IICRC
Standard and Reference Guide for Professional Mold Remediation
S520

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Chapter 3

Principles of Mold Remediation

INTRODUCTION

There are five general principles used in the remediation of mold-contaminated structures and materials. Application of these principles may require a multi-disciplinary approach involving professionals from a wide range of restoration and indoor environmental fields. The five principles of mold remediation are explained below.

1. Provide for the health and safety of workers and occupants

Mold-contaminated buildings, systems and contents are associated with a range of health problems. Performing mold remediation can expose workers to health and safety hazards. Therefore, remediation workers must be protected from exposure through a combination of engineering controls and specialized work practices, such as controlled demolition, containment and air pressure control, and use of appropriate respiratory protection and other personal protective equipment (PPE). It is highly recommended that a reasonable effort be made to inform occupants of and protect them from similar exposure as a result of investigation and remediation activities.

Prior to and during activities that disturb mold, engineering controls and work practices must be implemented to prevent mold contamination from spreading into Condition 1 areas. The spread of contamination has the potential to expose remediation workers or occupants to contaminants and create the need for additional remediation work. Use of appropriate containment and air pressure controls is usually the most effective way to prevent spreading microbial contaminants. Proper containment is also effective in preventing occupants from entering contaminated areas and being exposed.

If performed in an uncontrolled manner, the remediation process may result in a significant increase in the level of airborne mold contaminants within the contained work area. Exposing workers to such extreme levels of mold contamination is unacceptable and must be prevented. When used together, the following two measures can reduce remediation worker exposure:

- Appropriate engineering controls, such as controlled demolition, source containment and control of air movement direction must be implemented to reduce the quantity of spores and fragments that become airborne, or to reduce the time they remain in the air.

- Appropriate respiratory protection, as well as other appropriate PPE, must be used by remediation workers to prevent exposure to the contaminants that cannot be reduced through proper engineering controls.

2. Document the conditions and work processes

An effective mold remediation plan cannot be developed without first determining the extent of contamination to be removed. Condition 3 areas can be located using sensory (e.g., visual or olfactory)
investigative techniques, although it may be difficult or impossible to locate all pockets of hidden growth without use of intrusive or destructive techniques. If used without adequate containment, intrusive and destructive techniques can result in the release or spread of contaminants.

Spores that disperse from Condition 3 areas and settle on surfaces in other areas may create contaminated conditions in those areas where they accumulate. These areas are referred to as Condition 2. It is not possible to differentiate between Condition 2 and Condition 1 areas without appropriate sampling or testing methods. To avoid conflicts of interest, it is highly recommended that any sampling, testing and subsequent assessment be performed by an independent Indoor Environmental Professional (IEP).

While this contamination assessment is underway, mold growth and amplification may continue if conditions are suitable. To prevent further deterioration in building systems, materials and contents, appropriate steps must be taken to control moisture. It is highly recommended that psychrometric conditions and moisture levels of materials be determined and documented.

To ensure that remediation work is being properly performed, it is highly recommended that appropriate documentation of the remediation process be kept by project management.

When an IEP is used it is highly recommended that before the structure is rebuilt, the system be reactivated or the contents returned, that a return to Condition 1 status be verified and documented. It is highly recommended that this post-remediation verification be performed by an independent IEP.

3. Control the contaminant at its source

It is highly recommended that mold contamination be controlled as close to its source as possible. When mold spores are aerosolized, they become much more difficult to capture. Therefore, it is important to prevent aerosolization. This can be accomplished in a number of ways and at various stages of the remediation process by using appropriate work practices.

Control of the contaminant can be accomplished through the use of source containment. An example of source containment is the use of self-adhering plastic over mold growth on gypsum board to prevent dispersal. During remediation, control of the contaminant may be accomplished through proper engineering controls and work practices. Examples of work practices that control contamination at its source include minimizing dust generation during demolition, using vacuum-assisted power tools and locating an air filtration device close to the work area.

Initial moisture mitigation services may be performed to control mold amplification, while ensuring that mold contamination does not spread from more-contaminated to less- or non-contaminated areas.

4. Physically remove the contamination (source removal)

It is highly recommended that mold contamination be physically removed from the structure and contents to return them to Condition 1 status. Attempts to kill or encapsulate mold are not adequate to solve the problem. ACGIH Bioaerosols: Assessment and Control 16.2.3.
5. Correct the moisture problem to prevent recontamination

Since mold spores are present at background levels in a normal fungal ecology, mold growth is virtually inevitable if moisture is not controlled. To prevent this, moisture problems must be identified, located and corrected or controlled as soon as possible. Successful mold remediation results in the return of the remediated structure and contents to Condition 1. Reconstruction normally does not begin until moisture is controlled, mold remediation is complete and materials are dry.

REFERENCES

Protecting the Built Environment: Cleaning for Health, (1993), Berry, A., Michael, Ph.D., Chapel Hill, NC
Chapter 7

Structural Remediation

INTRODUCTION

Before beginning a mold remediation project, it is highly recommended that a clear objective and goal be established, outlined and understood by all involved parties. The mold remediation procedures outlined in this document are based on general indoor environmental hygiene practices, and safety and health principles. These procedures describe safeguards and controls that assist in achieving the goals of a remediation project.

ENGINEERING CONTROLS

One objective of structural mold remediation is to prevent releasing mold spores, fragments and dust from surfaces into the indoor air, both to reduce remediation worker exposure and to make the remediation process more efficient. Demolishing mold-contaminated building materials can create extremely high airborne spore concentrations as well as dust in the work area. Air movement from a contaminated work area to an unaffected area in a building can transport airborne mold contaminants and dust, a process referred to as “cross-contamination.”

To prevent cross-contamination and assure worker safety and health, engineering controls must be used in structural mold remediation projects. According to OSHA, engineering controls, not personal protective equipment, are the first line of defense for ensuring worker health and safety. Engineering controls may include, but are not limited to: source containment, isolation barriers, pressure differentials, dust suppression, HEPA vacuuming, and filtration.

Isolation

Isolation can be achieved by covering a moldy surface with self-adhering plastic or by erecting physical barriers (critical barriers) with polyethylene sheeting material (poly) to separate affected areas from unaffected areas. Isolating contaminated materials or areas also is referred to as “containment.” Containment barriers usually are constructed of polyethylene sheeting material. HVAC registers, building openings and fixtures in the remediation area also must be sealed off to prevent cross-contamination.

Pressure Differentials

Pressure differentials are used to manage airflow. The use of pressure differentials is a matter of professional judgment. If pressure differentials are used, contaminated areas must be negatively pressurized relative to unaffected or clean areas of the building to prevent cross contamination. If pressure differentials are used, it is highly recommended that they be created using HEPA AFDs. An AFD can be set up as a negative or positive air system, or as an air scrubber. Pressure differentials can be monitored by digital manometers, analog Magnahelic gauges, smoke tube or pencils and/or visual inspection. It is recommended that containment plastic be installed in a tight manner. The
billowing of the containment barrier can indicate the airflow direction. In specialized environments, such as health care facilities, using alarmed or alert systems with data logging capability is highly recommended.

"A pressure differential ≥5 Pascals (Pa) or 0.02 inches water gauge (w.g.), which is recommended for asbestos abatement work, may be adequate to contain dust and spores. However, an even higher pressure differential, e.g., -7 Pa (-0.028 inches w.g.) may be necessary in some cases. Two-hundred-fifty (250) Pa equals one (1) inch of water gauge pressure. These pressure differential guidelines are consistent with prudent industrial hygiene principles and have been adopted in the mold remediation industry.

**Polyethylene Sheeting Material ("Poly")**

Isolation barriers usually are constructed of 4-mil or 6-mil poly for walls and ceilings, and 10-mil poly for floors. Thinner polyethylene may be used for temporary tear-away protection of surfaces. Using fire-retardant poly is recommended and is required in some municipalities to minimize fire hazards. A flame-spread rating of 25 or less for containment plastic may be required.

It is highly recommended that medium-slip poly (no oil or talc coating) be used for erecting containments when available. This allows better tape adhesion to the poly. Different types of tape, adhesives and fastening methods are available to attach poly to surfaces.

Isolation barriers frequently are referred to as "critical barriers." Critical barriers also may be used to isolate portions of the building, the mechanical system, or other openings in the building envelope.

**Air Moving Devices**

Air moving devices with filters are referred to as "air filtration devices," or AFDs. These machines consist of a fan, an electric motor, a set of filter banks, and a housing. The air stream is filtered to remove dust, mold spores and other microbial particles. Air movers are rated by the cubic feet of air per minute (CFM) they can move.

AFDs can be installed to create negative or positive pressure differentials. When used to create negative pressure differentials, they are referred to as "negative air machines," or NAMs. They also may be used as air scrubbers to recirculate and filter air within a space. Usually, a series of filters are installed on the air intake side, starting with a preliminary filter, followed by a secondary (usually pleated) filter and finally, a HEPA filter. The preliminary and secondary filters are present to prevent premature loading of the HEPA filter by trapping larger particles. It is highly recommended that filters be selected and installed according to manufacturer specifications.

Flex duct and lay-flat ductwork are used to direct the flow of filtered exhaust air from AFDs. Flex ductwork, similar to uninsulated flex duct used in residential construction, can be used at the air intake side of the AFD because the spiral wire inside the duct prevents it from collapsing. Lay-flat ductwork has no spiral wire reinforcement and can be used only on the exhaust side. The length of the duct, its turns, angles and other restrictions, strangulations and constrictions can decrease airflow, thereby increasing static pressure.
It is highly recommended that AFDs be cleaned and inspected for proper performance before being placed at the job site. The performance of a unit can be evaluated with a sub-micron laser particle counter or other appropriate method. If unexpected pressure drops occur, it is highly recommended that all units and containment barriers be inspected and re-secured as necessary. If pressure has been lost, it is highly recommended that the area be contained and all work cease until the appropriate pressure differential is reestablished. It is highly recommended that AFD operation be inspected before starting work, before breaks and before leaving work each day. It is recommended that local and full containment systems in critical areas be monitored at all times, including days when work is not being performed.

Non-ducted AFDs can be placed inside a containment area to act as air scrubbers. In this application, they work as large portable air filters to reduce airborne dust and spore loads during cleaning processes. It is highly recommended that care be taken to ensure that using an AFD as a scrubber does not cause loss of control of the containment, thereby releasing contaminants into unaffected parts of the building. Air scrubber performance limitations may increase airborne particulate levels, due to the equipment’s limited capture zone, stratification of air, dead air spaces, and stirring up particles from reservoirs or during demolition. It is recommended that particle counters be used to monitor the environment when AFDs are used as air scrubbers.

When the AFD is inside the containment work area, it is highly recommended that the pre- and secondary filter changes be performed with the unit operating. This prevents releasing contaminants from filters into the workspace. It is highly recommended that HEPA filters be changed, while taking precautionary measures, with the unit turned off and removed from the job site to an area that would not be adversely impacted by a release of contaminants.

Equipment manufacturers use a variety of methods to determine when to change filters. These may include indicator lights, pressure gauges or other devices. The frequency for changing filters is determined by the work activity, the amount of dust created and captured, and filter element capacity.

It is highly recommended that the air intake side of an AFD be sealed before turning it off to avoid releasing contaminants. It is highly recommended that the intake side of an AFD that may contain accumulated mold spores and fragments remain sealed when not in operation and while being transported or stored. After use, it is highly recommended that the AFD be cleaned, dried and stored in a dry environment. Under humid work and storage conditions, trapped mold spores may colonize on moist HEPA paper filter elements, thereby necessitating earlier filter replacement.

It is highly recommended that exhaust air from HEPA AFDs be vented outdoors. If circumstances prevent exhausting the AFD outside, then, using redundant HEPA AFDs in series and/or particle monitoring when discharging into occupied portions of a building is recommended.

Containments

On mold remediation projects, containments generally are separated into three basic types:

1. source containment;
2. local ("mini") containment; and
3. full-scale containment.

Expanding containments may be necessary when fungal conditions become worse than expected.
Source Containment

Source containment may be used to address relatively small areas of mold growth, or in combination with other engineering controls to reduce the amount of spore release and dust generation. Source containment may be used alone when fungal growth is limited to small visible controllable areas where no hidden mold growth is anticipated. In areas where there is limited visible mold, and hidden mold growth is anticipated, a more extensive containment is highly recommended. Source containment methods may also be used within areas of more extensive mold growth in conjunction with other forms of containment. Examples of source containment methods include:

- Taping polyethylene sheeting or using self-adhering plastic short-term on a moldy surface or material before removing; and
- Wrapping, bagging, and securely enclosing moldy contents or materials in 6-mil poly or comparable packaging.

It is highly recommended that workers avoid crushing materials and other actions that would cause dust generation and dispersal of fungal spores and fragments. It is highly recommended that techniques that limit dust aerosolization be used in conjunction with HEPA vacuuming to control and remove dust immediately. Remediators must wear appropriate PPE.

Local Containment

Local or “mini” containments may be used when “moderate levels” of fungal growth are visible or suspected. A structural enclosure can be built to contain a work area and separate it from the unaffected section of the room or structure. PVC pipe, wood framing, or spring-loaded expansion poles can be used to build an enclosure, which then is covered with appropriate poly material. However, constructing structural support is not always necessary if the isolation barrier can be securely attached to wall and ceiling surfaces. Staples, cardboard reinforcements and duct tape can be used to secure these barriers. One or two layers of poly may be used to cover the enclosure or to erect isolation barriers.

HEPA-filtered AFDs/NAMs are installed to create negative pressure differentials in relation to surrounding areas. In very small local containments, a HEPA vacuum cleaner can be substituted, if it is able to create the necessary pressure differential. However, this works only if the vacuum canister is adequately sized and located outside the containment area.

Full-Scale Containment

Full-scale containments normally are used when significant and/or extensive mold growth is present or suspected, and cannot be effectively controlled and remediated with source or local containment methods.

In a full-scale containment, the entire room or building section is designated as the work/containment area. Critical barriers are established to separate unaffected areas from affected areas. Walls, ceilings, floors, cabinets, fixtures or other surfaces that cannot be cleaned effectively must be sealed off with poly barriers.
Decontamination Chamber

A decontamination chamber, sometimes referred to as a “decon unit” or “decon,” is used to provide a transition space between the containment (“dirty” area) and surrounding clean areas. Decontamination chambers are used for entry to and exit from the work area. These chambers also are used for decontaminating exterior plastic surfaces of bagged or wrapped contaminated materials; remediation tools, and the exterior clothing of personnel when exiting the work area. They are intended to prevent cross-contamination to unaffected areas and to provide controls to maintain pressure differentials.

Decontamination chambers usually are constructed with PVC piping or wood studs, and are covered with one or two layers of poly. Plastic flaps are installed on the entry and exit side. “Z” or “T” flaps are used in single or double layers. Prefabricated decontamination chambers also are available.

Three-stage decontamination chambers are used in asbestos abatement projects. They include a dirty room, shower and clean room. At present, there is no scientific evidence to justify the use of showers in mold decontamination systems. (ref. ACGIH Bioaerosols: Assessment and Control Ch. 15.2.3.3)

On mold remediation projects, single, double and triple-decontamination chambers have been used. Determining the number of chambers required is based on the extent, degree and type of mold contamination, the available space, the type of building environment and its occupants (e.g., moderate mold growth in a warehouse versus significant mold growth in a hospital).

In situations where an entire building has been involved with Condition 2 or 3, containment may not be necessary. Decontamination chambers, air pressure differentials, make-up air and other engineering controls may be required to address worker protection issues.

Air Flow and Exchange Rates

Air exchanges are used to dilute airborne fungal concentrations in work/containment areas. This helps reduce worker exposure and facilitates the clean-up effort. Airflow direction must be from clean to contaminated areas.

When air is exhausted from the containment area, replacement air will enter. This is referred to as “make-up air.” It means that one cubic foot exhausted requires one cubic foot of replacement or make-up air. It is important to note that negative pressure differentials may create a risk of carbon monoxide exposure from back drafting, or fire hazards due to flame rollout from gas appliances; e.g., furnaces, ovens and water heaters. Pressure differentials in buildings also can create hazards associated with fireplaces, laboratory hoods, and sewer lines, and they may cause unintended airflow, such as drawing air from wall and ceiling voids or chases. Negative pressure differentials in warm, humid climates or seasons also can cause moisture and consequent dampness to enter indoor spaces.

Indoor environmental hygiene practices highly recommend a minimum of four air changes per hour (four to 12 ACH is ideal) for contaminant ventilation and dilution. This recommendation also is used in mold remediation.
The minimum number of NAMs required is determined by calculating the CFM needed to achieve the desired air changes per hour (ACH) by using the following formula:

\[
\text{CFM required} = \frac{\text{Room volume} (\text{ft}^3) \times \text{Number of ACH}}{60 \text{ minutes}}
\]

Note: Room volume (cubic feet) = length x width x height.

The AFD's CFM performance rating is not the actual CFM a unit delivers in a project set-up. Actual CFM is lower than the factory rating, due to resistance in the filter elements, dirty filter elements (back pressure) and the attached ductwork (static pressure).

HEPA Vacuums

HEPA vacuum units are defined, for the purposes of this document, as those designed to effectively filter particles to HEPA levels (99.97% of particles at 0.3 microns). It is important to use only well-constructed professional HEPA vacuums in mold remediation projects so that fungal spores and fragments are retained. Most units that filter to this level are designed and marketed by the manufacturer for use in cleaning up hazardous materials, such as lead and asbestos. Other units may be marketed, especially to the general commercial or residential markets, as containing HEPA filters. However, many of these machines do not routinely achieve HEPA levels of filtration, due to leakage around filters or seals.

It is highly recommended that remediation workers not use regular shop-type or other vacuums, because they are not designed to prevent mold spores and fragments from passing through the equipment and re-entering the air. Remediation workers must use HEPA vacuums when they are specified.

It is highly recommended that HEPA units be cleaned and checked for proper performance before being placed at the job site. It is recommended that a sub-micron laser particle counter be used to field check the performance of HEPA vacuums. Damaged HEPA filters or improperly assembled canisters potentially can result in harmful particles escaping. HEPA vacuum cleaners function best if bags are not full. Hoses, filter bags and assemblies must be checked any time a drop in suction occurs or when the bag is changed. It is highly recommended that HEPA vacuum cleaners be serviced within the capture zone of an AFD; or outdoors using appropriate precautionary measures.

Before HEPA vacuums are removed from containment areas, it is highly recommended that the unit’s exterior be thoroughly cleaned to remove dust/spores. This cleaning includes the exterior of the hose. It is highly recommended that openings, such as filter and vacuum hose inlets, be sealed with tape, or plastic and tape to prevent particles from escaping.

Other vacuum systems

There are a variety of other vacuum cleaners and systems that do not fully meet the definition of HEPA filtration. Some of these may have valid uses in the remediation process, but they must not be substituted for a HEPA vacuum when it is specified, without approval by an IEP or other qualified person. Other vacuum units may include:
- High-filtration vacuums. For purposes of this document, these units are defined as those designed to be significantly more effective at trapping particles than “standard” vacuum systems. They may closely approximate the filtration performance of true HEPA vacuums. Such machines may contain a filter marketed as “HEPA,” which may be built-in or sold with the machine as an aftermarket attachment. These machines are not normally marketed for capturing hazardous materials, such as lead or asbestos. They frequently are less expensive than HEPA-rated vacuums.

- Standard wet-dry or canister vacuums. It is highly recommended that these machines not be used for most mold remediation work. Their inefficient filters allow mold spores and fragments to be aerosolized. However, they may be acceptable when used outdoors with appropriate precautions for preventing worker, occupant or public exposure; used inside high-volume laminar-airflow cleaning chambers; vented to the building exterior; in other situations where the aerosolized particles they exhaust do not create exposure issues or the particles can be adequately contained with engineering controls.

- Exterior-venting vacuum systems. This category includes equipment, such as truck-mounted carpet cleaning systems, or other high-volume vacuum systems that vent outside the building. Their use may be acceptable, if HEPA vacuums are not specified and the exhaust will not vent in a location where exposure issues result. These units will require decontamination after use.

**Containment Guidelines**

It is highly recommended that contaminated materials not be disturbed until the containment setup is erected, the negative air system installed, and the containment performance is checked. Also, it is highly recommended that containment not be removed until demolition, clean up, and final inspection has been completed. Post-remediation verification by an IEP may be required.

It is highly recommended that the integrity of the containment be maintained, along with negative air pressure differentials, throughout the remediation project. Tape can fail to hold up the plastic containment in hot and humid environments. Too much negative pressure can easily collapse containments, especially during unsupervised periods (nighttime). It is recommended that containment performance be visually checked and documented at appropriate intervals.

It is highly recommended that containment barriers be constructed so that, if pressure differentials are lost, containment flaps will close to prevent losing control. It is highly recommended that work be stopped any time there is a breach in containment or loss of pressurization, and not resumed until the containment has been repaired and the pressure differential re-established. It is recommended that any breach in the containment’s integrity be reported to a supervisor.

Spray adhesives can create a safety risk within containment. The propellant and adhesives may release chemicals that are toxic and flammable. Label instructions and precautions must be followed when using these products. Outdoor air ventilation and respirators with appropriate cartridges may be required.
Signage

It is highly recommended that remediators post warning signs that inform persons that mold remediation is ongoing. It is highly recommended that remediators restrict access to the work/containment area, and that signs be conspicuously placed at entrances to work areas and in areas of potential entry.

Dehumidification

Dehumidification may be needed during the remediation process to dry the structure or maintain conditions that will not support additional mold growth. Equipment operated in a Condition 2 or 3 portion of the building will require cleaning after use. It may be possible to precondition make-up air in a Condition 1 area of the building to provide dehumidification of the make-up air for the work zone.

REMEDIATION WORK PROCEDURES

Technical Specifications and Report Review

When available, it is highly recommended that remediators obtain environmental reports describing the nature and extent of existing mold contamination. It is highly recommended that remediators review documents and understand the objective, goals, methods, timeline, material requirements and other circumstances before work is performed. IEPs may or may not have conducted site visits, collected samples, provided interpretations, outlined necessary remedial actions, and/or written technical specifications.

In some cases remediators may not have the background data or inspection and testing reports needed to make technical or professional decisions involving remediation protocols (see Chapter 5). The extent and details of the remediation protocol may vary greatly. Some specifications may be very detailed and contain technical specifications, site monitoring or independent project oversight. If very few technical specifications for mold remediation are provided, it is highly recommended that remediators design their own protocols and provide them to appropriate parties for review and approval when necessary.

When post-remediation verification is conducted, it is highly recommended that it be done by an independent third party. This in no way is intended to prevent remediators from performing their own quality assurance testing.

Preliminary Steps

In order to implement or verify the remediation protocol, it is highly recommended that the remediator conduct a pre-remediation inspection to ascertain work site conditions and establish project scheduling. Considerations include, but are not limited to: accessibility, staging areas, logistics, work traffic flow patterns, occupancy, HVAC layout, safety issues, security, lighting conditions and issues with thermal comfort (e.g., heat stress, freezing temperatures, humidity). It is recommended that the building manager or a knowledgeable building representative be present during the pre-remediation inspection.

It is not necessarily the responsibility of remediators to identify and verify that water/moisture
sources have been determined or eliminated. However, it is highly recommended that all water intrusion sources be identified and eliminated by the appropriate moisture expert, drying contractor, building envelope expert, plumbing contractor, or other qualified tradesperson. Also, it is highly recommended that, on each job, there be a clear determination of whose responsibility it is to identify and eliminate water/moisture sources.

In some instances it may be necessary to set up temporary walls or barriers to facilitate privacy in occupied environments. These barriers also may be necessary to facilitate removing unaffected items before remediation begins.

An evaluation of contents is recommended to determine salvability, and how they should be handled. It is highly recommended that remediation workers be aware of other potential sources of mold growth or amplification, such as over-watered plants and un-emptied trashcans. If it is not possible to remove unaffected contents from the remediation zone, it is highly recommended that they be protected. Exercise caution when wrapping salvageable items in poly to prevent trapping residual moisture.

It is highly recommended that the HVAC and air distribution system be evaluated to determine if they have been impacted by the loss or by pre-existing conditions.

**Containment Set-up**

It is highly recommended that remediation workers verify that the ventilation system is sealed off or isolated from mold-contaminated work areas to minimize the risk of cross contamination. HVAC multi-zone systems and HVAC systems with energy management controls may require specialized training before sealing or isolating the system.

Determine where isolation barriers or contained work areas are to be established. Regulated materials, such as lead or asbestos, require specific mitigation and/or remediation protocols. The presence of these and other regulated materials take precedence over mold remediation, and they must be addressed according to federal, state, provincial and local laws and regulations.

It is highly recommended that remediation workers consider whether floors, walls and/or ceilings require a poly barrier erected over them; or if they can be left uncovered for later cleaning. Containment barriers on surfaces may cause condensation, change pressure differentials, or trap moisture or Condition 2 contamination on surfaces.

It is highly recommended that containment barriers be used to separate areas with different mold conditions (Condition 1, 2, 3) from each other. This can be achieved by using source, local or full-scale containment methods. More than one type of containment method may be used simultaneously for control in the same area. It is highly recommended that containment areas be large enough to allow sufficient room for workers to remove affected building materials. However, excessively large containments unnecessarily increase equipment requirements and final cleaning efforts. Consider collateral damage to surfaces when constructing containment barriers and using other engineering controls.

It is highly recommended that an appropriate entry and exit to the decontamination area be established, which is attached to the containment as a transitional space between work areas and unaffected areas of the building. It is highly recommended that remediation workers install containment
flaps to provide a neutral pressure zone, or to control make up air passing through the chamber. Small containments for smaller contaminated areas may not require a decontamination area.

It is highly recommended that negative pressure differentials be established and maintained with one or more APDs set up in a negative-air mode. Depending on the circumstances, the airflow controls may be established before or after containment is installed. HEPA vacuum cleaners can be used in small local containments to create the pressure differential.

Tack mats may be placed immediately outside the entrance of the decontamination chamber to limit contaminants from being tracked into unaffected areas after removing disposable protective clothing (booties).

**Suit Up and Entry**

Remediators must be aware that entry into confined spaces may require additional measures to meet regulations and safety requirements. Depending on the extent of mold contamination and associated hazards, appropriate PPE must be worn for worker safety. Suit up with one or two layers of disposable protective clothing with attached hood and booties, gloves, respirator, and eye protection. “User-seal-check” the respirator (both positive and negative) each time before entering the containment area.

**Demolition and Surface Cleaning**

It is highly recommended that porous building materials (e.g., drywall, insulation, ceiling tiles) that are Condition 3-contaminated be removed and discarded. It is highly recommended that new construction materials not be re-installed until post-remediation evaluation, or post-remediation verification if necessary, indicates that installation is appropriate. It is recommended that, if structural components must be reinstalled for structural integrity, new materials be cleaned along with the rest of the remediation area. Mold growth created by condensation on a non-porous surface layer usually can be cleaned by HEPA vacuuming or damp wiping. It is recommended that the appropriate cleaning procedures for different surface materials be used.

During demolition, mold spores can be dislodged easily, especially from dry materials, and become aerosolized. Care must be taken to limit the release of airborne spores, thereby reducing worker exposure and clean-up efforts. Dust suppression methods are required. For example, mold contaminated carpet can be covered with poly sheeting before it is cut and rolled up for removal.

It is highly recommended that contaminated building materials be removed carefully in as large a section as possible for bagging or wrapping, preferably in heavy-gauge poly, such as 6-mil disposal bags, or they may be securely wrapped in 6-mil poly sheeting. Generally, spraying, wetting or misting moldy building materials is not recommended because spores may be released or disbursed by the spray, and additional growth may be promoted by the moisture introduced. When mold remediation occurs concurrently with asbestos abatement or other types of demolition where misting water is required, the mold remediation work must be performed with adequate engineering controls in place to limit the release or spread of mold or spores within the work environment, or in other parts of the building, to prevent the development of new mold. Engineering controls may include:

* using source-control systems, such as vacuuming visible mold from surfaces or
covering it with poly to isolate the mold before misting materials that will be removed;
  • using pump sprayers or controlled sources of water, rather than hoses;
  • using only the amount of water necessary for satisfying regulatory issues while fulfilling their intent. It is highly recommended that remediation workers avoid wetting or misting construction and finish materials that are to be retained;
  • immediately cleaning up or extracting any spilled or run-off water;
  • monitoring specific humidity throughout the process and using dehumidification to quickly dry the environment to humidity levels that will not support or lead to mold amplification; and
  • bagging or wrapping wet materials immediately in heavy-gauge poly and removing them from the building for proper disposal.

Contaminated materials can be removed carefully with razors or knives, cutting rather than tearing them into pieces to avoid generating dust or bioaerosols. Unscrewing or carefully prying gypsum board away from studs is recommended. Demolishing these materials with a hammer or crow bar, or using electric saws without dust collecting devices is not recommended. It is highly recommended that saw blades be set so that they do not penetrate all the way through gypsum board backing paper or other wall materials. This helps minimize dust inside wall cavities and it promotes safety by preventing possible cutting of plumbing, electrical or other components that may be hidden within the cavity. Removal is completed by scoring the backing paper with a razor knife. It is highly recommended that insulation be removed carefully and bagged immediately, preferably in 6-mil disposable plastic bags. A razor knife is recommended for cutting paper or foil backings, rather than tearing it into pieces.

It is highly recommended that the work area be maintained as free from dust as possible by using a HEPA vacuum cleaner and by bagging debris immediately. This significantly reduces the amount of time and effort necessary for the final clean up of the containment, and it helps prevent failing post remediation verification. It is highly recommended that remaining drywall screws, nails and small debris be bagged and removed.

Mold growth on framing members usually can be removed with wire brushing or sanding, or with media blasting. This is accomplished best with wire brushing and HEPA vacuuming simultaneously, or with a HEPA vacuum attachment on sanders. HEPA vacuum-assisted power tools have been developed for the asbestos and lead abatement industry. These tools may also be used in mold remediation.

It is highly recommended that bagged materials be sealed inside a second bag before moving them outside the containment area (double bagging), if they are going to pass through Condition 1 areas of the building. It is highly recommended that sharp items capable of puncturing poly material be packaged in such a way as to prevent them from penetrating the material before being bagged or wrapped. Vacuuming and damp wiping tools, HEPA vacuum cleaners, and AFDs before they are removed from the containment area is highly recommended. Sealing the intake (contaminated) side of AFDs before turning the equipment off is highly recommended to prevent back flushing of filtered contaminants. Wrapping an entire unit with stretch wrap or other non-porous materials before removing it from the contained area also is recommended.

It is highly recommended that demolition debris be double bagged, moved from the containment
to a reasonably secure location and not be left unsecured outside. It is highly recommended that remaining interior surfaces and containment materials be cleaned using HEPA vacuuming and damp wiping. During damp wiping it is highly recommended that the amount of water be minimized to avoid wetting building materials, which may result in water damage or new mold growth.

Deviation from Removal Processes

The Principles of Mold Remediation (Sections 4.3 and 4.4 of this Standard) state that mold must be controlled at its source. Further, it is highly recommended that mold be physically removed during remediation, and that attempts to kill or encapsulate it are inadequate remediation measures. At the same time, these principles recognize that unique circumstances may arise and that biocides and encapsulants may be considered in specific situations.

Remediation principles highly recommend that unique situations be identified on a case-by-case basis before deciding to deviate from portions of this Standard. When Condition 3 situations exist that cannot be physically removed using reasonable measures, or when ongoing moisture intrusion cannot be resolved, it may be necessary to manage the Condition 3 area for extended periods by using long-term engineering controls, encapsulants, sealants or other methods. Allowing the mold or moisture condition to remain is strongly discouraged, since it may compromise the health of occupants, further damage building materials, and expose the remediator to liability and other consequences. However, when deviations from this Standard are considered, it is highly recommended that remediators advise customers in writing that allowing the mold or moisture condition to be controlled in place may:

- have limited effectiveness;
- result in a release of contaminants;
- result in additional structural deterioration;
- require long-term management; or
- result in additional remediation work being necessary.

Also, it is highly recommended that the written communication advise the customer that follow-up assessment of the affected area(s) by an IEP, may be appropriate when:

- the affected area(s) becomes visibly damaged;
- a change in the condition of the material or its surroundings occurs;
- there are health complaints, or
- the engineering solution(s) fails.

In addition, periodic assessments may be advisable.

It is recommended that the remediator consult with an appropriate technical professional and/or attorney for specific language to use in the written communication with the customer.

Removal and Disposal of Contaminated Materials

It is highly recommended that bags be handled carefully and not be dropped, thrown or handled roughly while moving them to the disposal container or site. It is highly recommended that bagged materials be placed in a reasonably secure location or transport vehicle after removing them from the building. Respirators are not required outside while transporting double-bagged materials.
If wrapped disposal materials rupture outside the containment, remediation workers must do appropriate PPE. It is highly recommended that workers secure the area from public access, initiate clean up (HEPA vacuuming), and contain the debris. It is recommended that dumpsters with debris be protected from scavengers and kept reasonably secure.

Non-regulated mold-contaminated gypsum board and other structural materials (i.e., those that do not contain asbestos, lead or other restricted waste) usually can be disposed in normal landfills as compost or construction waste. Generally, no special disposal provisions are recommended for mold-contaminated materials; however, federal, state, provincial and local disposal laws and regulations apply. Placing “mold” labels on bags and wrapped materials is recommended to discourage individuals from opening or removing them from the disposal site. It is recommended that label language be factual, not reactionary.

**Clean Up**

To achieve a Condition 1 status in the work area after demolition has been completed, it is important to clean it adequately by thoroughly removing dust and debris. Post remediation verification requires a purged containment with dust-free surfaces. Purging is the process of deliberately diluting containment air using conditioned makeup air.

It is highly recommended that cleaning procedures inside a containment area start from clean areas and work towards dirty areas in the following manner:

- clean from top to bottom; and
- clean from the source of make-up air towards the AFD.

Thorough cleaning consists of combining HEPA vacuuming with damp wiping so that minimum moisture remains on surfaces. Provide the necessary time for dust and spore settling between cleaning rounds. As a quality control measure, using a laser particle counter to monitor airborne particles during purging may be helpful to determine when to repeat the HEPA vacuuming/damp wiping process. It is highly recommended that HEPA vacuuming and damp wiping include the entry, exit chamber (walls, floor, ceiling and flaps) of the remediation area. To ensure that visible dust and all debris have been removed, it is highly recommended that a final inspection of the containment area be conducted by a knowledgeable project manager/supervisor as part of the post-remediation evaluation, prior to post-remediation verification by an IEP. It is highly recommended that dust, which may have settled outside the containment area, be removed by HEPA vacuuming and damp wiping.

Physically removing mold growth and spores is the guiding principle for mold remediation. Biocide application is discouraged and is not considered effective for mold remediation. However, there may be specific instances where professional judgment dictates that biocides be applied. Misapplication of biocides is a federal violation under the US Federal Insecticide, Fungicide, Rodenticide Act (FIFRA). Killing microorganisms usually does not destroy their antigenic or toxigenic properties. Biocide use may be appropriate when there is concurrent bacterial contamination, or when a specific pathogenic fungus is present. In these cases, the remediator must follow all federal, state, provincial, and local laws and regulations, as well as product label directions. Consultant specifications that are not consistent with biocide regulations and labeling instructions may be in violation of the law, and they may create
liability for the remediator.

Using antimicrobials during mold remediation is discouraged. Antimicrobials are products applied into or onto a material to “suppress or retard” future mold growth. Treatments may interfere with post-remediation verification and are generally ineffective on porous and semi-porous materials. Dirt, bio-films or organic matter usually render antimicrobials less effective. If an antimicrobial treatment is used, it is highly recommended the application be performed after the remediation and post-remediation verification is completed. The treatment must be applied according to antimicrobial regulations and label directions. It is highly recommended that remediators consider that applying certain antimicrobial products may change the permeability of materials and may trap moisture, thereby resulting in future deterioration, along with associated potential liability.

Using encapsulants and sealants is discouraged. Remediators need to consider that the application of certain encapsulant or sealant products may change the permeability of materials, cause condensation problems in the building assembly (trap moisture) and result in future deterioration and potential liability issues. Use of encapsulants may impede, mask or invalidate an inspection for dust and debris. Encapsulants and sealants that have been applied without a complete clean up of mold growth may result in the necessity of sanding off or removing the encapsulant or sealant in order to properly remediate the mold growth. These compounds may contain nitrogen that helps support future mold growth. Encapsulants may also alter the surface flammability characteristics of certain materials.

**Containment Exit Protocol**

After bagging demolition debris, move it to the exit chamber. It is highly recommended that the outside of bags be HEPA-vacuumed or damp-wiped and that bags be placed into a second bag and sealed before they are moved from the exit chamber. Tools and equipment being removed from the containment area must be wiped off and placed in clean sealed bags for detailed off-site cleaning using appropriate precautions.

If a two-entry/exit chamber is used, the first exit chamber (dirty room) is used to remove outer disposable coveralls, which are then placed into a trash bag. If only one suit is worn, its outer surface is vacuumed, after which the suit is taken off and disposed in a trash bag. Disposable gloves are taken off and placed in a trash bag. The outsides of respirators are cleaned with damp wipes and removed only after entering the second exit chamber.

If two sets of disposable coveralls are worn, the first coverall is removed in the first chamber as described in the preceding paragraph. The second is removed in the second containment chamber and hung up for reuse as the outer coverall when re-entering the workspace. If the inner disposable coverall has been damaged, it must not be reused. Dispose of it in the second chamber.

It is recommended that remediation workers wash their faces and hands thoroughly with soap and water after exiting Condition 2 or 3 work areas.

**Post-Remediation Evaluation**

It is highly recommended that a post-remediation evaluation be conducted by the remediator to confirm that the remediation process has been completed, prior to post-remediation verification by an
IEP. This evaluation involves application of the internal quality control procedures of the remediator, and a sensory inspection of the containment area to ensure that malodors, contaminated materials, visible dust and debris have been removed.

**Breakdown of Containment**

Before breaking down the containment, it is highly recommended that a thorough inspection of the cleaned containment area be conducted by a project supervisor or an IEP. Post remediation verification often is required and it is highly recommended that the containment pass the verification process before it is dismantled. It is highly recommended that containment materials be HEPA vacuumed and damp wiped before it is dismantled.

**REFERENCES**

American Conference of Governmental Industrial Hygienists (1999). *Bioaerosols: Assessment and Control*, Chapter 15: Remediation of Microbial Contamination and Chapter 16: Biocides and Antimicrobial Agent, American Conference of Governmental Industrial Hygienists, Cincinnati, OH.


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*IICRC Reference Guide for Professional Mold Remediation (IICRC S520)*
Chapter 8

HVCA Remediation

The Relationship Between a Building and Its HVAC System

HVAC systems have a major impact on controlling the conditions that lead to condensation films. The design, installation, operation and maintenance of HVAC systems are important factors in mold control. In addition, mold growth from other causes can be carried to the interior of HVAC system components where it accumulates and degrades the operation of the system. When operation is affected this may result in poor environmental control that allows more widespread condensation films to form. This condition can lead to the spread of contamination by the system and increase the scope of the mold problem by dispersing contaminants throughout a building.

Types of HVAC systems include residential, commercial and industrial. In a typical system, the fan or blower pulls air from the occupied space through the return grills and ducting, then through the filter, heating and/or cooling coils and supply ducting into the occupied space. The mechanical components of the system may be located in various areas of the occupied space, outdoors or in other locations. Residential systems are different from one part of North America to another; however, within each region of North America the systems are generally similar. Some of the most common types of systems include the following:

Up-flow Systems

In an up-flow system air is drawn through the bottom of the system and discharged out the top. These systems are usually located within the residence, in a basement or a closet constructed of wood and drywall materials. In addition, the return air plenum will often be a part of this enclosure, with openings covered by a metal grill. This type of construction provides an excellent food source for mold contamination if moisture from the HVAC has penetrated the materials.

Down-flow Systems

In a down-flow system the air is drawn into the top of the system and discharged out the bottom. Vertical down flow systems can be installed in a closet or garage, with the ductwork installed in the crawl space under the occupied space. Because of the location of these components, conditions can be favorable for moisture that can support mold growth. Working conditions are very confined and access may be difficult.

Horizontal Systems

Horizontal systems are mounted horizontally and discharge the air horizontally. These types of units are typically installed in an attic or in the crawl space of a building or residential structure. Major considerations when working on these systems include the temperature in the attic, access to the unit and associated ductwork, and the potential for falling through the ceiling into the occupied space.

Ductwork
HVAC ductwork consists of fiberglass duct board, metal duct with fiberglass linings, metal duct with fiberglass exterior wrap and insulated flexible duct. Ductwork consisting of a non-porous internal surface (usually galvanized sheet metal) is conducive to removal of visible mold growth (Condition 3 contamination). However portions of internal lined ductwork, duct board or flexible ductwork with Condition 3 contamination cannot be successfully cleaned, and therefore it is highly recommended that sections of ducting with Condition 3 contamination be removed and replaced.

Commercial HVAC Systems and Components

There are greater variations and combinations of HVAC components in commercial systems than residential systems. Common commercial systems may include, but are not limited to, single zone, multi-zone, single duct-variable volume, double duct, and induction systems. Commercial systems are larger and more complex than residential systems. Commercial systems have additional components, including mixing boxes, chillers, and variable air volume (VAV) boxes.

When a building containing widespread Condition 3 contamination is remediated, it is highly recommended that special attention be given to remediation of the HVAC system that supports the indoor environment of the building. In conjunction with mold remediation, it is highly recommended that the HVAC system be inspected in the manner described in this section and return to Condition 1. It is recommended that any identified HVAC deficiencies be corrected. Otherwise, the remediation may fail and growth may return because environmental conditions in the residence or building are no longer under control.

In some cases, there will be diffuse mold without an identifiable source of water. This may be related to the interaction of the building and its HVAC or ventilation system or other causes. Part of the task of HVAC systems is to support psychrometric conditions that will prevent formation of a condensation film on surfaces within the building. Such a film forms when the temperature of a surface drops below the dew point of the surrounding air. This can occur under a great variety of climatic conditions, during any time of year and in virtually any geographic region. Although condensation is often associated with hot and humid climates and air with high moisture content, the right combination of conditions will always result in condensation films.

In addition to the HVAC system, the building and its construction can establish the potential for condensation to take place. Building pressurization, selection and placement of vapor barriers, infiltration of moist air, poorly or improperly controlled air movement and even selection and method of installing building materials can impact condensation. A complete discussion of building science and all of the factors that can lead to formation of condensation films is beyond the scope of this guideline.

It is highly recommended that situations with widespread visible surface mold growth or suspected hidden growth be investigated by an IEP, the cause identified and corrective action taken before remediation of either the building or the HVAC system is undertaken. This is because building design or construction-related moisture accumulation may be beyond the capacity of even a properly designed, maintained and operated HVAC system to control. These issues raise serious questions about project scope and loss responsibility. In a strict sense, mold remediation does not include activities that would modify either a building or its mechanical systems from their original design. If structural or design conditions will result in significant risk of future growth, consideration of steps to avoid a recurrence of contamination is highly recommended. However, such steps may not be the responsibility
of the remediation contractor. At a minimum, however, the owner must be advised of known conditions that place the future integrity of the building at risk.

**HVAC Engineering Considerations**

It is highly recommended that HVAC systems be inspected for cleanliness and returned to a Condition 1 status as part of a building remediation. The National Air Duct Cleaners Association (NADCA) standard, *Assessment, Cleaning and Restoration of HVAC Systems* (ACR 2002) includes specifications for acceptable levels of cleanliness for HVAC systems and the appropriate inspection techniques. It is recommended to delay remediation of the HVAC system until other building remediation is complete, in order to avoid recontaminating the system. If this is not possible, then when an environment is in Condition 2 or 3 status, it is highly recommended that HVAC system components be isolated from the environment as part of the overall building remediation strategy. Restored HVAC system components that may be exposed to or impacted by ongoing building remediation activities must be re-inspected after building demolition and reconstruction activities are complete, but before removing isolation engineering controls. It may be necessary to provide for temporary heating, cooling and other environmental control for areas that are undergoing remediation and thus are not being served normally because they are isolated from the building HVAC system. Often, the condition of makeup air drawn through the containment will provide satisfactory conditions. In other cases, supplemental heating, cooling or dehumidification systems can be used to provide environmental control in the spaces undergoing remediation. It is highly recommended that where supplemental systems are used inside of critical containments, they be decontaminated, bagged or wrapped prior to being removed from the workspace.

It is highly recommended that in addition to a cleanliness inspection, a complete engineering assessment of the design and condition of the entire HVAC system be considered depending on the conditions that exist in the project. This is especially important if temperature and/or relative humidity conditions cannot be maintained within the spaces in compliance with the requirements of ASHRAE Standards 62.1 or 62.2; temperatures, relative humidity or airflow varies between different areas of the building; or the mechanical components are not in good condition and/or repair. There are four reasons this is important to the success of a remediation project:

- The original system design may not have been adequate to maintain optimal indoor environmental (or psychrometric) conditions in the building;
- Expansions, renovations or changes of use of the original space may have rendered the HVAC system design inadequate for the current needs of the building and its occupants;
- The system may not have been installed as designed or commissioned so as to assure that its operation met the design objectives; and
- Mechanical deterioration and/or physical damage to system components may have degraded their performance to the point where they cannot provide the needed level of air flows or capacity.

The description of what constitutes an adequate engineering evaluation of HVAC system condition and capacity is beyond the scope of this guideline. It is recommended that qualified engineering professionals or HVAC contractors be consulted for such an evaluation. ACCA, ASHRAE, NAIMA and SMACNA, and their published guidance documents; all provide construction standards, and/or design guidance for proper sizing, design and layout for HVAC systems. Regardless of
compliance with the latest HVAC system guidance, at a minimum an HVAC system must conform to applicable building codes.

Filtration is important in decreasing the spread of fungal spores from one part of a building to another. It is highly recommended that filtration upgrades be considered in buildings that have experienced condition 3 as part of a strategy to prevent future problems. In many cases, existing filter housings or tracks will accommodate upgraded filtration. In others, modifications must be made to the HVAC system layout to accommodate upgraded filtration. Whenever modifications are made to an HVAC system to accommodate upgraded filtration, airflow restrictions below design levels must not occur.

**HVAC System Cleaning and NADCA ACR 2002**

Once the HVAC system condition has been assessed for cleanliness and any mechanical corrections and/or enhancements completed, it is highly recommended that cleaning be carried out in accordance with the procedures described in NADCA ACR 2002, which is incorporated herein by reference. The sequence of activities (assessment, mechanical corrections and enhancement, cleaning) is determined based on the professional judgment of the remediator, and the conditions within the building being remediaged. A major factor impacting the determination of the sequence of activities is the potential impact from contamination of the HVAC system during remediation of the building.

**Fungal Contamination Considerations**

Determining the extent of fungal contamination present in an HVAC system can be challenging. Cleanliness criteria are set forth in NADCA ACR 2002. Multiple cleanings may be required to achieve a satisfactory level of cleanliness. More rigorous criteria may be specified on occasion, including surface testing procedures normally utilized with surfaces outside of an HVAC system; however, interpretation of test results may be more difficult than with exterior environmental surfaces and air samples. The complex nature of HVAC system interior structure provides reservoirs for both spores and viable organisms. There may be numerous amplification sites in HVAC system interiors that may or may not be of concern. It is highly recommended that individuals taking and interpreting such samples are IEPs with specific training in working on HVAC systems. It may also be difficult to select representative collection locations. Cooling coil interiors can be especially difficult to clean to their full depth. Coils with depths greater than four rows are especially difficult to both clean and assess for cleanliness. One technique that is available is to measure the pressure drop across the coil prior to and after cleaning and compare to manufacturer specifications where they are available. If a satisfactory level of cleanliness cannot be achieved, replacement of a coil is recommended. Coils that are not completely cleaned of soil and accumulated growth restrict airflow and have reduced latent capacity. Such coils are more at risk for contributing to future microbial growth.

It is highly recommended that special attention be given to the inspection of fan blades and blower wheels. Bacterial and fungal growth on these components can lead to rusting or pitting. A heavily fouled blower wheel may only be capable of a fraction of the air movement of a wheel with smooth, clean surfaces. In those cases where fan and blower surfaces cannot be returned to a smooth surface condition, it is highly recommended that the component be replaced. It may not be realistic to change out blowers in large commercial systems. Where these components are badly pitted a decision will have to be made between the probable loss in efficiency and the required capital expenditure.
Built up fungal growth is difficult to clean from coil fin surfaces. Remediators are tempted to use aggressive cleaning agents (high and low pH) because of the difficulty of soil removal. Overly aggressive cleaners such as those containing acids or caustics can damage heat transfer surfaces. Damage can range from pitting of surfaces that interferes with flow of condensate from fin surfaces to accelerated structural deterioration of components. Residues from such cleaners also can add contamination to air flowing over coil surfaces if not completely rinsed off. Excessive water pressure used during cleaning can also damage fin structures. Pressures as low as 100 psi have been found to deform coil fins if the flow rate and total volume of cleaning solution delivered is great enough. Spray is to be directed at the fin edge and not at an angle so as to avoid deforming the fins. Application equipment and techniques can be tested on scrap before being used in the field.

It is highly recommended that HVAC components be isolated from portions of the building where remediation is taking place. It is recommended that HVAC systems be remediated after other remediation activities have been completed. If this is not possible, it is highly recommended that the interior of the system be inspected after other remediation activities are complete and re-cleaned if found to contain visible particulate or soil.

Normally it is not necessary to build a containment for HVAC system cleaning. Procedures described in NADCA ACR 2002 will normally prevent the release of spores or other contamination during cleaning. Under unusual circumstances or in sensitive locations such as active health care facilities, construction of containment may be advisable. Another situation that may require construction of a containment would be an air handler in an equipment room that is part of the conditioned space. Air handlers located outside or on rooftops normally will not require containments during cleaning. However, remediators must always utilize appropriate personal protective equipment while cleaning systems, and isolate the portion of the HVAC system being cleaned from clean areas by blocking air ducts or supply vents. Sufficient ventilation must be used to dilute emissions from any cleaners used, and cleaner residue must be completely rinsed from all surfaces before equipment is placed back in operation.

Plenums, which have been lined on the interior with fiberglass or other porous insulation, are sites where mold contamination is likely to occur. Flexible duct sections are handled as indicated in NADCA ACR 2002. When growth is extensive or penetrates below the surface of the fiberglass coating, replacement or upgrading of the components may be necessary. It is recommended that any action taken be in accord with NADCA ACR 2002.

On occasion, use of an antimicrobial product may be considered to inhibit future mold growth in an HVAC system. Such use must never be substituted for complete removal of viable mold or fungal bodies. In addition, any product used must be specifically registered by the EPA or other applicable regulatory agency for use in HVAC systems, have undergone a risk assessment for such use, and contain specific and detailed label directions. If label directions cannot be followed completely, use must be avoided.
Chapter 9

Contents Remediation

APPROACH

Effective remediation of contents from a mold-contaminated environment includes the following tasks:

- categorize contents items by their likely restorability, which includes:
  - extrapolating the extent of mold contamination and water damage of the structure to the probable condition of the contents in different areas;
  - performing visual inspection for evidence of mold contamination, and possibly correlating the inspection with the results of a microscopic assessment of the contents performed by an IEP, in order to determine the Condition (1, 2 or 3) of the contents;
  - determining the basic composition of content materials. Contents composition and condition determine their cleanability. General categories of content material composition are defined as follows:

  Porous: Organic materials that quickly absorb water and provide an excellent food source for molds (e.g., clothing and other textiles, padded or upholstered items, leather, taxidermy, paper goods, many types of fine art);

  Semi-porous: Organic materials that absorb water slowly, but, still provide a possible food source for molds (unfinished wood, masonry); and

  Non-porous: Organic materials, which have been altered to not absorb moisture easily; inorganic or synthetic materials, which do not absorb significant amounts of moisture and/or do not provide a food source for molds (e.g., finished wood, glass, metal, plastic);

- providing options as to the relative cost of cleaning versus the cost of replacement;
- determining cleaning requirements in order to decide whether to clean contents on-site or in-plant;
- determining those contents requiring remediation by specialty cleaning professionals (e.g., fine art, electronics, rare books, priceless keepsakes); and
- communicating with an IEP, if involved in the project, regarding issues of sampling, analysis, and verification testing.

ASSESSMENT

The restorability of contents is dependent upon the following factors:

- condition of the contents;
- basic material composition of the contents;
- cost of remediation;
- financial value or cost of replacement; and
- other types of value (e.g., sentimental, legal, artistic, cultural, historical).

The type of service required for each content item may be categorized in one of three ways:

- restore - Items that will be cleaned and returned to customer at Condition 1;
- dispose – Items that will not be cleaned because customer does not want them or value does not outweigh cost of remediation. (See Disposal section);
- preserve with Risk Assignment – Items that are irreplaceable but cannot be brought to Condition 1. This category only applies to irreplaceable porous or irreplaceable semi-porous items in Condition 3.

Material composition, Condition, and value generally correlate to anticipated services as noted in the matrix below. Condition 1 is not included in the matrix because generally no services are required with the possible exception of removal, containment or prevention from becoming contaminated. There are exceptions to each of the general disposition categories set forth in the matrix below, some of which are discussed in the text of this chapter.

<table>
<thead>
<tr>
<th>Contents Services</th>
<th>Porous</th>
<th>Semi-porous</th>
<th>Nonporous</th>
<th>Irreplaceable Porous</th>
<th>Irreplaceable Semi-porous</th>
<th>Irreplaceable Nonporous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition 3</td>
<td>Dispose</td>
<td>Dispose</td>
<td>Restore</td>
<td>Preserve w/risk assignment</td>
<td>Preserve w/risk assignment</td>
<td>Restore</td>
</tr>
<tr>
<td>Condition 2</td>
<td>Restore</td>
<td>Restore</td>
<td>Restore</td>
<td>Restore</td>
<td>Restore</td>
<td>Restore</td>
</tr>
</tbody>
</table>

It is highly recommended that all interested parties participate in the decision about whether to restore or dispose of contents. Recommendations supplied by the IEP may be beneficial in making these decisions. The property owner or representative, the IEP, the remediator and others may all be involved in the content remediation decision-making process.

**Removal of contents from affected areas**

Before moving potentially contaminated contents from a contaminated area to a cleaner area or to another location, it is highly recommended that the remediator or other qualified professional:

- inspect all contents prior to inventory;
- determine and document the condition of the contents, including actual or perceived value of one or more of the types of value discussed above;
- photo-document the placement and condition of contents; and
- separate document the placement and condition of contents where possible.

Contaminated or potentially contaminated contents must be appropriately packaged or decontaminated, when moved into or through uncontaminated areas to prevent the spread of contaminants into unaffected areas and the exposure of workers or occupants to contaminants. It is highly recommended that the exterior of the packaging on its way through a decontamination chamber
system be decontaminated by cleaning and/or wrapping a fresh layer of packaging material around the item just before it exits the decontamination chamber system. Care must be taken when packaging items not to trap moisture inside the packaging, especially if contents are to be moved into a storage area where environmental conditions may be different.

**Inventory, Packing, Transport and Storage**

It is highly recommended that before contents are packed out a detailed inventory be prepared containing at least the following information:

- description of each item;
- quantity of each item;
- condition of each item;
- location of each item within the structure; and
- an assigned inventory number for each item, box, or group of items.

It is highly recommended that the customer sign a form accepting the inventory as representative of the existence and actual condition of the contents before the remediator assumes responsibility for contents transport and processing.

It is highly recommended that contents be packed, transported and stored using appropriate measures to minimize breakage/damage, loss, exposure to employees, occupants or the public, and contamination or cross-contamination of unaffected areas of the building. It is highly recommended that vehicles, equipment, storage vaults or facilities that become contaminated in the course of remediation be decontaminated.

It is highly recommended that storage conditions be controlled while contents are in the remediator’s custody to minimize conditions favorable to mold growth, contaminated contents be cleaned as soon as practical, rather than being stored for long periods while contaminated, and that cleaned contents be stored in a clean area that is separate from the area where contaminated contents are stored. In some cases, it may be necessary to add desiccant material to packaged contents to adsorb moisture and prevent related damage.

It is highly recommended that remediated contents not be returned to contaminated areas of the structure until both have attained Condition 1.

**Cleaning Contents – General Discussion**

Cleaning is the traditional activity of removing contaminants, pollutants and other undesired substances from an environment or surface to reduce damage or harm to human health or valuable materials. The goal of contents remediation is to clean items to Condition 1 by maximizing the physical removal of fungal contamination and odors.

Contents mold cleaning or remediation refers to returning contents items to Condition 1. It does not necessarily mean that an item has been improved in appearance. There are factors involving customer expectations that should be addressed. It is recommended that appropriate appearance enhancement processes be applied to the items after their return by remediation to Condition 1 has been completed.
As with structural remediation, additional damage may be discovered during the contents cleaning process, as a result of mold amplification or other factors. When additional damage or contamination to contents is discovered, it is highly recommended that remediation workers notify their supervisors, so that such additional damage can be documented, and that materially interested parties can be informed within a reasonable period of time.

Contents can be cleaned either on-site or in-plant. There are advantages and disadvantages to each approach.

**On-site versus In-plant**

Advantages of on-site cleaning include the following:

- items remain in customer’s control;
- expenses of packing, transport and storage are eliminated;
- normally, less chance of breakage or “mysterious disappearance;” and
- an on-site cleaning chamber system, as discussed below, can be set up to process items on their way out of the contaminated area into an uncontaminated area.

Disadvantages of on-site cleaning include the following:

- often extends the wait time before being able to start on the structure;
- increases possibility of cross-contamination to remainder of building;
- cleaning systems set up on site may be significantly less efficient than well-designed plant facilities; and
- if contents are not removed from contaminated part of the building, they may require several “rounds” of cleaning, similar to the structural materials.

Advantages of in-plant cleaning include the following:

- minimizes time before structure work starts;
- specialty cleaning chambers and systems can be more efficient; and
- structure and contents remediation can proceed simultaneously, potentially reducing total job time.

Disadvantages of in-plant cleaning include the following:

- significant costs associated with inventory, packing, transport and storage;
- increases possibility of breakage, “mysterious disappearance,” or accusations of theft;
- contractor assumes full responsibility for contents; and
- potential cross-contamination of plant facilities and of clean stored contents.

Whether contents are cleaned onsite or in-plant, it is highly recommended that appropriate precautions be taken to prevent the spread of contaminants from work or storage areas into unaffected areas.
Outdoors versus Multi-chamber Cleaning

It is highly recommended that Condition 2 or 3 contents be cleaned either outdoors or in a multi-stage cleaning chamber system.

Outdoors

When cleaning contents outdoors:

- all work performed outdoors without containment must be performed at a distance from a structure, air intakes, or unprotected people that allows adequate dispersal of released contaminants; and
- remediation workers handling or working near contaminated contents must wear appropriate PPE.

It is highly recommended that the remediator take other relevant factors into consideration before deciding to perform contents cleaning outdoors (e.g., weather, security, possible public alarm at the sight of people attired in PPE).

Multi-stage Cleaning Chamber System

A multi-stage cleaning chamber system maximizes removal of contaminants by allowing two or more “rounds” of cleaning to be performed on each item. Each item is processed through successive chambers, minimizing the chance of recontamination of the item as it is being cleaned. For the system to be effective, it is recommended that appropriate airflow and air pressure relationships be maintained.

Laminar-airflow, high-volume cleaning chambers are safe and efficient, and allow the potential use of techniques such as air washing and abrasive blasting that are inappropriate or hazardous in most other indoor environments, while preventing escape of or excessive worker exposure to contaminants.

Cleaning Methods

When selecting a cleaning method, it is important to choose the best one for the situation. Knowing the material composition, the Condition, and the location where contents are to be cleaned, is instrumental in selecting a method. It is also important to understand that a combination of methods may be necessary to facilitate the remediation of contents.

Air-based Methods

- HEPA-vacuum; and
- Air washing - This method uses an air stream to blow mold spores and fragments off surfaces which may result in their aerosolization creating the potential for massive exposures for workers and occupants. This method must not be used except outdoors or in laminar airflow, high volume cleaning chamber or in other situations where engineering controls are adequate to prevent excessive buildup of contaminants.
- Engineering controls, such as a down-draft cleaning table, are recommended to minimize contaminant dispersal.
Air washing is best for semi-porous and non-porous contents. It is important to note that air washing has the potential to drive mold spores and fragments deeper into porous materials such as padding or upholstery.

**Liquid-based Methods**

The liquid-based cleaning method relies on water combined with physical or mechanical cleaning processes to dislodge contamination. The following are examples of acceptable liquid-based cleaning methods:

- immersion cleaning with an appropriate cleaning agent;
- ultrasonic cleaning;
- damp-wiping with an appropriate cleaning agent;
- steam cleaning with live steam systems;
- cleaning with non-water-based liquid solutions;
- low-pressure flushing; and
- high-pressure washing. This method almost inevitably causes massive “splattering”, resultant aerosolization, and probably an increase in RH. It is highly recommended that high-pressure washing techniques be limited to situations in which aerosolization is not a critical factor (e.g., outdoors).

**Abrasive Methods**

Abrasive methods of cleaning rely on the use of a medium or material to dislodge contamination. The following are examples of acceptable abrasive cleaning methods, which typically employ a down-draft cleaning table:

- sanding;
- scraping, brushing, etc.; and
- abrasive media blasting (e.g., dry ice, soda, sand).

It is highly recommended that these techniques be used with caution, especially those involving abrasive blasting. By definition, abrasive blasting methods have a strong tendency to aerosolize the particles they remove from the surface. This may lead to extremely high levels of contaminants in the air, potentially creating unacceptable exposure for workers or occupants and/or allowing spread of contaminants into previously unaffected areas. Some media may also create a difficult cleanup problem or lead to the development of unacceptable worker exposure, such as the possibility of dry ice blasting in an enclosed space creating excessive levels of CO₂ in the work area.

It is highly recommended that abrasive blasting techniques be limited to situations in which aerosolization is not a critical factor (e.g., outdoors), or can be adequately controlled (e.g., high-volume, laminar airflow cleaning chambers).

**Appearance Enhancement**

Some of the methods listed above and many others are effective at improving the appearance of contents items. Although removal of contaminants is the primary focus of mold remediation, there are customer expectations that also should be addressed. It is recommended that contents be “appearance
enhanced” to the extent practical before being returned to the customer. This may involve polishing, waxing, buffing and other services.

**Encapsulation**

Encapsulation is not a cleaning method. Since the Fourth Principle of mold remediation is Removal, it is recommended that encapsulation be avoided as a standard practice. However, it can be useful in the following special circumstances:

- application of a coating over porous or semi-porous surfaces from which mold cannot be fully removed (e.g., shellac, varnish or lacquer over unfinished wood); and
- lamination of irreplaceable or valuable documents between two sheets of plastic.

It is recommended that remediators work closely with IEPs in making decisions about the advisability of encapsulation.

**Cleaning Porous Contents**

**General**

Because of the nature of porous contents, particularly textiles, it is important to note the Condition of contamination. It is recommended that special care be taken with porous Condition 1 contents to prevent potential contamination, which may occur while contents are stored in an off-site facility with different environmental conditions. HEPA vacuuming and brushing, with a soft bristle or tampico brush, while on a down-draft cleaning table are the most commonly used methods for cleaning porous contents. Air washing, in the proper situation, also may be effective on many porous items. However, air washing must be performed in a properly controlled work area, where the massive aerosolization associated with this method will not pose a health risk to workers or occupants during the process.

It is recommended that most cleaning processes start and end with HEPA vacuuming. It is recommended that contaminated clothing and other textiles be HEPA vacuumed prior to disturbing them at their location within the structure. Rapid drying and appearance enhancement, as necessary, follow all cleaning methods. It is recommended that the appearance-enhancement process take place after Condition 1 has been obtained.

Distinguishing between Condition 2 and Condition 3 may require visual inspection by the remediation specialist and/or appropriate sampling by an IEP.

The following matrices describe cleaning procedures to be used with items of different composition in different Conditions of contamination.
<table>
<thead>
<tr>
<th>Porous Items</th>
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<tbody>
<tr>
<td><strong>Category</strong></td>
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<tr>
<td>General</td>
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<tr>
<td>Porous Textiles: Clothing, Fabric, and other textile items</td>
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## Porous Items

<table>
<thead>
<tr>
<th>Category</th>
<th>Condition 2</th>
<th>Condition 3</th>
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<tbody>
<tr>
<td>Porous</td>
<td>physical removal of contaminants and associated odors, rather than microbial kill. Repeat laundering or dry cleaning may be needed to satisfactorily eliminate mold odors, as well as to provide an additional measure of assurance of maximum contaminant removal. The decision to conduct multiple launderings or dry cleanings involves professional judgment in consultation with the contents' owner and other interested parties.</td>
<td>Usually cannot be effectively remediated and restored to a pre-loss condition due to staining and other problems as listed for clothing above. If attempted, follow recommendations for Condition 2. It is recommended that most cleaning processes start and end with HEPA-vacuuming.</td>
</tr>
<tr>
<td>Furnishings: Area Rugs, Loose Carpet, Upholstery, Mattresses, Wicker, and similar items</td>
<td>It is recommended that most cleaning processes both start and end with HEPA-vacuuming. If items have not been used while contaminated, HEPA vacuum thoroughly and professionally clean by an acceptable extraction method following the IICRC S300 Standard and Reference Guide for Professional Upholstery Cleaning. Thorough moisture extraction and rapid drying are critical if this procedure is to be successful. As with clothing and soft goods, deodorization of severely contaminated contents may be conducted with appropriate techniques. One or more repeat cleanings may be needed to remove odors and further reduce contaminant levels. With all items, accelerated drying is critical. Appearance enhancement, as necessary, follows all cleaning methods. Area rugs and carpet may be cleanable in a controlled, in-plant facility (IICRC S500, standard 12.3.10.6). Determining the severity of contamination may necessitate the input of an IEP. Spread of spores, during the cleaning process is a potential problem. Immersion methods that clean rugs or carpet under water are less likely to aerosolize spores. Tapestries and other unpadded items may be HEPA-vacuumed thoroughly or air washed to remove accumulated dust and spores. It is recommended to follow this method with an upholstery cleaning process as specified in the IICRC S300. Air washing must be performed only in a properly controlled work area, or using controlled techniques, where massive aerosolization does not pose a health risk to workers or occupants. If padded items such as pillows and mattresses have been used while contaminated, attempts to return the item to Condition 1 usually are unavailing. Disposal is recommended. It is highly recommended that an IEP be involved in making this decision, in relation to irreplaceable and high value contents. Rapid drying and appearance enhancement, as necessary, follow all cleaning methods.</td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>Condition 2</td>
<td>Condition 3</td>
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<tr>
<td>Paper Goods: Books, Documents, Manuscripts, Family records, Scrapbooks, Photographs, and similar items</td>
<td>It is recommended that most cleaning processes both start and end with HEPA vacuuming. Clean by HEPA vacuuming, brushing while on a downdraft cleaning table, and perhaps other surface cleaning methods. Air washing may be effective. However, air washing must be performed only in a properly controlled work area, or using controlled techniques, where massive aerosolization will not pose a health risk to workers or occupants. Rapid drying and appearance enhancement, as necessary, follow all cleaning methods.</td>
<td>Difficult and costly to remediate. May not be cost-effective if items lack significant financial and/or sentimental value. Effective cleaning is a specialized conservation type process, and may not always be successful.</td>
</tr>
<tr>
<td>Fine Art Paintings, Sculpture, Works of art, and similar items</td>
<td>It is highly recommended that remediation of mold-contaminated fine art at Condition 2 be performed only by qualified, experienced specialists, primarily due to the high value of the items involved. Actual cleaning techniques parallel that of similar items in other categories, but often require extensive knowledge of the type of artwork in question to avoid damage to the piece.</td>
<td>Remediation of mold-contaminated fine art at Condition 3 may not be completely successful, and can be quite expensive. It is highly recommended that these services be performed by qualified, experienced, specialists.</td>
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</tbody>
</table>

Note: This is not a comprehensive list of all cleaning methods or cleaning method combinations.
<table>
<thead>
<tr>
<th>Category</th>
<th>Condition 2</th>
<th>Condition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-porous items</td>
<td>It is highly recommended that all items be examined first for unrestorable water damage. Cleaning usually is accomplished by HEPA vacuuming and/or air washing. It is recommended that most cleaning processes both start and end with HEPA-vacuuming. Abrasive blast cleaning with an appropriate media may also be effective. Air washing or abrasive blast cleaning must be performed only in a properly controlled work area using controlled techniques, where the particle aerosolization they cause will not pose a health risk to workers or occupants. (See Tools, Equipment and Materials for more information). Thorough brushing while on a downdraft cleaning table is another possible cleaning technique. Use of liquids, especially water-based solutions, may cause staining or discoloration of the wood. Appearance enhancement, as necessary, follows all cleaning methods.</td>
<td>It is highly recommended that all items be examined first for unrestorable water damage and/or mold damage. Semi-porous items are often unrestorable due to staining discoloration and decay caused by mold enzymes, unless growth is in a biofilm rather than in the wood. If growth is in a biofilm, follow directions for Condition 2. It is recommended that most cleaning processes both start and end with HEPA-vacuuming. If growth has penetrated wood, aggressive cleaning methods such as HEPA assisted hand sanding, abrasive blast cleaning with an appropriate media, and wire or other aggressive brushing (preferably on a downdraft cleaning table) may be required. Abrasive blast cleaning must be performed only in a properly controlled work area using controlled techniques, where the particle aerosolization it causes will not pose a health risk to workers or occupants. (See Tools, Equipment and Materials for more information). End results of such aggressive cleaning methods may result in an appearance that is unacceptable to the customer. It is highly recommended that attempts be made to determine if results will be acceptable before extensive cleaning is performed. Use of liquids, especially water-based solutions, may cause staining or discoloration of the wood. Appearance enhancement, as necessary, follows all cleaning methods.</td>
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</table>

Note: This is not a comprehensive list of all cleaning methods or cleaning method combinations.
<table>
<thead>
<tr>
<th>Nonporous Items</th>
<th>Condition 2</th>
<th>Condition 3</th>
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<tbody>
<tr>
<td>Nonporous items</td>
<td>It is highly recommended that all items be examined first for unreconstructable water damage.</td>
<td>It is highly recommended that all items be examined first for unreconstructable water damage. Some glass and plastic items may be etched or stained by long-term exposure to water and associated mold growth. Metal items may be unreconstructable due to corrosion, which can be accelerated by acids produced by fungal growth.</td>
</tr>
<tr>
<td>Finished wood, glass, metal,</td>
<td>Cleaning can usually be accomplished by using one or a combination of the following: detergent washing and rinsing; ultrasonic cleaning; HEPA vacuuming plus damp wiping with a suitable cleaning agent; or other process suitable for the particular item; followed by removal of cleaning residue. It is recommended that most cleaning processes both start and end with HEPA-vacuuming.</td>
<td>Cleaning can usually be accomplished by using one or a combination of the following: detergent washing and rinsing; ultrasonic cleaning; HEPA vacuuming plus damp wiping with a suitable cleaning agent; or other process suitable for the particular item; followed by removal of cleaning residue. It is recommended that most cleaning processes both start and end with HEPA-vacuuming.</td>
</tr>
<tr>
<td>plastic, electronics, and</td>
<td>Rapid drying and appearance enhancement, as necessary, follow all cleaning methods.</td>
<td>Rapid drying and appearance enhancement, as necessary, follow all cleaning methods.</td>
</tr>
<tr>
<td>similar items</td>
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</tbody>
</table>

**Note:** This is not a comprehensive list of all cleaning methods or cleaning method combinations.

**HIGH-VALUE AND IRREPLACEABLE CONTENTS**

High-value contents are those with high financial value or replacement cost. Irreplaceable contents are those with high historical, sentimental, cultural, artistic, legal or other types of value. Extraordinary cleaning procedures may be appropriate for these contents; such procedures may be as simple as repeated cleanings using standard practice as described above, or they may require highly specialized expert services.

For many categories of high-value and irreplaceable contents, specialty remediation services are available. Some remediators may provide these services in-house, while others will outsource them. These specialty remediation services include, but are not limited to:

- art restoration or conservation for paintings, valuable books, works of art on paper, documents, objects, frames, tapestries and other textiles;
- doll restoration;
- freeze drying for valuable books and documents (does not remove mold, but may prevent or arrest mold growth if wet books are dried quickly);
- area rug cleaning and repair;
- electronics and machinery;
- data recovery; and
- musical instrument restoration.

Such additional or specialty remediation procedures may not return these items to Condition 1. Depending on the item restored and the level of contamination, an IEP may be necessary to determine
whether or not an item has been restored to Condition 1. If items are not restored to Condition 1, then it is highly recommended that materially interested parties be consulted to determine an acceptable course of action with respect to the disposition of the items.

UNRESTORABLE CONTENTS

Unrestorable contents are those on which remediation is not attempted, due to lack of cost-effectiveness, severity of damage, or other factors, as well as those items for which remediation procedures have not been effective. After being categorized as unrestorable, it is highly recommended that they be inventoried, photo-documented, and removed or disposed of, in accordance with the IEP’s protocol, if applicable, or in compliance with the removal and disposal recommendations in this document.

It is highly recommended that unrestorable contents not be disposed of without the express written permission of the customer, the adjuster (if applicable), and/or other materially interested parties. These parties authorize disposal by signing an appropriate form listing the items. It is recommended that unrestorable items be removed from the work area before remediation services begin.

When returning contents to the customer that have not been restored to Condition 1, it is highly recommended that the remediator inform the customer of the circumstances involved (i.e., why the contents were not restored to Condition 1), advise the customer in writing of the potential consequences of accepting contaminated contents and attempt to obtain a written waiver and release of liability from the customer for those potential consequences.

DISPOSAL

Waste-Material Handling

It is highly recommended that waste materials be moved from the work area to the waste container in a manner that minimizes the possibility of cross-contamination or occupant or worker exposure. It is highly recommended that mold-contaminated, unrestorable contents be handled and removed carefully, preferably packaged in heavy gauge polyethylene, such as 6-mil disposal bags, or securely wrapped in 6-mil poly sheeting, unless contents are disposed directly through a waste-out tunnel or transfer system. It is highly recommended that sharp items capable of puncturing poly material be packaged in such a way as to prevent them from penetrating the material before being bagged or wrapped. It is highly recommended that poly surfaces be HEPA-vacuumed, damp wiped with an appropriate cleaning agent, double-bagged or wrapped in a fresh layer of poly just prior to being removed from the contaminated area or decontamination chamber. Respirators are not required outside while transporting double-bagged materials. It is highly recommended that bags not be dropped, thrown or handled roughly. If wrapped disposal materials rupture outside the containment, transporting workers must don appropriate PPE immediately, secure the area from public access, initiate clean up (HEPA vacuuming), and contain the debris.

If timely disposal of contaminated contents is not possible, it is recommended that staged debris be stored in a reasonably secure location. Generally, no special disposal provisions are recommended for mold-contaminated materials; however, federal, state, provincial and local disposal laws and regulations apply. Placing “mold” labels on bags and wrapped materials is recommended to discourage individuals from opening or removing them from the disposal site. It is recommended that label language be
factual, not reactionary.

**VERIFICATION OF EFFECTIVENESS**

There are two types of verification, i.e., sensory (visual/olfactory) and sampling/testing. Depending on the customer’s level of concern and the funds available, sampling and testing may or may not be performed on contents, although it is recommended. If sampling/testing is not performed, it is recommended that the customer be informed, in writing, that return of contents to Condition 1 is assumed. On those projects where returned contents will not be sampled, it is recommended that the contract include a clause waiving liability against the remediator for possible undetected contamination on or in the returned contents.

Sensory verification of remediation effectiveness by the remediator includes, but is not limited to, visual inspection focusing on acceptable removal of mold-associated stains, and olfactory inspection focusing on removal of malodor. If initial cleaning is questionable, either repeat processing may be warranted or items may be categorized as unrestorable.

Microbial verification sampling/testing provides a measure of assurance, within sampling, testing and analysis limitations, that contents have been remediated to Condition 1. If sampling and testing are performed, it is recommended that a cross-section of content types be included and highly recommended that an independent IEP conduct or oversee such activities.