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A Condensed Remediation Plan for Small Microbial Particles

The full document can be downloaded as a password-protected Adobe PDF document for patients in Dr. Ritchie Shoemaker's system. Ask your physician's office for details. This document is meant to educate patients. It should not be used as the complete remediation plan since variables like architectural details may create changes for the operation of containments. This is copyrighted material from AerobioLogical Solutions, Inc. All rights are reserved.

By Greg Weatherman, CMC

INTRODUCTION

Mold is common in the natural environment and is constantly introduced to indoor living spaces by outside air, on people, and through food. Many forms of mold may produce mycotoxins if water activity requirements are met along with other factors. For sensitive populations, even low levels of inhalable microbial particles can produce adverse health effects caused by toxic or allergic properties that may occur whether mold is dead or alive.

This mold remediation plan has been based on more than a decade of work with sensitive patients. Although the methods may seem excessive, given practices commonly used by other contractors and consultants, it is important to note that industry standards are not necessarily based on scientific research. Common practices may also be based on methods shown to be effective for whole spores or conidia but not for particles that are much smaller and float in the air for long periods of time. (See the studies by Gorny and by Brasel, listed in the Additional Resources section.)

The remediation plan presented here, like other plans, is accomplished by first creating a temporary cleanroom environment with incredibly low levels of mold. Because it is not possible to separate harmless dust particles from those that are harmful in a sufficient dose, all microbial particles that may contain mycotoxins must be removed.

In order to effectively remove these particles, the structure must be cleared of all objects except large pieces of furniture, such as dressers, china cabinets, etc. Other items are cleaned elsewhere. Rooms with demolition activities must be contained, with contaminated building material removed.

All surfaces should be cleaned using HEPA vacuums and physical dust removal cleaning methods. Heating, ventilation and air-conditioning (HVAC) and air ducts must be cleaned. All porous surfaces must be sealed; particles lingering in the air must be removed; the structure must have unplanned moisture intrusion corrected; and finally post-remediation testing must verify the results.

Depending on the client's wishes, each room in a residence may be approached separately for demolition or moisture correction, but ultimately, the whole structure must be addressed. It is harder to get good post-test results when you address rooms one at a time rather than the whole structure.

BEFORE BEGINNING REMEDIATION

The contractor and the client should make every effort to fully understand this document and to clarify any aspects that may impede successful remediation.

This plan has been developed for individuals with chemical and fragrance sensitivity and is intended for use with only the specified products. Products should not be substituted without the written consent of the client or a designated representative. Web links have been provided to show the intended products and to avoid confusion with products with similar names. Some products may be licensed to use for a patented method such as AeroSolver[®]. Some products may have special instructions such as 20 Mule Team Borax[®]. It is the customer's and the contractor's responsibility to ensure no patent infringement occurs based on reasonable research.

Working with the Client

Both the client and contractor must understand that the practical objective of remediation is the physical removal of harmful, inhalable particles—because complete removal of microbial particles is often impractical. As shown in a peer-reviewed study by S.C. Wilson, sodium hypochlorite (bleach) and acetone are the most effective methods for mycotoxin removal; but these are useful for only non-porous and non-reactive materials.

Mycotoxin removal is consequently nearly impossible for many furnishings and personal items made from soft and porous materials. This can be emotionally and financially difficult for the affected client. It is therefore important to involve the client in decisions regarding the cleaning and disposal of items. It may be possible

to store questionable contents elsewhere until the client's health has improved or until the client has become less sensitive enough to withstand exposure.

The client or client's representative has a right to view the work in progress at any time as long as remediation work is not impeded and all proper safety precautions are followed. The contractor should assign someone to answer client questions as they arise.

In some cases, clients may choose for financial reasons to perform certain tasks themselves. In such cases where the contractor will not be performing all aspects of the remediation, a legal agreement should be prepared in advance to release the contractor's liability for any work performed by the client and for guarantees of any post-testing results. An attorney should be consulted for any legal questions.

Most tasks involved with remediation require specialized expertise, skills, or equipment. However, when necessary, the following tasks may be performed by the client:

- Content removal
- Surface cleaning

Contractors and consultants should treat information regarding remediation as private medical information covered by the Health Insurance Portability and Accountability Act HIPAA. The remediation measures were deemed medically necessary to address the environmental issues affecting the client's health.

Documenting Work

Contractors should document all work with digital photos—especially conditions related to the removal of building material and any special requests. Digital photos should be kept in the logbook or on a thumb drive.

CONTAINMENT

1. Containment Setup Guidelines

Containments should be made as small as possible to address a few square feet at a time rather than a whole room. Negative air machines (NAMs) should be HEPA filtered but exhausted outdoors to account for any filter leakage. Containment should be erected with laminar airflow to the extent possible by creating an entry for new air opposite the position of the NAM. Plastic sheeting or similar material must be placed on the floor for demolition work. It is not necessary to cover walls

and ceilings with plastic unless there is an opening to another area outside of containment (critical control barrier). The air in the containment should be cleaned similar to the final air cleaning treatment before the containment is disassembled to prevent cross-contamination of airborne dust particles.

A tacky mat (<http://www.adhesivemats.com/>) should be placed at the entrance to any containment site to prevent cross-contamination. Negative air pressure differential containment should be erected when removing walls or removing windows to prevent cross-contamination in the rest of the residence with higher levels of microbial particulates.

Personal Protective Equipment (PPE). Contractors must wear all appropriate PPE during indoor microbial remediation/demolition activities. It is the contractor's responsibility to ensure workers are using adequate PPE following applicable OSHA or similar state regulations. Normally this includes a fitted respirator with a P100 particulate filter rated for organic vapors and approved by NIOSH. Protective clothing should be used to prevent cross contamination. Non-fogging safety glasses should be worn when there are flying particles. Disposable shoe covers (<http://www.amazon.com/Polyethylene-Covers-Static-Impervious-Linting/dp/B000E27XSG>) should be worn whenever on the site: foot traffic is the biggest cause of cross-contamination. Gloves can be used as necessary.

Waste Disposal. Waste material should be cleaned, bagged, and disposed immediately after removal/demolition and before work commences on another room. When removing bagged waste, the route through the structure should be minimized, and the bags should not be dragged on the floor to avoid rupture. As with asbestos abatement, bagged material should be placed in a second bag at the entrance of the containment to avoid the cross-contamination of dust from the outside of the first bag. Spraying the outside of the bagged materials with soapy water can also suppress dust particles. Dumpsters for waste should be wet on a regular basis to control dust.

2. Removing Contents

All contents, except large salvageable furniture, must be removed to prevent cross-contamination. Large pieces of furniture can be moved to another room or the other side of the room as necessary.

Soft, porous furnishings and items are extremely difficult to clean, and many items may not be salvageable if the client has severe medical issues. The remediation contractor should provide individual estimates for challenging items so the client can assess the costs of remediation vs. replacement. Such items include couches, chairs, and mattresses; all absorb moisture on a daily basis, and most require costly dismantling for cleaning.

Decorative items used in areas where there are no constant air currents to dislodge respirable particles are less dangerous for sensitive populations. These can be placed in storage and cleaned by the client at a future date, especially if cost is a concern.

Important documents should be electronically scanned and placed into storage.

Wall-to-wall carpeting is one of the last things to remove since it will protect the sub-flooring from contamination. When removing, the carpet should first be dampened to suppress dust particles; but care should be taken not to soak the sub-flooring. The carpet should then be cut, rolled, and immediately bagged. A pump bottle (1 gallon minimum) with soapy water should be readily available to re-moisten the quick-drying carpet. In areas without carpeting, a plastic sheet should be used to protect salvageable flooring.

3. Moisture Issues

Correct moisture issues that can be quickly addressed—not including basement waterproofing or re-grading. All required permits should be obtained and applicable building codes should be followed. Contractors may need licensing to conduct certain tasks. Complex repairs may require architectural engineering to ensure effective results.

DEMOLITION

4. Demolition

Perform demolition of moldy material with containment appropriate for each location. Use HEPA filtration equipment to keep dust levels low by having air scrubbers or HEPA vacuums close to any activities or equipment that create high dust levels, such as electric saws used to cut paper-faced gypsum board.

CLEANING

All rooms should be thoroughly cleaned even if there is no demolition activity. Waste material and debris in each work area should be cleaned and removed as soon as possible. Plan carefully to avoid cross-contaminating areas already cleaned. Walls should be wiped before floors. Begin cleaning floors from the point farthest from the exit and work toward the exit.

5. General Cleaning Practices

All surfaces should be cleaned by HEPA vacuuming followed by damp wiping with a cleaning agent that does not leave a residue. Surfaces should be visibly clean to the point there is no visible dust when viewing surfaces with a bright light or flashlight. All surfaces should be white glove clean.

Disinfection. It is normal to find microbial flora common to soil such as various species of *Aspergillus*, *Penicillium*, *Bacillus*, and *Streptomyces*. Some of these organisms produce toxins in wet environments on building materials. The four genera listed all produce spores including the latter two which are bacteria not addressed by most disinfectants unless they are EPA registered as “sporicidal” and used according to label directions that are normally not appropriate for residences. *Glutaraldehyde* is an example of a “sporicidal” disinfectant that may be more toxic than the organisms targeted. The health effects from mold are generally from toxic or allergic properties, which may occur whether mold is dead or alive. Most species of mold cannot live at human body temperature. The contractor must understand disinfection is impractical on many surfaces while *physical removal of inhalable particles is important*.

HEPA Vacuuming. All porous or coarse surfaces should be HEPA vacuumed. Most HEPA vacuums cannot remove all respirable particles, and because the leaked particles are small, they are difficult to remove from the air. Unless filter efficiency and level of filter bypass have been tested with a laser particle counter, the HEPA vacuum should be used only for pre-cleaning. A clear sign of filtration failure is a strong musty odor when vacuuming. Leaky HEPA vacuums can be used in a negative air pressure differential containment area or in an area separated by a positive air pressure differential containment. Equipment with HEPA filters should be wrapped tightly to avoid cross-contamination when moving equipment used on a previous job at another worksite. Contractors may be bringing more trouble to your place from other jobs. This can also happen with airscrubbers.

Deep Cleaning Porous Surfaces. Unfinished wood surfaces (e.g., framing lumber) and concrete surfaces in areas with visible microbial contamination should be cleaned using highly concentrated hydrogen peroxide cleaner according to label directions. Once dry, wood surfaces should be HEPA vacuumed. This cleaning method also removes some stains from enzymatic browning that occurs as microbial flora grow on surfaces such as paint and wood. This is the preferred method to remove excess dust from concrete or sub-flooring material whose porosity makes it difficult to clean with a HEPA vacuum.

Wet Scrubbing Other Surfaces. For most surfaces, terrycloth towels soaked with a cleaning agent that leaves no residue can be used to scrub off residues during pre-cleaning and before air cleaning. This will counteract electrostatic forces that

make removing particles difficult for smooth surfaces such as finished flooring and plastic crawlspace liners. This product has a slight odor that quickly evaporates after application without leaving a residue. It is important to apply pressure when wiping with the terrycloth towels since light friction enhances the particle-capturing capability of this cleaning method. Particles are transferred to the terrycloth towels from the surfaces. Terrycloth towels can be laundered and reused.

For surfaces with biofilms, a soft soap such as 20 Mule Team Borax[®] (<http://www.20muleteamlaundry.com/>) can be used.

Important: Never rinse terrycloth towels in dirty water or used cleaning solution since dirt and particles will remain on the towels. Always use clean towels so each towel can be used to assess the level of remaining residue. Always test inconspicuous surfaces to ensure scrubbing will not mar the surface. These products should not be mixed with any other products.

Air Blasting. This method can be used for particles that cannot be removed with a HEPA vacuum. It is common to use a nail gun air compressor with a trigger-operated air gun, sold at home supply stores (such as Home Depot). This should be done outdoors in a location downwind from the structure. The surfaces will still require cleaning by the other methods previously listed. (See S.C. Wilson, "Techniques for Cleaning Mold-Contaminated Home Contents," 2004).

Cleaning Paper Materials. Paper is extremely difficult to decontaminate. Important documents should be electronically scanned and placed into storage. Books should be HEPA-vacuumed while closed. Future use should be done in an area where a portable HEPA filtration unit can capture any escaping particles.

6. HVAC Cleaning

The HVAC (heating, ventilation, and air-conditioning) system should be cleaned according to National Air Duct Cleaners Association (NADCA) standards after all building materials are demolished and all surfaces are cleaned to the point of no visible dust. If the old HVAC units will be re-installed, the coils must be cleaned at the same time. Sheet metal ducting and porous wooden floor joists may need to be removed if they cannot be cleaned. Rusted ducting must be replaced. Openings into wall voids should be inspected to ensure they are not heavily impacted with dust build-up. Humidifiers should not be connected to HVAC fan-coil units.

The cost of dismantling and cleaning the HVAC fan-coil unit can be high, and it may be more cost-effective to replace it. If possible, have a remediation technician work with a licensed HVAC mechanic to mitigate differences in standards. Any retrofits or changes in design should be carefully designed by a mechanical engineer or equivalent as allowed by code officials and must be professionally insured.

A final cleaning is necessary after the HVAC cleaning since this process can disseminate additional dust particles, including microbial flora (mold).

7. Sealing and Painting Surfaces

Seal all porous surfaces with a clear, penetrating encapsulant. Clean all surfaces with terrycloth towels dipped in warm water until residues are removed.

Concrete Surfaces. Concrete should be sealed with a clear penetrating encapsulant using an airless paint sprayer. (Sprayers can be rented from Sunbelt Rentals.) Concrete flooring can be encapsulated with other materials if flooring finishes like tile will be installed in an airtight manner. This exception does not apply for floating floor products.

Wood Surface. Dry wood surfaces should be coated with an antifungal paint containing anionic silver if there is a moisture concern on external walls or crawlspaces. Unless an independent inspection will be performed, do not use paint with color pigmentation: the client must be able to view the substrate to check for acceptable final conditions, including the removal of surface dust checked with a flashlight. Old wood floors must be sealed with a sandable primer or oils specific to wood flooring.

REBUILDING

Prior to final cleaning of the entire structure, the ceiling should be replaced to protect the living space from outdoor air entering through the attic, crawlspace, or other exterior location. The interior gypsum board should be cleaned of dust in the same manner as other surfaces since gypsum board paper contains fragments of microbial flora. None pose a risk to health but may create a false positive in post-remediation tests. These surfaces should be painted with a drywall primer before post-remediation verification.

All other rebuilding should occur after acceptable results are obtained in ERMI post-remediation testing.

FINAL CLEANING

These procedures should followed in each area once demolition is completed, for the whole structure once remediation is complete, and after the HVAC system has been cleaned. Line the floor with 1-millimeter painter's plastic to protect the floor from particles. Once the final cleaning has been completed for each room, the plastic should be disposed in a bag and the floor should be cleaned.

8. Air Cleaning

Fogging. Stop all air scrubbers, negative air pressure machines (NAMs), dehumidifiers, and fans before air cleaning. Fog the air with AeroSolver Pure Air Cleaning Solution[®] using a B&G electric fogger with a flexible hose (<http://www.nikro.com/products/moreinfo.asp?i=162>). Open the venturi knob four full turns to produce droplets of approximately 50 micrometers in diameter. This cleans the air of fine and ultrafine particles by methodically creating turbulent coagulation (a more complex form of gradient or shear coagulation) in the methodical way similar to how rainstorms remove pollution from the outdoor air. A slow, gentle sweeping motion, similar to using an airless paint sprayer, should be used to ensure effective particle removal (see www.aerosolver.com for technique). The product should be applied at a rate of 50 square feet per minute after the mist becomes visible. The fogging plume usually stretches 10–15 feet. When possible, the fogger should be operated at least 7 feet away from a wall to avoid heavy product accumulation on the wall or other surfaces.

The plastic floor liner should be removed gently after fogging to avoid creating airborne dust.

Fogging should be done at the end of the day to allow the particles sufficient time to settle (at least four hours) before final cleaning. If this time must be compressed, the manufacturer can be contacted to obtain an alternative method. The manufacturer may have faster application methods to avoid the 4-hour delay if you contact them.

Wet-Cleaning. After particles have settled, all residue should be removed from surfaces using terrycloth towels soaked in warm water. In cold weather or high relative humidity, use warm water.

Once surfaces are dry, use a dry Swiffer[®] cloths to remove any remaining particles from all surfaces. A clean towel wiped over the surface should reveal no dust. Avoid using HEPA vacuums in final cleaning unless they have been checked according to the methods in Bob and Gail Brandys' *In-Field Test Methods*.

After final cleaning, all floor sealing and wall painting should be done by brush or roller. Airless paint sprayers create aerosol problems that may dislodge particles from surfaces due to the shearing effect as high pressure air currents strike the surfaces.

Alternative Method: HEPA-Filtered Air Scrubbers. This alternative method of air cleaning is less effective than the fogging method. The machines clean only the air that enters them, they create air turbulence that decreases capture efficiency,

and particles in the respirable size ranges are typically not removed. Prior to use, the efficacy of the machine should be checked according to the guidelines in Robert and Gail Brandys' *In-Field Test Methods and Reference Standards for Portable High Efficiency Air Filtration (PHEAF) Equipment* (www.oehcs.com). A laser particle counter will allow the user to assess the level of cleanliness. It may take an indeterminate amount of time to reach the required level of cleanliness. Clean air delivery rate (CADR) research on air-cleaning devices from University of Tulsa indicates a minimum of 300 cubic feet per minute to achieve 80% removal for the average room. The IICRC S520 warns that there are limited capture zones and dead spots for HEPA airscrubbers. A minimum of four fans are required to create a vortex around the HEPA airscrubber vented outside the area. There can be no obstructions to the air flow near architectural details like kitchen islands, stairs, fireplace, etc. More information can be found at the US EPA website for residential air cleaning devices and their limitations (<http://www.epa.gov/iaq/pubs/airclean.html>).

RECONSTRUCTION

9. Waterproofing

Correct outdoor waterproofing below grade to prevent future water intrusion through basement walls. Basement window leakage will affect the ERMI testing. You might temporarily seal them or replace them.

POST-REMEDIATION

10. Quality Analysis Tests

The following testing methods are optional and can be costly. Lab fees are approximately \$50 per dust surface sample and \$300 per ERMI sample. Additional costs include costs for mailing cassettes and consultant's fees. The restoration contractor cannot perform final post-remediation verification testing because of an inherent conflict of interest.

Total Surface Dust. Samples should be taken with pre-weighed, polycarbonate vacuum cassettes with the whole tops removed. The floor should be vacuum-sampled within 24 hours after remediation. The area should be vacuum-sampled for 5 to 10 minutes per square meter on a smooth area. The person testing should take care not to cross-contaminate the sampling area. Cassettes should be marked and sent by chain of custody to an AIHA-accredited laboratory. Total dust results

must be 100 milligrams per square meter or less, as prescribed in the AIHA Green Book. It is not uncommon to get less than 10 milligrams of total dust per square meter using our methods. This test should be done twice—after the initial demolition and cleanup and after reconstruction.

Environmental Relative Moldiness Index (ERMI). Although the ERMI test is valid for pre-testing an environment before remediation to assess long-term conditions, it has limitations because resuspension of particles may be caused by air jets, mechanical forces (even walking), and electrostatic forces. ERMI sample collection equipment should be set out immediately after total surface dust sample collection. However, ERMI *testing* should occur only after satisfactory total dust results have been achieved. If total dust results are unsatisfactory, cleaning must be resumed.

To collect samples, cut open large plastic bags (such as *Hefty*[®]) so the inner portion of the bag is facing upward. The bags should cover an area of at least 20 square meters. After one week, if the total dust test was satisfactory, use the smooth side of *Swiffer*[®] or similar cloths (folded so the inner 1/9 is used) to take dust samples from the plastic bags. One week allows the structure to return to normal levels of dust introduced from the outdoors and dislodged from the structure through shaking.

For comparison, an outdoor ERMI sample can be taken from a location upwind from the structure and a minimum of 20 feet away to avoid contamination from the structure. A *Swiffer*[®] cloth can be used to collect dust from a smooth surface, at least 3 feet above the ground, that is continually washed or re-exposed to airborne mold through rain and wind. The smooth surface of a mailbox or street sign is good places for sample collection.

The ERMI samples should be bagged separately, marked, and sent according to the appropriate chain of custody to Mycometrics, LLC. The lab will record the total weight of dust collected if requested ahead of time. The target ERMI score is 2 or less unless otherwise indicated by a treating physician because of the client's high sensitivity. The post-test is satisfactory even if the results are higher than the pre-test if the outdoor levels are statistically similar.

ADDITIONAL RESOURCES

Gorny, Rafael. "Fungal Fragments as Indoor Air Biocontaminants." *Applied Environmental Microbiology* 68, no. 7 (July 2002): 3522-3531.

Brandys, Robert and Gail Brandys. *In-Field Test Methods and Reference Standards for Portable High Efficiency Air Filtration (PHEAF) Equipment*. www.oehcs.com

Brasel, Trevor L. "Detection of Airborne *Stachybotrys chartarum* Macrocylic Trichothecene Mycotoxins on Particulates Smaller than Conidia." *Applied Environmental Microbiology* (January 2005)

Wilson, S.C. "An Investigation in the Techniques for Cleaning Mold-Contaminated Home Contents." *Journal of Occupational and Environmental Hygiene* (July 2004).

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