grow if moisture is not present.
a) True
b) False

Section 3
6. Mold spores are usually found in indoor air.
a) True

b) False

Section 6
7. The most important factor influencing mold growth indoors is _____.
a) Temperature
b) Light
c) Moisture or water
d) Organic matter

Section 7
8. Mold can grow in cold places.
a) True
b) False

Section 20
9. Dead mold is allergenic.
a) True
b) False

Section 5
10. All molds produce mycotoxins.
a) True
b) False

Section 8
11. All mold is black or green.
a) False
b) True

Section 8
12. A moldy odor in a building suggests that mold is growing in the building whether or not you see mold.
a) True
b) False

Section 9
13. Routine use of biocides (such as chlorine bleach) in mold cleanup is recommended.
a) True
b) False

Section 7
14. The way to control mold growth is to control _____.
a) time
b) moisture
c) RH
d) temperature

Section 8
15. Inadequate building ventilation could lead to mold growth.
a) True
b) False

Section 8
16. Using a gas stove can increase humidity in a room.
a) True
b) False

Section 8
17. Condensation could be a sign of high humidity.
a) True
b) False

Section 8
18. If ductwork insulation becomes contaminated with mold, the insulation must be removed or replaced.
a) True
b) False

Section 8
19. Drain pans should be sealed closed so that water does not get out.
a) True
b) False

Section 20
20. Mold can cause cosmetic damage to the building furnishings.
a) True
b) False

Section 23
21. Evaluating the damage to a building done by mold never requires special expertise.
a) True
b) False

Section 8
22. Mold will not grow in under-floor crawlspaces.
a) True
b) False

Section 20
23. Mold can grow on wet carpet and wet carpet backing or padding if they are not dried quickly.
a) True
b) False

Section 8
24. In which of the following areas of a building may mold problems be found?
a) The crawlspace
b) In pipe chases
c) Behind walls
d) All of the listed answers

Section 8
25. A contaminated ventilation system (HVAC system) may spread mold throughout the building.
a) True
b) False

Section 9
26. Moisture meters can be used to monitor the process of drying.
a) True
b) False

Section 9
27. Personal protective equipment (PPE) is never needed for mold inspections.
a) True
b) False

Section 15
28. An inspector should conduct a mold sampling whenever there is litigation involving the condition of the building.
a) True
b) False

Section 26
29. Quick action to address a moisture problem may make an extensive mold remediation effort unnecessary.
a) True
b) False

Section 20
30. Which of the following types of materials may have to be discarded when contaminated with mold or mold spores?
a) Hard surfaces such as granite or tile
b) Cellulose or fiberglass insulation
c) Plastics and metals
d) a, b, and c

Section 8
31. It is important to assess (or measure) the size and extent of any apparent mold problem once discovered.
a) True
b) False

Section 9
32. You should consider using personal protective equipment (PPE) if disturbing mold during a building assessment.
a) True
b) False

Section 9
33. Minimum PPE includes:
a) N-95 respirator
b) Gloves
c) Hat
d) Goggles
e) N-95 respirator, gloves, and goggles

Section 9
34. A remediation plan should cover:
a) The containment and removal techniques to be used to avoid the spread of mold
b) The use of PPE
c) Steps to correct moisture or water intrusion problems in order to prevent the recurrence of mold
d) All of the listed answers

Section 20
35. Professionals agree that there is only one acceptable method remediating mold problems.
a) True
b) False

Section 20
36. Remediation and cleanup activities should be scheduled for off-hours, when building occupants are less likely to be affected.
a) True
b) False

Section 24
37. When should full containment be used?
a) When more than 100 square feet of mold is found
b) When high levels of airborne dust or mold spores are likely
c) When intense or long-term exposures are expected
d) All of the listed answers

Section 9
38. An N-95 equipment piece provides eye protection.
a) True
b) False

Section 26
39. What is the key to mold prevention in a building?
a) Improving ventilation
b) Maintaining a warm temperature
c) Controlling moisture
d) Limiting food sources

Section Overview
40. The course is designed primarily for residential home inspection professionals.
a) True
b) False

Section Overview
41. This course is a requirement for membership of the International Association of Certified Indoor Air Consultants (www.IAC2.org).
a) True
b) False

Section Overview
42. The EPA does regulate some specific, toxic mold and mold spores in the air.
a) True
b) False

Section Overview
43. There are only a few federal and state threshold limit values for inspectors to use when interpreting results of mold spores in the indoor environment.
a) True
b) False

Section Overview
44. There are no federal or state requirements for inspectors in the sampling of mold.
a) True
b) False

Section 1
45. This course categorizes two types of mold inspections. One type is the _____ Mold Inspection. The other type is the _____ Mold Inspection.
a) Complete, Full
b) Express, Screen
c) Complete, Limited
d) Limited, Comprehensive

Section 1
46. The complete mold inspection is performed in accordance with the Mold Inspection Standards of Practice of the International Association of Certified Indoor Air Consultants.

a) True
b) False

Section 1
47. The inspector shall perform an invasive visual examination of the readily accessible, visible, and installed systems and components of the building listed in the IAC2 Mold Inspection Standards of Practice.
a) True
b) False

Section 1
48. For a complete mold inspection, at least two air samples for mold growth (one indoor and one outdoor) at the building according to the IAC2 Mold Sampling Procedures.
a) True
b) False

Section 1
49. The inspector shall report
a) moisture intrusion
b) water damage
c) musty odors,
d) apparent mold growth
e) conditions conducive to mold growth
f) all of the listed answers

Section 1
50. The inspector shall report any system or component listed in the Standards of Practice that were not visually examined and the reason(s) they were not inspected.
a) True
b) False

Section 1
51. The limited mold inspection does not include a visual examination of the entire building as required by the IAC2 Standards, but is limited to a specific area of the building identified and defined by the inspector and agreed to by the client.
a) True
b) False

Section 2

52. A mold inspection is intended to eliminate the uncertainty and the risk of the presence of mold or the adverse effects mold may cause to a building or its occupants.
a) True
b) False

Section 2
53. The inspector shall inspect a representative number of supply and return air registers.
a) True
b) False

Section 2
54. The inspector shall measure the humidity and temperature of every room or area of the building.
a) True
b) False

Section 2
55. The scope of a mold inspection (according to the IAC2 Mold Inspection Standards of Practice) includes hidden mold growth or future mold growth.
a) True
b) False

Section 3
56. Molds are neither plants nor animals. They are part of the kingdom _____.
a) Fungus
b) Fondu
c) Fungi
d) Mildew
e) Funge

Section 3
57. While animals ingest the food and degrade it internally, fungi excrete chemicals (enzymes) into the environment that degrade the complex carbon into soluble form.
a) True
b) False

Section 3
58. All mold is fungi; not all fungi is mold.
a) True

b) False
c) Huh?

Section 3
59. “Black mold" is not a species or specific kind of mold, and neither is "_____ mold."
a) toxic
b) aspergillus
c) chartarum
d) Cladosporium

Section 3
60. Some of the common indoor molds are Penicillium, Aspergillus, Cladosporium, and Robustia.
a) True
b) False

Section 3
61. One reason why there should be a concern about fungi in the indoor environment is the potential health effects of exposure to fungi and their byproducts.
a) True
b) False

Section 3
62. One reason why there should be a concern about fungi in the indoor environment is the effect of fungal contamination on the structural integrity of a building.
a) True
b) False

Section 3
63. One reason why there should be a concern about fungi in the indoor environment is the negative aesthetic effects fungi can produce both visually and on the human olfactory system.
a) False
b) True

Section 4
64. A mold has like long, threadlike strings of cells called hyphae.
a) True

b) False

Section 4
65. Foot traffic, carpet vacuums, or increased ventilation increases the number of _____.
a) mycotoxins
b) airborne mold spores
c) mold growing hyphae
d) mycelium counts

Section 5
66. Inhalation exposure to mold indoors can cause health effects in some people. Molds produce allergens.
a) False
b) True

Section 5
67. People who may be affected by mold more severely and sooner than others include infants and people with HIV infection.
a) True
b) False

Section 5
68. Current evidence indicates that _____ are the type of diseases most often associated with molds.
a) allergies
b) osteopetroses
c) achromatopsias
d) anchondromatoses

Section 5
69. Inhalation of fungal spores, fragments, or mycotoxins from a wide variety of fungi may lead to cause infections.
a) True
b) False

Section 5

70. Molds can irritate the eyes, skin, nose, throat, and lungs of individuals whether or not they are allergic to mold. Other symptoms include nasal and sinus congestion; burning, watery, red eyes; sore throat; loss of blood; and skin irritation.
a) False
b) True

Section 5
71. Out of the four important indoor allergenic molds, Alternaria and Cladosporium are outdoor molds that can be found indoors if the doors or windows of a building are left open, and the spores are carried by air currents.
a) True
b) False

Section 5
72. As molds grow, _____ of them may produce potentially toxic byproducts called mycotoxins under some conditions.
a) some
b) all
c) several
d) none

Section 6
73. Indoor relative humidity (RH) should be between 20% and 40% in the winter and less than 60% the rest of the year.
a) True
b) False

Section 6
74. Molds can grow on inorganic material such as concrete, glass, and metal, because it can grow on the dirt or dust that is present on the surface of those materials.
a) True
b) False

Section 7
75. There are four factors involved with mold growth. The following conditions are necessary for mold growth to occur on surfaces:
a) temperature range above 40°F and below 100°F
b) mold spores
c) nutrient base (most surfaces contain nutrients)

d) moisture
e) all of the listed answers

Section 7
76. To understand how to find mold growth and prevent mold growth in a building, inspectors must study and understand _____.
a) building science
b) building houses
c) commercial inspections
d) water potential

Section 7
77. _____ are dynamic environments affected by geographic location, season, weather conditions, HVAC system design and operation, moisture intrusion, pest colonization, and human activities.
a) Buildings
b) Mold structures
c) Greenhouses, barns, and sheds
d) Crawlspaces

Section 7
78. Moisture content (MC) is often expressed as a percentage (100 x (wet mass – dry mass)) ÷ (dry mass) or in terms of the amount of water in a certain volume (lbs/ft^3).
a) Correct
b) Incorrect

Section 7
79. Mold growth can be limited if the MC of wood can be kept below ____%.
a) 20
b) 25
c) 30
d) 90
e) 0.20

Section 7
80. Below a ___% MC of wood, virtually no microbial growth will occur on even the most susceptible materials.
a) 20
b) 17

c) 24
d) 28.5

Section 7
81. Mold growth can occur when the _____ properties (the tendency to absorb and retain moisture) of building surfaces allow sufficient moisture to accumulate.
a) humidity
b) absorbent
c) hygroscopic
d) hydrostatic

Section 7
82. Relative humidity (RH) is a ratio (expressed as a percentage) of the amount of moisture in air to the maximum amount the air can hold.
a) True
b) False

Section 7
83. It is the available _____ in a substrate (not the RH of the room's air) that determines if mold can grow or not.
a) food
b) carbons
c) moisture
d) humidity

Section 7
84. RH rises as the air cools, because cooler air has a lower moisture-holding capacity, increasing the risk of condensation in walls.
a) True
b) False

Section 7
85. The basic idea in controlling condensation due to vapor migration is to prevent warm moist-laden air from contacting _____ surfaces.
a) hot
b) hard
c) porous
d) low-perm
e) cool

Section 7
86. To control condensation in a building exterior wall in cold climates, install air or vapor barriers on the warm, interior-side of the building envelope.
a) True
b) False

Section 7
87. To control condensation in a building exterior wall in hot, humid climates, use permeable paints and wall coverings on the interior surfaces of the exterior walls.
a) True
b) False

Section 7
88. The reservoir of a humidifier is usually mold-contaminated in some degree.
a) True
b) False

Section 8
89. A _____ inspection is the most important initial step in identifying a possible mold contamination problem.
a) visual
b) invasive
c) mold
d) humidity

Section 8
90. You may suspect _____, even if you can't see it, if a building smells moldy.
a) water damage
b) bat droppings
c) mold
d) toxic mold

Section 8
91. mVOC stands for _____.
a) my very own creation
b) micro-vial organic compound
c) microscopic volatile organic compounds
d) microbial volatile organic compounds

Section 8
92. Watering house plants can generate large amounts of moisture indoors.
a) True
b) False

Section 8
93. Line drying the laundry indoors can generate large amounts of moisture indoors.
a) False
b) True

Section 8
94. An irrigation sprinkler systems that is spraying water on the house siding can cause moisture intrusion problems.
a) True
b) False

Section 8
95. An increase (up to 90%) in the relative humidity of air downstream of cooling coils is a natural result of the energy transfer between the air and the coils.
a) True
b) False

Section 8
96. Mold needs light to grow. Mold cannot grow in dark areas or on hidden surfaces.
a) True
b) False

Section 8
97. Being a certified home inspector is the best qualification to perform a thorough mold inspection.
a) False
b) True

Section 8
98. Crawlspaces where relative humidity (RH) is high are common sites of hidden mold growth, particularly if the crawlspace has a _____.
a) bare earth floor
b) vapor barrier

c) insulation barrier
d) lot of ventilation

Section 8
99. Mold sampling of the material accumulated on the filter may distinguish between a normal accumulation of material of biological origin on a filter and actual microbial growth (mold).
a) True
b) False

Section 8
100. _____ should not be carpeted.
a) Bedrooms
b) Kitchens
c) Bathrooms
d) Hallways

Section 8
101. The size and extent of the apparent mold problem should be measured. In general terms, a small mold contamination is less than ____ square feet of mold.
a) 10
b) 1
c) 50
d) 120

Section 10
102. Before any sampling takes place, an inspector should develop a set of _____ that address the concerns of the inspector's client.
a) complaints
b) hypotheses
c) hythopesis
d) ascumptions

Section 10
103. Determination of your client's sensitivity to fungi and the assessment of the relationship between that sensitivity and symptoms should be determined by a health care professional.
a) False
b) True

Section 10
104. The term “visible mold” applies to what appears only on the surface, not to what is borne out by professional examination, scientific sampling, and confirmation by laboratory analysis.
a) True
b) False

Section 12
105. An inspector shall take two outdoor air samples of the highest quality general air to be used as control samples (one located on the _____-side, and the other on the _____-side of the building).
a) windward, windless
b) windward, leeward
c) leeward, sheltered
d) north, south

Section 12
106. When sampling the HVAC system, a gentle or vigorous mechanical agitation of the ductwork (a bump or shake) would be inappropriate.
a) True
b) False

Section 12
107. Indoor air sampling should be made under closed-building conditions.
a) True
b) False

Section 12
108. On a Chain-of-Custody form, the weather conditions shall be recorded. The weather conditions should be _____ and _____.
a) clean, calm
b) windy, stormy
c) rainless, cloudy
d) hot, dry

Section 12
109. If the ground is completely covered with snow, outdoor air pump sampling should not be performed.

a) True
b) False

Section 12
110. _____ are air flow meters that provide field accuracy in an easy-to-read instrument.
a) Air bubblers
b) Roto-routers
c) Rotameters
d) Water levels

Section 13
111. Sampling devices (slides, swabs, cassettes, tapes) older than one year should not be used.
a) True
b) False

Section 14
112. The IAC2 Mold Sampling Decision Chart can assist in deciding when and where to take samples in a building.
a) False
b) True

Section 14
113. The swab sampling is expensive. But they can be performed quickly.
a) True
b) False

Section 14
114. If mold is visible on different substrates or building materials such as wood, drywall, or wallpaper, then a tape sample from each different material is recommended.
a) True
b) False

Section 14
115. A carpet tends to contain a _____ of any mold that has been growing in the building. The carpeting sampling is performed to reveal previous mold problems.
a) lot
b) history

c) absence
d) stain or mark
e) mVOC

Section 15
116. Do not sample for mold when your health or safety are in danger.
a) Correct
b) Incorrect

Section 17
117. The information expected from contact surface samples is often simple confirmation that the collected material was biological in nature or that the biological growth can be ruled out.
a) True
b) False

Section 17
118. Visible apparent mold, mold-damaged materials, and moldy odors should not be present in a _____ building.
a) large
b) residential
c) healthy
d) vacant

Section 17
119. The kinds and concentrations of mold and mold spores in a building should be _____ to those found outside.
a) different
b) greater in counts
c) similar
d) less effectual

Section 17
120. It is the mold inspector’s responsibility to establish that exposure to mold spores occurs or that exposure is a health hazard to their client.
a) True
b) False

Section 18

121. One reason why Threshold Limit Values are not defined is because biological exposures are often very complex organic mixtures of variable composition.
a) True
b) False

Section 18
122. People who have concerns about structural damage or the aesthetic effects of indoor fungi should seek the services from a _____.
a) certified mold inspector
b) certified home inspector
c) water intrusion professional
d) health care professional

Section 19
123. The following information should be included in a mold inspection report: The scope of work, visual examination findings, sampling information, laboratory results, and confirming health effects caused by mold exposure.
a) True
b) False

Section 28
124. Pump calibrations should take place once on every day that you have an inspection to perform, preferably in the morning before any air sampling takes place.
a) Correct
b) Not correct

Section 28
125. If there is no visible apparent mold, and there is no visible conducive conditions, then an inspector should take a swab sampling somewhere in the building.
a) False
b) True

Section 28
126. A mold inspection is meaningless if the work cannot be traced through a _____ document that identifies the date, address, sampling method, and sampling location.
a) Chain-of-Custody
b) Chain-of-Cursory
c) Who-Did-What
d) Chance-of-Custody

Section 29
127. A substance, such as mold, that can cause an allergic reaction is called an _____.
a) allergen
b) biocide
c) fungal count
d) mycotoxins

Section 29
128. An optical probe, inserted through a small hole drilled into a wall, that lets an investigator inspect a small portion of the wall without (hopefully) causing extensive damage is called a _____.
a) air tube probometer
b) wall sampler
c) borescope
d) borescot