MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH

BUREAU OF ENVIRONMENTAL HEALTH | INDOOR AIR QUALITY PROGRAM

Use of Moisture Measuring Devices for Evaluating Water Damage in Buildings

The evaluation of mold colonization and water damage in building materials can present challenges, particularly if no visible water stains, mold growth, or wet/musty odors are present inside a building. Mold growth is considered a manifestation of water damage to building materials. Mold growth occurs because water is moistening porous materials for longer than a 48-hour period. Water may originate or result from:

- Leaks in the building envelope (e.g., roof leaks, poorly sealed windows, wet basements)
- Releases from plumbing, sprinkler, or HVAC (heating, ventilation and air-conditioning) systems
- Humid air condensing on surfaces
- Excess humidity (over 70%) during an extensive period of humid weather
- Activities in a building (e.g., showers) that lacks exhaust ventilation or openable windows

Materials that can support mold growth share two traits; they are (1) porous and (2) contain carbon. Such materials include gypsum wallboard, carpeting, cloth, paper/cardboard, ceiling tiles, and wood materials. Mold can also grow on dust and paint on the surface of semi-porous or non-porous materials such as metal, wood, plastic, brick, and plaster. Extended contact between water (liquid or vapor) and materials prone to mold colonization create conditions that result in fungal growth, especially in the indoor environment.

Mold growth is a symptom of chronic dampness. Therefore, state regulations which address chronic dampness, 105 CMR 410.000 Minimum Standards of Fitness for Human Habitation (State Sanitary Code, Chapter II) can be used to address mold growth conditions inside buildings.

A moisture measuring device (MMD) can be used to detect the concentration of moisture in a building material. The following is guidance on using MMDs to determine moisture concentrations in building materials.

Moisture Measuring Devices (MMD)

The MMD operates on the principle of measuring electrical resistance. Different materials (e.g., gypsum wallboard, plaster, wood) will not readily conduct an electrical current when they are dry and intact. The addition of water to these materials increases the electrical conductivity. The MMD measures conductivity of electricity through the sampled material. These devices either have pins or are pinless; however, both types operate using similar principles.

The pins of a MMD provide two ends of an electrical circuit that, when inserted into wet material, create an electrical current. The MMD measures the strength of the electrical current traveling between the pin probes to estimate the moisture content of the sampled material, which is expressed by the device as a percentage. The probe of a pin-based MMD can be extended to allow the user to reach ceilings and tall surfaces. The pins from a MMD probe can damage materials, such as wallboard.

In contrast, a pinless MMD is non-destructive. A sensor plate on the back of the meter projects an electrical field into a material's surface. The MMD senses electrical changes caused by moisture in the material. To ensure an accurate measurement, the sensor plate of a pinless MMD must be flush with the surface sampled.

For ease of recording material moisture levels, an MMD with digital readout is recommended. MMDs can be used to ascertain moisture levels in plaster, wood, gypsum wallboard (GW), concrete, and brick. It is important

the correct material setting is used when taking moisture readings. MMDs can also be used in other materials (e.g., carpeting) to determine whether moisture is present. In these instances, it is recommended that the MMD be set to the "wood" setting.

Interpreting Moisture Meter Readings

MMDs typically have a color scale to indicate whether a material has moisture at levels expected, slightly elevated, or saturated. These color indicators can be used as a guide for determining whether a material is wet. The user guide is an important tool for understanding numeric readings for particular materials.

Sampling Methodology

In general, moisture sampling indoors should be conducted in at least two separate locations: the suspect material and a location that is not suspected of having a moisture problem (the control location). Sampling in the control location is necessary for comparison to ensure that measurements are accurate. More detailed guidance for determining sampling locations is below.

According to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), relative humidity greater than 70% can provide enough water vapor in the air to moisten building materials. This becomes important when sampling for moisture. If sampling is conducted in hot, humid weather, the relative humidity of the ambient air may be sufficient to indicate the presence of water in sampled materials. As part of any moisture sampling protocol, the temperature and relative humidity should be measured outdoors and indoors in an unaffected area as well as in the area of moisture concern. Various instruments are available to measure temperature and relative humidity; weather data from a nearby weather station can also be used to estimate outdoor conditions. Note, however, that extended exposure to relative humidity in excess of 70% can provide sufficient moistening of materials to allow for mold growth.

Sampling Protocols

The following are moisture sampling procedures used by IAQ Program staff to determine if materials should be removed.

Gypsum Wallboard (GW) with no visible mold growth or water damage

When water damage is not visible and no obvious water leak or flood has occurred, measuring the water content of building materials can help determine if the moisture content of GW is uniform throughout the building (due to atmospheric humidity) or whether a less obvious source (e.g., intermittent window leak) is the cause of the excess moisture in the GW. In this situation, it is recommended to sample as many rooms as possible to see if a pattern exists. Each area undergoing investigation should be sampled in a minimum of three locations: (1) the area of suspected water damage (usually an exterior wall); (2) the center of an interior wall between the exterior and (3) a hallway wall (Figure 1). By sampling three separate locations in a room, the moisture content can be compared to determine if one location contains more moisture than others.

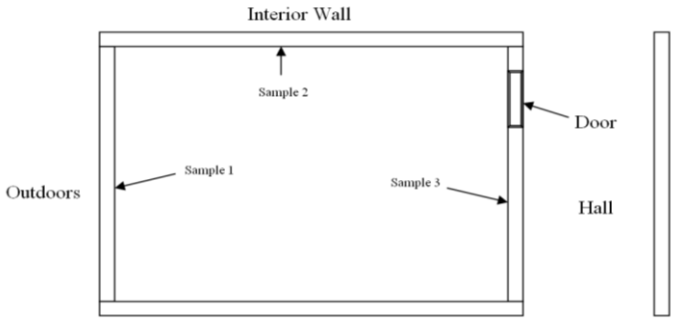
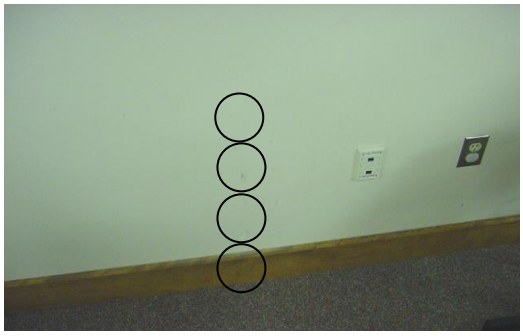


Figure 1: Sampling Locations

Once recorded, moisture sampling data can be compared to the control area sample. In general, if the majority of moisture measurements fall with a range of ±0.3 percent, it is likely that the source of moisture measured in the GW is a result of atmospheric relative humidity and not a hidden leak. Note that prolonged exposure to high relative humidity can be enough to allow for microbial growth in porous materials.

GW with visible water damage, but no mold growth

GW should be sampled in affected areas, and unaffected, control areas. GW readily absorbs and "wicks" water via capillary action and so can be moistened a significant distance above the standing water level. When testing GW, sampling should begin at the base of the wall. Each subsequent sample should be taken in regular intervals (about 3 inches apart) up the wall. When moisture measurements indicate the material is dry (within a range of ± 0.3 percent), mark the area to indicate the height where moistened GW is present. If GW has been wet more than 24 hours, all GW below this mark and an additional foot above this mark should be removed.

(a) 

(b) 

Figure 2 (a) Sampling locations in GW marked by circles and (b) wet GW indicated by arrow on wall

Carpeting

MMDs can be used to determine if other materials are moist, such as wall-to-wall carpeting. For carpeting, the "wood" setting is recommended; a range of 0-15 percent represents the dry (non-moistened) range. A control sample should be taken in an area not affected by the water damage, e.g., a floor above the suspect area. Moisture samples should be taken in carpets throughout the building. The MMD should be placed on/inserted into the surface of carpeting directly over the wall/slab near the location of suspected water damage and approximately 3 feet away from the first location. If moisture was detected in the 3 feet measurement, a third reading should be taken approximately 5 feet from the first location (Figure 3).

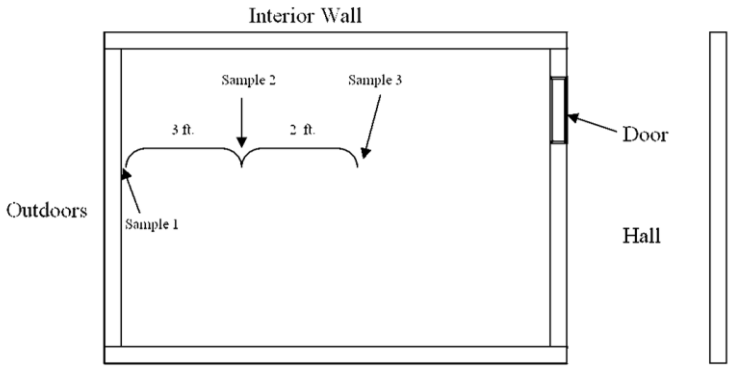


Figure 3: Carpet sampling locations

This process should be repeated at two foot intervals until measurements are either equal to the control measurement or non-detectable. Note that if the source of moisture in the carpet is atmospheric (e.g., humidity), moisture readings in carpet should be relatively uniform (i.e., with a narrow variation of ±2%) across the carpet. Significant variation in the moisture content indicates that the carpet is moistened and ashould be dried and/or removed.

Identifying Water Sources

While water staining or pooling water is an obvious sign of moisture, many materials do not appear visibly wet even when saturated enough to support mold growth. If water damage is suspected, examine conditions around the area to identify potential leaks from water pipes or ventilation equipment. In the absence of plumbing failure or high relative humidity levels, weather events are most commonly the cause for water damage in a building. Obtain recent and historic weather data to identify the most recent rainfall and precipitation event. Note the amount of rainfall and general wind direction of the last significant rainfall prior to the sampling. Use rainfall amount and direction information to see if these correspond to the location in the

building where moistened materials were found. The date of the weather event should be used to estimate the duration of time materials were wet.

The U.S. Environmental Protection Agency (EPA) recommends that materials be dried within 24 to 48 hours. If rainfall events are the likely source of moisture and the rainfall occurred 24 to 48 hours or more prior to the moisture sampling, it is highly likely these materials have been wet long enough to be subject to microbial growth. These materials should be removed and replaced. If the rainfall is within 24 hours, drying the materials with fans and heat may be sufficient. A MMD should be used to re-test moisture content following drying activity. Materials that remain wet after 48 hours should be removed and replaced.

Remediation of Moistened Materials

To minimize exposure to building occupants, mold contaminated materials should be removed in a manner that prevents cross contamination of clean areas. Remediation should be conducted following EPA guidelines in the document "Mold Remediation in Schools and Commercial Buildings." This document can be downloaded at the following web address: http://www.epa.gov/mold/mold-remediation-schools-and-commercial-buildings-guide.

References

US EPA. 2008. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, D.C. EPA 402-K-01-001. http://www.epa.gov/mold/mold-remediation-schools-and-commercial-buildings-guide.

For more information, contact:

Indoor Air Quality Program
Bureau of Environmental Health
Massachusetts Department of Public Health
250 Washington Street, 7th Floor
Boston, MA 02108
Phone: 617-624-5757 | Fax: 617-624-5183 | TTY: 617-624-5286
www.mass.gov/dph/iaq

May 2016