building science.com

Mold Remediation in Occupied Homes

Research Report - 0210
January-2002
Joseph Lstiburek, Terry Brennan and Nathan Yost

Abstract:

This article provides both general guidelines for mold remediation as well as specific guidelines for the typical locations where mold is most often found in houses.

Mold Remediation in Occupied Homes

Nathan Yost, MD
Joseph Lstiburek, Ph.D, P.Eng.
Terry Brennan, MS

Introduction

The recommendations presented are based on the current NYC Health Department guidelines. The purpose of this document is to assist builders with the decisions regarding what to do and how to do it when mold is found in specific locations. The New York City guidelines are based on the area (number of square feet) that have mold on them. Unfortunately the area of involvement is often difficult to determine before removing sheathing or gypsum board. These recommendations are based on typical locations where moisture and mold occur in houses. Each case, however, is somewhat different, so proceed with caution and realize that the problem might be greater than anticipated.

Four Steps for Responding to Mold Problems

1. Respond quickly with appropriate actions to stop water damage and limit potential exposure to occupants

2. Identify:

- The cause of the moisture problem
- The extent of contamination
- The safety precautions for remediation

3. Implement remediation

- Remove damaged material that cannot be effectively cleaned or that is more expensive to clean than replace.
- Clean and salvage materials that are not severely damaged.
- Dispose of the damaged material in an appropriate manner. Moldy materials can be sent to a regular landfill. Seal them in plastic bags to protect workers while the material is in transit.

4. Repair and replace removed materials incorporating the necessary changes to correct the underlying moisture problem.

- Dry out the area being remediated before closing in a wall or ceiling.

General Recommendations

Carefully assess the problem before beginning the cleanup. If the moisture problem started in a closed cavity (wall, ceiling or floor), the mold that can be seen may be only a fraction of the mold present. Put another way, there may be a lot more mold in the wall than you think there is. Assume and prepare for the worst, while hoping for the best.

Discuss the planned work with the owner and occupants. It is easier to address their concerns before you begin the work.

Perform the work in a manner that minimizes the risk to the workers doing the remediation and the occupants of the building. Opening moldy wall cavities can release millions of mold spores and mold parts; inhaling these spores and body parts along with their associated toxins can potentially cause health problems.

Make certain that the workers understand how to do the work and what they need to do to protect themselves and the occupants of the building..

Dispose of the damaged material in an appropriate manner. Moldy materials can be sent to a regular landfill. Sealing them in plastic bags protects workers while the material is in transit.

Whenever possible remove moldy material through a window or door to minimize the chance that mold will be released into the rest of the building. Transporting moldy materials through clean areas should be minimized.

Clean before you dry. Drying before cleaning can cause mold to become airborne.

You do not have to kill mold in order to clean up mold. Cleaning up mold in essence means removing mold. Biocides can be more dangerous than the mold. Don't use bleach; use soap and water. Bleach kills, but it does not clean (remove) the mold.

In single family residential buildings it is often possible to pressurize the occupied portion of the building rather than to depressurize the work area. For example, if the problem is a moldy crawlspace, pressurize the upstairs using a fan door. Workers with appropriate personal protection can perform the work by entering through an exterior access, avoiding airlocks, protection of furnishings and passing contaminated material through the occupied space. If there is not an external access, make one. This makes the clean-up much simpler and safer. Attics, garages, basements and easily isolated additions can be treated this way. Special attention must be paid to any air ducts that are located in the contaminated area.

Deciding Whether a Material Should be Replaced or Salvaged

The general guidance is that soft, absorbent materials that contain a carbon source easily accessible to mold should be discarded unless there are compelling reasons to attempt to salvage them. Paper, textiles and paper covered gypsum board are examples of materials that should usually be discarded. If there is only a small amount of obviously superficial contamination, these materials may be cleaned (soap and water). If they have more than a few colonies, but are worth enough to salvage (e.g. books, art work, musical instruments, vintage carpets), they are worth enough that the salvage work should be performed by specialists.

Materials like lumber, plywood, oriented strand board (OSB), particle board, paper covered gypsum board may or may not be salvageable. The base case test is - has the material lost structural integrity? Most mold species cannot degrade the cellulose-lignin cell wall of intact lumber (there are, of course, a few exceptions - stachybotrys and fusarium for example). So mold growing on solid lumber is most likely a surface contamination issue, not a structural issue. It can be cleaned, dried and salvaged. If solid lumber has lost structural integrity, then it has been colonized by wood decay fungi and probably certain bacteria and that portion must be replaced.

However, composite materials that are composed of wood held together with adhesives are a different story. Many of the adhesives can be degraded by fungal hyphae, at which time they begin to lose structural integrity (visualize hardboard siding or particle board that has turned to mush). So if one of these materials has only superficial mold, it can be cleaned and salvaged; but if it's decomposing it should be replaced. A good motto is "when in doubt, throw it out." Generally, the more a product is composed of solid wooden pieces the more resistant it is to penetration and damage by mold.

Use a pocket knife or ice pick to determine the depth of damage.

For rotted wood, cut it out. For moldy wood, clean it with soap and water and elbow grease. Do not sand it. If you have to sand it to clean it, it's not mold, it's rot. If it's rot, cut it out and get rid of it. Wood may be permanently stained (discolored) after you've clean it. If this bothers you, paint it with latex paint (because latex paint breathes). In rare instances sanding may be justified such as on structural members that may be difficult to remove. Leave such a decision to a qualified expert.

Cleanup Recommendations for Specific Situations

Surface mold due to condensation – less than 10 square feet

- Examples - bathroom ceiling, exterior wall in a closet, exterior wall behind furniture, boxes, shelving
- Correct the problem that caused condensation.
- Wash the mold area with soapy water and rinse thoroughly.
- Allow the surface to completely dry.
- Repaint if needed; superficial discoloration may remain.
- If the mold has penetrated below the surface (as on gypsum board) remove involved material and approximately one foot of uninvolved board in all directions. A general rule is to remove the gypsum board from one stud cavity on each side of the area that has mold growth and one foot above and below the area that has mold.
- Personal protective equipment (PPE): N95 mask, rubber gloves and eye protection.
- No containment is necessary

Mold in a wall cavity – less than 10 square feet

- Examples - under a window due to window leak; in a ceiling or wall due to a roof leak; in a bathroom wall due to a leaking pipe.
- Turn off the air handler (furnace or air conditioner) supplying the work area.
- Determine the extent of the area that has mold growth before proceeding with this set of guidelines. This can sometimes be done by removing the baseboard and checking the bottom plate or cutting small holes in the gypsum board behind the baseboard. A hole saw can be used to cut inspection holes that are easily repaired.
- Remove the contaminated gypsum board and approximately one foot of uninvolved board in all directions. A general rule is to remove the gypsum board from one stud cavity on each side of the area that has mold growth and one foot above and below the area that has mold.
- Vacuum while cutting the gypsum board using a HEPA vacuum or a vacuum with a high efficiency collection bag and vent the vacuum to the outside.
- Vacuum all moldy surfaces thoroughly. Vacuum surfaces before damp wiping or scrubbing.
- Damp wipe all surfaces with disposable wipes.
- If after vacuuming, mold growth is present, scrub the surface using soapy water and thoroughly rinse.
- Allow the wood framing to thoroughly dry before installing new gypsum board. This will usually mean returning at least a day later, or longer. Measure the moisture content with a moisture meter. Wooden materials should be less than 15 per cent moisture content by weight and concrete should be less than 4 per cent moisture content by weight.
- Drying can be accelerated by using heat lamps and a dehumidifier. Do not use fans blowing against the wall surfaces.
- You are done when all visible mold is removed and no dust is present (the white glove test).
- PPE – N95 mask, rubber gloves, eye protection.
- All contaminated material should be placed in plastic bags at least 6 mil in thickness, double bagged and disposed of as regular trash.
- Containment – although not required by the NYC Dept. of Health Guidelines, the use of an exhaust fan is recommended. This could be a bathroom fan ducted to the outside or a vacuum cleaner located outside that has its vacuum hose entering through a window. To do this, use a piece of sheathing that is the width of the window opening and several inches higher than the diameter of the vacuum hose. Use a hole saw to cut a hole in the sheathing into which the vacuum hose can be inserted.

Medium size areas of mold involvement in wall cavities – 10 to 30 square feet (one 4' x 8' sheet of gypsum board)

- Examples: window or roof leaks; slow bathroom plumbing leak
- Turn off air handler (furnace or air conditioner) supplying work area.
- Work area should be unoccupied.
- Erect a containment barrier using plastic sheeting to isolate the work area from the rest of the house.
- Exhaust the work area with a fan ducted to the outside or, alternatively, pressurize the area outside the work area.
- Determine the extent of the area that has mold growth before proceeding with this set of guidelines. This can sometimes be done by removing the baseboard and checking the bottom plate or cutting small holes in the gypsum board behind the baseboard. A hole saw can be used to cut inspection holes that are easily repaired.
- Remove the contaminated gypsum board and approximately one foot of uninvolved board in all directions. A general rule is to remove the gypsum board from one stud

cavity on each side of the area that has mold growth and one foot above and below the area that has mold.
- Vacuum while cutting the gypsum board using a HEPA vacuum or a vacuum with a high efficiency collection bag and vent the vacuum to the outside.
- Vacuum all moldy surfaces thoroughly. Vacuum surfaces before damp wiping or scrubbing.
- Damp wipe all surfaces with disposable wipes.
- Scrub any wood that has mold growth using soapy water and thoroughly rinse.
- Drying can be accelerated by using heat lamps and a dehumidifier. Do not use fans blowing against the wall surfaces.
- Allow the wood to thoroughly dry before installing new gypsum board. This will usually mean returning at least a day later, or longer. Measure the moisture content with a moisture meter. Wooden materials should be less than 15 per cent moisture content by weight and concrete should be less than 4 per cent moisture content by weight.
- You are done when all visible mold is removed and no dust is present (the white glove test).
- PPE – N95 mask, rubber gloves, eye protection.
- All contaminated material should be placed in plastic bags at least 6 mil in thickness, double bagged and disposed of as regular trash.

Large areas of mold contamination (greater than 30 square feet) require more extensive investigation and usually should be done by professionals with training and experience in remediating contaminated buildings. As the area of contamination becomes greater the need for adequate containment increases. This often requires more sophisticated barriers, entry chambers and maintenance of decreased air pressure in the work area or increased air pressure in surrounding areas.

There are, however, a few special situations in which a builder's own workers can safely remediate an area of mold contamination that exceeds 30 square feet. These are areas easily isolated from the rest of the building and that have separate means of egress (doors or windows). Crawl spaces, attics and building additions or wings are examples of this type.
- Seal openings between the work area and the rest of the home. If air ducts are located in the contaminated are, they should be sealed to protect them during the remediation. It is possible that the air ducts are already contaminated so they should be inspected as part of the remediation process.
- Evacuate the areas of the home adjoining the work area so that if containment is lost unprotected individuals will not be exposed. Better still, evacuate the home during the clean up. This issue needs to be addressed on a case by case basis **before** the work begins.
- Maintain a lower air pressure in the work area than in the adjoining areas by using a HEPA machine or a fan exhausted to the outside with HEPA filtration. Alternatively, maintain a higher air pressure in the surrounding areas using a fan door (blower door).
- Personal protective equipment: gloves, eye protection without vents, disposable protective clothing that also covers the head and feet and at a minimum a N95 respirator. Consider use of full-face mask respirators with HEPA filtration canisters.
- The remainder of the clean-up is similar to that for smaller areas.

In many instances where mold is found in exterior walls much of the work can be done from the outside. Houses with easy to remove cladding such as vinyl siding are ideally suited for this approach. The entire home can be pressurized when the work is being done from the outside. A plastic sheet taped to the interior of the exterior wall can be used to provide the containment barrier.

Large areas inside of homes (not within exterior walls) - (more than 100 square feet of mold damaged material) require individuals with training and experience in remediating extensively contaminated buildings. See the New York City Guidelines below.

The New York City Department of Health's Guidelines for Mold Remediation

Introduction

Although our recommendations are directed to specific locations or types of mold problems, we will briefly discuss the New York City Guidelines.

Level I - small isolated areas: less than 10 square feet, e.g. Ceiling tiles, small areas on walls
- Can be performed by regular maintenance staff.
- Personal protective equipment: N95 disposable respirator, gloves and eye protection.
- The work area should be unoccupied.
- Containment of the work area is not necessary. Suppress dust production by misting surfaces prior to removing.
- Contaminated materials that are removed should be sealed in plastic bags.
- Scrub contaminated materials with soap and water; rinse thoroughly and allow to dry.
- HEPA vacuum the work area so that it is free of dust.

Level II - mid-sized isolated areas: 10-30 square feet
- May be performed by regular maintenance staff.
- Personal protective equipment: N95 disposable respirator, gloves and eye protection.
- The work area should be unoccupied.
- The work area should be isolated from the rest of the building using polyethylene sheeting that is sealed with tape.

- Contaminated materials that are removed should be sealed in plastic bags.
- Scrub contaminated materials with soap and water; rinse thoroughly; and allow to dry.
- The work area and the access areas should be HEPA vacuumed and cleaned with disposable damp cloths.

Level III - large isolated areas : 30-100 square feet.

- Consult a health and safety professional with experience performing microbial investigations.
- Work should be done by individuals trained in handling hazardous materials.
- Personal protective equipment: N95 disposable respirator, gloves and eye protection.
- The work area should be unoccupied.
- The work area should be isolated from the rest of the building using polyethylene sheeting that is sealed with tape.
- Contaminated materials that are removed should be sealed in plastic bags.
- Scrub contaminated materials with soap and water; rinse thoroughly; and allow to dry.
- The work area and the access areas should be HEPA vacuumed and cleaned with disposable damp cloths.

Level IV – extensive contamination: greater than 100 square feet in one area.

- Consult a health and safety professional with experience performing microbial investigations.
- Work should be done by individuals trained in handling hazardous materials.
- Personal protective equipment: full-face respirator with HEPA cartridges, gloves and disposable protective clothing covering that also covers head and shoes.
- The work area should be unoccupied.
- The work area should be isolated from the rest of the building using polyethylene sheeting that is sealed with tape.
- Use an exhaust fan with a HEPA filter to generate negative pressure in the work (containment area).
- Use air locks
- Contaminated materials that are removed should be sealed in plastic bags.
- Scrub contaminated materials with soap and water; rinse thoroughly; and allow to dry.
- The work area and the access areas should be HEPA vacuumed and cleaned with disposable damp cloths.

About the Authors

Joseph Lstiburek, Ph.D., P.Eng., is a principal of Building Science Corporation in Westford, Massachusetts. Joe is an ASHRAE Fellow and an internationally recognized authority on indoor air quality, moisture, and condensation in buildings. More information about Joseph Lstiburek can be found at www.buildingscienceconsulting.com.

Terry Brennan, MS, is a building scientist and educator with Camroden Associates, Westmoreland, New York.

Nathan Yost, MD, investigated mold and moisture issues for Building Science Corporation.

Direct all correspondence to: Building Science Corporation, 30 Forest Street, Somerville, MA 02143.

Limits of Liability and Disclaimer of Warranty: