IICRC S520

Standard and Reference Guide for Professional Mold Remediation

INSTITUTE of INSPECTION CLEANING and RESTORATION® CERTIFICATION

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Second Edition

Disclaimer

The Institute of Inspection, Cleaning and Restoration Certification S520 Standard and Reference Guide for Professional Mold Remediation (referred to as the "Standard and Reference Guide" or the "S520") is intended to provide information about the remediation of mold contaminated structures, systems and contents and to assist individuals and entities working in the mold remediation industry in establishing and maintaining their professional competence. Users of this document should stay updated and informed about developments in the field of mold remediation, implement changes in technology and procedures as appropriate, as well as follow applicable federal, state, provincial and local laws and regulations. Since every mold remediation project is unique, in certain circumstances, common sense, experience and professional judgment may justify a deviation from this Standard and Reference Guide. Furthermore, this Standard and Reference Guide is not intended to be either exhaustive or inclusive of all pertinent requirements, methods or procedures that might be appropriate on a particular mold remediation project. The information upon which this Standard and Reference Guide is based is subject to change, which may invalidate any or all of the information contained herein.

This Standard and Reference Guide was developed through a consensus standard development process, which brought together volunteers representing varied viewpoints and interests to achieve consensus on mold remediation issues. While the Institute of Inspection, Cleaning and Restoration Certification (IICRC) administers the process and establishes policies, procedures and guidelines to promote fairness in the development of consensus, it does not independently test, evaluate or verify the accuracy of any information or the soundness of any judgments contained in this Standard and Reference Guide.

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While the information contained within this Standard and Reference Guide is provided in good faith and is believed to be reliable, the IICRC makes no representations, warranties or guarantees as to the accuracy or completeness of any information contained in this Standard and Reference Guide, or that following this Standard and Reference Guide will result in compliance with any applicable laws, rules or regulations, or in safe, satisfactory or complete performance of a mold remediation project. ALL WARRANTIES, EXPRESS OR IMPLIED, ARE DISCLAIMED, INCLUDING WITHOUT LIMITATION, ANY AND ALL WARRANTIES CONCERNING THE ACCURACY OR COMPLETENESS OF THE INFORMATION, ITS FITNESS OR APPROPRIATENESS FOR A PARTICULAR PURPOSE OR USE, ITS MERCHANTABILITY, ITS NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHTS, OR ANY OTHER MATTER.

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Reference Guide for Professional Mold Remediation

Foreword

Awareness of mold growth in buildings has risen sharply in recent years. Several factors have contributed to this heightened awareness, including energy conservation measures, changes in building materials, the use of fast-track construction techniques, failure of occupants to manage moisture intrusion and humidity properly, and an increased reliance on mechanical Heating, Ventilating and Air Conditioning (HVAC) systems for comfort control. In addition, significant media focus and litigation have fueled increased consumer concern.

Response by public and private organizations to mold concerns led to the publication of several documents and guidelines that address mold remediation. They were written primarily for risk managers, building managers, occupational safety and health professionals, public health officials and those making remediation decisions. The IICRC S520 Mold Remediation Consensus Body Standard Committee has reviewed and considered those existing documents; e.g., New York City Department of Health (NYCDOH) guidelines, Environmental Protection Agency (EPA) guidelines, and National Institute of Environmental Health Sciences (NIEHS) in the development of this revised document.

In 1994, the Institute of Inspection, Cleaning and Restoration Certification (IICRC) first published the *Standard and Reference Guide for Professional Water Damage Restoration* (S500, revised 1999, 2006), which describes procedures for water damage restoration of structures, systems and contents. While the S500 was a significant step forward in the water damage restoration industry and it recognized the problem of microbial growth associated with water damage, it was not intended to provide specific guidance on the subject of mold remediation. The IICRC S520 *Standard and Reference Guide for Professional Mold Remediation* (S520; referred to separately in this document as "Standard" or "Reference Guide") attempts to combine essential scientific principles with practical procedures for remediators facing mold remediation challenges.

The S520 is a procedural Standard. It is based on reliable remediation principles, review of available scientific and industry literature and information, and practical experience. In addition, there has been extensive consultation with, and information obtained from, numerous other sources. These sources include, but are not necessarily limited to, microbiologists and other scientists, government and public health professionals, industrial hygienists, international, national and regional trade associations serving the professional mold remediation industry, chemical formulators and equipment manufacturers, cleaning and remediation training schools, remediation firms, the insurance industry, allied trades persons and others with specialized experience. This document is subject to further revision as developments occur in technology and procedures.

The Second Edition of the S520 has been updated and rewritten. Additional Chapters and Sections have been added covering Building and Material Science and Equipment, Tools and Materials. This document supersedes the *IICRC S520 Standard and Reference Guide for Professional Mold Remediation* (S520 First Edition 2003, 2004).

This document is written for use by those involved in the mold remediation industry, primarily for mold remediation companies and workers, and secondarily, for others who investigate or assess mold complaints, prepare remediation specifications, protocols or procedures, and manage remediation projects, (e.g., indoor environmental professionals (IEPs), other specialized experts) and finally, for other potential materially interested parties (e.g., consumers and occupants, property owners and managers, insurance company representatives, government and regulatory bodies). The S520 is a voluntary Standard and Reference Guide. Although attempts have been made to ensure that this Standard and Reference Guide is technically consistent with knowledge about mold remediation at the date of its publication, there is no representation or guarantee that every issue and topic relevant to mold remediation has been thoroughly addressed. Users of this document should stay updated and informed about the rapid developments in the field of mold remediation, implement changes in technology and procedures, as appropriate, and follow applicable federal, state, provincial and local laws and regulations. All mold remediation projects are unique and in certain circumstances, common sense, experience and professional judgment may justify deviation from this Standard and Reference Guide. It is the responsibility of the remediator to verify on a case-by-case basis that application of this Standard and Reference Guide is appropriate. When in doubt, apply caution and seek additional professional opinions. Users of this document assume all risks and liability resulting from use of and reliance upon this Standard and Reference Guide.

The S520 is presented in a two-part format: the procedural Standard and a supplemental informative annex hereinafter referred to as a Reference Guide. The Standard is printed first within the document on colored pages, followed by the longer Reference Guide section. The Standard summarizes most of the significant and important procedures and methodologies of a mold remediation project, while the Reference Guide restates and further explains those procedures and methodologies, and provides additional background information which supports the Standard. Although the material in the Reference Guide does not carry the official status of a Standard, the two sections complement one another and should always be considered in tandem. The S520 does not attempt to teach mold remediation procedures, but rather provides the principles and foundation for understanding proper remediation practices. The S520 is not a substitute for remediation training and certification programs that are necessary to attain competence in the field of mold remediation and properly apply this Standard.

The S520 is not intended to establish procedures or criteria for assessing mold contamination in an indoor environment. These issues are most appropriately addressed by professional organizations that represent IEPs. Since these professional organizations have not agreed upon threshold exposure limits or levels of visible mold growth that constitute a concern for occupant and worker safety, the IICRC S520 Mold Remediation Consensus Body Standard Committee decided not to establish action levels or procedures based upon the quantity or size of the area of visible mold growth.

Remediators and other parties to the remediation process often request specific guidance regarding quantities of mold or mold spores that trigger remediation activities or confirm remediation success. Quantifying visible levels of mold growth alone is not feasible as an action level decision criterion, because it does not take into consideration hidden, concealed (not readily visible) mold growth, and it does not take into consideration contamination resulting from settled spores (not visible) that were dispersed from areas of actual growth.

Thus, S520 represents a philosophical shift away from using “size” of visible mold growth to determine the remediation response. Instead, it establishes mold contamination definitions, (Conditions 1, 2, and 3) and guidance, which, when properly applied, can assist remediators and others in determining remediation response or confirm remediation success.

The terms “indoor environmental professional” and “IEP” are used in this document and in the remediation industry to generically describe individuals having advanced technical competency in a wide range of subjects related to mold in the built environment, that qualify them to perform assessments and related professional services typically provided by an IEP, as defined in this document. Because there is such a broad array of skills encompassed within the description of an IEP, it is impossible to develop a single, meaningful course of study that would adequately address the advanced levels of knowledge an IEP should possess within their area of specialization. Therefore, the terms "indoor environmental professional" and "IEP" are used in this document and in the remediation industry as a description, and not as a title, designation, certification, trademark or service mark. Consequently, there is no single license, designation or certification that qualifies an IEP. The qualifications required for an IEP are often gained through years of formal study at the university level, specific training related to mold and the indoor environment, and years of on-the-job work experience, or a combination of these factors. Therefore, the IICRC does not offer or recognize a professional certification or designation for an IEP, and prohibits the exclusive use or co-option of the terms "indoor environmental professional" and "IEP" in association with any one individual, entity or organization, as such use would be contrary to the intent of this document. However, use of the terms "indoor environmental professional" and "IEP" as a generic description is permitted. Remediators and others who engage an indoor environmental professional are advised to consider the individual's knowledge, skill, education, training and experience to best judge their ability, qualifications and competence, as further explained in this document.

This Standard does not specifically address the protocols and procedures for remediation when potentially hazardous, regulated materials are present or likely to be present in mold contaminated structures, systems and contents. Such potentially hazardous, regulated materials include, but are not limited to: asbestos, lead, arsenic, mercury, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, radiological residues, and other chemical and biological contaminants. This standard also does not address water damage restoration; please reference the ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration* for information directly related to water damage restoration.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The IICRC is not responsible for identifying any or all such patent rights.

The S520 is a living document subject to change as more information regarding mold contamination and remediation becomes available and as scientific developments occur and advancements are made in remediation technology and practice. The S520 will be reviewed, evaluated and validated through application in the field, and thereafter revised and improved. This process and further professional and public review allows the industry to develop a body of mold remediation science and achieve the overall IICRC goal of improving the environments in which people live and work.

The IICRC invites and encourages professional and public review and comment. Please send comments and suggestions for S520 revisions or additions to:

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Vancouver, WA 98661, USA
Attention: IICRC Standards Committee

Dedication

Mark B. Hansen, a major contributor to the *IICRC S520 Standard and Reference Guide for Professional Mold Remediation* and long-time legal counsel to the IICRC, passed away following the completion of this document, but before its publication. The IICRC recognizes Mark for his outstanding leadership, writing and editing ability, and organizational skills in making the IICRC Standards truly, "*World Class*."

Mark was both complex and simple: complex in that he worked simultaneously on many projects requiring multiple skills and abilities; yet simple in that everything he worked on always was guided by the basic question, "What is right, ethical and honest?"

For almost 25 years, Mark Hansen served the cleaning and restoration industries as advisor, counselor, advocate and friend. Always professional and thorough, Mark guided IICRC through many difficult situations as its General Counsel including: the formation of IICRC as a non-profit organization, several total by-law revisions, legal reviews, contract negotiations, and commentary and legal review on every IICRC Standard published to date. More importantly, Mark served as legal advisor to ten IICRC presidents, gaining the trust and admiration of each. While his professional accomplishments demonstrate his expert legal skill, Mark was much more than a good lawyer. His attention to detail, his quiet yet insistent manner, his brilliant insights, and impeccable ethics all serve to define this unique man.

Complementing Mark's highly professional work was his personal life. Mark was good-natured, always ready to laugh at a good story, willing to adventure into new territory, loyal and true to his beliefs, and deeply spiritual. Mark was always able to look at life's challenges from a positive perspective and seek the good in any situation. Those who had the opportunity to travel with Mark came to know his thirst for adventure, always wanting to gain the most from any opportunity.

Mark loved his family deeply, especially his daughter Danielle, and his soul mate, Lori. It was while he was with his family that one could see the full measure of Mark Hansen. Mark was never too busy to share time with a friend or loved one. Even though he was brilliant, he never made those around him feel inferior.

The world is a better place because of Mark Hansen's presence. Those of us who count ourselves among his friends have been enriched by the opportunity to have worked and played alongside Mark. While he is no longer with us physically, his legacy remains forever. His work speaks for itself: detailed, insightful, comprehensive and ethical. However, Mark will be remembered most for his passion and love of life. We, the IICRC, dedicate this document to Mark Hansen: devoted father, fiancé, attorney, counselor and friend.

Acknowledgments

This publication is the result of a collaborative effort involving industry experts and trade associations, educational institutions, training schools and other organizations. The Institute of Inspection, Cleaning and Restoration Certification (IICRC) is the principle designer of the document. Other organizations contributing to the creation of this document include the Indoor Environmental Institute (IEI), the National Air Duct Cleaners Association (NADCA), and the Society of Cleaning and Restoration Technicians (SCRT). The IICRC specifically recognizes the significant contribution by the IEI toward the development of this standard and reference guide.

The development and publication of this document was made possible through the generous contributions of a dedicated group of volunteers. The IICRC Board of Directors and the Standards Committee genuinely appreciate the time and effort contributed by these individuals. They exhibit the true volunteer spirit that has been the driving force behind the IICRC since its inception. At the time of approval of the second edition of the S520 Standard and Reference Guide for Professional Mold Remediation, the IICRC S520 Mold Remediation Consensus Body Standard Committee consisted of the members listed below. Other contributors and some past contributors to this document and their respective roles are also listed below.

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Important Definitions

Throughout this document the terms "shall," "should," and "recommend" are used to compare and contrast the different levels of importance attached to certain practices and procedures. It is impractical to prescribe procedures intended to apply to every mold remediation situation. In certain circumstances, deviation from portions of this Standard and Reference Guide may be appropriate. Carelessness is unacceptable and common sense and professional judgment are to be exercised in all cases.

shall: when the term *shall* (previously "must") is used in this document, it means that the practice or procedure is mandatory due to natural law or regulatory requirement, including occupational, public health and other relevant laws, rules or regulations, and is therefore a component of the accepted "standard of care" to be followed.

should: when the term *should* (previously "highly recommended") is used in this document, it means that the practice or procedure is a component of the accepted "standard of care" to be followed, while not mandatory by regulatory requirements.

recommend(ed): when the term *recommend(ed)* is used in this document, it means that the practice or procedure is advised or suggested, but is not a component of the accepted "standard of care" to be followed.

In addition, the terms "may" and "can" are also available to describe referenced practices or procedures, and are defined as follows:

may: when the term *may* is used in this document, it signifies permission expressed by the document, and means that a referenced practice or procedure is permissible within the limits of this document, but is not a component of the accepted "standard of care" to be followed.

can: when the term *can* is used in this document, it signifies an ability or possibility open to a user of the document, and it means that a referenced practice or procedure is possible or capable of application, but is not a component of the accepted "standard of care" to be followed

For the practical purposes of this document, it was deemed appropriate to highlight and distinguish the critical remediation methods and procedures from the less critical, by characterizing the former as the perceived and recommended "standard of care". The IICRC S520 consensus body standard committee interprets the "standard of care" to be: practices that are common to reasonably prudent members of the trade who are recognized in the industry as qualified and competent. Notwithstanding the foregoing, this Standard and Reference Guide is not intended to be either exhaustive or inclusive of all pertinent requirements, methods or procedures that might be appropriate on a particular mold remediation project. Ultimately, it is the responsibility of the remediator to verify on a case-by-case basis that application of this Standard and Reference Guide is appropriate.

Standard and Reference Guide Cross-Reference Table

Although they are not numbered in the same sequence, several chapters of the Reference Guide correspond directly with sections of the Standard. The table below is designed to help the reader cross-reference those chapters. *For ease of use of this document, an electronic version of the S520 is available which will allow the user to search for specific keywords.

Section	Standard	Chapter	Reference Guide
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		3	Health Effects from Indoor Exposure to Mold in Water/Moisture-Impacted Buildings
2	References		
3	Definitions		
4	Principles of Mold Remediation	1	Principles of Mold Remediation
5	Equipment, Tools and Materials	5	Equipment, Tools and Materials
6	Building and Material Science	4	Building and Material Science
7	Remediator Qualifications		
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Standard for Professional Mold Remediation S520

1 Scope, Purpose and Application

1.1 Scope

This Standard describes the procedures to be followed and the precautions to be taken when performing mold remediation in residential, commercial and institutional buildings, and the systems and personal property contents of those structures.

The Standard explains mold remediation techniques, the principles of which may apply to other microbial remediation projects or services. This Standard assumes that determining and correcting the underlying cause of mold contamination is the responsibility of a property owner and not the remediator, although a property owner may contract with a remediator or other professional to perform these services.

1.2 Purpose

It is the purpose of this Standard to define criteria and methodology to be used by remediators for inspecting mold contamination and establishing remediation procedures and safety plans.

Because of the unique circumstances encountered in mold remediation projects, it is impractical to prescribe procedures that apply to every situation. In certain circumstances, deviation from portions of this Standard may be appropriate. Carelessness is unacceptable and common sense and professional judgment are to be exercised in all cases.

Among other things, S520 does not address *Histoplasma capsulatum*, *Cryptococcus neoformans,* hanta virus, animal-derived pathogens or other highly infectious agents, including those from bird and bat droppings. Refer to the Center for Disease Control (CDC) or the National Institute for Occupational Safety and Health (NIOSH) for appropriate decontamination procedures for these contaminants. See, for example, *Histoplasmosis, Protecting Workers at Risk,* NIOSH and NCID, U.S. Department of Health and Human Services, 2004.

In addition, this Standard does not specifically address the protocols and procedures for restoration, remediation, or abatement when potentially hazardous, regulated materials are present or likely to be present in water-damaged or contaminated structures, systems and contents. Such potentially hazardous, regulated materials include, but are not limited to: asbestos, lead, arsenic, mercury, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, radiological residues, and other chemical and biological contaminants.

1.3 Application

This Standard was written for use by those involved in the mold remediation industry, primarily for mold remediation companies and workers, and secondarily, for others who inspect or assess mold complaints, prepare remediation specifications, protocols, or procedures, and manage remediation projects (e.g., indoor environmental professionals or IEPs). Finally this document is for other materially interested parties (e.g., consumers and occupants, property owners and managers, insurance company representatives, government and regulatory bodies).

2 References

Portions of the following documents are referenced herein and thereby constitute provisions of this Standard and Reference Guide. At the time of publication, the references as cited were current. All cited references are subject to revision, and those using this Standard are directed to investigate the necessity of applying the most recent editions or amendments of the references indicated below:

29 CFR 1910, Occupational Safety and Health Standards for General Industry, U.S. Department of Labor

29 CFR 1926, Occupational Safety and Health Standards for the Construction Industry, U.S. Department of Labor

40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAP), U.S. Environmental Protection Agency

ACR 2006, *Assessment, Cleaning and Restoration of HVAC Systems*, National Air Duct Cleaners Association, 2006*

ASHRAE Standards 62.1 or 62.2

ASTM D-1653, Standard Test Methods for Water Vapor Transmission of Organic Coating Films

Bioaerosols: Assessment and Control, American Conference of Governmental Industrial Hygienists, 1999

Field Guide for Determination of Biological Contaminants in Environmental Samples, American Industrial Hygiene Association, 2005

A Guide for Mold Remediation in Schools and Commercial Buildings, US Environmental Protection Agency, 2001

Protecting the Built Environment: Cleaning for Health, Michael A. Berry Ph.D., 1993

IICRC S100 Standard and Reference Guide for Professional Carpet Cleaning, Fourth Edition, Institute of Inspection, Cleaning and Restoration Certification, (S100)*

IICRC S300 Standard and Reference Guide for Professional Upholstery Cleaning, First Edition, Institute of Inspection, Cleaning and Restoration Certification, (S300)*

ANSI/IICRC S500 Standard and Reference Guide for Professional Water Damage Restoration, Third Edition, Institute of Inspection, Cleaning and Restoration Certification, (S500)*

Safety Requirements for Confined Spaces, American National Standard Institute, ANSI Z117.1-1989Occupational, Safety and Health Administration, (OSHA) General Duty Clause, 29 USC 654, §5

OSHA Technical Manual TED 1-0.15A, Section III, Chapter 4

Damp Indoor Spaces and Health, the Institute of Medicine (IOM) of the National Academies of Science, (IOM, 2004)

Other reference materials used in the S520 are listed in the Source Acknowledgments of this document or listed as appropriate in the References at the end of the Chapters of the Reference Guide.

*The referenced documents indicated with an asterisk above are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

3 Definitions

actual growth: molds that have colonized a substrate, formed fungal mycelia, growth structures and spores; are active or dormant, visible or hidden.

air filtration device (AFD): depending on the mode of use, an AFD that filters (usually HEPA) and recirculates air is referred to as an air scrubber. One that filters air and creates negative pressure is referred to as a negative air machine.

assessment: a process performed by an indoor environmental professional (IEP) that includes the evaluation of data obtained from a building history and inspection to formulate an initial hypothesis about the origin, identity, location and extent of amplification of mold contamination. If necessary, a sampling plan is developed, and samples are collected and sent to a qualified laboratory for analysis. The subsequent data is interpreted by the IEP. Then, the IEP, or other qualified individual, may develop a remediation plan.

can: when the term *can* is used in this document, it signifies an ability or possibility open to a user of the document, and it means that a referenced practice or procedure is possible or capable of application, but is not a component of the accepted “standard of care” to be followed.

Condition: for the purpose of this Standard, Conditions 1, 2, and 3 are defined for indoor environments relative to mold.

Condition 1 (normal fungal ecology)**:** an indoor environment that may have settled spores, fungal fragments or traces of actual growth whose identity, location and quantity are reflective of a normal fungal ecology for a similar indoor environment.

Condition 2 (settled spores)**:** an indoor environment which is primarily contaminated with settled spores that were dispersed directly or indirectly from a Condition 3 area, and which may have traces of actual growth.

Condition 3 (actual growth): an indoor environment contaminated with the presence of actual mold growth and associated spores. Actual growth includes growth that is active or dormant, visible or hidden.

containment: a precaution used to minimize cross-contamination from affected to unaffected areas by traffic or material handling. Containment normally consists of 6-mil polyethylene sheeting, often in combination with negative air pressure, to prevent cross-contamination.

contaminated (contamination): the presence of indoor mold growth or mold spores, whose identity, location and quantity are not reflective of a normal fungal ecology for similar indoor environments, and which may produce adverse health effects, cause damage to materials or adversely affect the operation or function of building systems.

cross-contamination: the spread of contaminants from an affected area to an unaffected area.

engineering controls: using methods, equipment or containment in such a manner that they limit the exposure of remediation workers and occupants to contaminants and prevent the introduction of contaminants to surrounding uncontaminated areas and contents.

fungus (plural "fungi"): one of the kingdoms into which living things are categorized. Fungi have distinct nuclei and include a variety of types, such as molds, mildews, yeasts, and mushrooms.

HEPA: an acronym for “high efficiency particulate air/arrestance”, which describes an air filter that removes 99.97% of particles at 0.3 microns in diameter.

HVAC: an acronym for “heating, ventilating and air-conditioning”.

indoor environmental professional (IEP): an individual who is qualified by knowledge, skill, education, training, certification and experience to perform an assessment of the fungal ecology of structures, systems and contents at a job site, create a sampling strategy, sample the indoor environment and submit to an appropriate laboratory, interpret laboratory data and determine Condition 1, 2 or 3 for the purpose of establishing a scope of work and verifying the return of the job site to Condition 1.

inspection: the gathering of information regarding the mold and moisture status of the building, system, contents or area in question.

materially interested parties: an individual or entity substantially and directly affected by a mold remediation project.

may: when the term *may* is used in this document, it signifies permission expressed by the document, and means that a referenced practice or procedure is permissible within the limits of this document, but is not a component of the accepted “standard of care” to be followed.

mold: a group of microscopic organisms that are a part of the Fungi Kingdom. They generally reproduce by means of spores and are ubiquitous. Often, the terms mold and fungi are used interchangeably.

normal fungal ecology (Condition 1): an indoor environment that may have settled spores, fungal fragments or traces of actual growth whose identity, location and quantity are reflective of a normal fungal ecology for a similar indoor environment.

personal protective equipment (PPE): safety items designed to prevent exposure to potential hazards. Examples include: respirators, gloves, goggles, protective clothing and boots.

post-remediation: following remediation; after removing contaminants and contaminated materials.

post-remediation evaluation: an inspection performed by a remediator after a remediation project, which can include visual and olfactory methodologies to confirm that the remediation process has been completed.

post-remediation verification: an inspection and assessment performed by an IEP after a remediation project, which can include visual inspection, odor detection, analytical testing or environmental sampling methodologies to verify that the structure, system or contents have been returned to Condition 1.

preliminary determination: a conclusion drawn from the collection, analysis and summary of information obtained during an initial inspection and evaluation to identify areas of moisture intrusion and actual or potential mold growth.

quality control: activities performed by a remediator that are designed to assure the effectiveness of the remediation process.

recommended: when the term *recommended* is used in this document, it means that the practice or procedure is advised or suggested.

remediation: the process of removing contamination consistent with this Standard.

remediation contractor: the remediation company or firm that is responsible for the remediation project.

remediator: when the term "remediator" is used in the S520, it refers to either the remediation contractor or the remediation worker.

shall: when the term *shall* (previously "must") is used in this document, it means that the practice or procedure is mandatory due to natural law or regulatory requirements, including occupational, public health and other relevant laws, rules or regulations, and is therefore a component of the accepted "standard of care" to be followed.

should: when the term *should* (previously "highly recommended") is used in this document, it means that the practice or procedure is a component of the accepted "standard of care" to be followed, while not mandatory by regulatory requirement.

standard of care: practices that are common to reasonably prudent members of the trade who are recognized in the industry as qualified and competent.

4 Principles of Mold Remediation

There are five general principles used in the remediation of mold-contaminated structures and materials. Applying these principles may require a multi-disciplinary approach involving professionals from several fields of expertise.

4.1 Provide for the Safety and Health of Workers and Occupants

When it has been determined that an indoor environment is contaminated with mold, remediation workers shall be protected from exposure. Engineering controls and work practices are the primary means for preventing exposure. Appropriate respiratory protection or other personal protective equipment (PPE) shall be used in conjunction with engineering controls to protect workers when engineering controls are insufficient, as indicated in 29 CFR 1910.134(a)(1). Reasonable efforts should be made to inform occupants of and protect them from similar exposure as a result of investigation and remediation activities. Employers shall identify safety and health issues prior to commencing work.

4.2 Document the Conditions and Work Processes

Environmental conditions and work processes associated with mold remediation should be documented.

4.2.1 Assessment

When a preliminary determination indicates that mold contamination exists or is likely to exist, an assessment should be performed prior to starting remediation. An independent IEP who has no business affiliation with the remediator should be used for this purpose. In circumstances where an entire building or system is fully involved as a result of Condition 3 mold contamination or when the scope of work can be determined without sampling or independent IEP inspection and assessment, engagement of an IEP for assessment may not be necessary. Furthermore, some mitigation services may be initiated before or during assessment of conditions or performance of remediation processes. Notwithstanding the foregoing, if health issues are discovered or apparent that seem to be related to the actual or suspected mold contamination, an IEP or other appropriate professional should be engaged by the property owner and the extent and Condition (1, 2 or 3) to which areas of the structure, systems and contents are potentially mold-contaminated should be assessed, documented, and reported to the client.

4.2.2 Documentation During Remediation

The conditions and work processes should be documented on an on-going basis during remediation work.

4.2.3 Post-Remediation Documentation

The return of the remediated portion of the structure and salvable contents to Condition 1 should be documented before the structure is rebuilt or the contents reused.

4.3 Contamination Control

The spread of mold contamination should be controlled as close as practical to its source. Methods of controlling the spread of contamination are further defined herein.

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

4.4 Contamination Removal

Physically removing mold contamination is the primary means of remediation. Mold contamination should be physically removed from the structure, systems and contents to return them to Condition 1. Attempts to kill, encapsulate or inhibit mold instead of proper source removal generally are not adequate.

Remediated structures, systems and contents can be considered clean (post-remediation evaluation) when contamination, unrestorable contaminated materials and debris have been removed, and surfaces are visibly free of dust. The term “visibly” can include direct and indirect observation (e.g., using a white or black towel to wipe a surface to observe for cleanliness). Also, remediated areas should be free of malodors associated with microorganisms. At that point, it is probable that the structure, systems and contents have been returned to Condition 1.

After a post-remediation evaluation, the remediated structures, systems and contents are ready for post-remediation verification. When verification that the structure, systems and contents have been returned to Condition 1 and when it is requested or required, a post-remediation verification should be performed by an independent IEP.

4.5 Contamination Prevention

To prevent recontamination or future contamination, the moisture problem that contributed to the mold growth shall be identified and corrected or controlled as soon as practical . Affected salvable materials should be dried to acceptable moisture content following the current ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration* (S500).

5 Equipment, Tools and Materials

Before mold remediation work can begin, remediators should be familiar with and have access to certain equipment, tools and materials required to accomplish their work.

Since this document is not designed to be a training manual, remediators should have specialized training in using and operating equipment, tools and materials during mold remediation work.

Remediators shall follow manufacturer instructions and label directions for the safe and proper use of equipment, tools and materials.

5.1 Inspection/Monitoring Tools

Before remediation procedures begin, it is necessary to determine the status of the structure, systems and contents during the inspection process. When using tools for inspecting and monitoring remediation projects, the same tool should be used in the same general location to allow consistent data collection and to promote more accurate project monitoring and post-remediation evaluations.

5.2 Thermo-hygrometer

Temperature and relative humidity readings taken during a project should be recorded to document environmental conditions within the remediated space before and during the project. Readings can be taken inside and outside the contained area. If readings indicate conditions that are likely to promote microbial growth, remediators should take steps to control the environment. Because differences in calibration can occur from one piece of equipment to the next, the same thermo-hygrometer should be used to monitor conditions throughout a project.

5.3 Moisture Sensors

A moisture sensor (probe) typically has penetrating pins and produces an audible or visible signal. Generally, it is used to indicate elevated moisture in various materials. Because moisture meter sensor pins penetrate materials, remediators should consider and mitigate where possible potential collateral damage before use. Contaminants in materials (e.g., animal urine) or materials that are naturally conductive can give false indications of moisture.

5.4 Moisture Meters

Remediators should use properly calibrated moisture meters, in accordance with manufacturer specifications, to determine the presence of moisture which can indicate the potential for mold growth and amplification on structural materials. Readings should be taken on materials that are considered to be at acceptable moisture content or have a known moisture content. These readings can be used as target drying goals or dry standards against which all other readings can be compared.

5.5 Infrared (IR) Thermometers and Thermal Imaging Devices

Infrared (IR) cameras and infrared thermometers are used to detect surface temperature differences and do not detect moisture or measure moisture through materials. Suspect areas identified with an IR camera should be verified by other means, such as using a moisture meter. Remediators using infrared thermography equipment in surveying buildings for moisture damage should receive proper training on its use.

5.6 Structural Cavity Drying Systems

Structural cavity drying systems carry many of the same risks as air movers and axial fans in that they can spread contamination. When drawing moist air out of potentially contaminated cavities using negative pressure, an in-line HEPA filter should be used to remove contamination before exhausting the air into the structure. A potentially contaminated cavity should not be positively pressurized.

The possibility of cross-contamination due to a breach should be considered when routing exhaust in any ducting material through a non-contaminated area.

5.7 Supplemental Mechanical Systems

Supplemental mechanical systems may be required during mold remediation projects when combustion-type mechanical systems (e.g., natural gas, fuel oil) or other services are disconnected or removed from service. Supplemental systems can include heating and air conditioning equipment, power generators and domestic water heaters. Supplemental equipment of this type shall meet applicable federal, state, provincial and local laws, regulations and codes.

5.8 Post-Remediation Materials, Considerations and Alternative Methodologies

Physically removing mold contamination is the primary means of remediation. Mold contamination should be physically removed from the structure, systems and contents to return them to Condition 1. Before implementation or adoption of new, innovative or alternative mold remediation methodologies, whether specified or requested, remediators should evaluate whether or not such methodologies are consistent with the *Principles of Mold Remediation*, the goals of a specific remediation project, and carefully consider the potential benefits and consequences from use. In addition, use of a particular product or technique in the industry does not necessarily equate to remediation efficacy.

5.8.1 Chemicals (Antimicrobials and Biocides)

There are a variety of chemical products available for professional mold remediation, and remediators should be familiar with the advantages and disadvantages of the using these products along with customer concerns and preferences.

Source removal of mold contamination should always be the primary means of remediation. Indiscriminate use of antimicrobials, coatings, sealants, and cleaning chemicals is not recommended.

5.8.1.1 Limitations of Use

Antimicrobials are not to be used as an alternative to proper cleaning procedures and physical removal of mold contamination. Antimicrobials should only be used in conjunction with proper cleaning, and should not be used indiscriminately. For thoroughly cleaned non-porous building materials, antimicrobials are generally not needed. It is important to note that killing mold and fungal spores does not eliminate the contaminants or contaminated material's allergenic or toxigenic properties.

5.8.1.2 Antimicrobial Application Considerations

Antimicrobials (biocides) can harm humans, pets and wildlife if used improperly. When using antimicrobials in a post-remediation application, for efficacy, safety and legal liability reasons, remediators shall follow label directions carefully and explicitly. In some countries, such as the United States, it is a violation of law to use these products in a manner inconsistent with the label. In order to minimize potential liability, remediators shall:

- Only apply chemicals to treat microorganisms for which the product has been registered by appropriate governmental agencies;
- Only apply chemicals on those types of surfaces for which the product has been registered by appropriate governmental agencies (i.e., porous, semi-porous, non-porous);
- Only apply chemicals in those types of structures for which the product has been registered by appropriate governmental agencies (i.e., schools, hospitals, residential);
- Only apply chemicals for the purpose for which the product has been registered by appropriate governmental agencies;
- Comply with applicable training, safety, use and licensing requirements in their respective jurisdictions;
- Ensure that proper personal protective equipment (PPE) is available and worn by remediators who are engaged in antimicrobial (biocide) use and application;
- Not use such products in any heating, ventilating, air-conditioning, or refrigerating systems unless the product is specifically approved for that application by the appropriate governmental agencies;
- Apply products strictly in accordance with label directions, and
- Dispose of antimicrobials (biocides) according to label directions.

In addition, remediators should:

- Discuss potential risks and benefits with the customer, make available product information including the MSDS, and obtain a written informed consent with the customer's signature before applying any antimicrobial (biocide). Inquire about any pre-existing health conditions that might require special precautions. Advise customers to remove occupants and animals from the product application site, particularly children and those with compromised health;

- Document relevant biocide application details;

- Refrain from making statements or representations to the customer beyond those stated on the product label or in the efficacy claims made by the product and approved by the applicable government agency, and

- Clean treated surfaces of antimicrobial (biocide) residues, if required by the product label.

5.8.2 Antimicrobial Coatings and Sealants

Antimicrobial coatings and sealants should not be used in place of proper source removal of mold contamination, moisture control, and regular cleaning and maintenance, but can protect some materials from microbial growth.

Antimicrobial coatings and sealants should not create a vapor barrier that could lead to a buildup of moisture, and possibly contribute to a future microbial or structural problem. Products should demonstrate reasonable permeability as tested under ASTM D-1653 (minimum 1.0 perms). Antimicrobial coating and sealant products should be water-based, low odor, and contain low volatile organic compounds (VOCs).

5.8.2.1 Limitations of Use

Antimicrobial coatings and sealants are only effective when applied to surfaces that have been properly cleaned, and disinfected/sanitized when appropriate. A layer of dirt and debris accumulated on treated materials or surfaces can act as a physical barrier between the coating or sealant film and a microorganism, and eliminate product effectiveness.

Mold-resistant coatings should not be used as 'sealants' or 'encapsulants' to contain or cover active, viable mold growth. Failure to properly clean and remove mold can permit continued growth beneath the coating, as the active ingredients in these products inhibit growth only on or in the coating film.

Fungicidal coatings should not be used as 'sealants' or 'encapsulants' to contain or cover active, viable mold growth. Fungicidal coatings are only effective as an antimicrobial after visible growth has been removed and the surface has been cleaned. Some jurisdictions might require users of fungicidal coatings to be licensed pesticide applicators.

Where concern exists that an opaque coating or sealant may be used to cover up mold contamination without proper cleaning, a clear or translucent product may be used to allow visual post-inspection of the treated surfaces.

Coatings and sealants should only be applied after post-remediation evaluation and verification has verified the return to Condition 1. If antimicrobials, fungicidal coatings, mold-resistant coatings or sealants are used, and concerns exist that there could be future recurrence, the use of non-pigmented (clear) coatings could permit future visual inspection of treated surfaces.

5.8.3 Heat

Methods involving controlled application of heat to a structure have been reported to be an effective form of biological control, which might or might not kill some fungal spores and vegetative structures. This process is a developing technology and should be evaluated and understood before use. It is important to note that killing mold and fungal spores has not been shown to eliminate the contaminants or their allergenic or toxigenic properties.

6 Building and Material Science

Remediators should understand building systems and related physical laws in order to remediate a contaminated building and return it to its intended function. Building and material science addresses the materials and interrelated systems that create structures in our built environment. It also addresses how buildings respond to different climatic environments. Climatic and regional variables include rainfall, temperature and relative humidity. Such variations can necessitate that remediators use different equipment and techniques when remediating similar structures.

A properly constructed building envelope acts as a physical separator between the interior of the built environment and the effects of outside climatic conditions. However, the actions of remediators can force outside conditions to come into the built environment. The result can be either positive or negative with respect to the goals of a mold remediation project. Remediators should have a basic understanding of how a building envelope works and the interaction of building assemblies and coatings, in order to properly remediate damaged components.

It is complex and expensive for buildings to be constructed to function optimally in a single climatic zone during all seasonal conditions within a calendar year. Due to the variations within a single year or season, the building construction may be more or less appropriate with respect to prevailing ambient conditions. It follows that drying and remediation techniques will not be the same at all times of the year in all of these regions. Due to these varying climatic conditions, it is necessary for remediators to combine science and abilities with professional judgment to successfully remediate mold-contaminated structures.

Building components are interrelated so that even a small change in one component can have a dramatic and potentially unexpected effect on the entire building. The interaction of these components affects the safety and health of occupants and the function and durability of a building.

6.1 Wall, Floor and Ceiling Assemblies

It is important for remediators to understand the construction of wall, floor and ceiling assemblies and the effect of moisture on materials to facilitate making educated decisions about drying and remediation. Knowledge of construction materials and their applications for strength, function, sound transmission and fire ratings all affect decisions as to how a building or structure can be properly dried and remediated. Since all components of a building are interrelated, it is recommended that remediators attempt to discern the intent of the design and construction of a building during a remediation project, and address those aspects individually and collectively.

6.2 Elements of Airflow

It is important for remediators to understand the elements of airflow because it is a key transport mechanism for moisture, mold spores and fragments. In order for a given volume of air to enter a building, an equal volume of air must leave. The type of building design and construction will influence where air will enter or exit, and how moisture and contaminants can be controlled or removed. The better a remediator understands the mechanisms of air ingress, egress and passage through a structure, the more efficiently and effectively the remediation process can be planned and executed.

All structures have planned openings (e.g., doors, windows, vents) and unplanned openings (e.g., cracks, crevices, gaps, material shrinkage, and utility penetrations). Planned openings can be designed to either add or remove air from a building. If designed properly these openings do not compete for air. In order for air to move into or out of an enclosed space, such as a building or portion of a building, there must be an opening and a driving or pulling force. At times, these forces may be unexpected and potentially dangerous.

Caution should be used when blocking, sealing, or restricting airflow, or reversing the direction of airflow through a planned opening. Serious safety and health problems can result. If large amounts of air are drawn out of a building, the probability of combustion appliances backdrafting or experiencing flame rollout is increased.

There are always unplanned openings in a building. If accompanied by a driving force, an unplanned opening can allow airflow into a building from garages, crawlspaces, attics or other air spaces. Driving forces, such as wind, heat/stack pressure, fans and duct systems, can affect the indoor environment and a building system.

6.3 Mechanisms of Moisture Flow

Understanding the four mechanisms of moisture flow is helpful in determining where and how moisture gets into a building, and is necessary when devising an effective remediation plan. The four mechanisms of moisture flow are liquid flow (bulk water), air transport, vapor diffusion, and capillary action.

6.4 The Effects of Moisture on Materials

Remediators should be aware of the effects of moisture on building materials and the potential contamination from mold growth. Understanding how materials react to moisture allows remediators to more adequately devise a remediation plan. How materials react to moisture depends upon many factors (e.g., porosity, permeability, absorption, moisture holding capacity, evaporation rates, and susceptibility to damage and microbiological growth).

7 Remediator Qualifications

7.1 Licensing Requirements

Licensing requirements for mold remediation work vary by country, state, province and municipality. Remediators shall possess the necessary licenses to satisfy federal, state, provincial and local laws and regulations.

7.1.1 Business License

Local business licenses are frequently required for doing business. Remediators shall comply with state, provincial and local business licensing requirements.

7.1.2 Contractor's License

Companies that perform intrusive and destructive work might be required to obtain a General Contractor's License or a specialty license. These requirements vary widely, and are usually administered by a state contractors licensing board. Remediators shall comply with state, provincial and local contractors licensing requirements.

7.1.3 Specialty Contractor's License

Companies or individuals that are engaged in the cleaning of HVAC systems and the attached duct work might be required to hold a specialty license (e.g., mechanical, electrical). Such licenses are often issued on a state or provincial level. Remediators shall comply with state, provincial and local contractors licensing requirements.

7.2 Training and Certification

7.2.1 Training

Remediators are expected to be qualified by education, training and experience. Remediation workers should be trained in the principles of mold remediation as defined in this document, appropriate to their work responsibilities, including, but not limited to: safety and health, engineering controls, containment methods and appropriate work practices.

Depending on the project, additional training could be required by federal, state, provincial or local laws and regulations. Employers shall be familiar with these requirements and provide training for remediation workers in the recognition and avoidance of hazards they encounter. Employers shall also provide training regarding hazards in accordance with the company's written injury and illness prevention program, if applicable under federal, state, provincial and local laws and regulations. Training can include, but is not necessarily limited to:

- physical hazards;
- chemical hazards;
- microbial hazards;
- PPE, and
- building-related regulated substance (e.g., asbestos, lead) awareness.

7.2.2 Certification

Training alone does not imply or confer certification in the field of mold remediation. Credible certification requirements may include a combination of field experience, course work (including classroom attendance) and successful completion of a written examination. It is recommended that the certifying body be a recognized and established non-profit organization with experience in the remediation or restoration industry.

Various governmental bodies require certification as a requirement for performing mold remediation services, and remediators shall be aware of and comply with applicable laws and regulations. In the absence of specific legal requirements, certification is recommended for those engaged in mold remediation.

8 Safety and Health

Protecting the safety and health of remediators and building occupants is of paramount importance in mold remediation projects. In the United States and in other countries there are laws that require employers to comply with applicable safety and health regulations. This section addresses safety and health issues that employers shall comply with in the United States. Laws governing worker safety can be found in the Occupational Safety and Health Act (OSHA) and in regulations implementing the Act found in Title 29 of the Code of Federal Regulations (CFR). While these laws and regulations do not apply to remediators in other countries outside the United States, the principles referenced in these laws would apply to most, if not all, remediation projects regardless of geography.

8.1 Applicable Regulations

Applicable sections of the Federal safety and health regulations that can impact the employees of a remediation business include, but are not limited to, the following OSHA Standards found in Title 29 of the Code of Federal Regulations (CFR) parts 1910 and 1926:

- 29 CFR 1910 – General Industry Standards
- 29 CFR 1926 – Construction Industry Standards

The OSHA Standards for the Construction Industry (29 CFR 1926) require that no employee "shall work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his or her health or safety" (29 CFR 1926.10). Each state is required to use Federal OSHA as a minimum statutory requirement. Individual state and local governments may have additional safety and health requirements that are more restrictive than the Federal Occupational Safety and Health Act. Employers shall comply with these safety and health regulatory requirements. Safety and health plans shall be established as required by applicable laws, rules and regulations promulgated by federal, state, provincial and local governmental authorities.

8.1.1 General Regulations

Specific provisions addressed by these regulations include, but are not limited to, the following:

- emergency action and fire prevention plans;
- personal protective equipment;
- respiratory protection;
- asbestos abatement;
- lead-based paint abatement;
- heat disorders and health effects;
- bloodborne pathogens;
- confined work spaces;
- hazard communication;
- lockout/tagout procedures and electrical safety orders;
- fall protection;
- noise exposure, and
- scaffolds.

8.1.2 OSHA General and Specific Duty Clause

The OSHA "General Duty Clause" states that "Each employer shall:

- furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.
- comply with occupational safety and health standards promulgated under this Act."
  (See 29 USC 654, §5)

In the absence of a specific OSHA standard for mold remediation, it is important to recognize general principles of exposure prevention as they are covered in the "General and Specific Duty Clause," as well as to understand the current information available about health effects from occupational exposure in mold contaminated structures, systems and contents.

8.2 Emergency Action and Fire Prevention Plans

Emergency action and fire prevention plans (OSHA 29 CFR 1926.20 and 1910.38-39) are required for all work places, including mold remediation job sites. Requirements include, but are not limited to:

- communication and alarm systems;
- the location of the nearest hospital and fire station;
- emergency phone numbers (posted);
- shut down, evacuation and rescue procedures (posted);
- escape routes and signage (posted);
- use of less-flammable materials;
- use and placement of fire extinguishers, and
- a written program, if the employer has 20 or more employees.

8.3 Personal Protective Equipment (PPE)

According to 29 CFR 1910.132 employers shall provide their employees with the necessary PPE to reduce the risk of exposure to chemical, physical or biological hazards.

8.3.1 Routes of Exposure:

- inhalation (respiratory);
- contact with mucous membranes (eyes, nose, mouth);
- ingestion, and
- dermal (contact with skin).

8.3.2 Selecting PPE

Employers shall provide dermal and respiratory protection for employees entering a containment area where microbial contamination is present and remediation is being performed. The selection of PPE depends on the anticipated exposure, types of microbial contamination, activities to be completed and potential hazards of chemicals that may be used in the remediation process. Remediators should consult an IEP or other specialized expert, if there is a question regarding PPE selection. Employers should review accident and illness logs periodically to determine if the selection of PPE is appropriate or needs to be upgraded. PPE can consist of the following:

- respirator;
- eye protection;
- disposable coveralls including hood and booties;
- foot protection;
- hand protection;
- head protection, and
- hearing protection.

8.3.2.1 Respirator Use and Written Respiratory Protection Plan

Employees shall wear respirators whenever engineering and work practice controls are not adequate to prevent atmospheric contamination at the job site. Untrained visitors to work sites should be warned of hazards and encouraged to not enter the worksite. If visitors insist or must enter a worksite, they should be encouraged to wear respiratory protection and other appropriate PPE if they are able.

Respiratory protection regulations are found at 29 CFR 1910.134. Respiratory protection program outlines written program requirements, and shall include, but not be limited to:

- selection and use of NIOSH approved respirators;
- medical evaluation;
- respirator fit testing;
- user instruction and training in the use and limitations of the respirator, prior to wearing it;
- designated program administrator, and
- cleaning and maintenance program.

8.3.2.1.1 Respirators

Respirators range from NIOSH approved N-95 filtering face-piece respirators, to full-face air-purifying respirators (APR) or powered air-purifying respirators (PAPR) equipped with HEPA filter cartridges and air-supplied respirators, such as self-contained breathing apparatus (SCBA). HEPA filter cartridges should be used to protect against fungal spores and fragments, bacterial spores, dust and particles. Organic vapor cartridges protect against microbial volatile organic compounds (MVOCs), and some chemicals used in other microbiological remediation projects. Cartridge selection should be based upon the chemicals that are present.

Air-purifying respirators (APR) or powered air-purifying respirators (PAPR) shall not be used in oxygen-deficient atmospheres or in other atmospheres that are immediately dangerous to life or health (IDLH).

8.4 Warning Signs

Where applicable warning signs shall be posted to Identify:

- egress means and exits (29 CFR 1910.37[q]);
- biological hazards (29 CFR 1910.145[e][4], [f][8]);
- caution (29 CFR 1910.145[c][2], [d][4]), and
- dangers (29 CFR 1910.145[c][1], [d][2], [f][5]).

Warning signs posted to identify hazards that might exist on the job site should list the following emergency-contact information: the remediation company name, remediation company address, 24-hour emergency contact number and the name of project supervisor.

When warning signs are posted on confined-space projects, they shall be printed with the date they were posted and the approximate date they are expected to be taken down or reassigned. Typical signs specifically related to remediation work can include, but are not limited to:

- Do Not Enter – Mold Remediation in Progress
- Caution: Slip, Trip and Fall Hazards
- Caution: Hard Hat Area
- No Unauthorized Entry

8.5 Asbestos

Asbestos safety regulations are found in OSHA Construction Standards 29 CFR 1926.1101 and General Industry Standard 1910.1001. These regulations shall be followed whenever a detectable amount of asbestos is encountered or presumed in the course of a remediation project.

Remediators are responsible for identifying and controlling asbestos exposure during demolition and removal of materials. If remediators encounter materials containing asbestos or presumed to contain asbestos that has been or potentially will be disturbed during the course of work activities, they shall stop activities that can cause the material to become friable or aerosolized. Qualified asbestos abatement contractors shall be engaged to perform the asbestos abatement. Many states and local governments require that asbestos inspections be performed by licensed or AHERA accredited asbestos building inspectors.

Both 29 CFR 1926.1101 and 1910.1001, state the regulations apply any time there is asbestos present. A clarification letter issued by OSHA states that this means "any detectable amount of asbestos" whether the amount present is greater than 1% asbestos containing material (ACM) or not. Both regulations also contain requirements for dealing with asbestos content determined to be less than 1%. (Standard Interpretations 11/24/2003 - Compliance requirements for renovation work involving material containing less than 1% asbestos).

8.6 Lead

Lead regulations are found in OSHA Standards 29 CFR 1926.62 and 1910.1025. Lead construction work includes work that involves lead-based paint or other structural materials containing lead; (e.g., emergency cleanup, demolition, repair or other work that could disturb the lead).

Remediators are responsible for identifying and controlling lead exposure during demolition and removal of materials. If remediators encounter lead-based paint during the course of their activities, they shall stop activities that can cause the material to become aerosolized and shall engage a qualified lead abatement contractor to perform the lead abatement.

8.7 Heat Disorders

Work activities involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities may result in an increased potential for inducing heat stress. Employees are at risk for heat induced stress particularly when engaged in activities in areas such as attics and crawlspaces, or when wearing PPE.

Remediators shall address prevention, and on-site response to heat disorders. For more information on heat related disorders, see OSHA Technical Manual TED 1-0.15A, Section III, Chapter 4.

8.8 Confined Space Entry

OSHA regulations addressing confined spaces are found in 29 CFR 1910.146 and 29 CFR 1926.21. Further guidance can be obtained from American National Standards Institute ANSI Z117.1-1989, *Safety Requirements for Confined Spaces.* A “confined” or “enclosed space” means any space that:

- is configured so that an employee can enter it;
- has limited means of ingress or egress, and
- is not designed for continuous occupancy.

If it is determined that the workplace is a confined space, then the confined space entry program shall include:

- determining if the space meets the definition of a Permit-Required Confined Space;
- identifying the confined spaces and hazards in the workplace;
- monitoring of atmospheric conditions in the space;
- instructing workers on the proper use of the safety equipment;
- defining the duties of the confined space entry team, and
- developing training requirements for employees who enter the confined space.

Permit-required confined space (permitted space) means a confined space that has one or more of the following characteristics:

1. it contains or has a potential to contain a hazardous atmosphere;
2. it contains a material that has the potential for engulfing an entrant;
3. it has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section, or
4. it contains any other recognized serious safety or health hazard.

If it is determined that the confined space is a Permit Required Confined Space, then the confined space shall have a posted permit and remediators shall comply with OSHA entry requirements.

8.9 Hazard Communication

The OSHA Hazard Communication Standard (29 CFR 1910.1200) requires that information concerning chemical hazards (physical or health hazards) be provided to employers by chemical manufacturers and communicated to employees by employers. This is accomplished by means of hazard communication programs (HCP), which include a written program, container labeling and other forms of warning, maintenance of material safety data sheets (MSDS), and annual chemical specific employee training prior to working with hazardous chemicals. Employee training shall include: how the HCP is implemented in the workplace; how to read and interpret information on labels and MSDS; hazards associated with the chemicals used in the workplace and the measures that employees shall take to protect themselves; and specific emergency procedures that are to be instituted.

Remediators working on multi-employer work sites shall:

- inform other employers of hazardous substances;
- inform other employers of means to protect their employees;
- provide access to MSDSs, and
- inform other employers of the labeling systems used.

8.10 Lockout/Tagout (Control of Hazardous Energy)

The OSHA Standard on the Control of Hazardous Energy (Lockout/Tagout), found in 29 CFR 1910.147, delineates steps employers shall take to prevent accidents associated with hazardous energy. This standard addresses practices and procedures necessary to disable machinery and prevent the release of potentially hazardous energy while maintenance or servicing activities are performed.

8.11 Safe Work Practices in Contaminated Buildings

Remediators should incorporate the following items into remediation work procedures:

- no eating, drinking, or smoking in any potentially contaminated or designated work area;
- remove protective gear and wash hands before eating, drinking, smoking, rest periods, using the bathroom and at the end of the work day;
- dispose of contaminated protective clothing with other refuse before exiting the containment;
- do not move used protective clothing from one area to another unless properly contained;
- wear latex or nitrile chemical-resistant or vinyl gloves while inside containment areas, designated work areas, or while handling bagged contaminated materials;
- wear a second pair of gloves (rubber, textile or leather work gloves) to protect against personal injury;
- use the buddy system when working in high heat, remote or isolated work spaces;
- address cuts, abrasions and first-aid blood-borne pathogen issues promptly, especially when sewage-damaged materials are present;
- discard gloves that are damaged, wash hands with soap and water, and inspect hands for injury, and
- dispose of used disposable gloves as contaminated material, along with contaminated debris.

Remediators shall incorporate the following items into their remediation work procedures where appropriate:

- tailgate meetings to discuss the daily work activities, including a review of safety issues;
- electrical safety practices (e.g., using Ground Fault Circuit Interrupters and lock-out tag-out);
- wear PPE appropriate to the hazards identified in the work area;
- inspect PPE prior to use;
- use protective disposable coveralls with attached or separate shoe covers;
- don protective clothing before entering containment or other designated areas;
- repair or replace damaged personal protective equipment;
- workers are to be instructed as to job specific emergency plans including emergency exits;
- when an injury occurs, the injured worker and co-workers are to take the steps delineated in the company safety program;
- workers are to be informed about the location of emergency shower and eye-wash stations, and
- report injuries to a supervisor as soon as practical.

8.12 Immunizations and Health Affects Awareness

Remediators should consider reducing the risk of infectious disease to workers by referring them to their primary health care physician for information on available immunizations. Workers, who are at an increased risk for opportunistic infections, including but not limited to, those who are immunocompromised due to HIV infection, neoplasms, chemotherapy, transplantation, steroid therapy, or underlying lung disease, should be advised of the increased risk of disease due to their condition. Such workers are usually precluded from participating in remediation activities in mold-contaminated buildings. Employees who have medical conditions that are of concern (e.g., AIDS, HIV seropositivity, pregnancy) should be evaluated by a qualified physician for a recommendation regarding whether performing assigned remediation activities presents an unacceptable health risk.

9 Administrative Procedures, Documentation and Risk Management

Remediation project administration typically includes, but is not necessarily limited to:

- use of written contracts;
- good verbal and written communication;
- thorough project documentation and recordkeeping;
- appropriate methods to manage risk;
- responsiveness;
- an ability to understand and coordinate multiple tasks and disciplines, and
- a professional and ethical attitude.

It is recommended that remediators establish and consistently follow methods and procedures for project administration, including but not limited to, business and quality control systems and operational plans and protocols.

9.1 Contracts

Remediators should enter into an adequate written contract before starting a remediation project. Remediators should seek legal counsel for the development of a contract that includes appropriate terms and conditions, or when circumstances or situations dictate, the need for contract modifications, addendums or project-specific legal advice. Remediators should verify that contracts contain the elements necessary to form an enforceable contract under the laws of the applicable jurisdiction.

9.1.1 Recommended Contract Specifications

Although projects vary in size and scope and may have unique issues and complications, it is recommended that contracts specify the following, at a minimum:

- the identity and contact information of the client and materially interested parties;
- a description of work to be performed, which may include references to attached project specifications or other documents that specify the details of the work;
- description of and responsibility for repair of collateral or consequential damage;
- known limitations, complexities or potential complications of the project;
- permits required for the project;
- the respective duties and responsibilities of parties;
- the project start date and time and estimated time for completion of the work;
- the price or professional fees charged for the work or method for calculating them;
- the party responsible for payment and the terms of payment;

- provisions dealing with contract default and termination;
- whether or not an insurance company or surety is involved, and how claims will be handled;
- warranty and disclaimer provisions, if any;
- criteria for determining the effectiveness of remediation, and
- provisions relating to changes or additions to the work, including change orders.

It is recommended that contract documents be accurate and complete, free of ambiguity, and contain adequate disclaimers, reservations or recommendations when project uncertainties, limitations, complexities or complications exist, or are anticipated. In addition the contract should be dated and signed by all parties to the contract and each party should be given a copy of the contract as soon as reasonably practical. If a written contract is executed, it is recommended that each page of the contract be initialed by all parties to the contract.

Specific information, including the source and extent of the contamination is necessary to adequately define the scope of work and develop a work plan for a mold remediation project. Remediators should determine if the moisture problem at issue has been identified, controlled or repaired, and if not, to identify the process and party responsible for doing so. This determination may be delegated to a specialized expert as necessary (e.g., moisture intrusion expert, drying contractor, building envelope expert or other qualified tradesperson).

9.1.2 Changes to Contracts

Substantive or material changes from the original, agreed-upon contract or scope of work should be documented in a written and detailed change order, which includes a description of the changes to the work, time for performance, price or fees, and method of payment. Further, it is recommended that the client, or the client’s designated agent, and the remediator’s representative accept the change order in writing.

9.2 Communication

Communication between all materially interested parties is important on remediation projects. Many times the source of a dispute between parties is the failure of the parties to communicate clearly and adequately. It is recommended that materially interested parties agree on the purpose and subjects of project communication, the frequency and mode of communication, and with whom communications will be distributed. It is recommended that any significant items that could affect the job be discussed verbally and then reduced to writing and distributed to appropriate materially interested parties.

Remediation project communication may often involve professional advice, education and warnings. When providing such information, remediators should inform customers and occupants that any information provided is not to be construed as medical advice, directive or diagnosis. Customers and occupants who express health concerns or ask medical questions should be instructed to seek advice from qualified medical professionals or public health authorities. It is recommended that remediators not give advice, education or warnings on subjects outside their area of professional expertise.

9.3 Project Documentation and Recordkeeping

Documentation and recordkeeping are important in developing a remediation plan, executing the plan, and completing a successful remediation project, especially if there is a need to review or reconstruct the remediation process or project at some future time. Thorough documentation and recordkeeping should be performed and maintained throughout the remediation project. To properly document the remediation project, it is recommended that remediators attempt to obtain all pertinent project information developed before, during and after a remediator’s involvement in the project. It is also recommended that remediators document important communications, to reduce the possibility of misinterpretation.

Before the remediation project beings, remediators should attempt to obtain available environmental reports, remediation plans or protocols and other pertinent project documentation.

Remediators should establish and maintain a document retention program.

9.3.1 Required Documentation

Documents and records obtained and maintained by remediators shall include documents required by applicable laws, rules and regulations promulgated by federal, state, provincial and local governmental authorities.

9.3.2 Documentation that Remediators Should Create and Maintain

To the extent the documents exist, a remediator's documentation (which may include photographs) and recordkeeping should include, at a minimum, the following:

- the written remediation contract;
- the scope of work and remediation plan or protocol;
- materials related to project limitations on Standard compliance or deviations from Standard compliance (e.g., notices, agreements, disclosures, releases, waivers);
- environmental reports made available to remediators;
- written remediation recommendations or technical specifications from IEPs, industrial hygienists, inspectors and others acting in the capacity of consultants or advisors, if made available to remediators;
- contents and personal property inventories, both salvable and non-salvable, signed and dated by remediators and customer with both parties receiving copies of the documents as soon as reasonably practical;
- detailed work or activity logs, including a description of who did what, when, where, how and for what duration, including entry and exit logs, where applicable;
- equipment logs or similar documents that include a description of equipment and supplies used on the project (including biocides and antimicrobials), the quantity and length of time used (where applicable) and other relevant information;
- documents reflecting customer approval for the use of chemical compounds, including Material Safety Data Sheets for cleaners, antimicrobials and biocides;
- documentation of project safety and health elements (e.g., safety and health plan, occupant communication and worker "Right-to-Know" information; safety meetings; hazard signs; PPE; a general description of the nature and location of containment, negative air machines, air filtration devices, and the like, used on the project);
- records of pressure readings in and out of containment (if negative pressure is being used);
- change orders, if any, and
- estimates, invoices and bills.

9.3.3 Recommended Documentation

It is recommended that a remediator's documentation and recordkeeping include the following:

- administrative information (e.g., customers and materially interested parties contact information and call report records; copies of notices, disclosures, documents and information provided; notes or synopses of meetings that summarize the substance of the meetings and the decisions made, and which generally document the progress of the project; communication logs; important written communications [correspondence, e-mail messages and the like]; decisions to transfer project investigation to an IEP, or to involve an IEP, in a mold remediation project; background and qualification information for subcontractors or trades engaged by a remediator on a project, if any);
- subcontractor contracts, work specifications and change orders for subcontractors engaged by remediators on a project;
- insurance and financial information (e.g., identifying the party responsible for payment, and determining responsibility for collateral and consequential damage resulting from remediation);

- permits and permit applications (if available);
- building and contents information, including: property type (e.g., residential, commercial, industrial, institutional); the relationship of the customer to the property (e.g., owner, lessor, purchaser, property manager); building history (i.e., relevant known characteristics of the building or its history that materially affect the remediation process, including information about remodeling, renovation and maintenance issues); pertinent known information about the subject property (e.g., the cause and date of the moisture problem, a description of when and how the problem was discovered, leak detection reports, and description of previous remediation efforts);
- observations upon inspection (e.g., diagrams; moisture "mapping"; photography or videography of pre-existing conditions, water stains or damage, and areas of visible or suspected mold, or efflorescence);
- other relevant project or customer observations or perceptions (e.g., odors; condensation; relative humidity readings; temperature, moisture content or moisture levels of structural materials, and health complaints);
- contact information for employees, known visitors or occupants, IEPs, industrial hygienists, inspectors, adjusters, claims representatives and other materially interested parties who enter contained areas or who participate in the remediation process or its administration;
- lien notices and lien releases (if applicable), and
- certificate(s) of completion.

9.3.4 Documentation of Limitations and Deviations

A client or customer may request or refuse some services that prevent a remediator from complying with remediation plans or protocols, or the requirements and recommendations of this Standard (see Chapter 9, *Limitations, Complexities, Complications and Conflicts* and Chapter 11, *Structural Remediation*). When proceeding under such circumstances, there is a heightened risk of future conflict with a client or customer, which can create potential liability for a remediator. If a remediator decides to proceed with the project despite limitations on compliance with this Standard, they should adequately document the situation and circumstances, which may include advising the client or customer of the potential consequences of such noncompliance in writing and attempting to obtain a written waiver and release of liability for those potential consequences.

It is recognized that remediation projects are unique, and that in certain circumstances, common sense, experience and professional judgment may justify deviation from this Standard. It is the responsibility of remediators to determine and verify on a case-by-case basis that application of this Standard is appropriate. When material deviation from this Standard is warranted, it is recommended that remediators adequately document the situation and circumstances, which when appropriate may include notices and disclosures to the client or customer, or obtaining consent, approval, waiver or release of liability from the client or customer.

9.4 Recordkeeping and Record Retention

Remediators shall maintain remediation project documentation for the time required by record retention laws and regulations of applicable jurisdictions, if any. It is also recommended that remediation project documentation be maintained for the longest applicable statute of limitations in the relevant jurisdiction, at a minimum. In some circumstances, it may be appropriate to maintain remediation project documentation indefinitely. It is recommended that remediators obtain advice from qualified counsel regarding timeframes for document retention. The method of recordkeeping and record retention is beyond the scope of this document.

9.5 Emergencies

In some circumstances, remediation projects are conducted on an emergency basis. Emergency situations may impede project communications or limit the opportunity to document the project as described in this chapter. However, once an emergency situation is resolved, to the extent practical , remediators should attempt to complete the appropriate documentation and correct communication deficiencies caused by the emergency.

9.6 Insurance

9.6.1 Customer/Client Insurance

The interpretation of an insurance policy is outside the scope of a remediator's responsibility and expertise. It is recommended that mold remediation companies refrain from analyzing and interpreting insurance policies. It is recommended that such matters be referred to an appropriate insurance professional or attorney.

9.6.2 Risk Management

Prudent business management in the remediation field includes an awareness of risk and potential exposure to liability, and the application of various management tools. It may be appropriate for remediators to consider developing a formal Risk Management Program.

It is recommended that remediators obtain and maintain adequate insurance with sufficient amounts of coverage for the remediation work they perform. In some jurisdictions, remediators are required by law to obtain and maintain certain types of insurance in certain minimum amounts. Remediators shall determine and comply with governmental insurance requirements related to their business operations. It is recommended that remediators consult with credentialed environmental insurance specialists, in addition to their local insurance agent, to ensure that appropriate insurance coverage is placed for their business operations. Because insurance related to the remediation industries is rapidly evolving, it is incumbent upon remediators to stay abreast of insurance industry developments impacting their businesses.

10 Inspection and Preliminary Determination

An inspection is primarily an information gathering process that typically includes a physical inspection of affected premises for moisture problems and potential mold contamination. After the initial inspection is completed, remediators develop a "preliminary determination", which is a conclusion that identifies actual or potential mold growth, known or suspected areas of moisture intrusion, and the need for assistance from other specialized experts such as an IEP to conduct assessments or to perform necessary services beyond the expertise of the remediator. The preliminary determination performed by the remediator, and assessments performed by an IEP (if any), provide the basis for developing work plans, protocols and specifications.

10.1 Qualifications

Remediators are expected to be qualified by education, training and experience to appropriately execute the skills and expertise required to safely remove mold contamination from structures, systems and contents, and to restore Condition 2 or 3 structures, systems and contents to Condition 1. Remediators should be qualified by education, training and experience in water damage restoration and inspection. It is recommended that remediators have a basic knowledge of building science as it applies to moisture intrusion.

Remediators should perform only those services that they are qualified to perform. If situations arise where there is a need to perform services beyond their expertise, remediators should engage specialized experts or other support services, or recommend to customers or clients that appropriate specialized experts be retained, in a timely manner.

Remediators should not act as their own IEP. In addition, remediators shall comply with applicable federal, state, provincial and local laws and regulations relating to the services that they perform.

10.2 Initial Contact

Inspections for moisture problems that may have resulted in mold growth can begin in many ways and be initiated by any number of parties for a variety of reasons. When mold contamination is discovered, a building moisture inspection and evaluation should be conducted promptly.

10.2.1 Health Complaints

The inspection process is not intended to be an exposure assessment, and as such is not intended to address occupant health complaints or risks. However, if occupants express health concerns or have medical questions during the inspection process, remediators should instruct them to seek advice from qualified health care professionals, public health authorities, or IEPs. It is recommended that remediators not give advice, education or warnings on subjects outside their area of expertise.

10.3 Inspection Process

The inspection process includes, but is not necessarily limited to gathering information, and conducting a physical inspection of the affected premises for moisture problems and potential mold contamination. The inspection process can require a multi-disciplined approach involving specialized experts from various fields. The inspection process is not intended to be an exposure assessment, and as such is not intended to address occupant health complaints or risks.

10.3.1 Information Gathering

Remediators should make a reasonable attempt to obtain available background information on the affected premises, including a building history. This information can help establish a building inspection strategy.

Occupant health concerns or conditions can be an important part of the information gathering process and can serve several purposes including: determining the need for additional occupant protection; the need to involve an IEP or other specialized expert; or the need for occupant referral to a qualified health care professional or public health authority. It is recommended that remediators not give advice, education or warnings on subjects outside their area of expertise.

10.4 Building Inspection

A physical site inspection or a walk-through of affected premises should be performed in order to gather information about the condition of a property that can lead to a preliminary determination about the presence of moisture and mold. The building inspection can include, but is not limited to, looking for: water intrusion or condensation, water stains, structural damage, HVAC operation, odors, construction type, previous repairs or remodeling, and structure defects.

Contamination is actual growth that can be active or dormant, visible or hidden, in the form of settled spores or a combination thereof. Regardless of the quantity of visible mold growth and extent of water damage, remediators should attempt to obtain enough information to locate or predict the approximate extent of associated concealed or non-visible mold contamination. Obtaining a building history and performing an inspection assists in locating concealed mold contamination. In order to locate potentially concealed mold, remediators should identify, to the extent practical, the pathway(s) of the water intrusion in the affected premises.

It is recommended that remediators have a basic knowledge of building science as it applies to moisture intrusion and air pathways. A building moisture inspection should be performed and documented in accordance with ANSI/IICRC S500, *Standard and Reference Guide for Professional Water Damage Restoration*.

In some cases during the inspection process, remediators may need to conduct intrusive activities. Remediators shall check with local regulatory agencies to determine whether or not permits or licenses are required for such activities. Where visible or suspected mold growth is present or potentially disturbed, immediate containment, other engineering controls and personal protective equipment (PPE) should be considered during the inspection process. Such decisions should be based upon the remediator’s professional judgment and shall be consistent with applicable laws and regulations and the guidance set forth elsewhere in this document.

During the inspection process, the presence of hazardous or regulated materials that might be disturbed during the remediation process shall be determined. Remediators shall comply with federal, state, provincial and local laws and regulations regarding the handling of hazardous or regulated materials, such as asbestos or lead-based paints. In some states and countries, individuals who perform these types of investigations or remediation services shall have appropriate training and licensing.

10.5 Developing a Preliminary Determination

After the initial inspection is completed, the next step involves developing a preliminary determination. A preliminary determination is a conclusion that identifies actual or potential mold growth, known or suspected areas of moisture intrusion, the need for the assistance of an IEP to conduct a formal assessment of Conditions 1, 2 or 3, or whether other specialized experts to perform necessary services beyond the expertise of a remediator. Generally, the preliminary determination is made by a remediator, and is based upon the analysis and evaluation of information obtained during the initial inspection, and the exercise of professional judgment by a remediator.

A remediator should engage or recommend to customers that they engage an IEP when Condition 1, 2, or 3 cannot be determined by the remediator.

Remediators also should recommend to customers that they engage an IEP and other appropriate specialized experts (e.g., qualified health care professional) when health issues are discovered or apparent that seem to be related to the mold contamination. Furthermore, in all situations, remediators should exercise professional judgment in making appropriate recommendations.

10.5.1 Summary of Possible Preliminary Determinations

- Enough information is currently available to determine that Condition 1 exists throughout the structure, systems, or area, including contents, and therefore, no remediation activity is required.
- Enough information is currently available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, including contents, and therefore, work plans, protocols and specifications can be developed.
- There is not enough information available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, including contents, and therefore, the remediator should engage or recommend to the customer that they engage an IEP to assess the affected structure, systems, or area, including contents.

10.6 Developing Work Plans, Protocols and Specifications

The inspection information, preliminary determination, and assessments performed by an IEP, provide the basis for developing work plans, protocols and specifications, the development of which can necessitate the further assistance of an IEP or other specialized expert.

When preparing work plans, protocols and specifications for a mold remediation project, remediators should use the information contained in this document to determine the need for specific services and procedures. When developing work plans, protocols and specifications, at a minimum consideration should also be given to the following:

- containment;
- pressure differentials;
- hazardous or regulated materials;
- safety and health provisions;
- contents;
- contaminated material removal and handling;
- detail cleaning;
- disposal;
- post-remediation evaluation;

- post-remediation verification, and
- containment removal.

11 Limitations, Complexities, Complications and Conflicts

Remediators can be faced with conditions that present challenges to the work process, producing limitations, complications, complexities or conflicts. Remediators should have a thorough understanding of these issues and communicate them to appropriate parties.

11.1 Limitations

A “limitation” is a restriction placed by others upon a remediator that results in a limit on the scope of work, the remediation activities, or the outcomes that are expected. Before beginning non-emergency work, known or anticipated limitations and their consequences should be understood, discussed and approved in writing by remediators and the owner or owner’s agent.

Remediators should refuse to allow anyone other than the owner, or the owner’s agent, to impose limitations on the performance of a remediation project. If an attempt to impose a limitation is initiated by any other materially interested party, the owner or owner’s agent should be advised and provide approval before the limitation takes effect. Limitations should be defined in writing.

11.2 Complexities

A “complexity” is a condition that causes a project to be more difficult or detailed, but does not prevent remediators from performing work adequately. Before beginning non-emergency work, known complexities and their consequences should be understood, discussed and approved in writing by remediators and the owner or owner’s agent.

11.3 Complications

A “complication” is a condition that arises after the start of work and causes or necessitates a change in the scope of activities, because the project becomes more complex, intricate, or perplexing. The owner or owner’s agent should be notified in writing as soon as practical regarding complications that develop. The presence of project complications can necessitate a written change order.

11.4 Conflicts

“Conflicts” are limitations, complexities, or complications that result in a disagreement between the parties involved about how the remediation project is to be performed. Mutual agreements to resolve conflicts should be documented in writing, and releases, waivers and disclaimers should be reviewed by a qualified attorney.

11.5 Hazardous or Regulated Materials

The presence of a hazardous or regulated material on a project can present a limitation, complexity, or complication. The presence or potential presence of a hazardous or regulated material on a project shall be carefully evaluated to determine if remediators and remediation employees are qualified to work in that environment. Some hazardous or regulated materials require HAZMAT training, while others require more specific training and licensing or they may necessitate engaging a qualified specialized expert. Remediators shall avoid situations that result in an activity that is illegal, or which is likely to result in injury or adverse health consequences for workers or occupants.

11.6 Change Orders

Disputes can develop when contract additions or modifications are made while performing work, but are not adequately documented in writing. In order to protect all parties to a remediation contract, substantive changes in the scope of work, time frame, price or method of payment or other material provision of a contract should be documented in a written change order that details the changes. Further, it is recommended that the owner or the owner's designated agent and the remediator's representative accept the change order in writing.

11.7 Insurance

Remediators should be aware that the terms and conditions of their insurance coverage can create project limitations and complications. If applicable insurance does not cover the work anticipated at commencement of the project, a limitation can result if insurance is required. If a complication develops or is discovered after commencing project work, it is possible that resultant changes in the scope of work might not be covered by the remediator's insurance policy. Remediators should determine whether or not specialized insurance coverage is required for their operations.

11.8 Work Stoppage

In some situations, limitations, complexities, complications or conflicts can necessitate work stoppage. In the event an illegal or dangerous limitation, complexity or complication exists, occurs or is discovered on a mold remediation project, the condition shall be resolved immediately or the work stopped.

Remediators shall avoid situations that result in activities that are illegal or are likely to result in injury or adverse safety or health consequences for workers. Remediators should avoid situations that result in activities that are likely to result in injury or adverse safety or health consequences for occupants.

The reason for the work stoppage and the significant events leading to a work stoppage decision should be documented in writing. It is recommended that a work stoppage be reviewed by a qualified attorney.

12 Structural Remediation

Structural Remediation is defined as that portion of a remediation project that deals specifically with a building's structure and typically does not address a building's contents or HVAC components. Mold remediation procedures in a contaminated building are based on generally accepted industrial hygiene practices, and safety and health principles. These procedures describe safeguards and controls that assist in achieving remediation project goals.

Regulated materials, such as lead or asbestos, require specific mitigation or remediation protocols. The presence of these and other regulated materials take precedence over mold remediation, and they shall be addressed according to federal, state, provincial and local laws and regulations.

The remediation of different building materials (remediation methods) depends upon the ability of materials to absorb or adsorb moisture (i.e., whether or not they are porous, semi-porous or nonporous), the ability of the material to support fungal growth, and the structural integrity of the material. In addition, remediation methods can depend on exposed substrates or material layers with different porosities (composite materials). Thus, contaminated materials should be carefully evaluated before attempting mold remediation. If structural components have been compromised and require removal, a qualified structural engineer should be involved in decisions to remove such components.

12.1 Engineering Controls

Remediators should prevent cross-contamination and shall use engineering controls to help ensure worker safety and health in structural mold remediation projects. In accordance with generally accepted industrial hygiene principles and Occupational Safety and Health Act "OSHA" regulations and standards, engineering controls, not personal protective equipment, are the first line of defense for ensuring worker safety and health. Engineering controls may include, but are not limited to: source containment, isolation barriers, pressure differentials, dust suppression, and high efficiency particulate air (HEPA) filtration and vacuuming.

12.1.1 Isolation

Isolation can be achieved by covering a moldy surface with self-adhering plastic or by erecting physical barriers that separate affected from unaffected areas. Isolation barriers are commonly referred to as "containment barriers" or "critical barriers." Isolation barriers are usually constructed of polyethylene (poly) sheeting. HVAC registers, and building openings and fixtures in the mold remediation area should be sealed off to prevent cross-contamination. Fire retardant polyethylene with a minimum flame-spread rating of 25 should be used to reduce fire hazards and shall be used when required by applicable federal, state, provincial or local laws and regulations.

12.1.1.1 Containments

During mold remediation projects, containments generally are separated into three basic types: source containment; local ("mini") containment; and full-scale containment. Expanding containments may be necessary when additional mold contamination is discovered.

12.1.1.2 Source Containment

Source containment may be used:

- To address relatively small or limited areas of mold growth, or it can be used in combination with other engineering controls to reduce the amount of spore release and dust generation;
- Alone when mold growth is limited to small visible controllable areas where hidden mold growth is not anticipated, and
- Within areas of more extensive mold growth in conjunction with other forms of containment.

When there are small or limited areas of mold growth, and hidden mold growth is anticipated, a more extensive containment should be used.

12.1.1.3 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. In a local containment HEPA-filtered air filtration devices (AFDs), when used as negative air machines (NAMs), are installed to create negative pressure differentials in relation to surrounding areas. In 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.

12.1.1.4 Full-Scale Containment

Full-scale containments normally are used when significant or extensive mold growth is present or suspected, and where source and local containments cannot effectively control or eliminate cross-contamination. Critical barriers are established to separate unaffected from affected areas. Walls, ceilings, floors, cabinets, fixtures or other surfaces that cannot be cleaned effectively should be isolated with polyethylene barriers.

12.1.1.5 Decontamination Chamber

A decontamination chamber, sometimes referred to as a "decon unit" or "decon," is engineered to provide a transition space between the containment ("comtaminated area") and surrounding clean areas, and are used for:

- Entry to and exit from work area, and
- Decontaminating exterior surfaces of plastic bags or sheeting used to contain contaminated materials, remediation tools, and the exterior clothing of personnel when exiting the work area.

Decontamination chambers are intended to prevent cross-contamination to unaffected areas and to provide controls to maintain pressure differentials.

12.1.1.6 Containment Maintenance

Remediators should:

- Not disturb contaminated materials until containment is erected, a negative air system is installed, and the containment's performance is checked;
- Not remove containment until demolition, remediation, clean-up and post-remediation evaluation by the remediator and post-remediation verification by an IEP when required, have been completed;
- Maintain integrity of the containment throughout the remediation process including post-remediation evaluation;
- Monitor and document containment performance at appropriate intervals;
- Construct containment barriers so that if pressure differentials are lost, containment flaps will close to prevent losing control, and
- Stop work any time there is a breach in containment or loss of pressurization, and not resume work until the containment has been repaired and pressure differentials have been re-established.

It is recommended that any breach in the containment's integrity be reported immediately to a supervisor.

Remediators shall apply spray adhesives, if used, according to label instructions because propellant and adhesive can release chemicals that can be toxic or flammable.

12.1.2 Pressure Differentials

Pressure differentials are used to manage airflow. Professional judgment determines how airflow is managed and pressure differentials are applied. Contaminated areas should be negatively pressurized relative to unaffected or clean areas of the building to prevent cross-contamination. Generally, when pressure differentials are used, they should be created using HEPA filtered air filtration devices (AFDs) used as a negative air machines (NAMs).

Pressure differentials can be monitored by analog or digital manometers, smoke tube or pencils, or visual inspection. In sensitive environments, such as daycare or healthcare facilities:

- Alarmed or alert pressure differential monitoring systems with data logging capability should be used, and
- Multiple AFDs should be used when appropriate and operated on separate electric circuits where available.

12.1.3 Air Flow and Exchange Rates

Air exchanges are used to dilute airborne fungal concentrations in work or containment areas. This helps reduce worker exposure and facilitates the clean-up effort. Airflow direction should be from clean to contaminated areas. Industrial hygiene practices recommend a minimum of four air changes per hour for contaminant ventilation and dilution.

Pressure differentials in buildings can create hazards associated with fireplaces, laboratory hoods, and sewer lines, and can cause unintended airflow, such as drawing air from wall and ceiling voids or chases. Negative-pressure differentials in warm, humid climates or seasons can cause moisture and consequent dampness to enter indoor spaces. In cold climates, negative pressure can draw cold or freezing air into the indoor environment potentially creating unwanted condensation or freezing. The remediator should exercise care to avoid such unintended consequences when managing airflow on remediation projects.

12.1.4 Air Filtration Devices

Air moving devices with filters are referred to as air filtration devices (AFDs). AFDs can be installed to create negative or positive pressure differentials. When used to create negative pressure, they are referred to as negative air machines (NAMs). AFDs also may be used as air scrubbers. When using an AFD as an air scrubber, care should be taken to prevent positive pressurization of the contaminated area, thereby causing a release of contaminants into unaffected parts of the building.

Remediators should:

- Clean and inspect AFDs for proper performance prior to use at a job site;
- Vent exhaust air from HEPA AFDs outdoors. (If circumstances prevent exhausting the AFD outside, then a deviation from the standard may be necessary (e.g., using redundant HEPA AFDs in series) and it is recommended that particle monitoring be performed when discharging into occupied portions of a building);
- Inspect and re-secure, as necessary, all units and containment barriers if unexpected pressure drops occur;
- Cease all work if pressure has been lost, until the appropriate pressure differential is re-established;
- Select and install AFD filters according to equipment manufacturer specifications. The filter change frequency is determined by the work activity; amount of dust created and captured, and filter capacity. When the AFD is inside contained work area, the pre- and secondary filter changes should be performed with the unit operating. This prevents releasing contaminants from filters into the workspace. HEPA filters should be changed with the unit turned off in a negatively pressurized contained area, or by removing the AFD from the job site to an area that would not be adversely impacted by a release of contaminants;
- Seal the air intake side of an AFD used in a contaminated area before turning it off to avoid releasing contaminants. The intake side of an AFD that contains accumulated mold spores and fragments should remain sealed when not in operation and while being transported or stored, and
- Clean and dry the exterior of the AFD after use and prior to removal from the project site, and subsequently store the AFD in a dry environment.

12.1.5 HEPA Vacuums

Remediation workers should use HEPA vacuums when performing remediation. HEPA vacuum units are designed to effectively filter 99.97% of particles at 0.3 microns. Only well-constructed professional HEPA vacuums should be used in mold remediation projects. Regular shop-type or standard consumer vacuums should not be used for remediation, because they are not designed to prevent mold spores and fragments from passing through the equipment and re-entering the air.

Remediators should:

- Clean and check HEPA units for proper performance before being placed at the job site;
- Check hoses, filter bags and assemblies any time a drop in suction occurs or when the bag is changed;
- Service HEPA vacuum cleaners within the capture zone of an AFD, or outdoors using appropriate precautionary measures, and
- Before removing HEPA vacuums from containment areas, thoroughly clean the unit's exterior to remove dust/spores. This cleaning includes the exterior of the hose. Openings, such as filter and vacuum hose inlets, should be sealed with tape, or plastic and tape to prevent particles from escaping.

12.1.6 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 typically they should not be substituted for a HEPA vacuum during remediation. Other types of vacuums should not be used for most mold remediation work.

12.1.7 Misting

Misting is a method of atomizing water or other aqueous solutions into the air for the purpose of controlling airborne and surface particulates during remediation. If deemed acceptable, in the professional judgment of a remediator, misting may be considered for dust suppression and clean-up purposes, when applied in conjunction with adequate engineering controls.

When mold remediation occurs concurrently with asbestos abatement or other types of demolition where misting water is required, mold remediation shall 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.

12.1.8 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 Condition 2 or 3 portions of a building requires cleaning after use. It may be possible to precondition make-up air in Condition 1 areas of the building to provide dehumidification of the make-up air for the work zone.

12.2 Remediation Work Procedures

12.2.1 Technical Specifications and Report Review

Remediators should:

- When available, attempt to obtain environmental reports describing the nature and extent of existing mold contamination;
- Review available documents related to the project, and understand the project objectives, goals, methods, timeline, material requirements and other circumstances before work is performed;
- In cases where enough information is currently available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, including contents, develop work plans, protocols and specifications following this standard;
- In cases where there is not enough information available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, including contents, use an environmental report provided by an IEP, based on a pre-remediation assessment, to develop the work plan. The extent and details provided by the IEP can vary greatly. Some protocols may or may not be detailed, and contain technical specifications, site monitoring, or independent oversight. If incomplete or inadequate technical specifications for mold remediation are provided by an IEP, then remediators should seek clarification and, thereafter as necessary, design and implement their own protocols and work plans, and provide them to appropriate materially interested parties for review and approval when necessary, and
- Provide that when post-remediation verification is conducted, it is performed by an independent IEP. This in no way is intended to prevent remediators from performing their own post-remediation evaluation.

12.2.2 Preliminary Steps

In order to implement remediation work plans, protocols or technical specifications, remediators should:

- Ascertain site conditions;
- Establish project scheduling. (It is recommended that the building owner, manager or a building representative be present during the project walk through);
- Determine contents salvability and how contents should be handled, and avoid trapping residual moisture when wrapping salvageable contents;

- Be aware of other potential sources of mold growth and amplification, such as over-watered plants and un-emptied trashcans;
- Protect unaffected contents if they cannot be removed from the remediation area, and
- Evaluate the HVAC and air conveyance system to determine the presence of contamination and pre-existing conditions. The remediator may consider temporary heating or cooling depending on climatic conditions.

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

12.2.3 Containment Set-up

During containment set-up, remediators should:

- Determine the necessity for, extent and location of required containment;
- Use containment barriers to separate Condition 1 areas from Condition 2 or 3 areas, (i.e., source, local or full-scale containment methods);
- Verify that the structure's ventilating system is sealed off or isolated from mold-contaminated work areas to minimize the risk of cross-contamination;
- Erect containment in a manner that mitigates the potential for cross-contamination and exposing workers and occupants to contamination;
- Consider whether floors, walls and ceilings require a polyethylene barrier erected over them; or if they can be left uncovered for later cleaning;
- Be aware that containment barriers on surfaces can cause condensation, change pressure differentials, or trap moisture or Condition 2 contamination on surfaces;
- Consider and mitigate, where practical, the potential for collateral or consequential damage at the point where the containment barrier is joined to a structure's finish materials. (It is recommended that a description of, and responsibility for, repair of such collateral damage be established prior to starting a project);
- Make the containment area large enough to allow sufficient room for workers to remove affected building materials;
- When a decontamination chamber is used, establish an appropriate entry and exit, which is attached to the containment as a transitional space between work areas and unaffected areas of the building. Tack mats can 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);
- Install containment flaps to provide a neutral pressure zone, or to control make up air passing through the decontamination chamber, and
- Establish and maintain negative pressure differentials with one or more AFDs set up in a negative-air mode. Depending on circumstances, airflow controls can be established before or after containment is installed. HEPA vacuum cleaners can also be used in small local containments to create a pressure differential.

Regulated materials, such as lead or asbestos, require specific mitigation and remediation protocols. The presence of these and other regulated materials take precedence over mold remediation, and they shall be addressed according to applicable federal, state, provincial and local laws and regulations.

Caution: negative pressure differentials can create unintended air flow resulting in risk of carbon monoxide exposure, and a risk of fire due to back-drafting or flame roll-out from gas appliances, such as furnaces, ovens and water heaters. When gas appliances are in areas where negative pressure differentials are created, they should be rendered temporarily inoperable and the use of supplemental mechanical systems may be necessary.

12.2.4 Signage

Remediators should:

- Post warning signs stating that mold remediation is in progress;
- Restrict access to the work or containment areas, and
- Place signs conspicuously at entrances to work areas and in areas of potential entry.

12.2.5 Suit Up and Entry

Remediators shall:

- Wear appropriate PPE when working in areas where there is mold contamination and other potential hazards, for worker safety;
- Check the respiratory PPE prior to entering a containment area to ensure that it is functioning properly, and
- Be aware that entry into confined spaces can require additional measures to meet regulations and safety requirements.

12.2.6 Demolition and Surface Cleaning

Remediating building materials that are Condition 3 depends upon the materials' porosity and susceptibility. Porous building materials (e.g., drywall, insulation, and ceiling tiles) that are Condition 3 should be removed and discarded. Other materials that are semi-porous (e.g., wood studs) can be HEPA-vacuumed and either wire brushed or sanded, then damp-wiped. Small isolated areas of mold growth on a surface layer of condensation on enamel-painted walls or other non-porous surfaces, where mold growth has not resulted in concealed areas, usually can be removed by HEPA-vacuuming and damp wiping as part of a regular maintenance program.

Remediators should:

- Use appropriate cleaning procedures for the surface material being remediated;
- Minimize dust generation and aerosolization. During demolition, mold spores can be easily dislodged and aerosolized, especially from dry materials;
- Take care to limit the release of airborne spores, thereby reducing worker exposure and clean-up efforts;
- Avoid crushing materials and other actions that could cause dust generation and dispersal of fungal spores and fragments;
- Use techniques and controls that limit dust aerosolization and remove dust immediately. Work areas should be maintained as free from dust as practical by using a HEPA vacuum cleaner and by bagging debris immediately. Contaminated materials can be removed carefully with razor knife or utility knives by cutting rather than tearing them into pieces to avoid generating dust or bioaerosols. Demolishing contaminated materials with a hammer or crow bar, or using electric saws without dust collecting devices, is not recommended;
- Remove contaminated building materials carefully in as large a section as practical and bag or wrap, preferably in 6-mil heavy-gauge polyethylene disposal bags or sheeting;
- Set the cutting depth of saw blades so that they do not penetrate all the way through gypsum board backing paper or other wall materials;
- Remove insulation carefully and bag immediately, preferably in 6-mil disposable polyethylene bags;
- Bag and remove remaining drywall screws, nails and small debris;

- Remove mold growth on wood framing members by HEPA-vacuuming followed by damp wiping, wire brushing, sanding, or other appropriate method, while using HEPA-vacuuming or performing removal within the capture zone of an AFD, along with other appropriate controls;
- Seal bagged materials inside a second bag before moving them outside a containment area (double bagging), if they are going to pass through Condition 1 areas of the building, to prevent potential cross-contamination. Sharp items capable of puncturing polyethylene material should be packaged in such a way as to prevent them from penetrating the material before being bagged or wrapped. Mold-contaminated materials such as building framing, casements, cabinets, tubs, showers, doors, and appliances may not require bagging or wrapping if removal can be accomplished by direct access to an outside secure disposal location, and handling such materials does not pose a cross-contamination source during removal;
- Clean remaining building interior surfaces and containment materials using HEPA-vacuuming and damp wiping;
- Minimize the amount of water used during damp wiping to avoid wetting building materials, which may result in water damage or new mold growth;
- Dry construction and finish materials that are wetted or dampened from misting to prevent mold growth, and
- Not install new construction materials until post-remediation evaluation; or post-remediation verification as necessary, indicates that installation is appropriate. However, if new construction materials must be installed for structural integrity prior to completion of the remediation, those materials should also be cleaned along with the rest of the affected area.

Remediators shall:

- Wear appropriate personal protective equipment (PPE), and
- When mold remediation occurs concurrently with asbestos abatement or other types of demolition where misting water is required, perform mold remediation 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.

12.2.7 Deviation from Removal Processes

The Principles of Mold Remediation state that mold contamination should be controlled as close to its source as practical. Further, mold should be physically removed during remediation. Attempts to kill, encapsulate or inhibit mold instead of proper source removal generally are not adequate.

It is recognized that remediation projects are unique, and that in certain circumstances, common sense, experience and professional judgment may justify deviation from this Standard. It is the responsibility of remediators to determine and verify on a case-by-case basis that application of this Standard is appropriate. 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 a Condition 3 area for extended periods by using long-term engineering controls, encapsulants, sealants or other methods. Allowing mold or moisture conditions to remain is strongly discouraged, since it can compromise the health of occupants, further damage building materials, and expose remediators to liability and other consequences. However, when deviations from this Standard are considered, it is recommended that remediators advise customers in writing that controlling mold or moisture condition in place can:

- 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.

It is recommended that remediators advise customers that follow-up assessment of affected area by an IEP may be appropriate when:

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

Since deviation from the source removal principle occurred, periodic assessments may be advisable. It is recommended that remediators consult with appropriate technical professionals or attorneys for specific language to use in written communications with customers.

12.2.8 Disposal of Contaminated Materials

Mold-contaminated gypsum board and other structural materials that are not regulated (i.e., those that do not contain asbestos, lead or other regulated 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 and shall be followed.

Remediators should:

- Handle bagged or wrapped materials carefully, and not drop, throw or handle them roughly while moving them to the disposal container or site;
- Place bagged or wrapped materials in a reasonably secure location or transport vehicle after removing them from the building, and
- When bagged or wrapped disposal materials rupture outside the containment, but inside the building, secure the area from public access, initiate clean-up (HEPA-vacuuming), and contain the debris.

Remediators shall:

- Don appropriate PPE, if bagged or wrapped disposal materials rupture outside the containment, but inside the building.

It is recommended that:

- Descriptive warning labels be placed on bags and wrapped materials which describe the contents to discourage individuals from opening or removing them from the disposal site;
- Label language be factual, not overstated or unnecessarily alarming, and
- Dumpsters with contaminated debris be kept reasonably secure.

12.2.9 Clean-up

To achieve Condition 1 in the work area after demolition has been completed, it is important to clean it adequately by thoroughly removing dust and debris. Thorough cleaning consists of combining HEPA-vacuuming with damp wiping so that minimum moisture remains on surfaces. During this process, cleaning procedures inside containment should 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 toward the AFD.

Remediators should also:

- HEPA-vacuum and damp wipe entry and exit chamber ceilings, walls, flaps and floor of remediation areas;

- Conduct a final inspection of the containment area as part of the post-remediation evaluation, prior to post-remediation verification is accomplished by an IEP, to ensure that visible dust and all debris have been removed, and
- Remove dust that may have settled outside the containment area by HEPA-vacuuming and damp wiping.

Physically removing mold growth and spores is the guiding principle for mold remediation. Indiscriminate antimicrobial or biocide application is discouraged. Biocide application is not considered effective as a substitute for proper source removal, however, there may be specific instances where professional judgment dictates that biocides be applied (e.g., bacterial contamination as addressed in IICRC S500). Killing microorganisms with biocides does not typically destroy their antigenic or toxigenic properties. Remediators shall follow federal, state, provincial, and local laws and regulations, as well as product label directions. Misapplication of biocides is a federal violation under the U.S. Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Specifications that are not consistent with biocide regulations and labeling instructions can be in violation of the law, and they can create liability for the remediator.

Using antimicrobials, fungicidal coatings, mold-resistant coatings, or sealants (products applied into or onto a material to “suppress or retard future growth”) during mold remediation as a substitute for proper source removal is discouraged. However, there may be specific instances where professional judgment dictates that antimicrobials be applied. Soil, bio-films or organic residues from inadequate cleaning, or accumulate on surfaces treated with fungicidal coatings and sealants generally render them less effective. Products of these types can interfere with post-remediation verification.

If antimicrobials, fungicidal coatings, mold-resistant coatings, or sealants are used, they shall be applied according to regulations and label directions.

If antimicrobials, fungicidal coatings, mold-resistant coatings, or sealants are used, remediators should:

- Apply them after completion of remediation, and after completion of post-remediation verification, when necessary;
- Consider that applying these products can change the permeability of materials, can cause condensation problems and trap moisture, and their application can result in future deterioration and potential liability, and
- Consider that products of this type can change the flammability of the materials to which they are applied.

12.2.10 Containment Exit Protocol

After bagging or wrapping, demolition debris is moved to an exit chamber.

Remediators should:

- HEPA-vacuum or damp wipe the outside of bags or wrapped materials, and thereafter place them into a second bag or wrapping and sealing before they are moved from the exit chamber;
- Wipe off tools and equipment being removed from the containment area and place in clean sealed bags for detailed cleaning off-site, using appropriate precautions;
- Vacuum and damp wipe tools, HEPA vacuum cleaners, and AFDs before they are removed from the containment area, and
- Seal the intake (contaminated) side of AFDs before turning the equipment off to prevent back flushing of filtered contaminants.

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 set 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 shall not be reused, but rather disposed in the second chamber.

12.2.11 Post-Remediation Evaluation

Post-remediation evaluation should be conducted by remediators to determine whether or not remediation has been completed. This evaluation involves implementing internal quality control procedures. It can include visual inspection, olfactory evaluation, laser particle counting and moisture measurements.

Remediated structures and systems can be considered clean when contamination, unrestorable contaminated materials and debris have been removed, and surfaces are visibly free of dust. The term “visibly” can include direct and indirect observation (e.g., using a white or black towel to wipe a surface to observe for cleanliness). Also, remediated areas should be free of malodors associated with microorganisms. At that point, it is probable that structural components and systems have been returned to Condition 1. The evaluation can also include moisture measurements and the use of a laser particle counter. If visible mold, dust or debris have not been removed, malodors are present or initial cleaning is questionable, repeating the cleaning process may be warranted.

12.2.12 Post-Remediation Verification

Following post-remediation evaluation by the remediator, it may be requested or required to verify the return of a structure, systems or contents to Condition 1. In such situations, post-remediation verification should be performed by an independent IEP. It is recommended that:

- The criteria and process used in the post-remediation verification be documented, and
- The remediator and IEP clarify the minimum performance requirements of post-remediation verification prior to commencement of work.

12.2.13 Breakdown of Containment

Remediators should:

- HEPA vacuum and damp wipe containment materials before containment is dismantled;
- Conduct a thorough post-remediation evaluation of the cleaned containment area after cleaning the containment, and
- When post-remediation verification is requested or required, verify the containment passes the verification process before being dismantled.

13 HVAC Remediation

The design, installation, operation and maintenance of HVAC systems are important factors in controlling microorganism germination, growth, amplification and dissemination. In addition, mold growth from other causes can be carried to the interior of HVAC system components where it can accumulate and degrade system operation. When system operation is affected, this can result in poor environmental control that allows widespread condensation to form. This can lead to the spread of contamination by the system and increase the scope of the mold problem by dispersing contaminants throughout a building.

Ductwork with a non-porous internal surface (e.g., galvanized sheet metal) responds well to remediation. However, sections of internally lined ductwork, duct board or flexible ductwork that are Condition 3 cannot be successfully cleaned, and therefore such ducting with Condition 3 should be removed and replaced.

13.1 HVAC Operational, Maintenance and Modification Issues

When a building is being remediated, special attention should be given to remediating the HVAC system that supports the indoor environment where remediation is taking place. Also, the HVAC system should be inspected in the manner described within this section and returned to Condition 1 as part of the overall mold remediation project. It is recommended that HVAC deficiencies be identified for correction by the customer’s HVAC service contractor. Otherwise, the remediation can fail and growth can return, adversely affecting environmental conditions within the building.

In situations with visible surface mold growth or suspected hidden growth, the cause should be identified and moisture sources controlled or corrected before remediating either the building components or the HVAC system. Remediating the HVAC system alone might not be sufficient to prevent future mold growth. The services of a qualified mechanical or professional engineer may be needed to recommend repairs or modifications that mitigate the likelihood of reoccurring mold contamination. Implementing such recommendations is not necessarily the responsibility or within the expertise of the remediator. At a minimum, however, customers should be advised by the remediator of known HVAC conditions that put the integrity of the building at risk.

13.2 HVAC Engineering Considerations

HVAC systems should be inspected for cleanliness and returned to Condition 1 as part of a building remediation. The National Air Duct Cleaners Association (NADCA) standard, *Assessment, Cleaning and Restoration of HVAC Systems* (ACR 2006) includes specifications for acceptable levels of cleanliness for HVAC systems and appropriate inspection techniques. It is recommended that HVAC system remediation be scheduled after other building remediation is completed, in order to avoid cross-migration of particulate into the mechanical system. When this is not practical and the environment is Condition 2 or 3, HVAC system components should be isolated from the environment as part of the overall building remediation strategy. Remediated HVAC system components that can potentially be exposed to recontamination during ongoing building remediation activities should be re-assessed after building component demolition procedures and reconstruction activities are complete. Reassessment should be conducted before removing containments or other engineering controls.

When providing temporary heating, cooling and other environmental controls within areas undergoing remediation, equipment should be decontaminated and bagged or wrapped prior to being removed from the workspace. When air-handling systems are operational, remediators should consider where to locate containment so that contaminants are not drawn into the fresh-air intake and that the negative pressure created by the fresh-air intake does not adversely affect the pressurization differential of the contained area.

In addition to a cleanliness inspection, a complete engineering assessment of the design and working condition of the entire HVAC system should be considered, depending on the Conditions (1, 2 or 3) that exist in the project. This is especially important if temperature or relative humidity cannot be maintained within the affected area in compliance with the requirements of American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standards 62.1 or 62.2; temperatures, relative humidity or airflow varies between different areas of the building, or mechanical components are not in good working condition or repair. Modification to an HVAC system shall conform to applicable building codes.

Filtration upgrades should 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 can accommodate upgraded filtration. In others, modifications should 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 should not occur.

13.3 HVAC System Cleaning and NADCA ACR 2006

If enough information is currently available to determine that Condition 2 or 3 exists throughout affected systems, remediation work plans, protocols and specifications can be developed. In situations where there is visible mold growth and it cannot be determined that Condition 2 or 3 exists throughout the affected system, remediators should engage or recommend that customers or clients engage an IEP to assess the affected system.

Once the HVAC system’s condition has been assessed for cleanliness and mechanical corrections or enhancements have been completed, cleaning should be carried out in accordance with procedures described in NADCA ACR 2006, or equivalent industry standards.

13.3.1 Use of a Mechanical System as a Dehumidification Device

Use of an HVAC system is often considered, during the initial evaluation of a moisture-related problem, to assist in the dehumidification process. Using mechanical systems during remediation often results in the need to decontaminate the system after remediation and prior to post-remediation verification. In order to determine if the HVAC system needs remediation, it should be inspected and cleaned using the procedures outlined in the *NADCA ACR 2006,* or the equivalent.

When considering usage of an HVAC system for dehumidification, it is recommended that the following be considered:

- operational building pressurization during HVAC usage;
- airflow volume across the evaporative coil;
- fresh air intake status;
- air distribution network and potential for particle migration;
- protection of the mechanical system for the duration of the project;
- reheat coil operation and sequencing;
- decontamination of the HVAC system after usage;
- the original engineering design for the HVAC system;
- impact on the overall building strategy, and
- migration of particulate to unintended areas.

13.3.2 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 2006. Multiple cleanings might be required to achieve a satisfactory level of cleanliness. On occasions, more rigorous criteria can be specified, including surface testing procedures normally used on surfaces outside of an HVAC system; however, interpretation of test results may be more difficult than with exterior environmental surfaces and air samples. Individuals procuring and interpreting such samples should be IEPs with specific training in identifying mold issues within HVAC systems.

The interior of evaporators or cooling coils can be especially difficult to clean through all layers of the coil. If a satisfactory level of cleanliness cannot be achieved, replacing coils is recommended.

Attention should be given to inspecting fan blades and blower wheels. In cases where fan and blower surfaces cannot be returned to a smooth surface condition, the component should be replaced.

HVAC components should 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. Normally it is not necessary to build containment for HVAC system cleaning. Under unusual circumstances or in sensitive locations, such as active health care facilities, containment should be constructed. In addition, if an air handler is located in an equipment room that is also part of the conditioned space, containment should be constructed. Air handlers located outdoors or on rooftops require only limited containment procedures during cleaning. Remediators should use appropriate personal protective equipment while cleaning HVAC systems, and isolate the portion of the system being cleaned from uncontaminated areas by blocking air ducts or supply vents. Sufficient ventilation is needed to dilute emissions from cleaners used. Residue from cleaning products should be completely rinsed from surfaces before the equipment is placed back into operation.

Using an antimicrobial product may be considered to inhibit future mold growth in an HVAC system, but only after mechanical surface cleaning has been performed and the need for such treatment has been deemed necessary. Antimicrobial use should never be substituted for complete removal of mold contamination. In addition, any product used shall 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.

Care should be taken to use antimicrobial products in compliance with applicable regulations. Such products shall be used in accordance with safety regulations. If label directions cannot be followed completely, antimicrobial use shall be avoided.

Coatings and sealants used in HVAC systems, which claim antimicrobial performance, shall be registered by the EPA or other applicable regulatory agency specifically 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, including the use of personal protective equipment, such use shall be avoided.

14 Contents Remediation

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 to the structure to the probable condition of the contents located in different areas;
  - visually inspecting for evidence of mold contamination, and possibly correlating the inspection with the results of a pre-remediation assessment performed by an IEP, to determine the content's Condition (1, 2 or 3),
  - determining the basic composition of content materials. Contents composition and condition determine their ability to be cleaned. General categories of content material composition are defined for purposes of this chapter as follows:
    - **Porous:** Materials that easily absorb or adsorb moisture and, if organic, can easily support fungal growth (e.g., clothing and other textiles, padded or upholstered items, leather, taxidermy, paper goods, many types of fine art);
    - **Semi-porous**: Materials that absorb or adsorb moisture slowly and, if organic, can support fungal growth (e.g., unfinished wood, masonry); and
    - **Non-porous:** Materials that do not absorb or adsorb moisture or those that have been surface treated and do not easily support fungal growth (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.

14.1 Inspection and Evaluation for Restorability

- 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 to Condition 1 and returned to the customer;

  - o dispose – Items that will not be cleaned because either the customer does not want them or the remediation cost exceeds the item's value. (See "Disposal" section below),
  - o preserve – Items that are irreplaceable but cannot be returned to Condition 1. This category only applies to irreplaceable porous or irreplaceable semi-porous items with Condition 3 contamination. When preservation is required, the remediator should follow the additional precautions set forth in Section 14.4 "Unrestorable Contents".
- The condition of the contents can be determined when the inspection provides:
  - o enough information to determine that Condition 1 exists throughout the structure, systems, or area, and therefore no remediation of contents is required; or
  - o enough information to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, and therefore an assumption can be made that all of the contents are either Condition 2 or 3, or
  - o there is not enough information available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, and therefore the remediator should engage or recommend to the customer or clients that they engage an IEP to assess the contents to make the determination. When sampling is requested or required, it is recommended that a cross-section of content types be included and that an independent IEP should conduct such activities.

Materially interested parties should participate in the decision about whether to restore or dispose of contents.

14.2 Removing Contents from Affected Areas

Before removing potentially contaminated contents from a contaminated area to a cleaner area or to another location, the remediator or other qualified professional should:

- inspect all contents prior to inventory;
- document the condition of the contents, including actual or perceived value of one or more of the "other types of value" mentioned above;
- photo-document the placement and condition of contents;
- separate affected from unaffected contents where practical , and
- ensure that clients agree and authorize disposal of contaminated contents in writing before disposal.

Contaminated or potentially contaminated contents should be appropriately packaged or decontaminated, when moved into or through uncontaminated areas (Condition 1) to prevent the spread of contaminants into unaffected areas and the exposure of workers or occupants to contaminants. The exterior of the packaging on its way through a decontamination chamber system should be decontaminated by cleaning or wrapping a fresh layer of packaging material around the item just before it exits the decontamination chamber system. Care should 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.

14.2.1 Inventory, Packing, Transport and Storage

Before contents are packed out, a detailed inventory should be prepared containing at least the following information:

- description of each item;
- quantity of each item;
- Condition (1, 2, or 3) of each item;
- location of each item within the structure, and
- an individually assigned inventory number for each item, box, or group of items.

The customer should sign a form accepting the inventory as representative of the existence and actual physical condition of the contents before the remediator assumes responsibility for contents transport and processing. Contents should 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. Vehicles, equipment, storage vaults or facilities that become contaminated in the course of remediation should be decontaminated.

Storage conditions should be controlled while contents are in the remediator's custody to minimize conditions favorable to mold growth. Contaminated contents should be cleaned as soon as practical, rather than being stored for long periods while contaminated, and cleaned contents should be stored in a clean area that is separate from the area where contaminated contents are stored. They should not be returned to contaminated areas of the structure until both have attained Condition 1.

14.3 Cleaning Contents – General Discussion

The goal of contents remediation is to clean items to Condition 1 by physically removing fungal contamination and odors. When additional damage or contamination to contents is discovered, it should be documented, and materially interested parties informed within a reasonable period of time. It is recommended that appropriate appearance enhancement processes be applied to the items after their return to Condition 1 has been completed. Contents can be cleaned either on-site or in-plant. Whether contents are cleaned onsite or in-plant, appropriate precautions should be taken to prevent spreading contaminants from work or storage areas into unaffected areas.

14.3.1 Outdoors versus Multi-stage Cleaning Chamber

Condition 2 or 3 contents should be cleaned either outdoors or in a multi-stage cleaning chamber.

14.3.1.1 Outdoors

When cleaning contents outdoors:

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

14.3.1.2 Multi-stage Cleaning Chamber

A multi-stage cleaning chamber maximizes removal of contaminants by allowing two or more "rounds" of cleaning to be performed on each item. For the system to be effective, appropriate airflow and air pressure relationships should be maintained.

14.3.2 Cleaning Methods

When selecting a cleaning method, remediators should choose the most appropriate 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. Also, a combination of methods may be necessary to facilitate remediating contents.

14.3.2.1 Air-based Methods

- HEPA vacuuming – This method uses a vacuum with a filter that is 99.97% efficient in removing particles at 0.3 micrometers. It is recommended that this method be applied at least three times in a cross pattern to each affected item.

- Air washing - This method should be used outdoors or in laminar airflow, high-volume cleaning chamber or in other situations where engineering controls are adequate to prevent excessive buildup of contaminants.

14.3.2.2 Heat

Methods involving controlled application of heat to a structure have been reported to be an effective form of biological control, which might or might not kill some fungal spores and vegetative structures. This process is a developing technology and should be evaluated and understood before use. It is important to note that killing mold and fungal spores has not been shown to eliminate the contaminants or their allergenic or toxigenic properties.

14.3.2.3 Liquid-based Methods

The liquid-based cleaning method relies on water combined with physical or mechanical cleaning processes to dislodge contamination. High-pressure washing techniques should be limited to situations in which aerosolization is not a critical factor (e.g., outdoors).

14.3.2.4 Abrasive Methods

Abrasive methods of cleaning rely on the use of a medium or material to dislodge contamination. These techniques should 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 can lead to extremely high levels of contaminants in the air, potentially creating unacceptable exposure for workers or occupants or allowing spread of contaminants into previously unaffected areas. Some media can also create a difficult cleanup problem (e.g., sand, soda, sponge corn husks, and rice hulls) or lead to the development of unacceptable worker exposure (e.g., dry ice blasting in an enclosed space creating excessive levels of CO_2 in the work area).

Abrasive blasting techniques should 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).

14.3.3 Appearance Enhancement

Although removing contaminants is the primary focus of mold remediation, it is recommended that customer expectations be addressed and that contents be “appearance enhanced” to the extent practical before being returned to the customer. The presence of visible stains is not an indication that an item is contaminated. The removal of mold stains can be included in appearance enhancement.

14.3.4 Cleaning Porous, Semi-Porous and Non-Porous Contents

Condition 3 porous contents are generally not restorable. It is recommended that special care be taken with porous Condition 1 contents to prevent potential contamination, which can occur while contents are stored in an off-site facility. HEPA-vacuuming and brushing, with a soft bristle or tampico brush, while on a downdraft cleaning table are the most commonly used methods for cleaning Condition 2 porous contents. Air washing, in the proper situation, also can be effective on many porous items. However, air washing should be performed in a controlled work area, where the massive aerosolization associated with this method will not pose a health risk to workers or occupants during the process.

Most cleaning processes should start and end with HEPA-vacuuming. Rapid drying after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods. It is recommended that appearance-enhancement processes take place after Condition 1 has been obtained.

14.3.4.1 Cleaning Porous Contents

Porous materials are items that easily absorb or adsorb moisture and, if organic, can easily support fungal growth (e.g., clothing and other textiles, padded or upholstered items, leather, taxidermy, paper goods, many types of fine art). After carefully examining items for unrestorable water damage, the proper cleaning method should be selected based on material composition and manufacturer's instructions. It is recommended that contaminated clothing and other textiles be HEPA vacuumed prior to disturbing them at their location within the structure. The following specific guidance supplements the general guidance provided above.

- **Porous Textiles:** Clothing, Fabric, and other textile items.
  - **Condition 2 -** Porous contents with Condition 2 contamination may or may not be restorable using appropriate cleaning methods, based on material composition. Use of a detergent in the laundering process facilitates the removal of contaminants. The laundering process also can be enhanced by increasing the water temperature. Care should be taken not to exceed the manufacturer's water temperature recommendations.
  - **Condition 3 -** Porous contents with Condition 3 contamination are usually unrestorable, based on material composition.
- **Porous Furnishings:** Area Rugs, Loose Carpet, Upholstery, Mattresses, Wicker, and similar items.
  - **Condition 2 -** Porous contents with Condition 2 contamination are usually restorable using appropriate cleaning methods, based on material composition. Area rugs and carpet may be cleanable in a controlled, in-plant facility. Determining the severity of contamination may necessitate an assessment. The spreading of spores during the cleaning process is a potential problem. Submersion methods that clean rugs or carpet under water are less likely to aerosolize spores.

    If Items such as pillows, sofa cushions, mattresses and or leather products have been used while contaminated, attempts to return the item to Condition 1 usually are unsuccessful. Disposal is recommended.
  - **Condition 3 -** Porous contents with Condition 3 contamination are usually unrestorable, based on material composition.
- **Paper Goods:** Books, Documents, Manuscripts, Family Records, Scrapbooks, Photographs, and similar items.
  - **Condition 2 -** Porous contents with Condition 2 contamination are usually restorable using appropriate cleaning methods, based on material composition. Air washing can be effective. However, air washing should 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.

    Valuable or irreplaceable documents that cannot be cleaned or decontaminated may be encased, laminated or otherwise sealed.
  - **Condition 3 -** Porous contents with Condition 3 contamination are usually unrestorable, based on material composition. Cleaning may require a specialized conservation process, and might not be successful. Valuable or irreplaceable documents that cannot be cleaned or decontaminated may be encased, laminated or otherwise isolated.
- **Fine Art:** Paintings, Sculpture, Works of Art, and similar items.
  - **Condition 2 -** Porous contents with Condition 2 contamination are usually restorable using appropriate cleaning methods, based on material composition. Remediation of mold-contaminated fine art at Condition 2 should be performed only by qualified, experienced specialists, primarily due to the high value of the items involved.
  - **Condition 3 -** Porous contents with Condition 3 contamination are usually unrestorable, based on material composition. Remediation of mold-contaminated fine art at Condition 3 might not be completely successful, and can be quite expensive. These services should be performed by qualified, experienced, specialists.

14.3.4.2 Cleaning Semi-porous Items

Semi-porous materials are those that absorb or adsorb moisture slowly and, if organic, can support fungal growth (e.g., unfinished wood, masonry). The following specific guidance supplements the general guidance provided above.

- **Condition 2 -** Semi-porous contents with Condition 2 contamination are usually restorable using appropriate cleaning methods. Air washing or abrasive blast cleaning with an appropriate media may also be effective.
- **Condition 3 -** 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 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.

End results of such aggressive cleaning methods may result in an appearance that is unacceptable to the customer. Attempts should be made to determine if results will be acceptable before extensive cleaning is performed.

14.3.4.3 Cleaning Non-porous Items

Non-porous materials are those that do not absorb moisture or have treated surfaces and do not easily support fungal growth (e.g., finished wood, glass, metal, plastic). The following specific guidance supplements the general guidance provided above.

- **Condition 2 -** Non-porous contents with Condition 2 contamination are restorable and cleaned using appropriate methods, based on material composition.
- **Condition 3 -** Non-porous contents with Condition 3 contamination are usually restorable and can be cleaned using appropriate methods, based on material composition. 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.

14.4 High-value and Irreplaceable Contents

High-value or irreplaceable 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 can 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 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 might prevent or arrest mold growth if wet books are dried quickly);
- area rug cleaning and repair;
- electronics and machinery restoration;
- 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 the materially interested parties should be consulted to determine an acceptable course of action with respect to the disposition of the items.

14.4.1 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, they should be inventoried, photo-documented, and removed or disposed of, in compliance with the removal and disposal recommendations in this document.

Unrestorable contents should not be disposed of without the express written permission of the customer, the adjuster (if applicable), and 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 that have not been restored to Condition 1 to customers, or when performing preservation services on irreplaceable items, remediators should inform customers of the circumstances involved (i.e., why the contents were not restored to Condition 1), advise customers in writing of the potential consequences of accepting contaminated contents, and attempt to obtain a written waiver and release of liability from customers for those potential consequences.

14.5 Disposal and Waste Material Handling

Waste materials should 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. Mold-contaminated, unrestorable contents should be handled and removed carefully, preferably packaged in heavy gauge polyethylene, such as 6-mil disposal bags, or securely wrapped in 6-mil polyethylene sheeting, unless contents are disposed directly through a waste-out tunnel or transfer system. Sharp items capable of puncturing polyethylene material should be packaged in such a way as to prevent them from penetrating the material before being bagged or wrapped. Polyethylene surfaces should be HEPA-vacuumed, damp wiped with an appropriate cleaning agent, double-bagged or wrapped in a fresh layer of polyethylene just prior to being removed from the contaminated area or decontamination chamber. Respirators are not required outside while transporting double-bagged materials. Bags should not be dropped, thrown or handled roughly. If bagged or wrapped disposal materials rupture outside the containment, transporting workers shall 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 practical, 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 and shall be followed. Placing descriptive warning 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 overstated or unnecessarily alarming.

14.6 Post-Remediation Evaluation

Post-remediation evaluation should be conducted by remediators to evaluate whether or not remediation has been completed. This evaluation involves implementing internal quality control procedures. The evaluation begins with subjective criteria that includes, but is not limited to, visual inspection focusing on acceptable removal of visible mold, and olfactory inspection focusing on removal of malodor.

Remediated contents can be considered clean when contamination, unrestorable contaminated items and debris have been removed, and surfaces are visibly free of dust. The term “visibly” can include direct and indirect observation (e.g., using a white or black towel to wipe a surface to observe for cleanliness). Also, remediated contents should be free of malodors associated with microorganisms. At that point, it is probable that the contents have been returned to Condition 1. The evaluation can also include moisture measurements. If the visible mold, dust or debris has not been removed, malodors are present or initial cleaning is questionable, either repeat processing may be warranted or items may be categorized as not restorable.

14.7 Contents Post-Remediation Verification

Following post-remediation evaluation by the remediator, it may be requested or required to verify the return of the contents to Condition 1. When post-remediation verification is not performed on contents, remediators should inform customers of the circumstances involved, advise customers in writing of potential consequences of accepting contaminated contents, and attempt to obtain a written waiver and release of liability from customers for those potential consequences.

When sampling is requested or required, it is recommended that a cross-section of content types be included and that an independent IEP should conduct such activities.

15 Post-Remediation Verification

Following post-remediation evaluation by the remediator, it may be requested or required to verify the return of the structure, systems or contents to Condition 1. In such situations, post-remediation verification should be performed by an independent IEP. It is recommended that the criteria and process used in the post-remediation verification be documented.

The post-remediation verification can include subjective or objective criteria. Subjective criteria can include but are not limited to, visual inspection and odor detection and characterization. Objective criteria can include but are not limited to, analytical testing (e.g., moisture monitoring, temperature and relative humidity) and environmental sampling.

Post-remediation verification provides a measure of assurance, within sampling, testing and analysis limitations, that the structure, systems or contents have been remediated to Condition 1.

16 Indoor Environmental Professional

The IICRC S520 defines an indoor environmental professional (IEP) as an individual who is qualified by knowledge, skill, education, training, certification or experience to perform an “assessment” of the fungal ecology of structures, systems, and contents at the job site, create a sampling strategy, sample the indoor environment, submit to an appropriate laboratory or individual, interpret laboratory data, determine Condition 1, 2 and 3, and verify the return of the fungal ecology to Condition 1.

Using the IICRC S520 as guidance, a qualified remediator can use the preliminary determination to develop a scope of work (work plans, protocols or specifications) for a mold remediation project. However, when a pre-remediation assessment or post-remediation verification is requested or required, it should be performed by an IEP. The assessment information can assist the remediator in developing additional technical specifications, detailed protocols and post-remediation verification parameters.

It is preferable that the IEP be an unbiased resource. An IEP engaged to perform pre-remediation assessment or post-remediation verification should be independent of the remediator. In some jurisdictions, the law may require that the inspection and assessment function be performed by an individual or entity independent of the remediator. If there are complexities, complications or conflicts, a remediator may need to request additional input or guidance from the IEP.

17 Final Documentation

After post-remediation evaluation and verification, it is recommended that the remediator take appropriate action to close the job, complete closing paperwork and project documentation. Final documentation can include a certificate of completion, which involves entering into an agreement with the customer acknowledging the completion of the project; documenting the post-remediation evaluation and verification; obtaining final project payment and releasing liens; or filing lien notices as necessary. In addition, there can be notices or other requirements specific to the laws and regulations of the jurisdiction in which a mold remediation project is located.

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S520 Reference Guide Table of Contents

Introduction

IICRC S520 is a procedural Standard, as well as a supplementary reference guide, intended for use by those involved in the mold remediation industry. The Standard is printed on colored paper within this publication, followed by the longer Reference Guide. Although material contained within the Reference Guide does not carry the official status of a standard, the two sections complement one another and should always be considered in tandem.

For the most part, IICRC S520 Standards are extracted from the material in the Reference Guide. This means that, while the Reference Guide is a supplement to and explanation of the IICRC S520 Standard, its primary purpose is to clarify and explain the procedural points made in the Standard. Therefore, while much of the S520 Reference Guide lists many of the same points included in the Standard, the Reference Guide is more detailed in defining and expanding information to the point that the volume of information would be inappropriate for a procedural Standard. Moreover, the S520 Reference Guide contains science-based research and information that assists the user of the document in understanding the definitions, concepts and principles upon which the Standard is based.

Each chapter of the IICRC S520 Reference Guide was written by members of section/chapter teams who are experts in their respective fields. The section/chapter teams brought together expertise and scientific and industry literature and information designed to reflect industry consensus on the subject matter assigned. Each chapter of the Reference Guide was examined by the entire IICRC S520 Consensus Body Standard Committee, integrated into the document as a whole, and edited for consistency between Standard sections and Reference Guide chapters.

The Important Definitions set forth at the front of the Standard section, and the glossary of terms at the back, define and clarify terminology used in the Reference Guide. The appendices provide supporting documentation for the information contained in the Reference Guide. An Index is provided to assist readers in locating and cross-referencing pertinent subjects throughout the document.

Chapter 1

Principles of Mold Remediation

INTRODUCTION

There are five general principles used in remediating mold-contaminated structures and materials. Applying 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 Safety and Health of Workers and Occupants

Mold-contaminated structures, systems and contents are associated with a range of safety and health problems. Performing mold remediation can expose workers to safety and health hazards. Therefore, remediation workers shall 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). Employers shall identify safety and health issues prior to commencing work. Reasonable effort should 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 shall be implemented to prevent mold contamination from spreading into Condition 1 areas. Spreading contamination has the potential to expose remediation workers or occupants to contaminants and create the need for additional remediation work. Using appropriate containment and air pressure controls is usually the most effective way to prevent spreading microbial contaminants. Also, proper containment is 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 increased levels of mold contamination is unacceptable and shall be prevented. When used together, the following two measures can reduce remediation worker exposure:

- Appropriate engineering controls and work practices, such as controlled demolition, source containment and control of air movement direction shall 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 and other appropriate PPE, shall be used by remediation workers, in conjunction with engineering controls, to prevent exposure to contaminants that cannot be reduced through proper engineering controls and work practices.

2. Document the Conditions and Work Processes

Thorough documentation and recordkeeping should be performed and maintained throughout a remediation project. To properly document a remediation project, it is recommended that remediators attempt to obtain pertinent project information developed before, during and after a remediator's initial involvement in the project.

Before a remediation project begins, remediators should attempt to obtain available historical information about the building, environmental reports, remediation plans or protocols, and other pertinent project documentation, particularly information relevant to the nature and extent of mold growth. Using this information, remediators should perform an inspection and make a preliminary determination that should be documented. An indoor environmental professional (IEP) can use this documentation to perform an initial assessment, on-going assessment, and post-remediation verification. To avoid conflicts of interest, assessments and post-remediation verification should be performed by an independent IEP.

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 using intrusive or destructive techniques. If used without adequate containment, intrusive and destructive techniques can result in releasing or spreading 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 by an 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 shall be taken to control moisture. Psychrometric conditions and moisture levels of materials should be determined and documented.

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

After remediation is completed, before a structure is rebuilt, the system reactivated, or contents returned, the return to Condition 1 should be verified and documented. This post-remediation verification should be performed by an independent IEP.

3. Control the Contaminant at its Source

Mold contamination should 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.

Controlling contaminants can be accomplished by using source, mini, local or full containment. An example of source containment is the use of polyethylene sheeting over mold growth on gypsum board to prevent dispersal. During remediation, controlling contaminants may be accomplished with 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 air filtration devices close to work areas.

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)

Mold contamination should be physically removed from the structure and contents to return them to Condition 1. Attempts to kill or encapsulate mold are not adequate to solve the problem (ACGIH, 1999).

Remediated structures, systems and contents can be considered clean (by post remediation evaluation) when contamination or unrestorable contaminated materials and debris have been removed, and surfaces are visibly free of dust. The term "visibly" can include direct and indirect observation (e.g., using a white or black towel to wipe surfaces to observe for cleanliness). Also, remediated areas should be free of malodors associated with microorganisms. At that point, it is probable that the structure, systems and contents have been returned to Condition 1.

When verification that the structure, systems and contents have been returned to Condition 1 is requested or required, post-remediation verification should be performed by an independent IEP.

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 shall be identified, located and corrected or controlled as soon as possible. Successful mold remediation results in returning a remediated structure and contents to Condition 1. Reconstruction normally does not begin until moisture is controlled, mold remediation is completed and materials are dried. Affected salvable materials should be dried to acceptable moisture content following the current ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration* (S500).

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Chapter 2

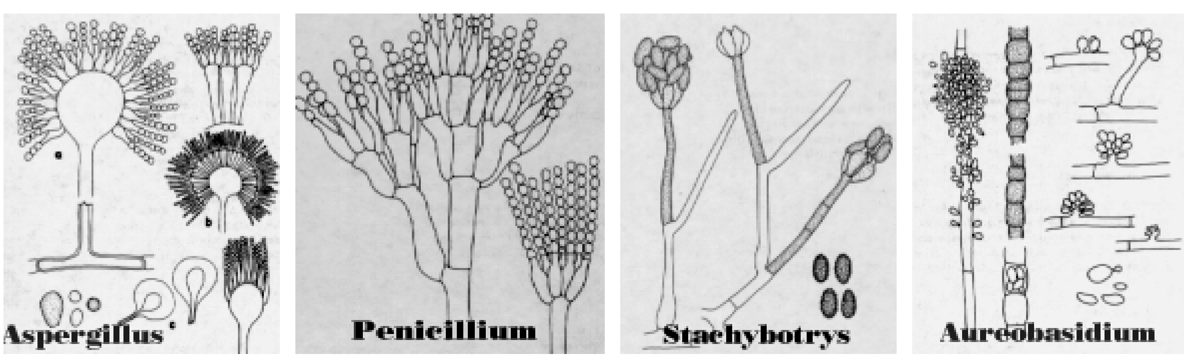
The Fungal Biology of Indoor Environments

INTRODUCTION

Those responsible for the remediation of mold-contaminated environments should understand how water damage promotes fungal and related microbial growth and amplification (rapid growth under optimum environmental conditions). Such amplification may affect structural, finishing and furnishing materials and create a health risk for both remediation workers and occupants. Measures to minimize health risks may require containment of workspaces, controlled airflow, and personal protective equipment.

FUNGAL BIOLOGY

There are approximately 70,000 to 100,000 described species of fungi, including molds, mushrooms and yeasts (Alexopolous et al. 1996, Hoog et al. 2000). The majority of fungi are saprobes; that is, they use non-living organic material for food. Molds, as referred to in this document, are those commonly described as microfungi, differentiating them from macrofungi, such as those that form mushrooms and other fleshy structures. Molds develop from unique, microscopic seed-like structures called spores, which are not visible to the unaided eye. When spores settle on a surface under appropriate moisture and temperature conditions, they absorb water, swelling to 2-3 times their original size, and begin to form thread-like structures known as hyphae. As the hyphae grow, they interweave to form a tangled mass known as a mycelium. With continued growth, a mycelium, unlike a spore, becomes visible to the naked eye. The mycelium grows out in all directions across the surface of a material, generally forming a circular pattern, with aerial hyphae growing above the surface and hyphae penetrating into or below the food source. When the fungus matures, spores form within specialized structures, or individually on aerial hyphae. These spores can then be carried away by air currents, moisture droplets or insects to new environments to start the reproductive cycle over again. The distinctive, microscopic appearance of the sporulating aerial hyphae (spores and conidiophores) of some common molds is shown in the following illustrations:



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THE BUILDING ECOSYSTEM

Each indoor environment is an ecological system of interaction between the non-living or physical environment and the living or biological environment, and their products or components. The physical environment includes structural objects, finishing and furnishing materials, paints, coatings, and sealants, as well as temperature, moisture and airflow. The living or biological indoor environment typically includes bacteria, fungi, insects, arachnids (spiders and mites), and mammals (rodents, pets, humans). Products and components of the living environment include proteins, enzymes, glucans, endotoxins, mycotoxins, and volatile organic compounds.

Microenvironments

The indoor ecosystem is comprised of an interrelated complex of microenvironments, each of which has its own mix of physical and biological factors, and can serve as a reservoir for a variety of pollutants that can potentially affect the quality of the air in occupied spaces. Some microenvironments are structural components such as interior and exterior wall cavities, ceiling spaces, air-handling systems and crawlspaces. Some microenvironments serve as reservoirs that readily collect dusts, soil, and associated microorganisms on a routine basis. Examples include: flooring materials, upholstered furniture, textile furnishings, ceiling tiles, bathrooms, pet areas, and HVAC systems.

Microbial Flora

Normal building flora usually associated with microenvironments include viable (living) and non-viable (dead) microorganisms. Examples include environmental and human-associated bacteria, and common fungi (yeasts and molds) and their associated antigens, spores, toxins, volatile metabolites and enzymes (Samson et al. 2000). In the absence of rapid attention to water damage (intrusion and/or accumulation), and preventive programs of routine climate control, maintenance and cleaning, microenvironmental reservoirs can quickly become sources of contamination through extensive accumulation of settled spores (Condition 2) and actual mold growth (Condition 3).

Molds are microorganisms that use organic substrates as nutrient sources in the presence of moisture. Their spores germinate, grow and amplify when indoor moisture is uncontrolled through chronic water damage (intrusion or condensation), catastrophic flooding, or simple neglect (lack of routine maintenance and cleaning). Under such circumstances, molds can grow and produce massive numbers of spores on a variety of surfaces such as wood, gypsum board and paint. Additionally, many soil bacteria, especially gram-negative bacteria and actinomycetes, thrive in damp indoor conditions and are routinely found in environments where mold amplification is identified (see ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration* for a more detailed discussion of bacterial growth in buildings).

SHIFTING ECOLOGY

Indoor environments normally contain settled fungal spores and may occasionally reveal small, residual areas of fungal growth. When excessive moisture or water is introduced into such an environment, spores produced by many of the common environmental molds that are typically present, such as *Aspergillus, Penicillium* and *Cladosporium* will germinate, grow and multiply on building materials. Eventually this could lead to material degradation, and potential negative effects upon the quality of the indoor air. As available moisture increases over time, the microbial ecology shifts to favor the growth and amplification of those molds that are more suited to high water activity conditions. Competition among organisms begins to favor the emergence of more water-tolerant species, including *Stachybotrys, Acremonium, Ulocladium* and *Chaetomium.* Thus, the introduction of moisture into a normal indoor environment leads to growth and proliferation of fungi, and the composition of these microbial communities can "shift" or "change" over time as environmental conditions change. The following photograph of a wallboard, wet for three weeks from flooding, shows a shift in fungal ecology, with a change in fungal communities along a moisture gradient, as water wicks up the wall.

The goal of mold remediation is to return the indoor environment to a state of *normal fungal ecology.* For the purposes of this document, normal fungal ecology represents the typical fungal background and is defined as types and predominance of molds typically found in non-water-damaged, environmentally-well-maintained structures, and reflective of the ecological and climatic elements of the geographic region in which the building is located.

Water Activity, Humidity and Fungal Growth on Building Materials

Fungal growth on materials can be correlated with many aspects of moisture in a building, including surface water activity, relative humidity, infiltration and moisture content of materials. In addition, fungal growth can result in unwanted odors and degradation of building materials.

The amount of free water available to microorganisms for growth on a substrate (food source) or microenvironment is described as water activity (a_w). Water activity is the ratio of the water-vapor pressure in the substrate to the water-vapor pressure of pure water at the same temperature. It can be compared to the equilibrium relative humidity (ERH) of a material. Many fungi have a minimum requirement of 0.88 a_w or 88% ERH. Some have a limit that can be considerably below 0.80 a_w (80% ERH), meaning that they require less water to germinate and multiply. These lower-water-activity, or "xerophilic" fungi are often "primary colonizers," and are best represented by some species of *Penicillium* and *Aspergillus*, including *Aspergillus versicolor, Eurotium* and *Wallemia*. "Secondary colonizers" typically have between 0.80-0.90 a_w (80-90% ERH), and include molds such as *Cladosporium, Paecilomyces, Scopulariopsis* and a variety of *Aspergillus* and *Penicillium* species. Finally, extremely wet microenvironments, particularly those with cellulose-based materials (e.g., wallpaper, gypsum board and books), favor the growth of "tertiary-colonizer" fungi with >0.90 a_w (90% ERH), such as *Stachybotrys*, *Acremonium, Ulocladium*, *Fusarium*, *Trichoderma*, *Chaetomium,* and a variety of yeasts (Domsch et al. 1993, Pitt and Hocking 1999).

A variety of bacteria, yeasts and molds can also grow in stagnant water reservoirs of HVAC systems. Depending upon their location, fungi and bacteria may multiply significantly without being noticed by occupants (i.e., non-visible contamination), such as within wall cavities, ceiling spaces or HVAC units. Although water activity is the moisture parameter that allows for mold growth, it can be correlated with moisture content of materials. Different building materials will support mold growth at different moisture contents. For example, at 80% ERH (0.80 a_w), the moisture content of softwood is around 17%, which is sufficient to support mold growth (Flannigan and Morey 1996).

As increased water activity/ERH (from leaks, flooding, or high relative humidity and condensation) persists over time, the likelihood increases that changes will occur in the microbial composition of a part of the indoor environment or the entire building, with potentially damaging effects upon materials and the quality of the indoor air (Cole et al. 1999, Flannigan and Morey 1996, Macher 1999). Controlling relative humidity (RH) in the indoor environment is essential to successful mold remediation, as well as in the overall prevention of indoor mold problems. Excessive airborne moisture can facilitate the germination, growth, and amplification of molds on building and finishing materials. A meticulous study of the growth of *Penicillium* species on ceiling tiles dramatically demonstrated the increased potential for mold growth and amplification as RH increased, especially above 70% (Foarde et al. 1992). The study showed, that the more moisture present in the air, the less capacity the air has for holding moisture attempting to migrate from porous materials (evaporation). If enough moisture is available, over time, mold spores will germinate, grow, and amplify, setting the stage for degrading materials and resulting in detrimental effects on the indoor air quality.

In addition to visible mold growth and the detection of moisture in porous materials, an obvious indicator of microbial amplification is an odor that may be described as musty, moldy or mildewy. Fungi and bacteria produce a variety of volatile organic compounds (VOCs) during active growth. The microbial volatile organic compounds (MVOCs) we detect through our olfactory senses are generated by a variety of molds and also by actinomycete bacteria, such as *Streptomyces* and related organisms.

Given sufficient moisture and appropriate environmental conditions, growth of wood-decay fungi may occur on building materials, representing the additional problem of loss of structural integrity. Although many molds can grow on wood and other cellulose containing materials, primary wood decomposition is caused by fungi of the basidiomycete group. These fungi are able to degrade cellulose and lignin, the two structural components of wood (Alexopolous et al. 1996). Common wood-decay basidiomycetes include some mushrooms, polypores, and dry-rot fungi. The dry-rot fungi (*Serpula* species) may be particularly problematic in buildings, due to their rapid growth rate and ability to effectively decompose relatively dry lumber by translocating water from a distant source.

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Chapter 3

Health Effects from Indoor Exposure to Mold in Water/Moisture-Impacted Buildings

INTRODUCTION

Although the health effects of exposure to certain types of molds in the outdoor environment have been long recognized and described in medical literature, specific effects of exposure to molds in the indoor environment are only a relatively recent area of concern and investigation. The complexity of fungal contamination in indoor environments presents unique challenges in assessing worker and occupant health risks. These complexities include: the variety of molds and co-existing bacteria; changing conditions (e.g., moisture, temperature, building envelope and mechanical ventilation dynamics), and concentrations and components or by-products (e.g., spores, hyphae, glucans). Understanding the types and relative significance of actual health risks is critical to developing and implementing effective remediation methods that adequately resolve occupant health problems that result from occupying a mold-contaminated indoor environment.

MOISTURE, MOLD, AND HEALTH RISK

Summary and Consensus Documents

National and international scientific, research and regulatory organizations have published consensus documents regarding the relationship between water damage in buildings, resultant microbial (mold) amplification on wet building materials, and human health risk from exposure to mold spores and related spore by-products in the indoor living or work environment. These documents are based on varying levels of review and interpretation of clinical case studies, epidemiological, and, to a lesser extent, experimental studies of certain adverse health effects and their association with water intrusion or moisture accumulation in residential, institutional and commercial buildings.

National Academies of Science

The Institute of Medicine (IOM) of the National Academies of Science published its document, *Damp Indoor Spaces and Health*, which was described as, ". . . a comprehensive review of the scientific literature regarding the relationship between damp or moldy indoor environments and the manifestation of adverse health effects, particularly respiratory and allergic symptoms."[1] The review concluded that, ". . . excessive indoor dampness is a public health problem."

While neither confirming nor inferring causality, the IOM committee found "sufficient evidence" of an association between the presence of mold or other agents in damp indoor environments, and cough, wheeze, upper respiratory tract symptoms (nasal and throat) and asthma symptoms in allergic and asthmatic persons, with limited or suggestive evidence of an association with lower respiratory illness in otherwise healthy children. However, the IOM panel found inadequate or insufficient evidence regarding the association between "mold" and a number of disorders including: new-onset asthma, pulmonary hemorrhage in infants, permanent neuropsychiatric symptoms, reproductive effects, and cancer, among others. Although some people may incorrectly interpret the latter to mean that there is no definitive association between these health effects and mold and related microbial contamination, the report actually states that additional research studies are needed to help clarify if an association exists between such health effects and mold and related microbial agents in damp indoor environments.

U.S. Environmental Protection Agency (USEPA)

In *Mold Remediation in Schools and Commercial Buildings* (2001), the USEPA concluded that, "When moisture problems occur and mold growth results, building occupants may begin to report odors and a variety of health problems, such as headaches, breathing difficulties, skin irritation, allergic reactions, and aggravation of asthma symptoms," some or all of which could plausibly be associated with mold exposure.[2] Beyond stating that all molds have the potential to cause health effects through one or more potential mechanism, this document did not provide a detailed review or critique of the medical literature. Nonetheless, the document recommended remediation measures to remove mold growth and its by-products.

Health Canada

Based on intensive review of the research literature to 2001, Health Canada published its findings in *Fungal Contamination in Public Buildings: Health Effects and Investigation Methods.*[3] This review acknowledged the dearth of well-conducted clinical or epidemiological research studies on specific respiratory effects from indoor mold exposure in non-industrial buildings, as have other reviews. However, this document also emphasized that, in spite of the lack of detailed scientific research, damp conditions and mold growth need to be prevented, and that fungal contamination in buildings should be remediated.

ACGIH, ISIAQ, and AIHA

The American Conference of Governmental Industrial Hygienists (ACGIH), in its document *Bioaerosols: Assessment and Control*, stated that, ". . . chronic flooding or leaks will almost always result in microbial growth in the indoor environment."[4] Similarly, the International Society of Indoor Air Quality and Climate (ISIAQ), in its document, *Control of Moisture Problems Affecting Biological Indoor Air Quality,* corroborated that, ". . . the presence of consistently moist or wet materials such as carpet, ceiling tiles, and gypsum board . . . provides a suitable environment for microbial proliferation. The dominance of one or two non-phylloplane mould species is an indication of a moisture problem causing deterioration of the quality of the indoor air."[5]

The American Industrial Hygiene Association (AIHA) in its *Field Guide for the Determination of Biological Contaminants in Environmental Samples* (1996) concluded that: "Although biological contaminants have been given little attention until relatively recently, a substantial proportion of building-related illness (BRI) and sick building syndrome (SBS) . . . is the result of exposure to such contaminants . . . There is abundant evidence from investigations in several countries that symptoms of eye, nose, and throat irritation as well as cough and tiredness and fatigue are present in excess among persons or populations in certain buildings. Although several agents have been suggested as causative, the most extensive evidence is found for dampness and mold."[6]

Centers for Disease Control and Prevention (CDC)

Addressing possible health effects in the aftermath of major hurricanes and floods, the CDC recommends that visible and extensive mold growth should be remediated and that, ". . . excessive exposure to mold-contaminated materials can cause adverse health effects in susceptible persons regardless of the type of mold or the extent of contamination."[7]

HEALTH EFFECTS

Building-Related Disorders

The term "sick building syndrome" (SBS) was coined in the early 1970s to describe the advent of "unexplained" illness among occupants of a building. The first reports came from Europe, Scandinavia, and the United States in which multiple occupants of new office buildings complained of: inflammatory symptoms of the mucous membranes (i.e., eye, nose and throat); upper and possibly lower respiratory tract symptoms, as well as fatigue, headaches, and neurocognitive changes, and notable difficulty with concentration and inattentiveness. These symptoms characteristically improved each time occupants left the building.[8] Most environmental investigations of sick buildings looked for chemical etiologies such as, volatile organic compound (VOC) emissions from paints, adhesives, carpeting and other flooring materials; building materials (e.g., particle-board, plywood); inadequate ventilation, and psychogenic factors.[9,10] Research studies arbitrarily categorized occupant health complaints and described them as "irritant" or "non-specific" symptoms. Simplistic epidemiological methods were employed, which lacked sufficient power or sensitivity to detect and measure the presence of a distinct clinical syndrome. As a result of these methodological shortcomings, none of these studies demonstrated a consistent etiology that adequately explained the illnesses reported by occupants, nor, in most cases, did reduction or removal of the suspected environmental problem or agent result in clinical resolution. AIHA corroborated this critique by stating that while, ". . . no serious case can be made that sick building syndrome does not exist . . . a review of the literature to 1992 indicates that most studies of this problem have been poorly designed . . ."[6] SBS continues to be the major IAQ occupant health problem today in multi-occupant, non-industrial workplaces, and residential buildings.

The term "building-related illness" (BRI) has been used to describe medically recognized diseases (disorders) for which specific diagnostic criteria and testing can confirm the presence or absence of the condition. Diseases in this classification were categorized as: allergic/immunological (e.g., asthma, hypersensitivity pneumonitis or HP); infectious (e.g., Legionnaire's disease), and toxicological (e.g., carbon monoxide toxicity, fiberglass-induced dermatitis, and organic dust toxic syndrome [ODTS]). Although these conditions are well recognized and can be readily diagnosed in individuals, collectively they account for a disproportionately small percentage of documented adverse health effects observed in mold-contaminated buildings.

This definitional distinction between SBS -- the most prevalent occupant health problem for the past 40 years -- and BRI, has paradoxically hindered recognition and scientific understanding of the relationship between mold exposure and occupant illness. ACGIH has referred to the most prevalent occupant health complaints (e.g., runny nose, sore throat, headache, fatigue, difficulty concentrating.) as "building-related symptoms" (BRS), for which the most likely etiology is fungal toxins or spore wall components.[4] AIHA has proposed the specific medical entity of, ". . . building-related illness arising from microbial contamination of building materials caused by condensation and leaks . . ." and notes that several plausible mechanisms of disease related to exposure to fungal agents (e.g., mycotoxins, glucans) are the most likely cause.[6] The specific role of construction-related defects leading to water intrusion into buildings also has been recognized as a likely cause of SBS,[11] while the association between specific fungal agents and SBS also has been established.[12,13]

More recently, the relationship between SBS, BRS, BRI, and indoor mold exposure in water-impacted buildings has been recognized by several investigators as a distinct symptom complex of mucous membrane, upper, and possibly lower respiratory tract inflammation, fatigue, and neurocognitive symptoms, with the important features of temporality (discrete onset after occupying a particular building or after a particular event, such as a flood or leak), consistency (among multiple occupants), and reversibility (symptoms abate when away from the indoor environment).[14,15] The unique feature of "building-relatedness" distinguishes these so-called "non-specific symptoms" not only from other common, non-building-related disorders, such as allergic rhinitis or respiratory tract infections, which have some overlapping symptoms (primarily upper respiratory tract), as well as, but also from potential building-related illnesses, such as asthma or HP, which are limited to the lower respiratory tract. Studies have demonstrated that respiratory symptoms in occupants of sick buildings are unrelated to atopy (allergic predisposition) and are not explained merely by the diagnosis of asthma.[16, 17, 18]

Building "Dampness" and Mold

In general, building dampness (i.e., moist or wet conditions), and the resulting surface and airborne mold contamination, have significant potential impact on the health of occupants. A review of 61 peer-reviewed articles by a European consortium concluded that dampness in buildings is consistently associated with an increased risk for symptoms in the respiratory tract, as well as self-reported tiredness, headache and respiratory tract infections.[19] An updated literature review by the same group confirmed these associations, though most of the studies cited were cross-sectional in design and either focused on asthma or on health effects only in children.[20] Another review of case reports, case-control studies and cross-sectional studies from a 15-year period concluded that, ". . . evidence of an association between respiratory problems and the presence of fungi and dampness is strong."[21] A study of occupants of 19 office buildings measured a dose-response effect for dampness and symptoms of eye irritation, cough, and lethargy or fatigue,[22] while another study of 231 buildings found that dampness and odorous compounds are associated with an increase in occupants' symptoms consistent with SBS.[23] Other literature reviews have similarly concluded that, while signs of mold growth and dampness and certain BRS are consistently associated with one another, the measures of indoor mold contamination (i.e., airborne spore or CFU concentrations) are not consistently correlated with symptoms, thus underscoring the limitations of such exposure measurements.[6,24] The predominance of atypical molds and their by-products or components in the indoor environments, especially those associated with water intrusion and chronic dampness, presents an increased health risk through one or more plausible mechanism(s) of disease.

Mechanism(s) of Illness

The aforementioned consensus statements and research collectively acknowledge that there is a consistent, positive association between: water damage in buildings, mold contamination on water-impacted surfaces (with dispersal of mold spores into the occupied spaces) or exposure of occupants to these mold contaminants, and subsequent risk for certain adverse health effects among occupants.

Current controversy about the validity and severity of mold-related health effects (largely debated in the context of construction defects litigation and insurance-related flooding events in the U.S.) stems from a scarcity of scientific research into the pathophysiology and mechanism(s) of illness, including the actual agent(s) of disease, and methodological limitations in quantifying occupants' exposure and its causal association with specific health effects. Furthermore, questions about whether health effects are transient or permanent, and whether certain populations are predisposed or more susceptible to certain health effects, remain incompletely studied. A robust research agenda has been recommended by all of the aforementioned organizations, but thus far there has been little substantive funding in the United States to address the many scientific questions that remain outstanding.[25] The significance of such limitations in scientific understanding, versus the immediate need for public health measures to prevent occupant illness (along with methods for adequate building remediation solutions), is addressed at the end of this chapter.

Allergy/Immunological Mechanisms

The IOM has previously stated that, ". . . all fungi probably produce allergens that will cause disease with appropriate exposure."[26] In the general outdoor environment, certain molds that arise naturally from soil and plants are associated with development of allergic rhinitis (AR) and the related condition, allergic conjunctivitis (watery, red, itchy eyes). The principal outdoor fungi associated with AR include *Cladosporium, Alternaria*, certain species of *Penicillium*, and other genera that are typically found as the dominant outdoor molds in North America and in other parts of the world. Although these same taxa are commonly found indoors in non-problem buildings at concentrations lower than outdoors, they are rarely found as predominant taxa in modern buildings with water damage or where occupants complain of BRS. The presence of these normal background fungi in homes and office buildings is, therefore, not a health hazard unique to the indoor environment, though their presence can sometimes confound interpretation of indoor sampling data that relies upon total spore counts.

Allergic respiratory disease (i.e., immediate hypersensitivity) can occur when indoor microbial contaminants, primarily fungal and bacterial spores and growth fragments, are deposited in the nasal or sinus cavities and upper or lower airways. Symptoms may develop rapidly or may take weeks or months, depending upon the extent of the exposure and an individual's immunological sensitization to the agent(s). Allergic reactions occur only in selected genetically susceptible individuals (as opposed to the entire population) and require prior exposure for sensitization. Once allergic sensitization occurs, an occupant's symptoms may be initiated by very low exposures. Therefore, it would be expected that a relatively small percentage of occupants in a particular building would develop an identical allergic sensitization to the same agent at the same time - in contrast to the common finding of a high percentage of building occupants complaining of BRS, of which non-respiratory and non-mucous membrane (i.e., non-allergic) symptoms are a prominent part of the symptom complex. The most commonly described allergic diseases attributed to indoor mold exposure are AR (i.e., watery eyes, runny nose, or nasal congestion) and asthma (i.e., reversible inflammation and increased airways reactivity, manifested by symptoms of shortness of breath, wheezing, chest tightness, and cough). However, the actual evidence that mold contamination in buildings produces a specific allergic response is indirect and inconsistent,[24,26] though it is clear that individuals with underlying asthma are at increased risk of worsening when they reside or work in mold-contaminated buildings.

Another disease that commonly is considered important in relationship to indoor mold exposure is hypersensitivity pneumonitis (HP). HP is an immunologically mediated (i.e., delayed-type) reaction to specific biological antigens from plants, insects, bacteria and fungi. Acute HP develops 6-12 hours after a relatively high-intensity exposure, and is marked by symptoms including shortness of breath, cough and fever. HP does not cause runny nose, watery eyes, headaches, or neurocognitive symptoms. Only those individuals, who are immunologically sensitized to the particular antigenic agent of exposure, become symptomatic; thus, among groups of workers with similar exposures, only a small percentage are actually at risk of developing HP. HP has been well described in certain occupations in which high-dose exposure to a specific causal organism has been identified. Such exposures and disease are not limited to the indoor environment. Examples include HP caused by thermophilic bacteria, or *Aspergillus* mold species in contaminated hay among farmers (i.e., "farmer's lung"). However, in most cases where HP has been diagnosed in mold-contaminated buildings, the basis of the diagnosis did not meet generally accepted, diagnostic criteria for HP.[29,30,31] Furthermore, studies of immunological markers of exposure for HP in mold-contaminated buildings have not demonstrated consistent immunological responses.[32,33] A recently convened occupational medicine physician panel corroborated that HP has been reported in some mold-contaminated buildings, but that the condition is uncommon.[25]

In summary, for molds in the normal outdoor environment, and for certain occupational settings where high-dose exposures or certain specific allergic or other immunological hazards to exposed individuals are present, the risk of the above cited diseases in mold-contaminated, water or moisture-impacted indoor environments appears to be limited. These allergic or immunological disorders do not appear to explain the preponderance of BRS/SBS-related health complaints most commonly observed in mold-contaminated, water-damaged buildings.

Toxicological Mechanisms

A considerable amount of research information indicates that the growth and dissemination of fungi in water-damaged buildings results in the production of certain toxins that may be responsible for BRS or certain other putative health effects. Although there are hundreds of genera of molds that can appear in indoor environments, only a relatively small number of them (and a limited number of species within each genus) are of concern in terms of disseminating mold in water-impacted buildings. Such molds appear to cause significant occupant health effects unique to the indoor environment. While much attention has been given to health concerns regarding *Stachybotrys chartarum*, certain species of *Aspergillus* (notably *A. versicolor*), *Penicillium*, *Chaetomium*, *Trichoderma*, *Phoma*, and *Fusarium* (all of which are commonly observed colonizing water-damaged, carbon-containing building materials) are also capable of producing a class of compounds known as mycotoxins.[34] Mycotoxins form the basis for the term "toxic mold," however, a more appropriate term is "toxigenic mold," which indicates the capability of producing toxins.

Mycotoxins are a group of metabolic byproducts often produced by a variety of molds growing on various organic substrates in damp building environments.[35] When present, mycotoxins typically are found on mold spore walls and fungal growth fragments. A particular class of mycotoxins of medical concern is the trichothecenes, which have been shown to produce adverse health effects in experimental animals at high exposure concentrations under conditions not representative of actual human indoor environments.[36] Mycotoxins are not always produced by actively growing molds, as production is dependent upon the physiology and genetics of the organism, as well as the amount of moisture, light and temperature.[37] In *Damp Indoor Spaces and Human Health*, the IOM states that the research data it reviewed, ". . . shows that molds that can produce mycotoxins under the appropriate environmental and competitive conditions can and do grow indoors."

Fungal spores may contain significant amounts of mycotoxins, and while various diseases, symptoms and syndromes have been associated with inhalation of probable mycotoxin-containing spores,[30, 32, 34, 38, 39] a causal association has not been demonstrated.[36] The ability of molds to produce mycotoxins under the appropriate environmental and competitive conditions on wet indoor building materials, is acknowledged in the aforementioned organizational consensus documents; however, all of them conclude that the specific role that mycotoxin exposure may have in producing BRS and other putative human health effects remains somewhat poorly understood. Understanding the health effects of mycotoxins is further limited by a lack of commercially available environmental assays, relatively wide ranges of background concentrations for mycotoxins in the normal indoor environment, and a lack of human toxicology and pathophysiology research into specific exposure routes and mechanisms of disease causation. The ability to establish dose-response relationships is complicated by limitations in the reliability of air samples for fungal particles, current air-data interpretation guidelines, which rely primarily on comparison of total outdoor vs. indoor spore counts, and the constantly changing conditions of mold growth and spore dissemination in indoor environments.[6]

In addition to mold growth, water-impacted indoor environments may also facilitate the growth of bacteria that can have toxic and inflammatory effects.[1] Bacterial endotoxins are generated particularly in agricultural settings from cell walls of bacteria or certain fungi. Occupational exposure to high concentrations of endotoxins has been recognized to cause specific health effects (i.e., ODTS), which are inconsistent with the more subtle, multi-system symptoms seen in BRS. In general, bacterial contaminants associated with indoor water/moisture intrusion are not considered significant as agents of occupant illness.

The question of whether infants are at risk for developing idiopathic pulmonary hemosiderosis (IPH) with exposure to *Stachybotrys chartarum* has evoked much controversy regarding the health hazards of indoor mold exposure in water/moisture-impacted buildings. Numerous mold-contamination cases, experimental research and time (nearly 10 years) have not replicated this finding in a consistent manner. A subsequent reassessment of the original Cleveland study addressed many methodological issues, which may have skewed the interpretation of the data toward a causal association.[40] While the cause of this particular life-threatening disease in infants is not definitively understood, the available information to date indicates that this condition - popularized even today by the media in reports of mold-related health effects - represents a relatively minor, if not negligible risk for occupants of mold-contaminated buildings.

Regardless of the unclear clinical effect and lack of established methods for mycotoxin exposure assessment, as discussed above, it has been generally recognized in environmental health and industrial hygiene fields that the predominance of these “toxigenic” molds in water-damaged buildings is consistently associated with occupant health complaints described above as BRS.[4,6] AIHA’s recommendation that, “ . . . the confirmed presence of *Stachybotrys chartarum, Aspergillus versicolor, A. flavus, A. fumigatus* and *Fusarium moniliforme* requires urgent risk management decisions to be made . . .” is based on the association between mold growth resulting from water damage to a building, and the likelihood of spreading mold contaminants throughout a building, with the resulting risk of occupant exposure and illness.[6] Other toxigenic fungi, such as *Trichoderma*, *Chaetomium*, and certain species of *Penicillium*, may also be applicable to this recommendation. Recently addressing this issue, the U.S. Centers for Disease Control and Prevention (CDC) stated that, “Although the potential for health problems is an important reason to prevent or minimize indoor mold growth and to remediate any indoor mold contamination, evidence is inadequate to support recommendations for greater urgency of remediation in cases where mycotoxin-producing fungi have been isolated.”[7]

Microbial volatile organic compounds (MVOCs) are gas-phase metabolites that typically are recognized by the human nose as "musty, moldy and mildewy" odors. While their presence is often an indicator of active microbial growth and moisture problems inside wall or other building cavities, the aforementioned occupant health effects do not appear to be toxicologically associated with exposure to one or more MVOCs.

INFECTIOUS MECHANISMS

Specific occupationally acquired fungal infections (e.g., invasive aspergillosis) and hypersensitivity disorders (e.g., allergic bronchopulmonary aspergillosis) have been described for particular occupations that entail recurrent, intense exposure to certain fungal agents. Some fungal infections (including, but not limited to those resulting from molds) can theoretically be acquired by any person with exposure, whereas other infections are opportunistic; that is, they occur only in individuals with certain underlying immunocompromising diseases or conditions (e.g., HIV, certain cancers, chemotherapy, organ transplants, chronic renal failure, high-dose corticosteroid therapy).[41,42] In some cases, these infections and their underlying conditions make them life-threatening. These infectious diseases can be diagnosed by history, physical examination, and, in most cases, certain diagnostic tests, including culture of infected tissue, immunoassays (to antibodies), and molecular methods (e.g., polymerase chain reaction or PCR). One such occupational, highly infectious and potentially fatal disease is histoplasmosis, which results from the inhalation of spores of *Histoplasma capsulatum*. This fungus does not arise as a result of building water damage and resultant mold contamination, but it may be encountered when removing bird and bat droppings from building spaces. Guidance relative to this type of remediation has been published elsewhere.[43]

Environmental molds commonly found in both indoor and outdoor environments, which include those that tend to colonize water-impacted building materials, have been reported to opportunistically infect immunocompromised individuals in hospital settings.[44] Exposure to such fungi (e.g., *A. fumigatus, A. flavus, Rhizopus*, and *Fusarium*) otherwise does not present a risk of opportunistic infection in immunocompetent individuals (the vast majority of the population). Additionally, immunocompetent occupants of mold-contaminated buildings have not been shown to have increased susceptibility to common and chronic (clinically proven) bacterial or viral respiratory tract infections, (even though their symptoms may be misdiagnosed as, or mimic, infectious diseases, such as the common cold or bacterial sinusitis).[45]

Immunological studies of occupants in heavily mold-contaminated buildings have failed to demonstrate significant immunocompromised states in those occupants, either as clinical infections or through markers of immune status.[29,32,33] Some laboratory research on certain mold mycotoxins has suggested that immunological effects can occur from exposure; but these effects have not been demonstrated in occupants of mold-contaminated buildings. The rationale that infants and the elderly are at increased risk from infectious diseases from indoor mold exposure, due to varying degrees of immune dysfunction, appears to be based more on conservative public health principles rather than definitive clinical or epidemiological studies.

OCCUPANT HEALTH INVESTIGATION AND RESPONSE

Clinical Investigation

Investigation of mold contamination in buildings, or of "sick" buildings where the source, extent, and distribution of occupant health problems remains unclear, should include not only assessment of water intrusion and measurement of mold contaminants, but also - and preferably beforehand - clinical assessment of symptomatic as well as asymptomatic occupants. Such clinical evaluations are best conducted by physicians with appropriate training and experience in the area of indoor air quality exposures, who can evaluate environmental, epidemiological and statistical data, and who can communicate risk in an unbiased manner. At present, no commercially available, reliable diagnostic tests have been developed to measure past or present exposure or illness related to SBS or BRS in mold-contaminated buildings.[46,47] Currently available antibody panels for *Stachybotrys* serology, as well as immunological cell profiles, have not been demonstrated to be reliable or predictive of exposure or illness in indoor mold exposures.[48] Standard allergy skin tests for ordinary, outdoor fungal allergens (e.g., *Cladosporium*, *Alternaria*) also have not been demonstrated to be reliable markers of exposure to, or illness from specific fungi associated with water- or moisture-impacted buildings.[49] For individuals with a history of asthma, or when physical examination findings strongly indicate a specific BRI, such as asthma or HP, additional diagnostic tests are available.

A recent document, intended for physicians without expertise in IAQ to evaluate and treat individuals with illness related to indoor mold exposure, has been published by the University of Connecticut, with funding from USEPA.[50] The document affirms that, ". . . there is strong evidence that significant disease can result from dampness or fungi in the home or workplace . . ." and it corroborates the aforementioned conclusions regarding the limited scientific understanding of mechanisms and exposure assessment. This medically-oriented guideline, however, virtually ignores BRS and SBS, and thus does not address the prominent, non-respiratory symptoms from indoor mold exposure that are well described in the literature. Instead, the Connecticut document focuses on what it deems to be "serious" allergic disorders, such as asthma and HP, which, as discussed above, are readily diagnosed but disproportionately uncommon and often over-diagnosed in occupants of mold-contaminated buildings. Although this document also ignores the significance and importance of corroborating symptoms among other multiple, similarly exposed occupants (which, when present, collectively, make the diagnosis of allergic disorders highly unlikely), it nonetheless recommends the same approach as advised herein: namely that the physician document symptoms and signs of illness, obtain a detailed environmental history, and ". . . look for links between the exposure and the symptoms or illness . . ." emphasizing the temporal pattern of symptoms. It also advises that removing affected occupants and environmental remediation are the keys to treatment. Evaluating patients before and after exposure to the environment of concern is emphasized as an important diagnostic method to demonstrate a causal connection between symptoms and exposure; whereas immunological tests are noted to be of questionable value. Thus, the Connecticut document provides the same recommendations for medical management of mold-exposed individuals as those provided herein.

Epidemiological Investigation

In multi-occupant buildings - specifically workplaces - an epidemiological study is sometimes indicated to clarify whether there is a building-related problem, and if so, its nature, which may have implications for resolution.[4] This approach is equally applicable to residential structures, such as apartment buildings, condominiums, and single-family housing developments. Properly conducted epidemiological studies also serve as a baseline for comparison of occupant health after remediation or other interventions (or decisions not to intervene) have been made. Epidemiological studies, when called for, include methodological features that minimize and measure sources of collection bias, and avoid arbitrary clinical definitions that can result in disease misclassification.[4, 24]

Treatment

Regardless of the incomplete understanding of the mechanism of SBS, BRS, and other building-related disorders, it is generally recognized that definitive treatment of symptomatic occupants almost always requires removing them from the mold-contaminated indoor environment, either temporarily or permanently. This may cause, or be hindered by, significant economic, social, and logistical complications and barriers. Long-term health effects from indoor mold exposure have not been studied, but no clinical or epidemiological research to date indicates that permanent health effects are likely to occur in most typical mold contamination situations. Neither antibiotics for presumptive bacterial upper respiratory tract infections, nor commonly prescribed antihistamines, nasal corticosteroid sprays, or various corticosteroid medications for allergic rhinitis, have been demonstrated to produce long-term resolution of building-related symptoms in occupants of mold-contaminated buildings. Individuals with clinically demonstrated asthma exacerbations may benefit from increased use of asthma medications, however, this cannot necessarily be relied upon in lieu of relocation from mold-contaminated areas.

Ultimately, remediating the contaminated environment (as set forth in this Standard) is the only reliable, established method to ensure that occupants can safely return to the building. Properly conducted mold remediation will result in acceptable indoor environmental quality for most or all occupants, which may be objectively assessed clinically or through follow-up epidemiological study.[51] It is important to convey documentation of the scope of remediation and post-remediation evaluation or verification not only to occupants, but also to their treating physicians, so that occupants can be safely reintroduced into the remediated structure and monitored to determine whether their prior BRS is or is not recurring.

Occupational Risk for Health Effects

Unprotected mold remediation workers are at increased and potentially significant risk from dermal, inhalation and ingestion hazards resulting from frequent, high-intensity exposures to mold-contaminated environments, and the practices and procedures required to mitigate such conditions.[2] Such workers shall have appropriate training and medical clearance (per OSHA requirements) before being provided with appropriate personal protective equipment (PPE); see Chapter 5, *Equipment, Tools and Materials,* and Chapter 6, *Safety and Health*. Until further research addresses the mechanisms of disease and health risks to certain, theoretically “high-risk” populations, mold remediation workers with a history of chronic respiratory disease, and those who have been diagnosed with AIDS, or who or are undergoing immunosuppressive or long-term antibiotic therapy, or who are pregnant, should be evaluated and counseled by a qualified, unbiased occupational medicine physician on a case-by-case basis. Formal guidelines regarding pre-employment screening and medical evaluation have not been developed by medical or industrial hygiene organizations beyond regulatory requirements.

RELEVANCE OF HEALTH EFFECTS TO REMEDIATION METHODS

The entire foregoing discussion of what is currently known and unknown about mold health effects of exposure to molds arising in water-impacted buildings is directly pertinent to the rationale behind the principles and methods of remediation recommended in this Standard and Reference Guide. Much more sophisticated and relevant clinical and epidemiological research is needed to explain and understand the mechanisms of illness, actual agents of disease and dose-response relationships, as well as to improve exposure assessment. In spite of these current knowledge gaps, it is crucial to recognize that, ". . . laboratory testing and theoretic speculation about possible mechanisms are important, but no more so than direct, straightforward observation of what actually happens in human populations." [52]

Public Health Rationale

It is a generally accepted public health principle that, in the absence of explicit, complete scientific understanding of a particular risk, conservative measures are appropriate to ensure that risk to occupant health is minimized. There is sufficient information at present to justify remediating mold contamination, including not only mold growth at the site of water intrusion or accumulation, but also mold contaminants (e.g., spores, fragments, and other byproducts) that are disseminated from the mold growth source to distant sites in the building, including floor coverings, bedding materials, other furnishings, HVAC systems, and other contents. In these areas distant to the site of water damage and surface mold growth, temporary relocation of occupants may be required in conjunction with containment, to preclude exposures to contaminants during remediation activities.

There is no scientific evidence to support the assertion that only immunologically susceptible individuals are at increased risk from mold exposure in residential and workplace environments. In some buildings where prevalent occupant illness has been adequately documented, consideration of temporary relocation of *all* occupants during remediation (as opposed to just those who vocally complain or seek medical attention) is warranted from a public health perspective. In hospitals and other health care facilities where infectious diseases are of particular concern, the approach to mold remediation may require additional precautions for occupant health.

Post- Remediation Occupancy and Health Outcomes

In the event that occupants complain of recurring BRS, or other previously documented health effects, after re-occupying the remediated building, those complaints may warrant a detailed review of the remediation process (facilitated through documentation by the remediator), along with an appropriate sampling and analysis protocol designed and overseen by an IEP. In the interim, occupants can be offered alternative living or work conditions. If the validity of occupant health complaints is questioned, then evaluation by a qualified, unbiased physician, who can document whether or not reversibility of respiratory health effects occurs upon re-occupancy, is recommended.

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Chapter 4

Building and Material Science

INTRODUCTION

This Chapter is intended to provide information on how buildings function based on natural physical laws. Understanding building envelopes, wall assemblies, complex systems that co-exist within structures, and the impact that moisture has upon them, aids in making informed decisions about the remediation of mold contamination. The way moisture moves through the building envelope affects building design, materials, construction, maintenance, repair, disaster preparedness, disaster response and the mitigation of mold problems. Prevention of uncontrolled water intrusions in a structure is the first line of defense against the development of mold.

Building components are interrelated so that even a small change in one component can have a dramatic and potentially unexpected effect on the entire building. The interaction of these components affects the safety and health of occupants, and the function and durability of a building. Many building component failures are due to damage from water in one of its three phases (i.e., solid, liquid, vapor,). Remediators should understand building systems and related physical laws in order to remediate a contaminated building and return it to its intended function. Remediators should have a basic understanding of how a building envelope works and the interaction of building assemblies and coatings, in order to properly remediate damaged components. The lack of understanding about the relationship between building components can lead to a system failure, and consequently, a reduction of building value and function.

When restoring buildings, it is helpful to understand the laws of thermodynamics, which state that hot moves toward cold; wet moves toward dry; high pressure moves toward low pressure; more moves toward less; and everything in nature seeks equilibrium. The above principle prevails and causes natural change in temperature, pressure and moisture content, unless variables are present that prevent natural movement.

ELEMENTS OF AIRFLOW

To evaluate how systems within a building interrelate, it is important to understand the elements of airflow. For a given volume of air entering a building, an equal volume of air must leave. Conversely, if air is being removed from a building, an equal volume must enter. This can be stated as: cubic feet per minute (CFM) in, equals CFM out. The better the remediator understands the mechanisms of air ingress, egress and passage through a structure, the more efficiently and effectively the remediation process can be planned and executed. Proper execution of the remediation process results in an enhanced opportunity to properly maintain the integrity of a building system, and the indoor air quality (IAQ). The type of building design and construction influences where air enters or exits, and how IAQ is affected. (Example: air coming down a chimney or up through a crawlspace may not be good quality air for breathing, due to potential airborne contaminants.)

As with fluids, moving air seeks the path of least resistance. In most cases air rises when heated and falls when cooled. Air flows from high pressure to low pressure. Example: an inflated balloon has higher pressure on the inside relative to the outside. The obstruction of the balloon casing prevents the high pressure from moving toward the lower outside pressure.

All structures have planned openings (e.g., doors, windows, vents) and unplanned openings (e.g., cracks, crevices, gaps, material shrinkage, and utility penetrations). Planned openings may be designed to either add or remove air from a building. If designed properly, these openings do not compete for air. In order for air to move into or out of an enclosed space, such as a building or portion of a building, there must be an opening and a driving or pulling force. At times, these forces can be unexpected and potentially dangerous. Example: a dryer vent may pull air so strongly on the built environment that it causes the airflow from a water heater gas vent to reverse.

Caution should be used when blocking, sealing, or restricting airflow, or reversing the direction of airflow through a planned opening. Serious safety and health problems can result. If large amounts of air are drawn out of a building, the probability of combustion appliances backdrafting or experiencing flame rollout is increased.

There are always unplanned openings in a building. If accompanied by a driving force, an unplanned opening can allow airflow into a building from garages, crawlspaces, attics or other air spaces. Driving forces, such as wind, heat or stack pressure, or fans and duct systems, can affect the indoor environment and a building system.

- Wind - The impact of driving wind on a building envelope creates pressure differentials. Wind can drive air and moisture into or out of a building.
- Heat - As air is heated, it rises and pulls cool air from lower areas of a structure. This is known as the “stack effect.” The taller the building, the stronger the force.
- Fans - Some fans are designed for moving air within a building, and other fans are used to move air out of a building (e.g., fans in attics, kitchens, bathrooms, clothes dryers, air exchange and central vacuum systems). These devices often create unplanned pressure imbalance because they intentionally force air out of a building while causing a pressure differential that results in infiltration of makeup air from unplanned openings.
- Duct systems - Duct systems usually are connected to fans that distribute air through heating and cooling systems. These ducts often leak and sometimes run through unconditioned spaces. They can draw air from many unknown and uncontrolled areas.

MECHANISMS OF MOISTURE FLOW

Moisture moves into and through buildings in four ways. Understanding these four mechanisms is helpful in determining where and how moisture gets into a building, and this understanding is necessary when devising an effective remediation plan. The following are the four mechanisms of moisture movement:

- Liquid flow (bulk water) - Liquid flow causes the greatest amount of moisture to enter a building in the least amount of time. Rain, melting snow, ground water, overflowing appliances, or water intrusion from a broken water supply or drain line are some causes or sources of liquid flow.

- Air transport - Moving air carries moisture through either planned or unplanned openings in a structure.
- Vapor Diffusion - Water vapor pressure causes moisture to move through airspaces, whether in a room, a smaller interstitial space, or through voids within materials. In areas where water vapor pressure is different from one side of a structural component (e.g., a wall) to another, moisture is diffused through the component (e.g., a wall) to equalize the pressure. In this instance, both vapor diffusion and capillary action act in a step-by-step sequence to move water through the material and its voids. “High permeability” materials, such as brick, gypsum board and fibrous insulation, allow moisture to move freely. “Low permeability” materials, called vapor barriers or retarders, resist the flow of moisture.
- Capillary Action - Porous materials are capable of absorbing water through capillarity. Concrete, wood, and gypsum are examples of materials that absorb water through capillarity.

HEAT FLOW

Heat flowing into and out of buildings is a major factor in determining comfort levels and operating costs. Heat flows from areas of warm temperature to areas of cool temperature in the absence of other factors. The greater the temperature difference between warmer and cooler areas (e.g., temperature gradient), the faster the heat flows. In winter, a heated building loses heat to colder outside air. Conversely, in summer an air-conditioned building gains heat from outdoor air. Buildings lose or gain heat in three ways: conduction, convection, and radiation heat transfer. These changes can be occurring at the same time to a greater or lesser degree.

- Conduction - Conduction is the transmission of heat through a material; e.g., a metal cooking pan conducts heat from the stove’s burner through the pan to the handle making it hot to the touch. During the winter, warm air inside a building is separated from the cold air outside by the building envelope. Because heat moves from areas of high temperature to areas of low temperature, the inside surface of a wall warms as heat moves toward the colder air outside a building; e.g., as an inside wall surface heats up, adjacent material also begins to warm. Over time, heat from inside a building transfers through a wall to the outside. Because exterior building materials and outside air are cold, the heat that travels through wall materials is lost to the outside.

  The rate of heat loss is directly affected by the temperature gradient between inside and outside air, and the conductivity of a material. Some materials transfer heat well. The more readily materials transmit heat, the more conductive they are. Glass, concrete and metals are examples of good conductors. Other materials called insulators are very poor at transferring heat. They include wood, fiberglass and foam sheathing.
- Convection - Convection is the movement of heated gases or liquids. This movement can be either natural or forced. Natural convection occurs when the movement of gas or liquid is caused by differences in density. Warm air rises because it has a lower density than the surrounding cool air. Since cool air has a higher density than warm air, the cool air drops as the warm air rises. The movement of air along the surface of a wall increases heat transfer

and causes convection loops adjacent to both interior and exterior surfaces. Convection may also take place inside interior wall cavities, especially uninsulated empty cavities.

Another example of convection is the movement of air in a double-pane window. In winter, air is heated on the inside surface of the window cavity, causing the air to rise. The air adjacent to the outside surface cools and drops. This creates a convection loop between the panes of glass that transfers heat from the inside to the outside.

In forced convection, the movement of a gas or liquid is caused by outside forces. If the wind is blowing, the air movement across an outside wall is higher, increasing the rate of heat transfer. This rate of heat transfer depends on the temperature difference, the velocity of the gas or liquid, and the kind of gas or liquid that is involved. For example, heat transfers more quickly through water than through air.

- Radiation Heat Transfer - Radiation heat transfer is the invisible electromagnetic waves that pass from one object to another (e.g., from areas of higher temperature to areas of lower temperature). For example, if someone stands by a window on a cold day, their body radiates heat to the cold surface of the window, making them feel cold. In the summer, radiant energy from the sun enters a building through windows. The walls and contents of a room absorb energy, while at the same time, various objects in the room release radiant energy, which causes the room to heat up.

CLIMATIC VARIABLES TO CONSIDER

Climatic and regional variables include rainfall, temperature and relative humidity. Such variations may require that remediators use different equipment and techniques when drying or remediating similar wet or contaminated structures during different times of the year, or in different climatic regions. A building envelope acts as a physical separator between the interior of a building and the effects of outside climatic conditions. However, a remediator's actions can introduce outside conditions into a built environment. The result can be either positive or negative with respect to remediation goals.

It is complex and expensive for buildings to be constructed to function optimally in a single climatic zone during all climatic conditions throughout the year. Because of variations within a single year or season, a building's construction may be more or less appropriate with respect to prevailing ambient conditions. It follows that drying and remediation techniques will not be the same at all times of the year in all regions. Because of varying climatic conditions, it is necessary for remediators to combine science and art with professional judgment to successfully dry or remediate structures.

The unwanted intrusion and movement of water, in any of its phases, can be caused by construction or component failures, and result in mold contamination. Groups, such as the Energy Efficient Building Association (EEBA), have had a positive influence on how buildings are designed and constructed. When selecting building components and specialized construction techniques, these groups are addressing the comfort and health of building occupants, the durability, longevity and energy efficiency of structural components, and environmental responsibility.

Building scientists designate climates according to general differences in temperature, humidity and rainfall. Microclimates exist within these general climates. General climatic differences can be seen in the following illustrations:

Temperature Variations Maps

U.S. Department of Energy, NREL, National Renewable Energy Laboratory, SR55034585

Heating Degree Day, a basis on which the use of fuel for home heating is measured; one Heating Degree Day is given for each degree below 65° Fahrenheit of the daily average temperature. If the average temperature is above 65 degrees, there are no heating degree days that day. If the average is less than 65 degrees, subtract it from 65 to find the number of heating degree days. Example: If the day's high temperature is 60 and the day's low temperature is 40, then the average temperature is 50 degrees. 65 degrees as the base minus 50 degrees for the average, equals 15 heating degree days.

Subarctic/Arctic – A region with approximately 12,600 heating degree days or more.

Very Cold – A region with approximately 9,000 heating degree days or more and fewer than 12,600 heating degree days.

Cold – A region with approximately 5,400 heating degree days or more and fewer than 9,000 heating degree days.

Mixed-Humid – A region that receives more than 20 inches of annual precipitation and has approximately 5,400 heating degree days or fewer and where the average monthly outdoor temperature drops below 45 degrees Fahrenheit during the winter months.

Hot-Humid – A region that receives more than 20 inches of annual precipitation and where one or both of the following occur:

A 67 degree Fahrenheit or higher wet bulb temperature for 3,000 or more hours during the warmest consecutive 6 months of the year; or

A 73 degree Fahrenheit or higher wet bulb temperature for 1,500 or more hours during the warmest 6 consecutive months of the year.

Hot-Dry – A region that receives less than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45 degrees Fahrenheit throughout the year.

Mixed-Dry – A region that receives less than 20 inches of annual precipitation.

Marine – A region that meets all of the following criteria:

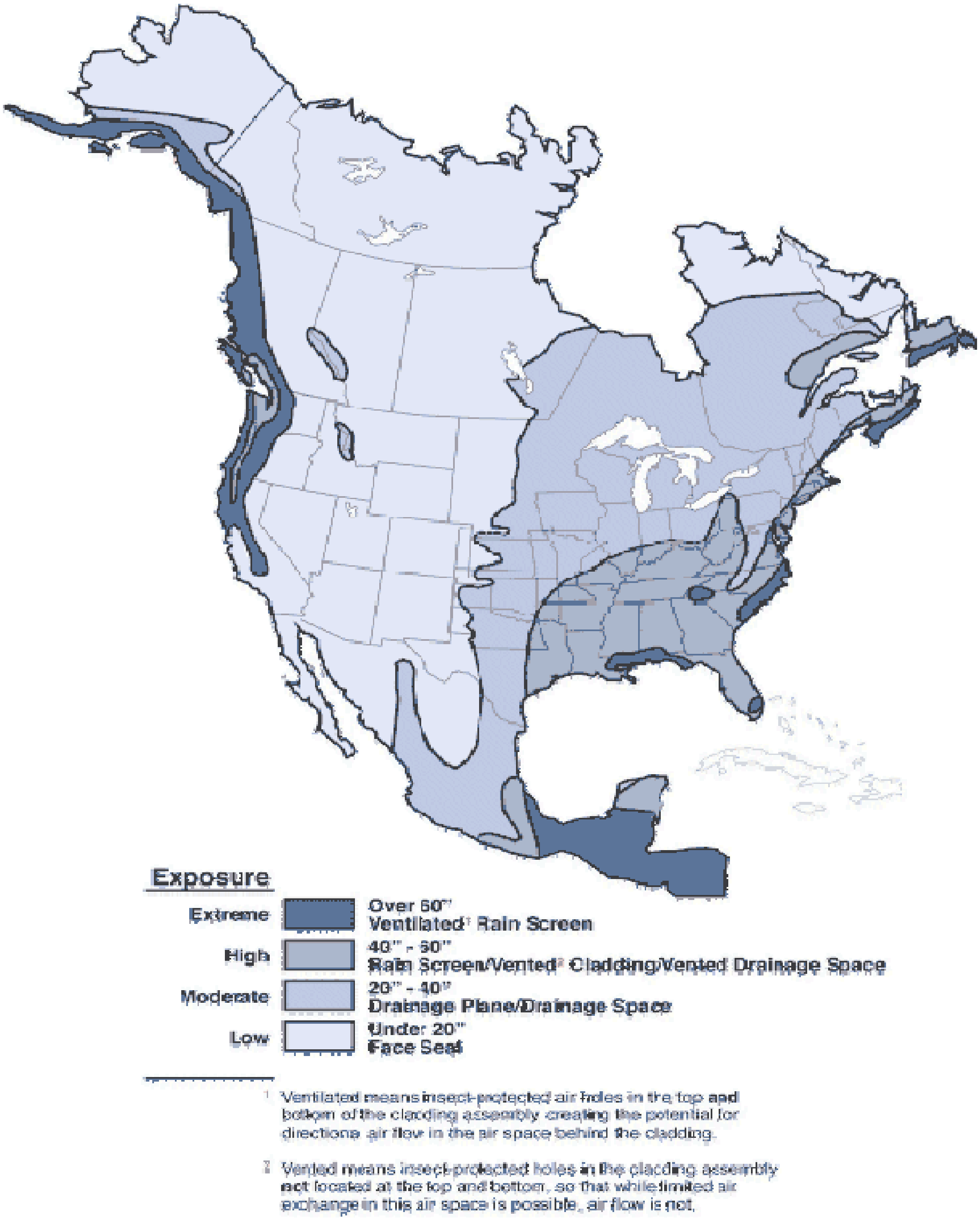
A mean temperature of coldest month between 27 and 65 degrees Fahrenheit

A warmest month mean of less than 72 degrees Fahrenheit

At least 4 months with mean temperatures more than 50 degrees Fahrenheit

A dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.

Moisture (Rainfall) Variations Maps



National Renewable Energy Laboratory (NREL), U.S. Department of Energy, Introduction to Building Systems Performance: Houses That Work, II, April 2004

THE BUILDING ENVELOPE

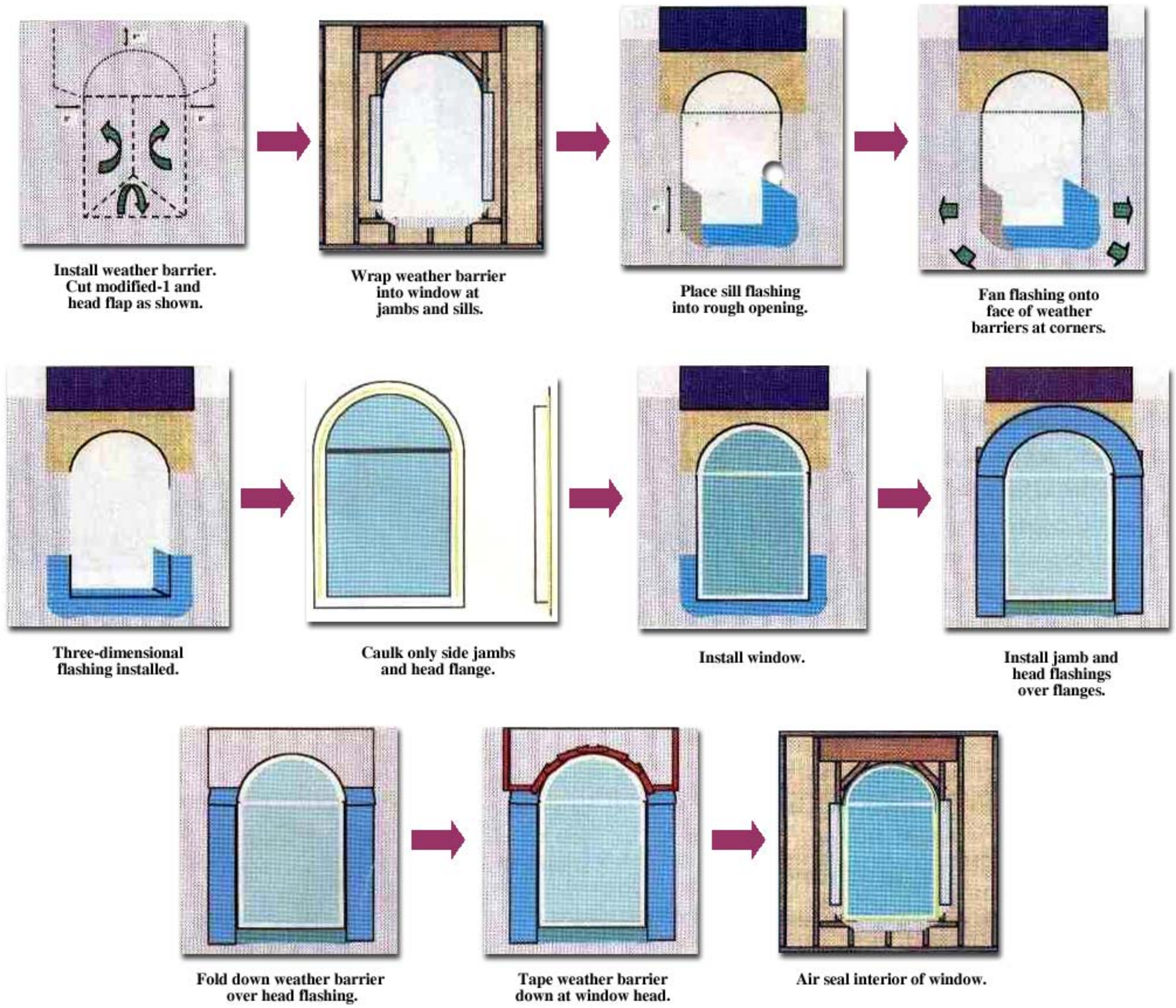
To properly construct building envelopes, it is necessary to apply the principles of building science. The building envelope separates the interior of a built environment from the outside environment. The building envelope includes: exterior walls, a foundation, floors, windows, doors, roofs and ceilings. The building envelope has several purposes including keeping out wind, rain and ground water, and controlling the transfer of energy between the inside and the outside.

A major purpose of building envelope design is to provide a structure that maintains comfortable temperature and humidity, while allowing adequate ventilation inside, regardless of outside conditions. The study of heat, air, and moisture flow is crucial to understanding building dynamics. Proper construction helps avoid problems, such as mold, poor indoor air quality, unwanted water intrusion, and other issues. Small changes in one component can have a dramatic effect on the entire structure.

A common error in building envelope design or construction occurs when materials at and around doors and windows are incorrectly designed or installed. If designed or installed correctly, the possibility of unwanted moisture entering the building envelope is reduced. Understanding flashing details helps remediators understand where to investigate potential moisture intrusion and migration, and potential mold growth. Any opening or penetration in the building envelope that is not properly flashed can result in moisture intrusion. Below are examples of a proper flashing sequence for a flanged window installation.

Examples of Building Envelope Details

Flashing Sequence for Flanged Windows Installed after Weather Barrier (Three-Dimensional Flashing).

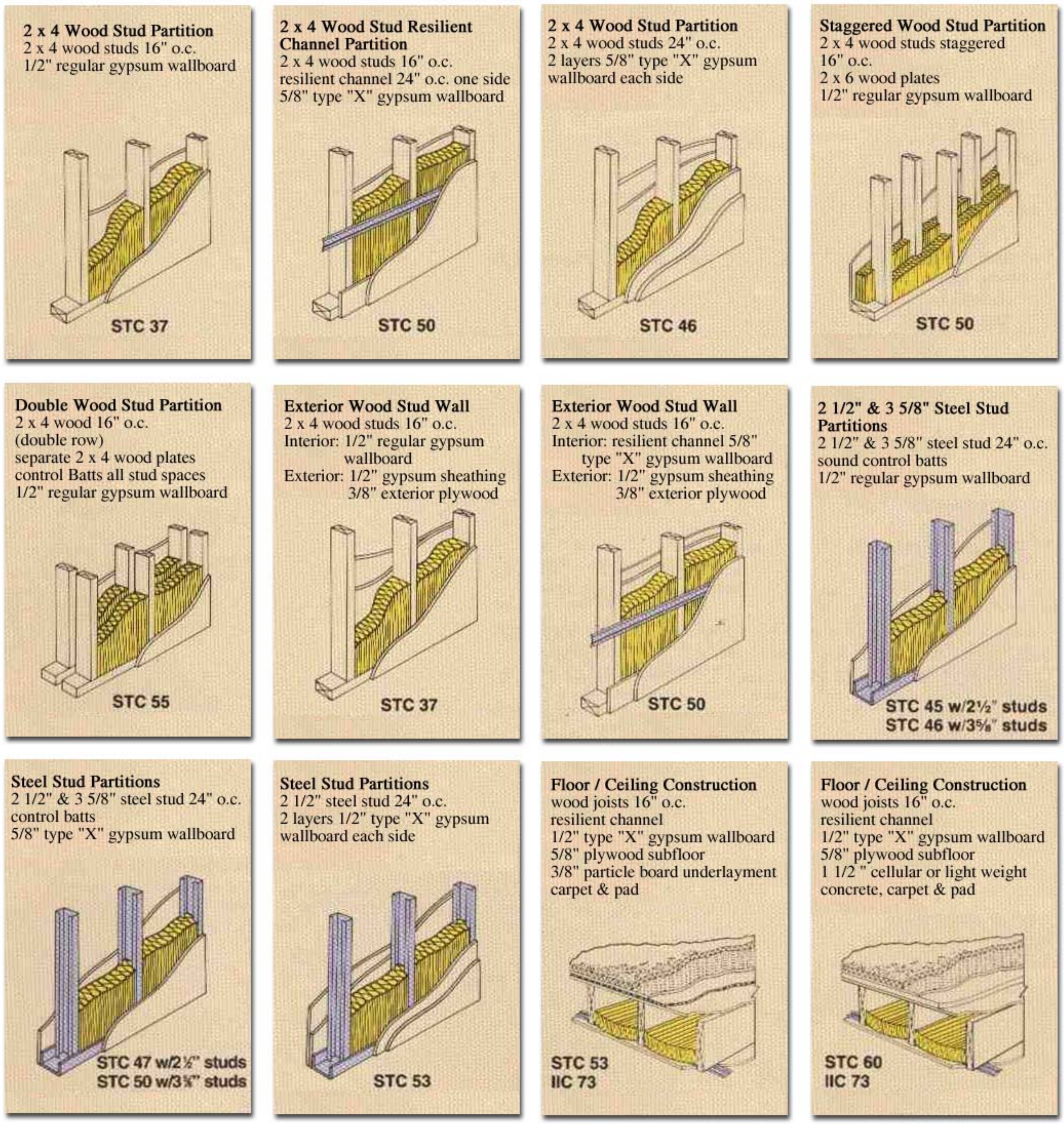


Weston, Ph.D., T.A., & Katsaros, Ph.D., J.D. (2003). *Innovations in window installations: keep the water out;* Walls & Ceilings, 66(9), 34-44.

Wall, Floor and Ceiling Assemblies

It is important for remediators to understand the construction of wall, floor and ceiling assemblies, and the effect of moisture on materials, to facilitate educated decision-making about drying and remediation. Knowledge of construction materials and their applications for strength, sound transmission and fire ratings, all affect decisions about how a building or structure can be properly dried and remediated. Since all components of a building are interrelated, it is recommended that remediators attempt to discern the intent of a building's design or construction during a remediation project, and address those aspects individually and collectively.

Diagram: Examples of construction assemblies that might be encountered on a jobsite.



Courtesy of Certainteed Corporation

For more information on sound transmission coefficient (STC) ratings, impact class ratings (IIC) and hourly fire resistance ratings, refer to the Gypsum Association (www.gypsum.org) GA 600 fire-resistance design manual and Underwriters Laboratories (www.ul.com) fire resistance directory.

Twenty-First Century Building Envelope Techniques

Existing building design and construction practices present challenges to drying after water intrusion. For example, commonly used moisture retarders can prevent expeditious drying of building components. In a warm humid climate, moisture tends to move from outside to inside and can become trapped inside walls. In a cold climate, moisture tends to move from inside to outside and can also get trapped within walls. In a mixed climate, moisture enters interstitial spaces from either side, depending on the season.

An increase in insulation decreases the drying potential of buildings. Installing materials with low permeance on the interior (such as polyethylene vapor retarders under the gypsum wallboard, vinyl and other wall coverings) prevents drying to the interior. Using materials that are moisture sensitive, such as particle board, paper-faced gypsum wallboard, and some laminate flooring, presents a challenge to drying. Some materials, such as oriented strand board (OSB) and concrete with chemical plasticizers, do not absorb water easily, and, if they become wet, they can be very difficult to dry. When buildings stay wet, they tend to develop mold growth.

MECHANICAL SYSTEMS

It is useful to understand mechanical systems and their function within a building. These mechanical systems include: plumbing, HVAC (heating, ventilating, and air conditioning) systems, gas appliances, chimneys, fireplaces, air-exchange systems, vents in kitchens and baths, clothes dryer vents, recessed light fixtures and central vacuums. Some of these systems create positive pressure, while some create negative pressure, and some are neutral. Pressure differentials should be considered when investigating problematic systems.

THE EFFECTS OF MOISTURE ON MATERIALS

Remediators should be aware of the effects of moisture on building materials and the potential contamination from mold growth. Understanding how materials react to moisture allows remediators to more adequately devise a remediation plan. How materials react to moisture depends upon many factors, including porosity, permeability, absorption, moisture holding capacity, evaporation rates, and susceptibility to damage and microbiological growth. Although many materials (e.g. plaster, stucco and fiberglass) are not themselves generally conducive to mold growth, soils and biofilms on these materials can provide conditions that allow microbial growth. Below is a list of materials commonly used in buildings and how moisture can affect them.

The following chart discusses drying of wet materials and makes reference to Categories of water. For further information on Categories 1, 2 or 3, see the *ANSI/IICRC S500 Standard and Reference Guide for Professional Water Damage Restoration.*

Concrete	Concrete is one of the least understood and least predictable materials in the construction and remediation industries. Moisture travels great distances through concrete when it is wet. When concrete slabs are placed directly on the ground without a proper capillary break, such as gravel, the concrete can absorb additional water from the soil. Other contributors to ground and concrete saturation include an improperly designed, installed, or even non-existent drainage system. There are many factors that affect the appearance, durability, strength, porosity and density of concrete. Individually and collectively, variations in these factors will influence how water is either absorbed or desorbed by concrete. The resulting unpredictability of how concrete reacts to moisture requires remediators to evaluate on-going concrete drying progress, which typically is not uniform. Changes in drying techniques, even within the same structure, as well as from job to job, are often required to completely dry all areas. Generally, concrete tends to release moisture more slowly than most other building materials. Lightweight concrete releases moisture even more slowly than concrete typically found in most flooring systems. Lightweight concrete is typically 3/8” to 1½” thick and usually found over plywood. Post-tensioned concrete absorbs moisture even more slowly, due to compaction. Concrete does not create a favorable growing environment for mold; however, susceptible building materials in contact with wet concrete can develop mold growth. Due the extended length of time that is required to dry wet concrete, uncontrolled evaporating moisture can contribute to higher relative humidity and result in secondary damage.
Masonry (e.g., Bricks and Blocks)	The movement of water in and out of masonry wall assemblies should be considered when applying drying procedures. Wind-driven rain, capillary action and water vapor are sources of water in masonry walls. Integral water repellents, surface treatments and wall drainage can greatly reduce the absorption characteristics of masonry. Properly tooled mortar joints also play a role in the water tightness of finished buildings. Masonry does not create a favorable growing environment for mold; however, susceptible building materials in contact with wet masonry can develop mold growth. Due the extended length of time that is required to dry wet masonry, uncontrolled evaporating moisture can contribute to higher relative humidity and result in secondary damage.

Plaster and Stucco	While these porous materials may retain their structural integrity, decisions about removal or replacement should be made based on the contamination and location of the material (e.g., interior, exterior). Remediation options can include: drying in place; drying from above, below or behind; or complete removal in Category 3 losses, for access to pockets of saturation to thoroughly clean and sanitize. Plaster and stucco do not create a favorable growing environment for mold; however, susceptible building materials in contact with plaster or stucco can develop mold growth. Due the extended length of time that is required to dry these materials, uncontrolled evaporating moisture can contribute to higher relative humidity and result in secondary damage.
Paper-Faced Gypsum (Drywall)	Drywall loses its structural integrity when saturated, but regains it if dried properly. It should be classified as porous when making decisions about removal based on the Category of water. For example, in Category 3 losses, drywall should be removed to allow remediators access to pockets of saturation for thorough cleaning and drying to acceptable moisture content (MC). Paper-faced gypsum readily supports mold growth if left wet for a sufficient period of time.
Vinyl and Vinyl Composition Tile (VCT) Type Materials	While these materials do not absorb water, at least on their surfaces, when water penetrates underneath, they often need to be replaced due to failure of mastics, and for access to dry wet substrate materials.
Windows and Doors	Depending on construction components, windows and doors vary from semi-porous to non-porous. Each need to be handled according to its composition. Properly installing windows, along with properly integrating drainage planes, flashing and weather-resistant barriers, are key components in preventing moisture migration into building walls. Properly installed three-dimensional sill flashing is seamless and fully protects the rough opening. A weep system that provides a potential escape path for water should be created at the bottom of windows to eliminate the need for caulk at the bottom flange. Windows with weep holes and flashed openings should not be caulked.
Metal Structural and Decorative Components	These items are non-porous; do not absorb moisture readily and are not directly susceptible to mold growth. Moisture can cause corrosion and deterioration of metal surfaces or the materials to which they are attached.
Glass, High Density Plastics, Ceramic and Porcelain Materials	These items are non-porous; do not absorb moisture readily, and are not directly susceptible to mold growth. Moisture may cause failure of mastics and deterioration of materials to which they are attached.

Laminate Floors	There are many types and grades of laminate flooring. The layers of resin, high-density or medium-density fiberboard, and resin-saturated photographic paper are bonded with heat and pressure to form a direct-pressure laminate (DPL) or high-pressure laminate (HPL), after which a wear layer is applied. Laminated flooring can resist impact damage and scratching based on its abrasion class (AC) rating. Because fiberboard is highly hygroscopic, any water that gets past the photographic layer can absorb and distort edges, causing swelling and delamination. Some grades of laminate add higher resin content, waxes and oils to slow moisture absorption. Most laminate product maintenance instructions discourage wet mopping or "submersion cleaning." Therefore, water intrusions can quickly lead to deterioration. Laminate products do not respond well to the vacuum floor drying systems used on other hard surface floors. Often laminates are installed over a thin cushion material. On concrete, a three-mil plastic vapor barrier is often installed underneath the flooring. When significant water penetrates under laminate flooring, it should be removed for subfloor drying.
Solid Wood	Solid wood can be either soft or hardwood species. Solid wood materials can include: framing, flooring and trim. It should be classified as semi-porous material when making decisions about removal or replacement, considering the Category of water. For example, when Category 3 water penetrates behind or underneath solid wood molding or flooring, the material should be removed to expose pockets of saturation and contamination for thorough cleaning and drying to acceptable moisture content (MC). When the moisture content of wood exceeds 16%, it is more susceptible to mold growth.
Plywood	Plywood should be classified as a semi-porous material when making decisions about removal or replacement, considering the Category of water and time of exposure. When the moisture content of wood exceeds 16%, it is more susceptible to mold growth.
Oriented Strand Board (OSB)	OSB should be classified as a semi-porous material when making decisions about removal or replacement, considering the Category of water and time of exposure. When the moisture content of wood exceeds 16%, it is more susceptible to mold growth.
Engineered Wood Products	Engineered wood products include laminated wood beams, floor joists and other framing structural materials. They should be treated as semi-porous materials when making decisions about removal or replacement, considering the Category of water. When the moisture content of wood exceeds 16%, it is more susceptible to mold growth.
Particle Board and Fiberboard	When wet, these materials can swell, absorb water and lose shape and strength, and therefore, they often require replacement. When the moisture content of wood exceeds 16%, it is more susceptible to mold growth.

Heat and Pressure-Created Laminate Materials	This category includes materials that are often used as counter tops and hollow-core doors. These materials can absorb water and lose shape and strength; if so, they require replacement. If these materials retain their shape and strength, they should be treated as semi-porous materials.
Housewraps/Vapor/Air Retarders	The primary function of housewrap is to provide air and moisture control. Building paper and housewrap are installed in wall assemblies to prevent water penetration. Breakdown in this material increases the chance of water entering into the building envelope. Wood tannins can cause housewrap to become more permeable to water. Also, some additives in stucco can act as surfactants that promote penetration of moisture, and thereby lower the effectiveness of housewrap as a moisture retarder.
Insulation	The effectiveness of insulation is measured using a scale of R-values. The higher the R-value, the greater the resistance to heat transfer. All building products have an R-value. The U.S. Department of Energy has published a model energy code that recommends minimum insulation requirements for different climates of the United States. Generally, these are prescriptive in nature. For example, climate zone 4 recommendations are: R38 for ceilings, R19 for walls, and R19 for crawlspaces or basement floors. Proper placement of insulation in a building is climate-specific. When insulation has not been placed properly, construction failures and building-related problems can be linked to this defect. Insulation affects comfort, durability, energy efficiency, and indoor environmental quality. Basic principles explain the loss of insulation effectiveness. First, insulation works by trapping air or millions of tiny air bubbles. It is this air that insulates, just as air in a goose-down coat or comforter keeps a person warm. Second, water has much higher thermal conductivity than air. Moisture as a liquid or vapor can cause insulation to lose its ability to resist heat transfer. This means that moisture short-circuits the ability of insulation to perform its function in resisting heat transfer. Insulation should be considered a porous material when making decisions regarding drying or replacing. Insulation saturated with Category 2 or 3 water should be replaced. When remediators replace insulation, they should maintain the integrity of the vapor retarder as it was originally designed. Remediators should address insulation as a part of the building assembly, rather than as a single component. The effectiveness of insulation is dependant on the quality of the installation. Remediators shall not install insulation over lights or fixtures that are not rated for insulation contact (IC or ATIC rating), due to fire potential. Older structures that contain knob and tube wiring shall not be covered with insulation, since that may cause a fire hazard. Proper clearance around appliances, vent pipes, and combustibles shall be maintained.

Cellulose Insulation	Insulation can be made of shredded paper products that are chemically treated to reduce flammability. These chemicals can corrode metal parts in contact with the insulation. In a water intrusion, chemicals can leach out of cellulosic insulation, thereby changing its fire-retardant properties. In addition, water-saturated cellulosic insulation can compact and lose its R-value. Wet cellulose insulation should be removed, regardless of the Category of water, and replaced with new material after structural drying.
Rock Wool	Insulation may be manufactured from mineral materials, such as slag from steel mills (e.g., rock wool). In water damage situations, the batt form of rock wool insulation generally retains its loft or bulk after drying. When loose-fill rock wool becomes wet, it can compact and lose loft and R-value. Therefore, such insulation should be removed and replaced regardless of the Category of water.
Fiberglass	This insulation is manufactured from sand and minerals. In water damage situations, the batt form of fiberglass insulation generally retains its loft after drying. When loose-fill fiberglass becomes wet, generally, it can compact and lose loft. If compacted, remediators should remove fiberglass insulation and, after drying structural components, replace it with new material, regardless of the Category of water.
Foam	Open-cell foam can hold water and may need to be removed in order to dry other building components. Closed-cell foam does not readily absorb water and generally retains its R-value after a water intrusion. This insulation may be applied as rigid sheets, or by a spray method. Its main advantages are that it provides improved resistance to wind penetration, in addition to uniform R-value. After having been wet, it does not lose its form or R-value when dried.
Interior Duct Insulation	When internal ductwork insulation gets wet or is contaminated, it should be removed and replaced with new ductwork, according to NADCA ACR 2006 Assessment, Cleaning and Restoration of HVAC Systems.
Electrical, Plumbing, HVAC Components and Mechanical Systems	These systems should be evaluated by a specialized expert.
Paint films	Coatings and paint films affect the permeability and absorption rates of materials. Therefore, drying strategies need to consider the effect that desorption and evaporation rates, created by coatings, have on affected materials.

OCCUPANTS, PETS AND PLANTS

Occupants, pets and plants can have an effect on building performance. People directly influence the amount and flow of heat, air and moisture in a building by the way they operate appliances, adjust temperature, launder, bathe and cook. Also, they can change the efficiency of the building envelope by opening and closing windows and doors, and operating venting devices, such as fans. Since people and plants release heat and moisture into buildings, they also affect and change the flow of heat, air and moisture.

An abnormally large number of people per cubic foot of airspace, by itself, can dramatically raise humidity and temperature. Occupants' daily activities, such as cooking, showering and laundering, can dramatically increase the moisture load within a structure, unless extra dehumidification or air exchanges are employed. A large number of plants can increase the moisture load caused by watering and transpiration.

CONCLUSION

The study of building and material science includes how building components function and interact. An understanding of how moisture moves through the building envelope and affects building materials, and the impact of natural laws on this process, assists remediators in making accurate and informed decisions about remediating mold contamination. Locating and controlling water or moisture intrusion generally prevents the development of mold contamination. Although the information presented in this chapter is basic, it is intended to encourage users of this document to further investigate and expand their knowledge in the area of building and material science, and related processes.

Chapter 5

Equipment, Tools and Materials

INTRODUCTION

The objective of this chapter is to discuss some of the more common equipment, tools and materials, and their application to mold remediation projects. Before mold remediation work can begin, remediators should be familiar with, and have access to, certain equipment, tools and materials required to accomplish their work. Since this document is not designed to be a training manual, remediators should have specialized training in using and operating equipment, tools and materials, during mold remediation work. Remediators shall follow manufacturer instructions and label directions for safe and proper use of equipment, tools and materials.

SAFETY EQUIPMENT

Attention to safety equipment is mandated when employees are placed in potentially hazardous situations. Safety equipment, tools and materials are addressed in Chapter 6, *Safety and Health*.

INSPECTION/MONITORING TOOLS

Before remediation procedures can commence, it is necessary to determine the status of the structure, systems and contents during the inspection process. Chapter 8, *Inspection and Preliminary Determination*, describes inspection procedures. When using tools for inspecting and monitoring remediation projects, the same tool should be used in the same general location to allow consistent data collection and to promote more accurate project monitoring and post-remediation evaluations. The scope of this section of this chapter is limited to discussing the tools used for inspecting and monitoring mold-contaminated structures, systems and contents.

Thermo-hygrometer

This device measures the temperature and relative humidity (RH) of the air, and is used to compare psychrometric variations between affected and non-affected areas. Also, it is used to determine when air in the structure has returned to normal humidity and temperature. Also, thermo-hygrometers are used to monitor site conditions during a remediation project, and when employed with specialized attachments or procedures, they can be used to assess the approximate equilibrium relative humidity (ERH) at the surface of structural materials. A thermo-hygrometer enables remediators to predict when moisture in the air is likely to condense on cooler materials and provide sufficient water activity (a_w) to support microbial growth.

Temperature and relative humidity readings taken during a project should be recorded to document environmental conditions within the remediated space before and during a project. Readings can be taken inside and outside a contained area. If readings indicate conditions that are likely to promote microbial growth, remediators should take steps to control the environment. Because differences in calibration can occur from one piece of equipment to the next, the same thermo-hygrometer should be used to monitor conditions throughout a project.

Moisture Sensors

A moisture sensor typically has penetrating pins and produces an audible or visible signal. Generally, it is used to indicate elevated moisture in various materials. This is the easiest tool to use in determining areas of wet carpet and cushion, and the extent of water migration within an affected area. Sensor pins are inserted into the material to be evaluated and the sensor signal changes as conductivity between the pins changes. The moisture probe is limited to detecting the presence of moisture greater than 17% moisture content (MC). It also helps remediators in identifying damp areas where mold is most likely to be found.

Because moisture sensor pins penetrate materials, remediators should consider, and mitigate, where possible, the potential for collateral damage before use. Contaminants in materials (e.g., animal urine) or materials that are naturally conductive can give false indications of moisture.

Moisture Meters

Remediators should use properly calibrated moisture meters, in accordance with manufacturer specifications, to determine the presence of moisture that can indicate potential for mold amplification on structural materials. Generally, two types of hand-held moisture meters are available today:

- **Non-penetrating (non-invasive)**: Non-penetrating moisture meters use conductivity, capacitance or radio frequency emissions to detect moisture. These meters allow the operator to test or scan relatively large areas quickly without penetrating the material. These meters are ideal for rapidly identifying problem areas. The readings obtained can indicate the presence of moisture on or within materials and, in some cases, under materials.
- **Penetrating (invasive)**: Like a simple moisture sensor (probe), these meters operate on the principle of electrical conductivity by penetrating the surface of a material being tested. The electrical conductivity of a material between the probes, which is influenced by the presence of moisture, is measured and recorded on an analog or digital readout. These instruments can be used to provide quantitative measurements. Attachments include, but are not necessarily limited to: non-insulated pin probes, paddles, insulated extended probes, and hammer probes.

Commercially available moisture meters are designed and calibrated for either a specific material or a combination of different materials. Some models feature different scales to check wood, gypsum board, and other building materials. An understanding of meter operation and limitations is critical to accurate measurement and interpretation. Depending on the make and model, most moisture meters have a scale that is calibrated for wood with the ability to measure between 6% and 40% moisture content (MC). When measuring wood products, such as flooring, framing material, sheathing and furniture, the wood scale is used and the reading indicates the MC percentage. Some meters have a scale that is also calibrated for gypsum, with the capability to read MC over a range of 0.2%-50%. Most meters also have a relative scale for other materials, such as concrete and insulation, over a range of 0-100. It is important to note that a relative scale does not translate to a percentage of moisture content (% MC). It is intended to be used as a qualitative comparison of materials.

When using the relative scale, readings should be taken on material samples that are considered to be within an acceptable moisture content range or have a known moisture content. These readings can be used as target drying goals, or dry standards, against which all other readings can be compared. Although readings from the relative scale do not quantify the percentage of MC, when properly interpreted, they are useful for evaluating moisture conditions.

When moisture meters are used on concrete, plaster or brick, readings reflect a qualitative comparison with a dry standard, unless the meter is specifically calibrated for that specific material; then, the reading would be quantitative. Other quantitative measurements can be derived from two types of tests. These include measuring the moisture vapor emission rate, as determined by using a calcium chloride test kit, or the relative humidity (RH) of the interior mass of the concrete, determined by using a thermo-hygrometer measuring at a specified depth.

False-positive readings can be incorrectly interpreted as moisture when metal or certain chemicals are present in or behind a material being tested. In addition, with a typical ¾-inch detection depth, non-invasive meters might not accurately detect moisture in thicker materials. Separations or air gaps between dry and hidden wet materials can also result in inaccurate readings.

Psychrometric Chart or Calculator

After measuring atmospheric temperature and relative humidity in a structure using a thermo-hygrometer, the psychrometric chart or calculator can be used to determine dew point, specific humidity and vapor pressure. These measurements can be used to establish and monitor conditions for properly drying a structure, and to predict where equilibrium relative humidity (ERH), water activity (a_w) or condensation are sufficient to promote mold growth or amplification. The *ANSI/IICRC S500 Standard and Reference Guide for Professional Water Damage Restoration* covers the subject of psychrometry in more detail. Geography, particularly altitude, can affect the accuracy of psychrometric conversion information.

Manometer

A manometer is an analog or digital instrument that measures the static air pressure differential between two or more adjacent areas. Manometers are required to accurately monitor “negative” pressure in contaminated areas, as compared to non-contaminated areas. Some are equipped with alarms or phone-notification features that warn remediators of pressure changes that might result in cross-contamination.

Typically, a monitoring station is set up outside a contained area, with one air intake (usually by way of a flexible hose) stationed inside the contained area, and another in the area adjacent to the contained area. The difference in pressure between one intake and the other is then measured. his difference is expressed as either pascals (Pa) or inches of water column (w.c.). Manometers can be attached to electronic devices that provide data logging to document pressure differentials (ideally 5 to 7 Pa) in contaminated areas.

Manometers are beneficial when monitoring contaminated spaces to reduce the potential risk of cross-contamination. Contaminated areas should be under negative pressure compared to adjacent uncontaminated or less-contaminated areas. Pressure differentials of at least 5 to 7 Pa (.02 to 0.028 w.c.) should be maintained during a project. Improperly controlled pressure differentials can result in migration of exhaust gases or other contaminants into or out of a contained area.

Laser Particle Counter

Particle counters can be helpful in determining particle concentrations during remediation, both inside and outside of containment. These devices measure total particulates in air, not necessarily contaminants associated with mold. Some particle counters can be adjusted to measure particles at or above a desired size threshold.

Often a laser particle counter will be used to monitor particulate levels within a remediation area to indicate overall remediation effectiveness. These can be used as a quality-control tool by remediators, or as a precursor to post-remediation verification by an indoor environmental professional (IEP). By monitoring particle count differences at the intake and exhausts, equipment can also be monitored for effectiveness.

Gas Monitors

These instruments monitor the presence and quantity of various gases. Gas monitoring meters may be appropriate or required on certain work sites, in confined spaces, to identify flammable or toxic gases, or to monitor for oxygen deficiency.

A carbon monoxide (CO) meter or detector with digital readout may be used when natural gas or fuel oil mechanical systems (e.g., boilers, water heaters, furnaces) are in service during projects. Oxygen (O_2) and carbon dioxide (CO_2) monitors may be used with processes like dry ice blast systems. Other meters, such as explosive gas detectors, may be required to determine the quality of the air at the work site.

Infrared (IR) Thermometer

This device measures the surface temperature of materials from distances as far as 50 feet without direct contact with the surface. This tool allows remediators to scan large areas of material to indicate temperature differentials indicative of evaporation. Generally, this tool is used as a scanning device to identify likely areas of elevated moisture, to be verified by other means, such as using a moisture meter.

As the distance from the infrared thermometer to the surface increases, the size of the area scanned increases. The thermometer averages the temperatures it measures. This instrument, therefore, loses its ability to accurately monitor temperature differences at greater distances from the target material. Cooler surfaces do not always indicate evaporative cooling, but can be the result of other anomalies, such as insufficient insulation, thermal bridging and air penetration. For this reason, all areas showing indication of evaporative cooling should be verified using a moisture meter.

Thermal Imaging Devices

Infrared (IR) cameras, like infrared thermometers, are used to detect surface temperature differences and do not detect moisture or measure moisture through materials. An IR camera produces a thermal image of a material that can provide rapid identification of potentially moist areas by indicating temperature differences at the surface of materials. IR cameras can be a valuable tool for quickly scanning large areas of a building. Materials that register a temperature difference can result from evaporative cooling on a material's surface, which indicates moisture. Apparent differentials registered by an IR camera, however, are not always associated with evaporation and moisture. For example, differentials can also be the result of: cooler air striking a surface from an air conditioning supply; a lack of insulation in a wall cavity; a cold water line running through the area, or thermal bridging or reflectivity.

Non-porous materials that do not allow evaporation, and reflective materials that do not allow accurate temperature information to be transmitted to the camera, can result in misinterpretation of data. Suspect areas identified by an IR camera as having elevated moisture should be verified by other means, such as using a moisture meter. Remediators using infrared thermography equipment in surveying buildings for moisture damage should receive proper training in its use.

Borescope/Optical Devices

Borescopes and similar tools are optical devices that allow remote viewing into concealed areas, such as wall cavities. A small (usually 3/8" to 1") opening is required to allow a fiber optic cable or camera head to be inserted into the space. Generally, the viewing range is limited to one to four feet with traditional borescopes, and can be extended 50 feet or more on units using remote cameras. These devices are used to inspect the condition of wall cavities, HVAC systems and other concealed areas within work spaces. Viewing quality varies dramatically in currently available systems, necessitating caution to avoid faulty conclusions.

Data Loggers and Paper Recording Devices

Data loggers and chart recorders are devices that measure and record atmospheric conditions over time. These devices can keep a hard copy or electronic record, providing remediators with valuable supporting data and reports that document atmospheric conditions. Typically, a data logger is installed at the beginning of a project, and it provides a historical record of conditions throughout a project.

CONTAINMENT EQUIPMENT, TOOLS AND MATERIALS

The purpose of the following is to discuss the basic load list of equipment, tools and materials used in constructing containments. Containment materials are used to establish a physical barrier to limit movement of air from contaminated to lesser or uncontaminated areas. It is not within the scope of this chapter to cover constructing containments and related airflow management issues. Chapter 11, *Structural Remediation*, contains a discussion of this subject.

Framing Materials

Conditions can require that a durable frame be erected on which to install barrier material. A frame consisting of PVC piping and connectors, wood framing material, or commercially available adjustable poles, can be configured to provide a support for installing polyethylene sheeting. Typically, frames are installed at access points, as temporary walls, and for decontamination rooms or air locks. Remediators should consider and mitigate, where possible potential collateral damage from attaching containment materials to structure finish materials. The durability of the frame, relative to project requirements, is an important consideration when choosing materials.

Polyethylene Plastic

Polyethylene plastic (commonly known as "poly") is the most widely used material for both source containment and area containment. Typically, 6-mil polyethylene sheeting is used for walls and ceilings to erect physical barriers without penetrations (critical barriers) to separate affected from lesser or unaffected areas. Thinner polyethylene may also be used for temporary tear-away protection of surfaces. Source control can be achieved by covering a moldy surface with self-adhering plastic placed over a contaminated material. The impermeability of this material makes it ideal as a physical barrier to the migration of mold contamination. When selecting polyethylene for containments, the thickness, size and slip factor should be appropriate for the application. Visibility and illumination are also important factors in selecting polyethylene material for containments. Polyethylene choices for transparency are:

- **clear** – little loss of light and minimal limits to visibility across barrier
- **opaque** – minor loss of light and visibility is obscured across barrier
- **black** – complete blocking of light and visibility across barrier

Medium-slip grade polyethylene (no oil or talc coating) is preferred when erecting containments, when available. This allows better tape adhesion to the polyethylene surface. Fire-retardant poly with a minimum flame-spread rating of 25 should be used to reduce fire hazards, and shall be used when required by applicable federal, state, provincial or local laws and regulations.

Fasteners

Different types of fastening methods are available to attach containment materials (e.g., polyethylene sheeting) to containment frames and to surfaces of the existing structure. They include, but are not limited to: tape, adhesives (such as spray glue), staples, c-clips, t-rail clips, and a variety of clamps. Remediators should consider and mitigate, where possible, the potential for collateral or consequential damage at the point where a containment barrier is joined to the structure's finish materials. It is recommended that a description of, and responsibility for repair of such damage be established prior to starting a project.

Air Filtration Devices (AFDs)

AFDs are air moving devices with filters. AFDs consist of a motorized fan, banks of filters, and a housing. An AFD is designed to remove contamination from an incoming air stream based on the efficiency of the filtering media. AFDs have a bank of filters that usually consist of a pre-filter, secondary filter, and HEPA filter. The pre-filter and secondary filters prevent damage and premature loading of the HEPA filter by trapping larger particles, thereby extending filter life. AFDs are rated based on the cubic feet of air per minute (CFM) that they move. They can be configured to create negative, neutral or positive pressure differentials.

When configured as a "negative air machine" (NAM), an AFD is used to create a pressure differential by exhausting air from or into a contained area. When configured as an "air scrubber," an AFD is used to filter and re-circulate air within an area, and to remove contamination during demolition or remediation processes.

AFDs should be clean (free of exterior contamination), and be inspected for proper performance when placed at the job site. The intake side of an AFD used in a contaminated area should be sealed before shutting off the unit to prevent release of collected contamination. Sealing the exhaust side of a unit can trap moisture and result in internal condensation and mold growth in filters. After use, and prior to removal from the project site, AFD's exterior should be cleaned and dried, and subsequently, stored in a dry environment. Contaminated filters should be changed, as needed.

Caution: Negative pressure differentials can create unintended air flow resulting in a risk of carbon monoxide exposure, and a risk of fire, due to back-drafting or flame roll-out from gas appliances, such as furnaces, ovens or water heaters. When gas appliances are in areas where negative pressure differentials are created, they should be rendered temporarily inoperable, and the use of supplemental mechanical systems may be necessary.

Air Filters

Filter media are critical to the successful operation of an AFD. Several levels of filtration are available and used in AFDs, including pre-filters, secondary filters and HEPA-grade filters. Each step in the filtering process increases in efficiency to a point where, at the HEPA-stage, if properly installed and functioning, 99.97% of all particles at 0.3 microns in size will be captured and removed from the filtered air.

Proper use and timely replacement of primary and secondary filters increases the use-life of a HEPA filter. Damaged filters or seals and improperly installing filter components or assemblies can result in contamination passing through AFDs.

Supplemental Air Filtration

During a remediation project where negative air pressure is used, make-up air will enter a contained area. Controlling both the source and quality of make-up air can be crucial to successfully removing contamination. Filtering make-up air can improve the quality of air entering a contained area. However, restricting airflow with too much filtration can result in make-up air being drawn from unintended sources, resulting in unwanted contamination in a contained area.

Ducting

Ducting materials of various types are available to control the point where air is taken into or exhausted out of a contained space. Using ducting allows remediators to position equipment outside a contaminated area to reduce equipment decontamination requirements. It can also be used to improve the effectiveness of equipment by positioning a capture zone near the immediate area being remediated, or controlling the discharge of exhaust air from an AFD.

Flexible ducting (flex-duct) and disposable ducting (lay-flat) are commonly used in mold remediation. Flex-duct can be used on the intake or exhaust side of an AFD, and lay-flat can be used on the exhaust side only. Lay flat is a seamed polyethylene and can be susceptible to seam failure during a project. Ducted exhaust from an AFD will be under strong positive pressure relative to adjacent air. The possibility of cross-contamination, due to a breach, should be considered when routing exhaust in any ducting material through a non-contaminated area.

PRODUCTION EQUIPMENT AND TOOLS

The purpose of this section is to discuss the basic load list of equipment, tools and materials used during a remediation project. Some of the equipment, tools and materials commonly used in structural drying are the same as those used during a mold remediation project. The equipment and tools list below may be expanded as the remediation industry evolves.

Air Moving Equipment

Air moving equipment (e.g., air movers, fans, and structural cavity drying equipment) can be used to direct airflow at or across wet materials to promote evaporation, or to create a pressure differential between two areas. Also, air moving equipment can be used to create negative or positive pressure within an area or building by attaching it to ducting to direct airflow. If airflow is not properly controlled in a mold-contaminated environment, air movers can spread contamination in the area. When mold-contaminated environments are identified, minimal airflow, in a managed-airflow environment, can be used to minimize the potential for spreading contamination.

The term “air mover” is commonly used to describe equipment that contains either a centrifugal or axial fan. Centrifugal air movers use a squirrel cage assembly to produce high-volume airflow. Axial fans, both high-pressure and low-pressure, are designed with fan blades attached directly at the axis of rotation. Air movers can assist in drying textile floor coverings and other building materials.

Structural cavity drying systems (SCDS) can channel airflow into or out of walls, ceilings and other inaccessible areas where moisture can be trapped, including traditional wood floor and other, more complex flooring systems, for efficient drying. SCDS can be classified according to pressure ranges and by the manner in which they handle airflow through ducting and attachments. This equipment can be used to positively or negatively pressurize interstitial areas of a structure.

SCDS carry many of the same risks as air movers and axial fans in that they can spread contamination. When drawing moist air out of potentially contaminated cavities using negative pressure, an in-line HEPA filter should be used to remove contamination before exhausting that air into a structure. A potentially contaminated cavity should not be positively pressurized.

Dehumidification Equipment

Several kinds of dehumidification equipment are used to remove moisture directly from the air and indirectly from materials. Generally speaking, there are two categories of mechanical dehumidifiers: refrigerants and desiccants, with the former further divided into conventional and low-grain refrigerants. Mechanical dehumidification can be useful in removing evaporated moisture from air to mitigate additional mold growth during or following remediation.

Conventional Refrigerants

Refrigerant dehumidifiers work on the principle of condensation. Refrigerant dehumidifiers work most efficiently above 70°F (21°C) or 40% RH. Their typical lowest moisture level achieved for an air stream is a dew point of 46°F (8°C) and specific humidity (SH) of 45 grains per pound (gpp). Below this point, refrigerant dehumidifiers can cool moisture in the air below the frost point resulting in icing on evaporator coils. To alleviate this frosting, most manufacturers have placed defrost systems on their units. When conventional refrigerant dehumidifiers are operating in conditions that require defrost systems, or when they approach their lower-efficiency range, restorers may consider using low-grain refrigerant (LGR) or desiccant dehumidifiers.

Low-Grain Refrigerants (LGR)

LGRs have enhanced refrigeration systems that allows the dehumidifier to dry a space to much lower SH than conventional refrigerant dehumidifiers. The enhancement consists of methods of pre-cooling the incoming air stream (e.g., heat pipe or air-to-air heat exchanger). While conventional refrigerants begin to lose efficiency after drying the air to approximately 55 gpp, LGRs may continue to effectively remove some moisture from the air stream to as low as 34 gpp or 38°F/3°C dew point.

The enhanced performance of LGRs accelerates drying and makes it practical to dry difficult materials, such as hardwoods. LGR dehumidifiers remove more water, continue to dry to lower specific humidity, and remove more water (pints) per kilowatt of electricity consumed than a similarly sized conventional refrigerant dehumidifier.

Where temperature is a consideration, most refrigerant dehumidifiers deliver an air stream between 5-15°F (-15 to -9°C) warmer than its inlet temperature. Generally, refrigerant dehumidifiers are most efficient in the 70-90°F (21-32°C) range. Refrigerant dehumidifiers, either conventional or LGR, are available in sizes ranging from 90–500 CFM.

Desiccant

Most desiccant dehumidifiers work on the principle of adsorption. The key component of a desiccant dehumidifier is a desiccant-impregnated rotor or wheel. The desiccant material typically is silica gel. The rotor is divided into two sectors with separate streams of air passing through each sector. The “process” air stream is being dehumidified and delivered into the space. Water vapor in the process stream is adsorbed by the desiccant in the slowly rotating rotor, which then presents the wet section to the other stream of air, the “reactivation” stream. This air stream has been heated and causes the desiccant to release its moisture, which is then exhausted to the outside. While the rotor continues to turn slowly and loads up with moisture (i.e., adsorbing) in the process sector, the moisture is released (i.e., desorbed) in the reactivation sector.

Depending on air coming into the equipment, desiccant units can continue dehumidifying air typically to a SH as low as 15 gpp and a dew point of 20^{o}F (-7°C). Unlike refrigerant dehumidifiers, desiccant efficiency continues in low temperatures. Their best efficiency range is between 40-80^{o}F (4-27°C), however, above 90^{o}F (32°C), their efficiency drops rapidly. Desiccant dehumidifiers are manufactured for use in a broad range of applications and generally, are available in units that deliver as little as 75 CFM and up to 20,000+ CFM. As a result, desiccant dehumidifiers can be more efficient across a broader range of atmospheric conditions than refrigerant dehumidifiers – assuming sufficient power is available for their operation. Since desiccant dehumidifiers do not cool air, icing is not an issue.

Air/Heat Exchangers

Air and heat exchangers allow air from a structure to be exhausted to a building exterior while fresh outside make-up air is brought into a structure. These units are designed to capture heat from exhaust air and return it to the building, thus limiting energy loss during the exchange. An air and heat exchanger typically is used to exhaust moisture and to bring fresh make-up air into a contaminated space. This type of exchanger typically is used in colder climates where air exchange is important, but where heat (energy) loss can be a complexity in a project.

For detailed information on the use of specialized drying equipment and procedures, see ANSI/IICRC S500, *Standard and Reference Guide for Professional Water Damage Restoration.*

Heat Drying System

Drying structures using heated ambient air is a relatively new application of familiar drying principles. Heating ambient air:

- lowers RH, thereby increasing its capacity to carry moisture, and
- heats materials contacted by that air, thereby transferring energy to those materials, thus aiding in evaporating moisture from those materials.

Drying a building with heat involves circulating hot, “thirsty” air with low RH throughout a structure or in specific areas, thus absorbing evaporated moisture from materials. This moisture-laden air is then exhausted to the exterior of the space or structure being dried and effectively exchanged with more heated ambient make-up air. If airflow is not properly controlled in a mold-contaminated environment, air movement can spread contamination in the area.

For detailed information on the use of specialized drying equipment and procedures, see ANSI/IICRC S500, *Standard and Reference Guide for Professional Water Damage Restoration.*

This reference to heat-drying systems is not intended to be interpreted as an endorsement of heat being used to accomplish mold remediation.

Supplemental Mechanical Systems

Supplemental mechanical systems may be required during mold remediation projects when combustion-type mechanical systems (e.g., natural gas, fuel oil) or other services are disconnected or removed from service. Supplemental systems can include: heating and air conditioning equipment; power generators, and domestic water heaters. Supplemental equipment of this type shall meet applicable federal, state, provincial and local laws, regulations and codes.

Remediation Equipment

General Tool Bag

Generally, the following tools are used during mold remediation projects:

- eye protection
- respirator cleaning supplies
- straight stapler and staples
- pinch stapler and staples
- razor knives and blades
- drywall saw
- insulation knife
- hand saw
- zip tool with bits
- pry bar
- measuring tape
- self-stick or contact paper
- disposal bags (large and small)
- scrub pads/brushes
- disposable towels or rags
- first aid kit
- ladder(s)
- extension cords
- general hand tools (e.g., screwdrivers, hammer, pliers)

When selecting tools to be used in a remediation tool bag, remediators should consider a tool's potential for uncontrolled dust generation. Using power tools, while providing increased productivity, can create excess nuisance dust, which can disperse contaminants, if not contained. Power tools fitted with appropriate dust control cowls that are connected to HEPA vacuums can substantially reduce uncontrolled dust generation and speed up the remediation clean-up process. Regardless of the type of cutting tool used to remove contaminated building finishes, remediators should use care to avoid contact with, or damage to, concealed materials or components, such as water pipes or electrical wires.

HEPA Vacuum

HEPA vacuums are used to remove contaminants from both structural materials and contents. Most units that filter to this level are designed and marketed by manufacturers for cleaning up hazardous materials, such as lead and asbestos. Some units marketed to the general commercial or residential markets as containing HEPA filters do not achieve HEPA levels of filtration, due to leakage around filters or seals. When remediation contaminants are removed with vacuuming, only well-constructed professional HEPA vacuums that effectively filter particles to HEPA levels (99.97% of particles at 0.3 microns) should be used.

HEPA vacuum cleaners function best if bags are not full. HEPA units should be cleaned and checked for proper performance before being placed on the job site. It is recommended that a sub-micron laser particle counter be used to field check the performance of HEPA vacuums.

Hoses, filter bags and assemblies should be checked any time a drop in suction occurs or when the bag is changed. HEPA vacuum cleaners should be serviced within the capture zone of an AFD, or outdoors using appropriate precautionary measures. Damaged HEPA filters or improperly assembled canisters can potentially allow the escape of contaminants.

Other Vacuum Systems

There are a variety of other vacuum cleaners and systems that do not fully meet the definition of HEPA filtration. Examples include:

- **Standard wet-dry or canister vacuums:** These systems are designed with inefficient filters that can create aerosolization of mold spores and fragments.
- **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 a true HEPA-rated vacuum. Such machines can contain a filter marketed as “HEPA,” which can be built-in or sold with the machine as an aftermarket attachment. They frequently are less expensive than HEPA-rated vacuums. These machines are not normally marketed for capturing hazardous materials, such as lead or asbestos.
- **Exterior-venting vacuum systems:** These include high-volume vacuum systems, such as truck-mounted carpet cleaning systems, which vent outside a 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.

Neither standard nor high-efficiency vacuums are recommended for most mold remediation purposes. However, their use may be acceptable: when they are used outdoors with appropriate precautions for preventing worker, occupant or public exposure; inside high-volume laminar airflow cleaning chambers; when units are vented to a building exterior; or in other situations where the aerosolization they cause does not create exposure issues or the aerosolization can be adequately controlled with engineering controls. They should not be substituted for HEPA vacuums, when such is specified, without approval by an IEP or other qualified person.

Abrasive Tools

Mold growth on certain substrates may require physical or abrasive methods to remove contamination. Remediators should establish HEPA-filtered negative air with the intake located in close proximity to the work area, before abrasive cleaning begins, in order to limit distributing particles and the potential for spreading contamination. Abrasive tool options include, but are not limited to, the following:

Hand Sanding or Wire Brushing

The most commonly used abrasive tools are hand sanders with a dust collection device attached, coupled with a HEPA vacuum to aid in removing debris generated by the sanding process. Hand-sanding or wire-brushing techniques are used to remove residual mold staining and hyphae from salvable wood surfaces. Also, wire brushes are used in areas that are difficult to reach with a hand sander. Generally, a rough grit sand paper (e.g., 80-grit) is recommended. When preliminary sanding or brushing does not effectively remove mold growth from wood surfaces, more aggressive techniques may be needed.

Mechanical Sanders

Random orbital sanders are most commonly used to remove active mold growth. Round sanders might not adequately reach into corners. Detail sanders are often used to address such situations as appropriate. Sanders should be coupled to a HEPA vacuum, and used in conjunction with the HEPA-filtered negative air intake of an AFD located in close proximity to the work area to control dust while sanding.

Blast Tools/Media

Blast media may be considered as an alternative to hand-removal of contamination and mold staining from complex or difficult-to-access surfaces or materials, (e.g., framing lumber or concrete block). Using blast media has limited applications in mold remediation for a number of reasons including, but not limited to:

- difficulty controlling airborne dust, bioaerosols and contaminants generated by blasting, which raises significant worker protection issues;
- the possibility of driving contaminants into interstitial cavities or uncontaminated construction component spaces, and
- post-treatment clean-up with some abrasive blast media is time consuming and often complicated.

There are several types of blast tools and media available. Some may be more appropriate to mold remediation work than others, based on the size and scope of a project. Blast media options include, but are not limited to:

- **sand blasting:** Sand media normally is the most aggressive blast media. It can be destructive to surfaces if not carefully controlled.
- **sponge blasting:** This media type is designed to be re-used after blasting is completed. However, after blasting mold growth from surfaces, the media should be disposed appropriately to avoid cross-contamination.
- **soda blasting:** Sodium bicarbonate is used to remove mold growth from surfaces. This media type has an extended clean-up time.
- **dry ice blasting:** This media uses dry ice to remove mold contamination, and may have a reduced clean-up time compared to other blast systems because there is no secondary waste generated from the particles of dry ice. However, the surface growth and material removed by blasting would still need to be cleaned up. In a confined space, the carbon dioxide (CO_2) gas resulting from this cleaning process may displace the oxygen (O_2) in indoor air. This can result in depleting enough oxygen (<19.5%) to create a risk of asphyxiating technicians in that indoor environment. When using dry ice in an indoor environment or confined space (e.g., a crawlspace or confined space containment chamber), an oxygen monitor shall be used to continuously evaluate the oxygen content in a work environment. Proper engineering controls (AFDs with HEPA filtration) shall be used and exhausted outdoors to remove excess carbon dioxide gas from the indoor environment. In low-oxygen environments, supplied-air or self-contained breathing apparatus (SCBA) shall be used.

In any blast media application, worker protection is of paramount importance. Particular attention shall be paid to eye, skin, hearing and respiratory protection. Remediators should ensure that critical barriers are completely sealed and respiratory protection for workers is provided. Further, the rate of exhaust shall be sufficient to provide prompt clearance of dust-laden air within the area or enclosure after the cessation of blasting; cp. 29 CFR Part 1910.94 (a) 3 (b).

Regardless of the type of media used, containment is critical to prevent cross-contamination. To prevent contaminating supply lines typically used in blast media cleaning procedures, air-supply hoses and media-supply hoses should be covered with 6-mil polyethylene tube covering and sealed with duct tape on both ends prior to being taken into a contaminated area. Clean all surfaces before and after blast-cleaning procedures using a combination of HEPA-vacuuming and damp wiping with minimal water and a detergent.

Decontamination of Equipment and Tools

Equipment and tools taken into contaminated spaces should be decontaminated. Decontamination methods vary with the equipment to be decontaminated. Some items may simply be packaged in 6-mil polyethylene bags and processed outside of containment using standard decontamination procedures including, but not limited to: HEPA vacuuming, damp wiping or air washing, where appropriate. Equipment and tools that are too large to package may need to be processed in a separate cleanroom using HEPA vacuuming, damp wiping and final HEPA-vacuuming. Special procedures for air-moving equipment (e.g., AFDs, dehumidifiers, HEPA vacuums, carpet dryers) include sealing off air intake (and outlets) to prevent collected contaminants from being released.

POST-REMEDIATION MATERIALS CONSIDERATIONS AND ALTERNATIVE METHODOLOGIES

Introduction

Physically removing mold contamination is the primary means of remediation. Mold contamination should be physically removed from the structure, systems and contents to return them to Condition 1. See Chapter 1, *Principles of Mold Remediation*.

Mold remediation is a relatively young industry. New and innovative products and alternative techniques are likely to be proposed, developed and introduced subsequent to the issuance of this document. Before implementing or adopting new, innovative or alternative mold-remediation methodologies, whether specified or requested, remediators should evaluate whether or not such methodologies are consistent with the *Principles of Mold Remediation* and the goals of a specific remediation project, and carefully consider the potential benefits and consequences from use. In addition, using a particular product or technique in the industry does not necessarily equate to remediation efficacy.

Chemicals (Biocides and Antimicrobials)

There are a variety of chemical products available for professional mold remediation. Remediators should be familiar with the advantages and disadvantages of using these products, along with customer concerns and preferences. There are several different types of chemical products, each with different suggested uses, cautions, PPE requirements, and advantages and disadvantages.

Removing the source of mold contamination should always be the primary means of remediation. Indiscriminate use of antimicrobials, coatings, sealants, and cleaning chemicals is not recommended. However, chemical products can be useful, and complementary tools.

Definition and Regulation

Antimicrobial pesticides are defined by the United States Environmental Protection Agency (USEPA) as substances or mixtures of substances used to destroy or suppress the growth of microorganisms, whether bacteria, viruses, or fungi. The USEPA's Antimicrobials Division registers and regulates antimicrobial pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Some states require users of antimicrobial products to be licensed pesticide applicators.

The European Union (EU) Biocidal Products Directive establishes regulation of both antimicrobial products and other non-agricultural pesticides in member states. Also, while not a regulatory body, the international Organization for Economic Co-operation and Development (OECD), through the OECD Biocides Program, strives to promote harmonization of non-agricultural pesticides in the EU and in 15 other member countries, including the United States. In both the EU and the OECD, the term "biocides" includes both antimicrobial products and other non-agricultural pesticides, such as insecticides and rodenticides.

Product Efficacy

There are several general classes of compounds commercially available for use as antimicrobial pesticides. These products encompass a wide range of physical and performance characteristics. Antimicrobial pesticide activity varies widely, and effectiveness against specific microbial groups is designated by label claims, which can include the product classes described below. Some products can have special-use claims against specific microbes, such as *Legionella pneumophila*, *Mycobacterium tuberculosis, Aspergillus fumigatus*, or the hepatitis or human immunodeficiency viruses. Whether or not a chemical product is appropriate for a specific situation depends on the objectives of the application and project circumstances. Adherence to label instructions is extremely important, since effective use of antimicrobial products depends upon proper handling and application.

Terminology

Classes of antimicrobial pesticides include sanitizers, disinfectants, sterilizers (sporicides), and growth inhibitors:

- **sanitizers -** Used to reduce, but not necessarily eliminate, microorganisms from the inanimate environment to levels considered safe as determined by public health codes or regulations. Sanitizers may be used to treat semi-porous and porous materials, provided the product is specifically registered by the EPA for such materials.
- **disinfectants** - Used on hard, non-porous, inanimate surfaces and objects to destroy or irreversibly inactivate infectious fungi and bacteria, but not necessarily their spores.
- **sterilizers (sporicides)** - Used to destroy or eliminate all forms of microbial life, including fungi, viruses, and all forms of bacteria, and their spores.
- **growth inhibitors (bacteriostats, fungistats) -** Used to treat surfaces or incorporated into materials to suppress or retard future vegetative bacterial and fungal growth under potential moisture conditions.

Limitations of Use

Antimicrobials are not to be used as an alternative to proper cleaning procedures and physically removing mold contamination. Antimicrobials should be used only in conjunction with proper cleaning, and should not be used indiscriminately. For thoroughly cleaned non-porous building materials, antimicrobials generally are not needed. It is important to note that killing mold and fungal spores does not eliminate the contaminants or contaminated material's allergenic or toxigenic properties.

Gas- or vapor-phase antimicrobials have not been shown to effectively and safely remediate a microbially contaminated building because of problems with delivery, efficacy and toxicity, and the lack of physical removal of contaminants. Fungal growth is likely to remain viable unless the antimicrobial reaches every space and surface, and contacts microorganisms in sufficient concentration for the necessary period of time (as noted on the EPA-registered label for the antimicrobial product used). In summary, the efficacy of any aqueous fog, gas, or vapor-phase antimicrobial application is compromised when sufficient concentration cannot be maintained in a space for the necessary time. Moreover, as noted above, even when mold and fungal spores are killed, without physical removal, these application methods do not eliminate the allergenic or toxigenic properties of contaminants or contaminated materials. (Cole, Foarde, ACGIH Bioaerosols 16.2.5)

Antimicrobials should only be used in gas-vapor phase applications when such products are registered by the EPA specifically for this method of application. Remediators choosing to use antimicrobials in this manner should employ all reasonable engineering controls and necessary precautions to protect the safety and health of workers and occupants.

Antimicrobials should have clear, detailed label application directions, and adequate information on hazards and risks. If used, such products shall be used with full knowledge of their limitations and capabilities, and in strict accordance with manufacturer's directions and all regulatory requirements, and only with a client's informed consent obtained in advance.

Biocide and Antimicrobial Application Considerations

Biocides and antimicrobials can harm humans, pets and wildlife if used improperly. When using biocides or antimicrobials as a post-remediation application, for efficacy, safety and legal liability reasons, remediators shall follow label directions carefully and explicitly. In some countries, such as the United States, it is a violation of law to use these products in a manner inconsistent with the label. In order to minimize potential liability, remediators shall:

- Only apply chemicals to treat microorganisms for which the product has been registered by appropriate governmental agencies;
- Only apply chemicals on those types of surfaces for which the product has been registered by appropriate governmental agencies (i.e., porous, semi-porous, non-porous);
- Only apply chemicals in those types of structures for which the product has been registered by appropriate governmental agencies (i.e., schools, hospitals, residential);
- Only apply chemicals for the purpose for which the product has been registered by appropriate governmental agencies;
- Comply with applicable training, safety, use and licensing requirements in the respective jurisdictions;
- Ensure that proper personal protective equipment (PPE) is available and worn by remediators who are engaged in antimicrobial (biocide) use and application;
- Not use such products in heating, ventilating, air-conditioning, or refrigerating systems unless the product is specifically approved for that application by appropriate governmental agencies;
- Apply products strictly in accordance with label directions, and
- Dispose remaining antimicrobials (biocides) according to label directions.

In addition, remediators should:

- Discuss potential risks and benefits with customers, make available product information including the MSDS, and obtain a written informed consent with the customer's signature before applying antimicrobials (biocides).
- Inquire about pre-existing health conditions that might require special precautions.

- Advise customers to remove occupants and animals from the product application site, particularly, children and those with compromised health.
- Document relevant biocide application details.
- Refrain from making statements or representations to customers beyond those stated on the product label or in the efficacy claims made by the product manufacturer and approved by the applicable government agency.
- Clean treated surfaces of antimicrobial (biocide) residues, if required by the product label.

In addition to information concerning the use of chemical products in mold remediation in this document, the IICRC recognizes the practices for management of microbial growth and of antimicrobial product use outlined by the American Conference of Governmental Industrial Hygienists (ACGIH) in its publication *Bioaerosols: Assessment and Control*, 1999, as a valuable resource for understanding biocide use. Summarized below are several principles of microbial use contained within this publication in chapters 15 and 16: mold growth in a surface of condensation on painted walls or non-porous surfaces can usually be removed by vacuuming, washing with dilute biocide and detergent, cleaning, thorough drying, and repainting (Section 15.2); mold remediation can generally be accomplished by physical removal and thorough cleaning of non-porous materials. The application of a biocide would serve no purpose that could not be accomplished with a detergent or cleaning agent (Section 15.4); biocides should not be considered if careful and controlled removal . . . is sufficient to address a problem (Section 16.2); effective remediation involves the use of appropriate techniques to promote rapid drying and complete removal of contaminated materials rather than the application of biocides (Section 16.2.3).

Antimicrobial Coatings and Sealants

Definition and Regulation

Antimicrobial coatings and sealants are liquid-applied, film-forming products, which contain a “bound” antimicrobial agent. They are designed to help prevent future growth of mold on previously contaminated surfaces that have been properly cleaned, particularly in environments where moisture control is difficult. Antimicrobial coatings and sealants should not be used in place of: proper source removal of mold contamination, moisture control, or regular cleaning and maintenance. They can protect some materials from microbial growth. (Cole, Foarde, ACGIH Bioaerosols, 16.3.3).

Product Efficacy

Currently, there are no regulations regarding the nature, substance or minimum performance requirements of coatings and sealants formulated for mold. Antimicrobial coatings used in post-remediation applications demonstrate optimal performance results when tested in accordance with industry standards ASTM G-21 (‘0’ rating) and ASTM D-3273 (‘10’ rating).

Antimicrobial coatings and sealants should not create a vapor barrier that could lead to a buildup of moisture, and possibly contribute to a future microbial or structural problem. Products should demonstrate reasonable permeability as tested under ASTM D-1653. Antimicrobial coatings and sealants products should be water-based, low-odor, and contain low volatile organic compounds (VOCs).

Product Classes

- Mold-Resistant Coatings - Coatings and sealants that contain EPA-registered antimicrobials and are intended to inhibit mold growth on or in the coating film.
- Fungicidal Coatings - EPA-registered antimicrobial sealants are designed to deliver antimicrobial activity on pre-cleaned surfaces, while also providing long-term inhibition of fungal growth on treated surfaces.

Use Limitations

Antimicrobial coatings and sealants are effective only when applied to surfaces that have been properly cleaned, and disinfected or sanitized when appropriate. A layer of dirt and debris accumulated on treated materials or surfaces can act as a physical barrier between the coating or sealant film and microorganisms, and eliminate product effectiveness. (Cole, Foarde, ACGIH Bioaerosols 16.3.3).

Mold-resistant coatings should not be used as sealants or encapsulants to contain or cover active, viable mold growth. Failure to properly clean and remove mold can permit continued growth beneath the coating, as the active ingredients in these products inhibit growth only on or in the coating film.

Fungicidal coatings should not be used as sealants or encapsulants to contain or cover active, viable mold growth. Fungicidal coatings are only effective as an antimicrobial after visible growth has been removed and the surface has been cleaned. Some jurisdictions might require users of fungicidal coatings to be licensed pesticide applicators.

Where concern exists that an opaque coating or sealant may be used to cover up mold contamination without proper cleaning, a clear or translucent product may be used to allow visual post-inspection of the treated surfaces.

Coatings and sealants should be applied only after post-remediation evaluation and verification has verified the return to Condition 1. If antimicrobials, fungicidal coatings, mold-resistant coatings or sealants are used, and concerns exist that there could be future reoccurrence, the use of non-pigmented (clear) coatings could permit future visual inspection of treated surfaces.

Heat

Methods involving the controlled application of heat to a structure have been reported to be an effective form of biological control, which might or might not kill some fungal spores and vegetative structures. This process is a developing technology and should be evaluated and understood before use. It is important to note that killing mold and fungal spores has not been shown to eliminate the contaminants or their allergenic or toxigenic properties.

Gas-phase Ozone and Vapor-Phase Biocides

According to the American Conference of Governmental Industrial Hygienists (ACGIH), "No gas- or vapor- phase biocides can effectively and safely remediate a microbially contaminated building because of problems with biocide delivery, efficacy and toxicity." (ACGIH Bioaerosols 16.2.5) Studies have shown that ozone cannot be generated in sufficient concentration to kill or even suppress microbials on most structural materials, including wood and drywall. (Foarde, K.K., Van Osdell, D.W., Steiber, R.W., Investigation of Gas-Phase Ozone as a Potential Biocide, US EPA, Applied Occupational Environmental Hygiene, August, 1997) Ozone has been shown to increase submicron particles and adversely react with many compounds (Weschler, C.J, “Ozone in Indoor Environments: Concentrations and Chemistry”, Indoor Air, 2000) as well as cause damage to many types of artifacts (Cass, G.R., et al, “Protection of Works of Art from Atmospheric Ozone”, The Getty Conservation Institute, 1989). Ozone is a strong oxidizing agent, reactive (rubber and electrical wire insulation), and very unstable (Cole, Foarde, ACGIH Bioaerosols, 16.2.5).

Ultraviolet (UV) Light

UV light is not a practical mold remediation methodology for several reasons, including lack of intensity and insufficient dwell time. According to the Centers for Disease Control and Prevention (CDCP), “UVGI . . . has only a minimal inactivating effect on fungal spores.” (CDC: Guideline for Environmental Infection in Healthcare Facilities)

Chapter 6

Safety and Health

WORKER SAFETY AND HEALTH

Although few specific state or federal safety and health regulations related to mold and microbiological remediation exist, there are regulations that are applicable to businesses that perform such work. Employers are responsible for complying with these safety and health regulatory requirements.

Safety and Health regulations that may impact a remediation firm's employees include, but are not limited to, the following Occupational Safety and Health Act (OSHA) Standards found in Title 29 of the Code of Federal Regulations (CFR) parts 1910 and 1926:

- 29 CFR 1910 – General Industry Standards
- 29 CFR 1926 – Construction Industry Standards

Remediation firms shall comply with both the OSHA General Industry Standards and the Construction Industry Standards. Safety and health plans shall be established as required by applicable laws, rules, and regulations promulgated by federal, state, provincial, and local governmental authorities.

Specific provisions addressed by these two groups of regulations include, but are not limited to:

- emergency action and fire prevention plans;
- personal protective equipment;
- respiratory protection;
- asbestos abatement;
- lead-based paint abatement;
- heat disorders and health effects;
- confined work spaces;
- hazard communication;
- lockout/tagout procedures and electrical safety orders;
- fall protection;
- noise exposure, and
- scaffolds.

Issues directly pertinent to the health effects of mold exposure are addressed more specifically in the Chapter 3, *Health Effects* of this Reference Guide.

OSHA GENERAL AND SPECIFIC DUTY CLAUSE

The OSHA "General Duty Clause" states that "Each employer:

- shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.
- shall comply with occupational safety and health standards promulgated under this Act." See 29 USC 654, §5.

Protecting the safety and health of mold remediation workers and building occupants is of paramount importance in mold remediation projects. It is each employer's responsibility to ensure that his or her employees entering and working in remediation work areas, or in designated areas where contaminated contents are cleaned or handled, have received appropriate training, instruction, and personal protective equipment. In the absence of a specific OSHA standard for mold or indoor air quality, it is important to recognize the general principles of exposure prevention as they are conveyed through the "General or Specific Duty Clause," as well to understand the current information available about health effects related to mold. Mold remediation workers may also encounter lead, asbestos and other hazards as discussed later in this chapter. Industry standards have been adopted for recognized hazards by government agencies, such as OSHA and the Environmental Protection Agency (EPA), as well as the American Conference of Governmental Industrial Hygienists (ACGIH), and other industry trade associations.

OSHA Standards

OSHA standards are divided into sections that apply to various industries. When performing mold remediation or other restoration services, employees fall under the construction and general industry standards. These standards address hazards such as: scaffolding, electrical safety, confined spaces, falls and chemical safety, including asbestos, lead and chemical exposures, as well as training and education for employees about these hazards.

A complete list of federal OSHA Standards can be obtained from www.osha-slc.gov. The OSHA Standards for the Construction Industry (29 CFR 1926) requires that, "no employee shall work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his or her safety or health."

EMERGENCY ACTION AND FIRE PREVENTION PLANS

Emergency action and fire prevention plans (29 CFR 1926.20 and 1910.38-39) are required in all businesses. Requirements include, but are not limited to:

- communication and alarm systems;
- the location of the nearest hospital and fire station;
- emergency phone numbers (posted);
- shut down, evacuation and rescue procedures (posted);

- escape routes and signage (posted);
- use of less flammable materials;
- use and placement of fire extinguishers, and
- a written program, if the employer has 20 or more employees.

In particular, warning signs should be posted to identify hazards that may exist on the job site, and that emergency contact information is listed on the signs.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

According to 29 CFR 1910.132 employers shall provide their employees with the necessary PPE to reduce the risk of exposure to chemical, physical or biological hazards. Biological hazards that may be encountered when performing mold remediation work include, but are not limited to, allergenic, toxigenic or pathogenic microorganisms. Various types of PPE are available and necessary to prevent illness and disease.

The following are potential routes of mold and chemical exposure:

- inhalation;
- ingestion;
- contact with mucous membranes (eyes, nose, mouth); and
- contact with skin.

If remediators determine, upon application of the General Duty Clause, that there is a potential risk to employees, employers shall provide appropriate dermal and respiratory protection for workers entering a containment area where microbial contamination is present or remediation is being performed. The use of appropriate PPE helps protect workers from possible inhalation or skin contact with microorganisms or their by-products, as well as chemicals or other substances that may be applied or handled in the course of remediation work. Selecting PPE depends on the anticipated exposure, types of microbial contamination, activities to be completed and possible use of chemicals. PPE usually consists of:

- respirator – The level of protection depends upon the severity of the potential exposure.
- eye protection - Supplemental eye protection is used when workers are using half-face respirators.
- disposable coveralls including hood and booties – Protective clothing for mold remediation provides varying levels of protection depending on the severity of the potential exposure.
- foot protection (rubber safety boots) – Foot protection during mold remediation projects is used to avoid puncture wounds, injury from dropped objects, and slips and falls.
- hand protection (gloves) - Protective gloves are used when employees may have dermal exposure to harmful substances, severe cuts, punctures or lacerations, or chemical and thermal burns.
- head protection - Hard hats are used in construction areas or areas where there is the possibility of falling objects.

- hearing protection - When employees are exposed to excessive noise levels, appropriate hearing protection shall be used.

Respirator Use and Respiratory Protection Plan

Employees shall wear respirators whenever engineering and work practice controls are not adequate to prevent atmospheric contamination at the job site. In most cases, a respirator will be required because remediation workers will be working directly in areas from which contaminants are being removed, or where mechanical engineering devices are unable to reach. OSHA requires that a Respiratory Protection Program be implemented for employees who are required to wear a respirator. Untrained visitors to work sites should be warned of hazards and encouraged to not enter the worksite. If visitors insist on entering, or must enter a worksite, they should be encouraged to wear respiratory protection and other appropriate PPE, if they are able.

Respiratory protection regulations can be found in 29 CFR 1910.134. There are also several guidelines recommending respiratory protection including the Environmental Protection Agency (EPA) document *Mold Remediation in Schools and Commercial Buildings;* and the New York City Department of Health *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*. These documents contain regulations or guidance on the selection, maintenance and use of respirators.

29 CFR 1910.134 also outlines the requirements of a written Respiratory Protection Program, which include the following:

- use of NIOSH-approved respirators;
- medical evaluation;
- respirator fit testing;
- user instruction and training;
- designated program administrator, and
- maintenance program.

The types of NIOSH-approved respirators range from N-95 filtering face-piece respirators, to full-face air-purifying respirators (APR) or powered air-purifying respirators (PAPR) equipped with HEPA filters. Remediators should use HEPA filters to provide protection against fungal spores and fragments, bacterial spores, dust and other particles. Depending on workplace conditions, remediators may need to use a combination cartridge.

Organic vapor cartridges provide protection against Microbial Volatile Organic Compounds (MVOCs), some chemicals used when remediating sewage contamination, and other chemical compounds used in microbiological remediation projects that have extensive contamination. Cartridge selection should be based upon the chemicals that are present.

Respirators

When using an Air-Purifying Respirator (APR), air is drawn through filter cartridges into the face piece. Powered APRs have air mechanically delivered through the filter cartridge into the face piece. Several types of cartridges are available to filter out specific contaminants. However, they shall not be used in oxygen-deficient atmospheres or in other atmospheres that are immediately dangerous to life or health (IDLH).

Respirators provide varying levels of protection. They are divided into classes; with each respirator class assigned a protection factor to help compare its protective capabilities with other respirator classes. An assigned protection factor (APF) is a unitless number that is assigned by OSHA. APFs are numerical ratings given to different types of respirators to tell users how much protection the respirator can provide when used as part of an effective respiratory protection program. An APF table with several footnotes is included in the final standard to guide employers in selecting air-purifying, powered air-purifying, supplied-air (or airline respirator), and self-contained breathing apparatus (SCBA) respirators. An APF of 5 ideally infers that the respirator wearer was exposed to 1/5 (20%) of the airborne concentration that he or she would have been exposed to without a respirator, for an 80% reduction.

Commonly used respirators in mold remediation projects and their assigned protection factors are:

	Assigned Protection Factor			
Respirator Type	**Half Mask***	**Full face-piece**	**Helmet/hood**	**Loose-fitting face piece**
Air-Purifying	**10**	**50**	--	--
Powered Air-Purifying Respirator (PAPR)	**50**	**1,000**	**25/1,000**	**25**
Supplied-Air Respirator (SAR) or Airline Respirator:				
Demand mode	**10**	**50**	--	--
Continuous flow	**50**	**1,000**	**25/1,000**	**25**
Pressure-demand	**50**	**1,000**	--	--
Self-Contained Breathing Apparatus (SCBA):				
Demand mode	**10**	**50**	**50**	--
Pressure-demand or other positive-pressure mode	--	**10,000**	**10,000**	--

* This APF category includes filtering facepieces, and half masks with elastomeric facepieces. Source: OSHA final rule August 24, 2006. This was effective after November 22, 2006.

Respirator cartridges are generally color-coded according to the contaminant to be removed. The cartridges most frequently used in the mold remediation industry include:

Color Code	Contaminant Protection
Magenta	N or P-100 (HEPA) filter for particulates
Black	Organic vapor
Yellow	Organic vapor/acid gases
White	Organic vapor/acid gases/formaldehyde
Green	Ammonia

WARNING SIGNS

Signs shall be posted to identify egress means and exits (29 CFR 1910.37[q]); biological hazards (29 CFR 1910.145[e][4], [f][8]); caution (29 CFR 1910.145[c][2], [d][4]); and dangers (29 CFR 1910.145[c][1], [d](2], [f][5]) that may exist on the job site. Warning signs that are posted to identify hazards that may exist on the job site should list the following: emergency contact information; the remediation company name, remediation company address, 24-hour emergency contact number, and name of project supervisor. When warning signs are posted on confined-space projects, they shall be printed with the date they were posted and the approximate date they are expected to be taken down or reassigned. Typical signs specifically related to remediation work can include, but are not limited to:

- Do Not Enter - Mold Remediation in Progress
- Caution: Slip, Trip and Fall Hazards
- Caution: Hard Hat Area
- Work
- Area Under Negative Air-Pressure
- No Unauthorized Entry

ASBESTOS

Asbestos regulations can be found in OSHA Construction Standard 29 CFR 1926.1101 and General Industry Standard 1910.1001. This regulation shall be followed whenever asbestos-containing materials (ACM) or presumed asbestos containing materials (PACM) are (or are highly likely to be) encountered in the course of a mold remediation project. *Asbestos-Containing Material (ACM)* is defined as any material containing more than one percent asbestos by weight.

Even if the building owner does not have a survey for asbestos, the mold remediation contractor is still responsible for identifying and controlling asbestos exposure during demolition and removal of materials.

If remediation workers or contractors encounter ACM or PACM during the course of work activities, they shall stop work. Qualified asbestos abatement contractors shall be engaged to perform asbestos abatement if such material is to be disturbed. Many states and local governments require that asbestos inspections be performed by licensed or Asbestos Hazard Emergency Response Act (AHERA) accredited asbestos building inspectors.

LEAD

Lead regulations can be found in OSHA Standards 29 CFR 1926.62 and 1910.1025. Lead construction work is defined as work for maintenance, construction, alteration, renovation or repair, including painting and decorating, where lead or lead-containing materials are present.

Even if the building owner does not have a survey for lead, the mold remediation contractor is still responsible for identifying and controlling lead exposure during demolition and removal of materials. If mold remediation workers or contractors encounter lead-based paint during the course of their activities, they shall stop work. A qualified lead abatement contractor shall be engaged to perform lead abatement, if such material is to be disturbed.

HEAT DISORDERS

Work activities involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations, particularly when performed in such places as attics and crawlspaces, and when wearing PPE.

Outdoor operations conducted in hot weather, such as construction, asbestos removal, and mold remediation site activities, especially those that require workers to wear semi-permeable or impermeable protective clothing, present the possibility of heat-related disorders to workers. Heat disorders range from heat rash and dehydration to heat exhaustion and heat stroke, the latter two of which are medical emergencies. The remediation contractor's respiratory protection and other PPE plan shall address prevention and on-site response to heat disorders. See OSHA Technical Manual TED 1-0.15A, Section III, Chapter 4.

CONFINED SPACE ENTRY

OSHA regulations addressing confined spaces are found in 29 CFR 1910.146 and 29 CFR 1926.21. Further guidance may be obtained from American National Standard Institute ANSI Z117.1-1989, *Safety Requirements for Confined Spaces*. The OSHA and ANSI standards provide minimum safety requirements to be followed while entering, exiting and working in confined spaces at normal atmospheric pressure. A "confined or enclosed space" means any space that:

- is configured so that an employee can enter it;
- has limited means of ingress or egress, and
- is not designed for continuous occupancy.

If it is determined that the workplace is a confined space, then the confined space entry program shall include:

- determining if the space meets the definition of a Permit-Required Space;
- identifying the confined spaces and hazards in the workplace;
- monitoring of atmospheric conditions in the space;
- instructing workers on the proper use of the safety equipment;
- defining the duties of the confined space entry team, and
- developing training requirements for employees who enter the confined space.

Permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

- it contains or has a potential to contain a hazardous atmosphere;
- it contains a material that has the potential for engulfing an entrant;
- it has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section, or
- it contains any other recognized serious safety or health hazard.

If it is determined that the confined space is a Permit-Required Confined Space, then the confined space shall have a posted permit, and remediators shall comply with OSHA entry requirements.

HAZARD COMMUNICATION

The OSHA Hazard Communication Standard (29 CFR 1910.1200) requires that chemical manufacturers provide employers with information about physical and health hazards. Employers are responsible for providing this information to employees through a Hazard Communication Program (HCP). This written program includes: container labeling and other forms of warnings; maintenance of material safety data sheets (MSDS), and annual chemical-specific employee training. Examples of chemicals used during mold remediation are adhesive spray used to make enclosures, detergents and disinfectants for cleaning, and sealants or encapsulants. Employee training shall include: how the HCP is implemented in the workplace; how to read and interpret information on labels and MSDS; hazards associated with the chemicals used in the workplace and the measures that employees shall take to protect themselves, and specific emergency procedures that are to be instituted.

Contractors working on Multi-Employer work sites shall:

- inform other employers of hazardous substances;
- inform other employers of means to protect them;
- provide access to MSDS, and
- inform other employers of labeling systems used.

Although mold and other microorganisms are not a specific, regulated hazardous material, workers engaged in mold remediation activities are at increased risk of exposure to microbes, spores and their metabolic by-products that have the potential to cause adverse health effects. Although engineering and administrative controls, PPE, and other methods of exposure prevention or minimization may be in use, employee exposure may nevertheless occur in certain circumstances, including failure of such systems.

The health effects of mold exposure and description of medical evaluation are discussed in detail in the Chapter 3 *Health Effects* of this Standard. Employers may consider including additional content in their workers' medical surveillance (e.g., respirator fitness and pre-placement physical) examinations to identify pre-existing conditions or symptoms that may be related to, or aggravated by, past or present occupational mold exposures.

LOCKOUT/TAGOUT (CONTROL OF HAZARDOUS ENERGY)

Employees can be seriously or fatally injured if the machinery they service or maintain unexpectedly energizes, starts up, or releases stored energy. The OSHA Standard on the Control of Hazardous Energy (Lockout/Tagout), found in 29 CFR 1910.147, delineates the steps employers shall take to prevent accidents associated with hazardous energy. This standard addresses practices and procedures necessary to disable machinery and prevent the release of potentially hazardous energy, while maintenance or servicing activities are performed. There are other OSHA standards that apply to energy control and energy release requirements of various types of machinery.

SAFE WORK PRACTICES IN MOLD CONTAINMENTS

In addition to the specific safety/health concerns detailed in this chapter, a number of basic work practices have been adopted for mold remediation projects by safety professionals. Remediators should incorporate the following items into their mold remediation work procedures:

- no eating, drinking, or smoking in any potentially contaminated or designated area;
- remove protective gear and wash hands before eating, drinking, smoking, rest periods, using the bathroom, and at the end of the workday;
- dispose of contaminated protective clothing with other refuse before exiting the containment;
- do not move used protective clothing from one area to another unless properly contained;
- wear latex or nitrile chemical-resistant or vinyl gloves while inside containment areas, designated work areas, or while handling bagged contaminated materials;
- wear a second pair of gloves (rubber, textile or leather work gloves) to protect against personal injury;
- use the buddy system when working in high-heat, remote or isolated work spaces;
- address cuts, abrasions and first-aid blood-borne pathogen issues promptly, especially when sewage-damaged materials are present;
- discard gloves that are damaged; wash hands with soap and water, and inspect hands for injury, and
- dispose of used gloves as contaminated material, along with contaminated debris.

Remediators shall incorporate the following items into their mold-remediation work procedures where appropriate:

- tail-gate meetings to discuss the daily work activities, including a review of safety issues;
- electrical safety practices (e.g., using Ground Fault Circuit Interrupters and lock-out tag-out);
- wear PPE appropriate to the hazards identified in the work area;
- inspect PPE prior to use;

- use protective disposable coveralls with attached or separate shoe covers;
- don protective clothing before entering containment or other designated areas;
- repair or replace damaged PPE;
- workers are to be instructed as to job specific emergency plans including emergency exits;
- when an injury occurs, the injured worker and co-workers are to take the steps delineated in the company safety program;
- workers are to be informed about the location of emergency shower and eye wash stations, and
- report injuries to a supervisor as soon as possible.

Chapter 7

Administrative Procedures, Documentation and Risk Management

ADMINISTRATIVE PROCEDURES

Remediation project administration typically includes, but is not necessarily limited to:

- using written contracts;
- good verbal and written communication;
- thorough project documentation and recordkeeping;
- appropriate methods to manage risk;
- responsiveness;
- an ability to understand and coordinate multiple tasks and disciplines, and
- a professional and ethical attitude.

It is recommended that remediators establish and consistently follow methods and procedures for project administration, including but not limited to, business and quality control systems, and operational plans and protocols. Competent and effective project administration promotes the delivery of high-quality remediation services.

Contracts

Remediators should execute a written contract with clients before starting remediation projects. What constitutes an adequate written contract in any given situation or jurisdiction is beyond the scope of this chapter. However, remediators should verify that contracts contain the elements necessary to form an enforceable contract under the laws of the applicable jurisdiction. Although projects vary in size and scope, and can have unique issues and complications, it is recommended that contracts specify the following, at a minimum:

- the identity and contact information of the client and materially interested parties;
- a description of work to be performed, which may include references to attached project specifications or other documents that specify the details of the work;
- description of and responsibility for repair of collateral or consequential damage;
- known limitations, complexities or potential complications of the project;
- permits required for the project;
- the respective duties and responsibilities of parties;
- the project start date and time and estimated time for completion of the work;
- the price or professional fees charged for the work or method for calculating them;
- the party responsible for payment and the terms of payment;

- provisions dealing with contract default and termination;
- whether or not an insurance company or surety is involved, and how claims will be handled;
- warranty and disclaimer provisions, if any;
- criteria for determining the effectiveness of remediation, and
- provisions relating to changes or additions to the work, including change orders.

If a written contract is executed, it is recommended that each page of the contract be initialed by all parties to the contract. The contract should be dated and signed by all parties to the contract, and each party should be given a copy of the contract as soon as reasonably practical. Remediators should seek legal counsel for developing contracts including appropriate terms and conditions, or when circumstances or situations dictate, the need for contract modifications, addendums or project-specific legal advice.

By memorializing the understanding of the parties at the beginning of a project, written contracts reduce the possibility of dispute, disagreement or conflict when performing the work. It is recommended that contract documents be accurate and complete, free of ambiguity, and contain adequate disclaimers, reservations or recommendations when project uncertainties, limitations, complexities or complications exist or are anticipated.

Many contractual disputes develop when contract additions or modifications are made while performing work, but are not adequately documented in writing. Verbal change orders may create future misunderstanding or disagreement resulting in legal disputes and litigation. Substantive or material changes from the original, agreed-upon contract or scope of work should be documented in a written and detailed change order, which includes a description of the changes to the work, time for performance, price or fees, and method of payment. Further, it is recommended that the client, or the client's designated agent, and the remediator's representative accept the change order in writing.

Specific information, including the source and extent of the contamination, is needed to adequately define the scope of work and develop a work plan for a mold remediation project. (See Chapter 8, *Inspection and Preliminary Determination*) Remediators should determine if the moisture problem at issue has been identified, controlled or repaired, and if not, to identify the process and party responsible for doing so. This determination may be delegated to a specialized expert as necessary (e.g., moisture intrusion expert, drying contractor, building envelope expert or other qualified tradesperson). Remediators should attempt to obtain available environmental reports, remediation plans or protocols and other pertinent project documentation before starting a remediation project.

Communication

Many times the source of a dispute between parties is the failure of the parties to communicate timely, clearly and adequately. The following strategies are helpful in preventing or reducing communication problems:

- listen well;
- reiterate to the sender of a message the understanding perceived;
- communicate as soon as practical with materially interested parties about project developments, important events, problems, complexities, complications and conflicts. This

should be done as often as necessary to keep materially interested parties reasonably informed of the project status;

- maintain a professional demeanor and attitude during communications;
- respond quickly and thoroughly;
- develop, implement and consistently follow an organized and systematic method of receiving, evaluating and acting upon information during the course of a remediation project, and
- document communications when necessary or appropriate to verify the communication and satisfy documentation and recordkeeping recommendations set forth elsewhere in this document.

Communication between materially interested parties is important on mold remediation projects. It is recommended that materially interested parties agree on the purpose and subjects of project communication, the frequency and mode of communication, and the contacts with whom communications will be distributed. It is recommended that significant items that could potentially affect the job be discussed verbally, and then reduced to writing and distributed to appropriate materially interested parties.

Remediation project communication may often involve professional advice, education, or warnings. For example, customers or occupants may ask remediators whether evacuation of the structure is necessary. Also, there are times when project operations or containment make continued occupancy of the structure problematic or impossible. In some instances, it may be appropriate for remediators to provide customers or occupants with information to use in making a decision to evacuate. When providing such information, remediators should inform customers and occupants that the information provided is not to be construed as health or medical advice, directive or diagnosis. Customers or occupants who express health concerns or ask medical questions should be instructed to seek advice from qualified medical professionals or public health authorities. It is recommended that remediators not give advice, education or warnings on subjects outside their area of professional expertise.

PROJECT DOCUMENTATION AND RECORDKEEPING

Documentation and recordkeeping are important in developing a remediation plan, executing the plan, and completing a successful remediation project, especially if there is a need to review or reconstruct the remediation process or project at some future time. Thorough documentation and recordkeeping should be performed and maintained throughout the remediation project. To properly develop and document the remediation project, it is recommended that remediators attempt to obtain pertinent project information developed before, during and after their involvement in a project. Also, it is recommended that remediation contractors document important communications to reduce the possibility of misinterpretation. The extent of project documentation and recordkeeping varies with each remediation project.

Required Documentation

Documents and records obtained and maintained by remediators shall include documents required by applicable laws, rules and regulations promulgated by federal, state, provincial and local governmental authorities.

Documentation that Remediators Should Create and Maintain

While not an exhaustive list, documents (which may include photographs) and records that should be obtained and maintained by remediators include the following:

- the written remediation contract;
- the scope of work and remediation plan or protocol;
- materials related to project limitations on Standard compliance or deviations from Standard compliance (e.g., notices, agreements, disclosures, releases, waivers);
- environmental reports made available to remediators;
- written remediation recommendations or technical specifications from indoor environmental professionals (IEPs), industrial hygienists, inspectors and others acting in the capacity of consultants or advisors, if made available to remediators;
- contents and personal property inventories, both salvable and non-salvable, signed and dated by remediators and customer with both parties receiving copies of the documents as soon as reasonably practical;
- detailed work or activity logs, including a description of who did what, when, where, how and for what duration, including entry and exit logs, where applicable;
- equipment logs or similar documents that include a description of equipment and supplies used on the project (including biocides and antimicrobials), the quantity and length of time used (where applicable) and other relevant information;
- documents reflecting customer approval for the use of chemical compounds, including Material Safety Data Sheets for cleaners, antimicrobials and biocides;
- documentation of project safety and health elements (e.g., safety and health plan, occupant communication and worker "Right-to-Know" information; safety meetings; hazard signs; PPE; a general description of the nature and location of containment, negative air machines, air filtration devices, and the like, used on the project);
- records of pressure readings in and out of containment (if negative pressure is being used);
- change orders, if any;
- certificate of completion (e.g., completion agreement or acknowledgement), and
- estimates, invoices and bills.

Recommended Documentation

While not an exhaustive list, it is recommended that documents and records obtained and maintained by remediators include:

- administrative information (e.g., customers and materially interested parties contact information and call report records; copies of notices, disclosures, documents and information provided; notes or synopses of meetings that summarize the substance of the meetings and the decisions made, and which generally document the progress of the project; communication logs; important written communications (correspondence, e-mail messages and the like); decisions to transfer project investigation to an IEP or to involve an IEP in a mold remediation project; background and qualification information for subcontractors or trades engaged by the remediator on the project, if any);
- subcontractor contracts, work specifications and change orders for subcontractors engaged by remediators on a project;
- insurance and financial information (e.g., identifying the party responsible for payment; and determining responsibility for collateral and consequential damage resulting from remediation);
- permits and permit applications (if available);
- building and contents information, including: property type (e.g., residential, commercial, industrial, institutional); the relationship of the customer to the property (e.g., owner, lessor, purchaser, property manager); building history (i.e., relevant known characteristics of the building or its history that materially affect the remediation process, including information about remodeling, renovation and maintenance issues); pertinent known information about the subject property (e.g., the cause and date of the moisture problem, a description of when and how the problem was discovered, leak detection reports, and description of previous remediation efforts);
- observations upon inspection (e.g., diagrams; moisture "mapping"; photography or videography of pre-existing conditions, water stains or damage, and areas of visible or suspected mold, or efflorescence);
- other relevant project or customer observations or perceptions (e.g., odors; condensation; relative humidity readings; temperature, moisture content or moisture levels of structural materials, and health complaints);
- contact information for employees, known visitors or occupants, IEPs, industrial hygienists, inspectors, adjusters, claims representatives and other materially interested parties who enter contained areas or who participate in the remediation process or its administration, and
- lien notices and lien releases (if applicable).

Documenting Limitations and Deviations

The client or customer may request or refuse some services that prevent a remediator from complying with remediation plans or protocols, or the requirements and recommendations of this Standard (see Chapter 9, *Limitations, Complexities, Complications and Conflicts* and Chapter 11, *Structural Remediation*). When proceeding under such circumstances, there is a heightened risk of future conflict with the client or customer, which can create potential liability for the remediator. If a remediator decides to proceed with the project despite limitations on compliance with this Standard, they should adequately document the situation and circumstances, which may include advising the client or customer of the potential consequences of such noncompliance in writing and attempting to obtain a written waiver and release of liability for those potential consequences. However, this might not prevent remediator liability, because of the fact that the job was accepted with knowledge that it could not be completed successfully, or that the results might be questionable.

It is recognized that remediation projects are unique, and that in certain circumstances, common sense, experience and professional judgment may justify deviation from this Standard. It is the responsibility of remediators to determine and verify on a case-by-case basis that application of this Standard is appropriate. When material deviation from this Standard is warranted, it is recommended that remediators adequately document the situation and circumstances, which, when appropriate, may include notices and disclosures to the client or customer, or obtaining consent, approval, waiver or release of liability from the client or customer.

Recordkeeping and Record Retention

Remediators shall maintain remediation project documentation for the time required by record retention laws and regulations of applicable jurisdictions, if any. It is also recommended that remediation project documentation be maintained for the longest applicable statute of limitations in the relevant jurisdiction, at a minimum. Many jurisdictions follow the discovery rule, whereby the statute of limitations applicable to a remediation project only begins to run from the date of discovery of the problem, not the date the service was performed. Thus, in some circumstances, it may be appropriate to maintain remediation project documentation indefinitely. It is recommended that remediators obtain advice from qualified counsel regarding timeframes for document retention. The method of recordkeeping and record retention is beyond the scope of this document.

Emergencies

In some circumstances, remediation projects are conducted on an emergency basis. Emergency situations may impede project communications or limit the opportunity to document the project as described in this chapter. However, once an emergency situation is resolved, to the extent practical, remediator should attempt to complete the appropriate documentation and correct communication deficiencies caused by the emergency.

RISK MANAGEMENT

Risk Management Tools

Prudent business management in the mold remediation field includes an awareness of risk and potential exposure to liability, and the application of various risk management tools. Indeed, much of the material contained within this document addresses, directly and indirectly, matters relevant to risk management. It may be appropriate for mold remediation businesses to consider development of a formal Risk Management Program. Although not necessarily an exclusive list, it is recommended that remediators consider, at a minimum, applying the risk management tools summarized below:

- conduct remediation business within an entity having limited liability;
- be reasonably well capitalized;
- consider including risk allocation provisions in project contracts, if and when appropriate;
- perform thorough, quality work with the assistance of a quality assurance program;

- under-promise and over-deliver, (i.e., make sure you do what you say you will do, when you said you would to it);
- hire qualified and competent employees, and invest in and regularly update industry education, training and certification;
- engage qualified and competent subcontractors and specialized experts when necessary. (It is recommended that such subcontractors and specialized experts carry appropriate business liability insurance that includes coverage for environmental liability, if engaged in microbial remediation or water damage restoration work);
- avoid working outside the scope of your expertise;
- follow the proposed or approved scope of work for the project, notify appropriate materially interested parties if changes are required (e.g., complexities and complications are discovered or develop), and obtain written approval for such changes as necessary;
- stay current with industry developments;
- be aware of industry standards and follow them;
- when performing work, make sure drying goals and standards have been achieved, identify the source of the water intrusion and determine responsibility for correction;
- use standardized management and operational systems, procedures and forms, if possible and appropriate;
- create and maintain adequate project documentation and records;
- upon completing the work, consider using third-party verification or clearance testing, particularly in problematic situations;
- assure compliance with applicable laws and regulations;
- deal with problem situations immediately and do not ignore them;
- resist compromising applicable standards and protocols to satisfy the requests of an owner or insurance adjuster, or other materially interested party, but if required to do so, consider taking precautions such as documenting the deviation request, notifying appropriate materially interested parties, disclaim, and obtain releases;
- conduct business with integrity and treat others with respect and professionalism;
- obtain the counsel of a qualified lawyer if regulatory compliance or legal issues arise;
- investigate and obtain appropriate insurance coverage if possible;
- understand lien rights and procedures, and assert such rights lawfully, and
- purchase business liability insurance with appropriate Contractors Pollution Liability coverage or Professional Liability insurance, which provides coverage for mold-related damages, in addition to purchasing General Liability insurance.

Client or Customer Insurance

In response to the explosion of mold insurance claims between 2001 and 2002, insurance companies in North America added new exclusions and lowered coverage limits for mold-related losses on virtually all personal lines of insurance (e.g., homeowners and auto liability), commercial lines (e.g., general liability and property), and professional liability policies (e.g., consultants, insurance agents and architects). These exclusions and coverage limits left property owners and remediation contractors with a significant gap in their insurance coverage. Of course, the addition of policy exclusions and limitations did not make all losses disappear.

Recent mold claims research reveals that insurance companies are paying many fewer mold claims now than they were in 2002. Since the numbers of water damage events are more or less constant, if the impact of major water events like hurricanes and floods are taken into account, the loss data suggests that mold losses have shifted away from insurance policies and onto property owners. This means that less mold remediation work is currently being paid for under homeowners and commercial property insurance policies. In this evolving environment, it is more likely a remediator will face liability claims.

In the case of mold claims, mold exclusions and lowered coverage limits in insurance policies can force persons suffering a loss on their property to pursue other avenues for damage recovery, which can mean accessing the court system and bringing action against other parties, whether responsible or not. Anyone working with water or mold in the built environment (e.g., restorers, plumbers, appliance installers, remodelers), needs to be keenly aware that without primary insurance in the cost-recovery mix, the chances of being sued for mold-related damages increases.

These developments in the insurance industry have created ramifications for remediators. Accordingly, it is recommended that remediators be mindful of the following:

- Owner insurance policies covering structures subject to mold remediation are complex. Policy interpretation is beyond the responsibility and expertise of remediators. In some circumstances, even if a policy contains a mold exclusion or coverage limitation that may appear on its face to preclude recovery for mold remediation, the facts surrounding the loss and legal precedent applicable in the jurisdiction can actually allow a recovery. Therefore, it is recommended that remediators refrain from analyzing and interpreting insurance policies related to remediation projects. It is recommended that such matters be referred to an appropriate insurance professional or attorney.
- The existence and evaluation of insurance coverage in a mold remediation project has become much more uncertain and problematic.
- Payment for remediation services is increasingly coming directly from property owners rather than through an insurance company.
- Since property owners can be more inclined to engage in damage recovery efforts when insurance is not involved, remediators are more likely to be involved in supporting or assisting property owners in those efforts, including litigation.

Remediator Insurance

The mold remediation insurance market has undergone extensive change over the past several years, particularly in North America. In fact, at the time of the writing of this document, the insurance industry is still in a state of flux. The primary issue involves the introduction of universal mold exclusion across the entire retail insurance market place. In other words, general liability policies now written for remediators, and most other types of commercial liability policies, exclude some or all claims for injury or damage resulting from mold and pollutants, including the cost of clean-up. This exclusion creates a gap in coverage. Without environmental insurance specifically adapted to cover mold as a pollutant, remediators might not be insured for mold-related liability losses. Due to the nature and extent of the potential liability that may be experienced by mold remediators, the only business insurance available in North America to cover mold claims is through specialized environmental insurance packages. This specialized environmental insurance, coupled with proper planning, can maximize the value of the insurance purchased, while minimizing premiums paid and the potential professional liability exposure for materially interested parties.

Because of the introduction of universal mold exclusions in insurance policies, it is recommended that remediators obtain appropriate Contractors Pollution Liability insurance to cover their operations. These are available from various providers within the highly specialized environmental insurance market. The purchase of Contractors Pollution Liability insurance brings the insurance coverage on remediators back to where it was before the mold exclusions on Commercial General Liability insurance policies took mold coverage away.

Environmental insurance is complex and unlike general liability insurance, lacks insurance industry standardization. The current market includes only a small number of insurers capable of writing a full range of environmental coverage and supporting those policies with claims and loss-control services. Each insurer typically creates its own policy forms and names for its coverage, in accordance with its marketing objectives. Thus, two insurers may use different names to describe essentially the same coverage. To add to the complexity, different policy forms can be significantly modified by endorsement, or combined to provide packages of different types of environmental insurance that share a common policy limit. Some environmental coverage is available only as part of specialty insurance packages. Because of the complexity of environmental insurance, it is recommended that credentialed insurance agents with specific training in environmental insurance be consulted when procuring this insurance. These specialized insurance agents can be identified through searching the Internet under the keywords "mold insurance." Many of these environmental insurance specialists are wholesale insurance brokers who can work with general insurance agents throughout North America.

Insurance policies in different countries may treat loss exposures related to mold differently than insurance policies used in North America. It is recommended that remediators monitor the insurance they carry to ensure that they have coverage for mold-related damages. Coverage restrictions can appear in the form of mold exclusions or pollution exclusions. These restrictions can be addressed with the assistance of the remediator's specialized insurance agent or insurance provider.

There may be a tendency for remediators to attempt to restrict the coverage purchased in order to save money on premiums. Some of the more popular strategies to do this involve: insuring only jobs in which the customer is demanding mold coverage, while leaving the mold remediator uninsured for other jobs; creating a subsidiary to do mold remediation while the remainder of the business remains uninsured for mold; or insuring only mold remediation jobs while leaving other company services uninsured. From an insurance standpoint, these strategies are never recommended. They leave coverage gaps for the business and can increase the effective rate paid for the insurance purchased.

In general, the most efficient purchase strategy for environmental insurance is to aggregate as much loss exposure onto one policy as possible. Although the focus on mold remediation insurance may only be on self-performed mold remediation projects, a mold claim might also originate from: a water damage restoration project gone awry; subcontracted remediation; environmental consultants engaged on a project; or drying, plumbing, roofing and window work. Since the incremental cost to insure the entire mold remediation firm and all aspects of its projects and operations can be reasonable when compared to the initial premium, the additional coverage gained and the reduced business exposure can make it cost effective for remediators to aggregate coverage for all aspects of their operations into one policy.

Obtaining Contractors Pollution Liability (CPL) insurance does not replace or negate the remediator's need for Commercial General Liability (CGL) insurance, which provides coverage for aspects and potential claims of the remediator's business other than pollution or mold. It is recommended that remediators obtain sufficient Commercial General Liability insurance for the work they are performing. Considerations include: coverage of the business work facilities; damage to structures or property being remediated, including contents in their care, custody and control; injury to persons including occupants, and defense costs, among others. Some insurers offer CGL/CPL combination policies to provide a more complete insurance package for the insured. Nearly all CPL policies are written on a claims-made basis, and most CGL policies are written on an occurrence basis. However, combination policies are offered with CPL coverage on either a claims-made or occurrence basis, and the CGL portion on either a claims-made or occurrence basis. Separate limits can be specified if the remediator needs higher limits for pollution or general liability exposures. Both types of coverage are subject to a single aggregate limit, and typically, a single deductible (when both CPL *and* CGL claims are involved).

Using combination policies has several advantages. The first is that they provide the coverage needed by remediators to adequately protect themselves against pollution and mold claims. Another advantage is that they can eliminate inter-insurer coverage disputes that might otherwise occur if the coverage is provided by two different insurers. Combination policies also provide uniform defense for claims because disputes will not arise over which insurer has the duty to defend. A combination policy typically is less expensive than two or more coverage forms purchased separately, primarily because the coverage in a combination policy is subject to a single aggregate limit. Although this makes the policy less costly, it has the drawback of offering only one limit when the purchase of separate policies would provide two limits. This drawback can be overcome by purchasing a higher aggregate limit of liability on the package policy. Another advantage to a package policy is that there is only one deductible applicable in the combination policy form, whereas using separate policies results in applying two deductibles.

In some jurisdictions, mold remediators and mold assessors are required by law to obtain and maintain certain types of insurance in specified minimum amounts. Remediators shall determine and comply with governmental insurance requirements related to business operations.

While not an exhaustive list, it is recommended that remediators take the following actions:

- Obtain and maintain adequate insurance for the mold remediation business.
- Make changes to company insurance programs on a timely basis. Do not let the actions of a general liability underwriter not renewing the company's insurance policies put the firm in a crisis.
- Try to avoid general liability claims. Remediation firms with a high general liability claim frequency may not be able to find insurance at all. One claim, even if it is measured in the

tens of thousands of dollars, may be ignored by underwriters. It is the frequency of claims that raises concern among underwriters.

- Run a tight financial ship. Environmental underwriters likely will be interested in the firm's financial performance.
- Prepare an accurate application. The application may be seen as a warranty statement on behalf of the remediator, and it is often incorporated into the policy itself. Therefore, the application may be referenced during a claim in order to establish that accurate information was provided to the underwriter before purchasing coverage.
- Work with an expert in environmental insurance in addition to your local insurance agent. Using a specialty broker with experience in environmental insurance policies ensures that appropriate coverage is placed for the best possible price, thereby maximizing coverage and minimizing cost for remediators.
- Pay particular attention to potential differences in the coverage provided by different policies, e.g., Commercial General Liability (CGL) insurance versus Contractors Pollution Liability (CPL) insurance. Some policies may exclude significant causes of loss that other policies may cover. A credentialed environmental specialist insurance broker can assist in evaluating coverage. For remediation contractors some items of concern can be:
    - Does the policy cover Bodily Injury, Property Damage, Clean-up expenses and Defense costs arising out of the remediator's work and completed operations?
    - Are there any exclusions in the policy that may restrict these coverage grants for core business operations?
    - Does the policy exclude claims against the named insured for claims arising out of the work of subcontractors?
    - Does the policy exclude claims arising from the preparation of opinions or reports?
- If a mold remediator has no insurance coverage for mold, it is recommended that this fact be disclosed to customers in writing.

Assessor Insurance

Although this document is not intended to address directly the methods for contaminant assessment, qualified mold remediators can perform inspection and evaluation services during remediation activities. Remediators may have employees, divisions or subsidiaries that are also qualified to provide mold assessment or other services related to remediation, and meet the definition of an IEP, as described in this document. Remediators may work with an independent IEP on mold remediation projects. Remediators can face potential liability from inspection and evaluation services. Assessors can face potential liability from negligent professional errors, acts or omissions. Claims against such vendors can include allegations that they failed to identify contaminants, that their characterization of the site contains errors, that the design of remediation protocols is faulty, that they have made mistakes in analyzing samples, or that they have otherwise failed to perform in accordance with the industry standard of care. The remediator's insurance policy might not cover or might exclude the inspection, evaluation, and assessment services provided by the remediator, creating a gap in insurance coverage.

Virtually all General Liability and Contractor Pollution liability insurance polices contain exclusions for claims arising out of Professional Services. Professional Services exclusions are not standardized, but usually eliminate coverage for claims arising from the preparation or approval of drawings, opinions, reports, plans, surveys, or designs. Because some of these activities may be provided by remediators, significant gaps in insurance coverage can be created by the Professional Services exclusion, especially if these services are offered on a fee-for-service basis. There are three methods that can be used to fill this potential gap in insurance coverage. First, if remediators only prepare plans for jobs they will self-perform, the effect of the professional liability exclusion is minimal. Second, the best solution to the potential coverage gap created by the Professional Services exclusion in the General Liability and Contractors Pollution Liability policies is to amend the exclusion by endorsement so that it does not apply to the services provided by the remediator, which are incidental to the remediation business. It is likely an endorsement of this type will only be available from an insurance company with specialized insurance products for the remediation contracting business. Third, if a firm provides Professional Services on a fee basis, it will need to purchase Professional Liability insurance in addition to General Liability insurance.

Professional Errors and Omissions Liability (Professional E&O) insurance generally covers claims arising out of a professional error, act or omission. It is recommended that remediators performing inspection and evaluation services determine if their existing insurance program covers such services, and if not, the Professional E&O insurance form would be appropriate for their operations. It is recommended that qualified remediators providing assessment services or offering professional opinions, such as those rendered when acting as an IEP, consult with qualified attorneys or specialized risk management advisors to determine if Professional E&O insurance is important for the work they perform. In addition, it is recommended that remediators who engage independent assessment services, or obtain the services provided by an IEP, investigate and determine that the vendor carries Professional Liability insurance, and if so, whether or not the insurance carried by that vendor is adequate. It is important to verify that such policies cover the type of claims that might occur during a mold remediation project, particularly claims for environmental injury and damages, including those caused by pollution and mold. However, given that such insurance is typically written on a claims-made basis, is usually subject to a retroactive date, and has a substantial deductible, even after verification of the existence of such insurance at a point in time, there is no guarantee that insurance will be in force when a claim is made, or that the claim will be covered and paid by insurance. In such circumstances, it may be necessary to purchase “tail” coverage to extend the insurance beyond the claims-made period.

Other Insurance

The conduct of business as a mold remediation contractor requires consideration of several other types of insurance coverage:

- Worker’s Compensation/Industrial/Employee Insurance Requirements - remediation contractor employers shall meet legal requirements to provide worker compensation coverage for businesses having employees, and
- Automobile Insurance - It is recommended, and in many jurisdictions, required by law, that remediation contractors using vehicles in business obtain commercial automobile liability insurance.

Caveat

The insurance industry as it relates to the mold remediation and water damage restoration industries is rapidly evolving. Therefore, the insurance information and guidance presented in this discussion, although accurate when published, is subject to constant change as time passes. Environmental insurances were not originally developed for remediation contractors; therefore, many modifications to insurance policies are being made to adapt them to the needs of firms in the remediation business. Wide variations in the quality of the coverages provided by various policies continue to exist. It is incumbent upon remediators to stay abreast of insurance industry developments impacting their business. It is advisable that remediators develop and maintain a relationship with a qualified insurance professional to assist in this regard.

Chapter 8

Inspection and Preliminary Determination

INTRODUCTION

An inspection is primarily an information gathering process that typically includes a physical inspection of affected premises for moisture problems and potential mold contamination. After the initial inspection is completed, remediators develop a "preliminary determination," which is a conclusion that identifies actual or potential mold growth, known or suspected areas of moisture intrusion, and the need for assistance from other specialized experts such as an indoor environmental professional (IEP) to conduct assessments or to perform necessary services beyond the expertise of the remediator.

Generally, the preliminary determination is completed by the remediator, and is based upon the analysis and evaluation of information obtained during the initial inspection, and the professional judgment of the remediator. The preliminary determination, and assessments performed by an IEP (if any), provides the basis for developing work plans, protocols and specifications.

QUALIFICATIONS

Remediators are expected to be qualified by education, training and experience to appropriately execute the skills and expertise required to safely remove mold contamination from structures, systems and contents, and to restore Condition 2 or 3 structures, systems and contents to Condition 1. The primary purpose of the S520 is to provide the methods and procedures for achieving this goal. Remediators should perform only those services that they are qualified to perform. If situations arise where there is a need to perform services beyond their expertise, remediators should engage specialized experts or other support services, or recommend to customers or clients that appropriate specialized experts be retained, in a timely manner.

Remediators should be qualified by education, training and experience in water damage restoration and inspection. It is recommended that remediators have a basic knowledge of building science as it applies to moisture intrusion.

Although the discussions that follow are intended to provide guidance about the necessity to engage an IEP on mold remediation projects, it is not possible to provide definitive direction for every scenario, since the decision of whether or not an IEP is required on a particular project ultimately depends upon the unique facts and circumstances of each project. The expertise and professional judgment of the remediator are also applicable.

The assessment of Conditions 1, 2, and 3 by a remediator, on a project where the remediator has been contracted to perform remediation services, can create a conflict of interest. Ethical considerations can make such an assessment inappropriate and legislation can make it illegal. Therefore, remediators should not act as their own IEP. In addition, remediators shall comply with applicable federal, state, provincial and local laws and regulations relating to the services that they perform.

INITIAL CONTACT

Inspections for moisture problems that may have resulted in mold growth can begin in many ways and be initiated by any number of parties for a variety of reasons. An initial contact with a concerned individual (customer or client) can be a starting point for the inspection process.

If the initial contact is received by a remediator, the customer will likely receive recommendations following an approach most familiar to the remediator. A different approach may be recommended by a duct cleaner, restorer, engineer, industrial hygienist, public health official or an IEP.

If someone other than a remediator receives the initial contact, control of the project by another party may have already been established. This may present ethical and legal challenges for remediators, which are further addressed in Chapter 9, *Limitations, Complexities, Complications and Conflicts*.

Initial Inspection Triggers

There are two ways in which an inspection may be initiated. One results from an intentional discovery; another results from an incidental discovery. Either a remediator or an IEP can receive an initial contact and initiate a pre-remediation inspection for both intentional and incidental discoveries. Therefore, it is recommended that both parties be capable of conducting an initial interview and inspection for moisture-related problems in buildings, which leads to a preliminary determination.

Regardless of whether the discovery is intentional or incidental, a primary initial inspection consideration is whether or not isolation or containment of an area of visible mold growth is necessary. When mold contamination is discovered, a building moisture inspection and evaluation should be conducted promptly. This can require the use of moisture measuring equipment.

Intentional Discovery

An intentional discovery generally arises from a concern expressed by a facility manager, homeowner or building occupant about the indoor environment. Musty odors, health complaints, known water damage or areas of visible mold growth can trigger an initial contact.

Incidental Discovery

Incidental discoveries can result while performing other contracted services, such as: routine maintenance, repairs, emergency services or general inspections. Various trades working at a job site might encounter unexpected mold growth while performing their work. Water damage or areas of visible mold growth can trigger an initial contact.

Health Complaints

If occupants express health concerns or have medical questions during the inspection process, remediators should instruct them to seek advice from qualified health care professionals, public health authorities, or IEPs. It is recommended that remediators not give advice, education or warnings on subjects outside their area of expertise.

INSPECTION PROCESS

The inspection process includes, but is not necessarily limited to gathering information, and conducting a physical inspection of the affected premises for moisture problems and potential mold contamination. The inspection process can require a multi-disciplined approach involving specialized experts from various fields. During the inspection process, remediators can engage, or recommend that an IEP be engaged, to assess the extent and complexity of the mold contamination, and to evaluate the exposure risks and hazards to occupants. However, the inspection process is not intended to be an exposure assessment, and as such is not intended to address occupant health complaints or risks.

Information Gathering

Remediators should make a reasonable attempt to obtain available background information on the affected premises, including a building history. This information can help establish a building inspection strategy. Pertinent information to request includes, but is not limited to:

- what prompted the initial contact;
- recent history: information regarding recent moisture intrusions.
- past building history including, but not limited to:
  - building age;
  - construction materials;
  - maintenance schedule and deferred maintenance;
  - previous water intrusions;
  - previous mold problems;
  - previous structural damage;
  - mechanical systems;
  - remodeling and renovation;
  - premises use, and
  - occupancy history.
- additional information, proposals or reports from professionals who have been involved with the building;
- available information about occupants in the building to ascertain if they have concerns or conditions requiring implementation of extraordinary engineering controls during remediation activity. This can include, but is not limited to, individuals who are: immunocompromised, elderly, young children, chronically ill, pregnant, or environmentally sensitive.

Occupant health concerns or conditions can be an important part of the information gathering process, and can serve several purposes including: determining the need for additional occupant protection; the need to involve an IEP; or the need for occupant referral to a qualified health care professional or public health authority. It is recommended that remediators not give advice, education or warnings on subjects outside their area of expertise.

Building Inspection

A physical site inspection or a walk-through of affected premises should be performed in order to gather information about the condition of a property that can lead to a preliminary determination about the presence of moisture and mold. The building inspection can include, but is not limited to, looking for: water intrusion or condensation, water stains; structural damage; HVAC operation; odors; construction type; previous repairs or remodeling, and structure defects.

In addition to legal requirements to identify workplace safety and health issues, the purpose of the inspection is to determine the existence of moisture problems that can indicate potential contamination. Contamination is actual growth that can be active or dormant, visible or hidden, in the form of settled spores or a combination thereof.

While visible mold is contamination, it can also be an indicator of hidden or concealed contamination, or an indicator of Condition 2 contamination. For example, there may be extensive mold growth present in interstitial spaces or concealed areas. Regardless of the quantity of visible mold growth and extent of water damage, remediators should attempt to obtain enough information to locate or predict the extent of associated concealed or non-visible mold contamination.

Obtaining a building history and performing an inspection assists in locating concealed mold contamination. In order to locate potentially concealed mold, remediators should identify, to the extent possible, the pathways of water intrusion in affected premises, (i.e., since mold requires moisture to grow, finding the water intrusion pathway is an effective tool for locating mold contamination).

The building envelope has many openings that can allow water to penetrate and accumulate, thereby creating indoor conditions that allow mold to grow. Water also enters buildings through leakage, flooding and capillary action, or it can be present due to condensation.

It is recommended that remediators have a basic knowledge of building science as it applies to moisture intrusion. The building moisture inspection should be performed and documented in accordance with ANSI/IICRC S500, *Standard and Reference Guide for Professional Water Damage Restoration*.

In some cases during the inspection process, remediators may need to conduct intrusive activities. Remediators shall check with local regulatory agencies to determine whether or not permits or licenses are required for such activities.

Where visible or suspected mold growth is present or potentially disturbed, immediate containment, other engineering controls and personal protective equipment (PPE) should be considered during the inspection process. Such decisions should be based upon the professional judgment of the remediator and shall be consistent with applicable laws and regulations and the guidance set forth elsewhere in this document (see Chapter 6, *Safety and Health*).

During the inspection process, it might not be acceptable or practical to access all areas of potential mold growth. This can lead to discovering additional mold during the remediation process. If at a later time additional mold is discovered, it can become necessary to re-inspect and re-evaluate the building and determine the need for adjusting containment and other engineering controls.

During the inspection process, the presence of hazardous or regulated materials that might be disturbed during the remediation process shall be determined. Remediators shall comply with federal, state, provincial and local laws and regulations regarding the handling of hazardous or regulated materials, such as asbestos or lead-based paints. Older structures (typically those built before the mid-1980s) are more likely to have asbestos or lead-based paints. In some states and countries, individuals who perform these types of investigations or remediation services shall have received appropriate training or licensing.

DEVELOPING A PRELIMINARY DETERMINATION

After the initial inspection is completed, the next step involves developing a preliminary determination. A preliminary determination is a conclusion that identifies: actual or potential mold growth, known or suspected areas of moisture intrusion, whether or not the assistance of an IEP is necessary to conduct a formal assessment of Conditions 1, 2 and 3, or whether other specialized experts need to perform other necessary services or fulfill the needs of the remediator. Generally, the preliminary determination is completed by a remediator, and is based upon the analysis and evaluation of information obtained during the initial inspection, and the exercise of professional judgment by the remediator.

Factors considered in developing a Preliminary Determination include, but are not limited to: quantity and location of visible mold growth; cause of the mold contamination; the effects of time; building use and function; occupant type; the existence of known concealed mold contamination; the likelihood of suspected concealed mold contamination. It is recommended that remediators consider some combination of these factors during the inspection and evaluation process, which is used to develop a preliminary determination.

There are several different mold remediation approaches included in other guidance documents recognized by the IICRC S520 Consensus Body Standard Committee (e.g., NYCDOH, USEPA, ACGIH, NEIHS). Their remediation approaches base the recommended remediation response primarily upon the size of the actual visible mold growth. These alternative approaches and guidance documents established a foundation for development of the S520, and have been reviewed and evaluated during revision of the S520. The IICRC S520 Consensus Body Standard Committee, with collective experience involving hundreds of actual remediation jobs and reviews of sampling test results, has determined that using square footage of visible mold, alone, while helpful, is not feasible as an action level decision criterion.

Thus, the S520 represents a philosophical shift away from using "size" of visible mold growth to determine the remediation response. Instead, the S520 establishes mold contamination definitions (Conditions 1, 2, and 3) and guidance, which, when properly applied, can assist remediators and others in determining remediation response or confirming remediation success. The S520's philosophical shift places more importance on the consideration of hidden or concealed (not readily visible) mold growth, and it takes into consideration contamination resulting from settled spores and fragments (not visible) that were dispersed from areas of actual growth. Regardless of the differences in remediation approaches between the S520 and other guidance documents, they do contain valuable information and direction that may be helpful to remediators when completing the inspection process, developing the preliminary determination, and completing a mold remediation project.

Remediators should engage, or recommend to customers or clients that they engage, an IEP when Condition 1, 2, or 3 cannot be determined by the remediator. The definitions of Conditions 1, 2, and 3 are restated below and discussed further in this document.

Condition 1 (normal fungal ecology): an indoor environment that may have settled spores, fungal fragments or traces of actual growth whose identity, location and quantity are reflective of a normal fungal ecology for a similar indoor environment.

Condition 2 (settled spores): an indoor environment that is primarily contaminated with settled spores that were dispersed directly or indirectly from a Condition 3 area, and which may have traces of actual growth.

Condition 3 (actual growth): an indoor environment contaminated with the presence of actual mold growth and associated spores. Actual growth includes growth that is active or dormant, visible or hidden.

In addition, remediators should recommend engaging an IEP and other appropriate specialized experts (e.g., qualified health care professional) to customers or clients when health issues are discovered or apparent that seem to be related to mold contamination. Further, in all situations, remediators should exercise professional judgment in making appropriate recommendations.

Summary of Possible Preliminary Determinations

- enough information is currently available to determine Condition 1 exists throughout the structure, systems, or areas (including contents), and therefore, no remediation activity is required;
- enough information is currently available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or areas (including contents), and therefore, work plans, protocols and specifications can be developed;
- there is not enough information available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area (including contents), and therefore, remediators should engage, or recommend that customers or clients engage, an IEP to assess affected structure, systems, or areas, including contents.

DEVELOPING WORK PLANS, PROTOCOLS AND SPECIFICATIONS

The inspection information, preliminary determination, and assessments performed by an IEP, provide the basis for developing work plans, protocols and specifications, the development of which can necessitate the further assistance of an IEP or other specialized expert. When preparing work plans, protocols and specifications for a mold remediation project, remediators should use the information contained in this document to determine the need for specific services and procedures (e.g., Chapter 6, *Safety and Health*; Chapter 11, *Structural Remediation*; Chapter 12, *HVAC Remediation*; Chapter 13, *Contents Remediation*). When developing work plans, protocols and specifications, at a minimum, consideration should also be given to the following:

- containment;
- pressure differentials;
- hazardous or regulated materials;
- safety and health provisions;
- contents;
- contaminated material removal and handling;
- detail cleaning;
- disposal;
- post-remediation evaluation;
- post-remediation verification, and
- containment removal.

The table below helps clarify which tasks may be performed by remediators and which ones may be performed by an IEP or others. There may be situations in which an IEP or other specialized expert is either unnecessary, not reasonably available, or cannot be included in the process. In such situations, remediators should not offer advice or provide services that are outside their level of training and experience.

It is important that individuals who perform the tasks listed below have sufficient training and experience for those specific tasks, and that conflicts of interest between parties performing remediation processes and assessment activities be avoided.

Possible Tasks	Remediator	IEP	Other*
Occupant information	X	X	X
Occupant characterization and complaints	X	X	X
Detailed health-related interview (follow-up)		X	X
Occupant health evaluation			X
Building history	X	X	X
Site safety evaluation	X	X	X
Moisture detection	X	X	X
Intrusive inspection	X	X	X
Preliminary determination	X	X	X
Pre-remediation assessment		X	
Laboratory data interpretation and report		X	
Scope development	X	X	
Technical specifications	X	X	
Remediation	X		
Quality control	X	X	X
Monitoring work environment	X	X	
Post-remediation verification		X	

***** Qualified and licensed health or medical professional

REFERENCES

American Conference of Governmental Industrial Hygienists "Bioaerosols: Assessment and Control" (1999).

American Industrial Hygiene Association "Field Guide for the Determination of Biological Contaminants in Environmental Samples" (1996, 2005).

New York City Department of Health "Guidelines on Assessment and Remediation of Fungi in Indoor Environments" (2000).

U.S. Environmental Protection Agency "Mold Remediation in Schools and Commercial Buildings" (2001).

Chapter 9

Limitations, Complexities, Complications and Conflicts

Remediators can be faced with project conditions that present challenges. These challenges can produce limitations, complexities, complications or conflicts. Remediators should have a thorough understanding of these issues and communicate them to appropriate parties. A definition for each of these challenges follows.

"Limitation" means the act of limiting or the state of being limited, constrained or restricted. For purposes of this Standard and Reference Guide, a "limitation" is a restriction placed by others upon a remediator that results in a limit on the scope of work, the remediation activities or the outcomes that are expected.

"Complexity" means involved or intricate. For the purposes of this Standard and Reference Guide, a "complexity" is any condition that causes the project to become more difficult or detailed, but does not prevent work from being performed adequately.

"Complication" means the act of becoming complex, intricate or perplexing. For purposes of this Standard and Reference Guide, a "complication" is generally any condition that arises after the start of work and causes or necessitates a change in the scope of remediation work activities.

"Conflict" means a state of disharmony between persons, ideas or interests. For purposes of this Standard and Reference Guide, a "conflict" is a limitation, complexity or complication that results in a disagreement between parties involved about how a remediation project is to be performed.

Before beginning non-emergency work, known limitations and complexities, and their consequences, should be understood, discussed and approved in writing by a remediator and an owner or owner's agent. A discussion of each of these challenges follows.

LIMITATIONS

Restrictions that are placed upon remediators by another party that result in a limit on the scope of work, the remediation activities or expected outcomes, can include, but are not limited to, the following:

- the source of the water has not been corrected;
- the remediator is told to remove visible mold (Condition 3) and ignore settled spores (Condition 2);
- the remediator is told to clean-up Conditions 2 and 3 in a structure and ignore the HVAC system;
- the remediator is instructed to return contaminated contents without cleaning them;

- Conditions 1, 2 and 3 have not been determined;
- funds are limited, or
- the appropriate use of containment is limited or prohibited.

Only an owner or owner's agent, not the remediator or others, can impose limitations on performing a project. If an attempt to impose a limitation is initiated by any other materially interested party, the owner or owner's agent should be advised and provide approval before the limitation takes effect. Limitations should be defined in writing. Limitations placed on any project that are inconsistent with this Standard can result in a conflict.

COMPLEXITIES

Conditions that cause the project to become more difficult or detailed, but do not prevent work from being performed adequately, can include, but are not limited to, the following:

- inconvenient or limited space or path for entry and exit serving a work area or building;
- the remediation occurs after business hours or within a specific time period;
- work needs to proceed during adverse weather conditions;
- the remediation includes a permit-required confined space, attic or crawlspace;
- the business will be in operation or a space adjacent to an affected area will be occupied during remediation;
- access to a remediation area is desired by occupants;
- a lack of storage space is available for equipment, supplies, and debris;
- a project site is a problem because of building-specific uses (e.g., a cleanroom in a computer facility, intensive care unit or immune-compromised patient ward in a hospital), or
- access is required by other trades, such as HVAC, plumbing, or electrical, during remediation work in a contaminated area of a building.

COMPLICATIONS

Conditions that arise after the start of work that cause or necessitate a change in the scope of activities can include, but are not limited to, the following:

- additional mold is found requiring an expanded scope of work;
- sudden or unexpected changes in weather;
- there are unexpected delays;
- the client needs the remediation work completed sooner than originally planned;
- the building is not returned to Condition 1 under the present scope of work;
- a water loss, burglary, fire or other disaster occurs in the building or area being remediated,

or

- hazardous materials are discovered after work has begun.

The owner or owner's agent should be notified in writing as soon as practical regarding any complications that develop. The presence of project complications can necessitate a written change order.

CONFLICTS

Limitations, complexities, or complications that result in a disagreement between the parties involved about how the remediation project is to be performed are called conflicts. When limitations, complexities or complications develop or are placed on the project by the owner or owner's agent, and they prevent compliance with this Standard, remediators may choose to negotiate an acceptable agreement, decline the project, stop work, or accept the project with appropriate releases, waivers and disclaimers. Conflict resolution should be documented in writing and releases, waivers and disclaimers should be reviewed by a qualified attorney.

RELATED ISSUES

The presence of limitations, complexities, complications and conflicts on a mold remediation project can create additional consequences and ramifications. These related issues include the following:

Hazardous or Regulated Materials

The presence of a hazardous or regulated material on a project can present a limitation, complexity, or complication. The presence or potential presence of a hazardous or regulated material on a project shall be carefully evaluated to determine if remediators and remediation employees are qualified to work in that environment. Some hazardous or regulated materials require HAZMAT training, while others require more specific training and licensing, or may necessitate engaging a qualified specialized expert. Remediators shall avoid situations that result in an activity that is illegal, or which is likely to result in injury or adverse health consequences for workers or occupants.

Change Orders

Disputes can develop when contract additions or modifications are made while performing work, but are not adequately documented in writing. In order to protect all parties to a remediation contract, substantive changes in the scope of work, time frame, price or method of payment or other material provision of a contract should be documented in a written change order that details the changes. Further, it is recommended that the owner or the owner's designated agent and the remediator's representative accept the change order in writing.

Insurance

Remediators should be aware that the terms and conditions of their insurance coverage can create project limitations and complications. The extent of applicable insurance coverage, as further prescribed by the insurance exclusions in the policy, can exclude certain work activities from the insurance coverage (e.g., hazardous materials, mold). If applicable insurance does not cover the work anticipated at commencement of the project, a limitation can result, if insurance is required. If a complication develops or is discovered after commencing project work, it is possible that resultant changes in the scope of work might not be covered by the remediator's insurance policy. Providing remediation services without insurance, or providing such services that exceed the scope of existing insurance coverage, can potentially expose a remediator, or other materially interested parties, to risk. In some jurisdictions, remediators are required to maintain insurance coverage as a condition to performing remediation services. Remediators should determine whether or not specialized insurance coverage is required for their operations.

Work Stoppage

In some situations, limitations, complexities, complications or conflicts can necessitate work stoppage. In the event an illegal or dangerous limitation, complexity or complication exists, occurs or is discovered on a mold remediation project, the condition shall be resolved immediately, or the work stopped.

Remediators shall avoid situations that result in activities that are illegal or are likely to result in injury or adverse safety or health consequences for workers. Remediators should avoid situations that result in activities that are likely to result in injury or adverse safety or health consequences for occupants.

The reason for the work stoppage and the significant events leading to a work stoppage decision should be documented in writing. It is recommended that a work stoppage be reviewed by a qualified attorney.

Chapter 10

Indoor Environmental Professionals and Assessments

WHAT IS AN INDOOR ENVIRONMENTAL PROFESSIONAL?

The IICRC S520 defines an indoor environmental professional (IEP) as an individual who is qualified by knowledge, skill, education, training, certification or experience to perform an "assessment" of the fungal ecology of structures, systems, and contents at a job site, create a sampling strategy, sample an indoor environment, submit samples to an appropriate laboratory, interpret laboratory data, determine Condition 1, 2 or 3, and verify the return of the fungal ecology to Condition 1.

Using the IICRC S520 as guidance, a qualified remediator can use a preliminary determination to develop a scope of work (i.e., work plans, protocols or specifications) for a mold remediation project. However, when a pre-remediation assessment or post-remediation verification is requested or required, it should be performed by an IEP. The assessment information can also assist remediators in developing additional technical specifications, detailed protocols and post-remediation verification parameters.

The terms "indoor environmental professional" and "IEP" are used in this document and in the remediation industry to generically describe individuals having advanced technical competency in a wide range of subjects related to mold in the built environment, which qualify them to perform assessments and related professional services typically provided by an IEP, as defined in this document.

Because there is such a broad array of skills encompassed within the description of an IEP, it is impossible to develop a single, meaningful course of study that would adequately address the advanced levels of knowledge an IEP should possess within their area of specialization. Therefore, the terms "indoor environmental professional" and "IEP" are used in this document and in the remediation industry as a description, and not as a title, designation, certification, trademark or service mark.

Consequently, there is no single license, designation or certification that qualifies an IEP. The qualifications required for an IEP are often gained through years of formal study at the university level, specific training related to mold and the indoor environment, and years of on-the-job work experience, or a combination of these factors. Therefore, the IICRC does not offer or recognize a professional certification or designation for an IEP, and prohibits the exclusive use or co-option of the terms "indoor environmental professional" and "IEP" in association with any one individual, entity or organization, as such use would be contrary to the intent of this document.

However, use of the terms "indoor environmental professional" and "IEP" as a generic description is permitted. Remediators and others who engage an indoor environmental professional are advised to consider the individual's knowledge, skill, education, training and experience to best judge his or her ability, qualifications and competence, as further explained in this document.

INDOOR ENVIRONMENTAL PROFESSIONAL QUALIFICATIONS

Education and Training

Many IEPs possess technical degrees or professional credentials in industrial hygiene, medical technology, biology, microbiology, mycology, public health, environmental science, toxicology, building science, or engineering. While this may be a good place to begin looking for IEPs, these are such broad fields of study that no single field by itself guarantees competence. Regardless of their primary educational background, qualified IEPs generally have additional education, training or experience in the following subjects, including but not limited to:

- indoor environmental quality (IEQ);
- water damage restoration;
- occupational safety and health;
- environmental monitoring and assessment;
- construction basics;
- construction failure;
- building science;
- mechanical systems operation and maintenance;
- mechanical systems testing and remediation, or
- mold remediation.

Field Experience and Industry Contributions

It is one thing to have academic experience, but quite another to have the ability to combine academics with actual performance in the field. A qualified IEP will be able to verify a number of years of experience involving various mold investigation projects (with additional knowledge of other indoor environmental quality issues) and experience in sampling and designing remediation protocols or technical specifications. Other indicators of a qualified IEP include participation in industry-related professional societies and associations, writing standards and guidelines, publishing magazine or trade journal articles, and developing training and certification programs and exams.

Continuing Education

A qualified IEP keeps abreast of changes in technology and procedures through formal continuing education programs or self-directed study. Further, a qualified IEP is familiar with industry standards and reference documents including, but not limited to: ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration*; IICRC S520; AIHA's *Field Guide for Determination of Biological Contaminants in Environmental Samples*; ACGIH's *Bioaerosols: Assessment and Control*; the EPA's *Mold Remediation in Schools and Commercial Buildings,* and other published literature in the field.

INDOOR ENVIRONMENTAL PROFESSIONAL ACTIVITIES

An IEP's primary function, as it relates to mold remediation, is to assess fungal ecology, determine Condition 1, 2 or 3 of structures, systems and contents, and verify the return to Condition 1. To accomplish these functions, an IEP may need to perform the following tasks:

- pre-remediation assessment;
- occupant exposure assessment;
- worker exposure assessment;
- assess the Condition (1 or 2) of contents;
- assess suspected dissemination of airborne mold contaminants by the HVAC system;
- assess suspected cross-contamination of mold contaminants to areas of the building not directly impacted by Conditions 2 or 3;
- develop an appropriate sampling strategy, collect samples, select and use a qualified mycology or microbiology laboratory (e.g., EMLAP, A2LA, NELAP, or equivalent program) or individual (e.g., National Registry of Microbiologists, Public Works Canada Accredited Mycologist, or equivalent program), and interpret data with regard to Conditions 1, 2 or 3.
    - A qualified environmental mycology or microbiological laboratory employs mycologists or microbiologists who are trained in isolating and identifying environmental organisms, and use appropriate media, incubation conditions and a variety of tests specific to environmental isolates. They will be familiar with the microscopic morphology of fungi associated with the built environment. While a hospital or clinical microbiology laboratory is required for specimens collected from humans for the diagnosis or management of infectious disease, an environmental mycology/microbiological laboratory is necessary for air, surface, fluid and bulk samples collected from the ambient or work environment,
- provide additional or independent information or a second opinion, if needed;
- assist in developing work plans, protocols and specifications;
- provide project oversight including interim assessments, project monitoring and documentation;
- perform post-remediation verification.

An assessment by an IEP is not necessary when:

- there is enough information currently available to determine that Condition 1 exists throughout a structure, system, or area (including contents), and therefore, no remediation activity is required, or
- Condition 2 or 3 exists throughout the affected structure, systems, or area (including contents), and therefore, work plans, protocols and specifications can be developed.

WORKING WITH AN INDOOR ENVIRONMENTAL PROFESSIONAL

A remediator's relationship with an IEP can sometimes be quite complex depending on why, when and by whom the IEP was hired. If there are complexities, complications or conflicts, a remediator may need to request additional input or guidance from an IEP. (See Chapter 9, *Limitations, Complexities, Complications and Conflicts*)

Other relationship issues may include, but are not limited to:

- **independence -** It is preferable that the IEP be an unbiased resource. An IEP engaged to perform pre-remediation assessment or post-remediation verification should be independent of the remediator. In some jurisdictions, the law may require that the inspection and assessment function be performed by an individual or entity independent of the remediator.
- **confidentiality -** A company owes a duty to its client, which can include confidentiality. Where an IEP is retained by someone other than the remediator, there may be a limit to the information that the IEP can provide to the remediator. Ideally, an IEP will be authorized by the client to share all information with all parties. The EPA's *Mold Remediation in Schools and Commercial Buildings*, for example, encourages communication with occupants to help alleviate concerns and suspicions. However, in cases involving litigation, it may be difficult to share or obtain information.
- **reliance -** Mold remediators often rely on an IEP to determine the scope of work and other essential tasks. However, reliance on the training, experience, reputation and credentials of an IEP might not absolve the remediator of legal risk or other responsibilities.
- **overlap -** There may be circumstances when a remediator's normal activities overlap or conflict with those of an IEP. In those cases, a remediator can reach the point where a decision is necessary to continue an inspection or to transfer the responsibility for further inspection and preliminary determination to an IEP. Factors that influence the decision of whether and when to involve an IEP are addressed in Chapter 8, *Inspection and Preliminary Determination,* the Preface, and Sections 9 and 15 of this Standard.

Chapter 11

Structural Remediation

INTRODUCTION

Structural Remediation is defined as that portion of a remediation project that deals specifically with a building's structure and typically does not address a building's contents or HVAC components. Before beginning a mold remediation project, a clear objective and goal should be established, outlined and understood by materially interested parties. The mold remediation procedures outlined in this document are based on generally accepted industrial hygiene practices, and safety and health principles. These procedures describe safeguards and controls that assist in achieving remediation project goals.

Material Evaluation

Regulated materials, such as lead or asbestos, require specific mitigation or remediation protocols. The presence of these and other regulated materials take precedence over mold remediation, and they shall be addressed according to federal, state, provincial and local laws and regulations.

The remediation of different building materials depends on their porosity, their Condition (1, 2 or 3), and their structural integrity. Additionally, remediation methods can depend on the exposed substrates. Careful evaluation of materials containing layers with multiple porosities (composite materials) is appropriate. The following table represents the generally accepted remediation procedures for building materials affected by Condition 3 mold contamination. Contaminated materials should be carefully evaluated before attempting mold remediation. If structural components have been compromised and need to be removed, a qualified structural engineer should be involved in decisions to remove such components.

Porosity*	Materials	Remediation
Porous	drywall, ceiling tiles, insulation, particle board, medium-density fiberboard (MDF), carpet and similar porous materials	discard
Semi-porous	wood, brick, plaster, block, concrete, plywood, oriented strand board (OSB) and other semi-porous materials	abrasive methods: wire brushing, sanding, media blasting, or other appropriate methods.
Non-porous	glass, metal, laminate, plastic, porcelain, ceramic and other non-porous materials	surface cleaning: damp wiping, HEPA-vacuuming, or other appropriate methods.

*S520 definitions for the purposes of this table:
Porous: Building materials that easily absorb or adsorb moisture and, if organic, can easily support fungal growth
Semi-porous: Building materials that absorb or adsorb moisture slowly and, if organic, can support fungal growth
Non-porous: Building materials that do not absorb or adsorb moisture or have been surface treated and do not easily support fungal growth

ENGINEERING CONTROLS

One objective of structural mold remediation is to prevent releasing mold spores, fragments and dust from surfaces into indoor air, both to reduce remediation worker exposure and to make the remediation process more efficient. Demolishing mold-contaminated building materials can create 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.”

Remediators should prevent cross-contamination and shall use engineering controls to ensure worker safety and health in structural mold remediation projects. In accordance with generally accepted industrial hygiene principles and Occupational Safety and Health Act (OSHA) regulations and standards, engineering controls, not personal protective equipment (PPE), are the first line of defense for ensuring worker safety and health. Engineering controls may include, but are not limited to: source containment, isolation barriers, pressure differentials, dust suppression, and high efficiency particulate air (HEPA) vacuuming and filtration.

Isolation

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

Polyethylene Sheeting or “Poly”

Isolation barriers usually are constructed of 4-mil or 6-mil polyethylene for walls and ceilings, and 10-mil polyethylene for floors. Thinner polyethylene may be used for temporary tear-away protection of surfaces. Fire-retardant polyethylene, with a minimum flame-spread rating of 25, should be used to reduce fire hazards, and shall be used when required by applicable federal, state, provincial or local laws and regulations.

Medium-slip polyethylene (no oil or talc coating) is preferred when erecting containments, when available. This allows better tape adhesion to the polyethylene. Different types of tape, adhesives and fastening methods are available to attach polyethylene to surfaces.

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 additional mold contamination is discovered.

Source Containment

Source containment may be used to address relatively small or limited 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 mold growth is limited to small visible controllable areas where no hidden mold growth is anticipated. When there are small or limited areas of mold growth, and hidden mold growth is anticipated, a more extensive containment should be used. 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, and
- wrapping, bagging, and securely enclosing moldy contents or materials in 6-mil polyethylene or comparable packaging.

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 polyethylene material. However, constructing structural support is not always necessary if the local containment can be securely attached to wall and ceiling surfaces. Local containments can be secured by a variety of methods: e.g., staples, cardboard reinforcement, adhesive tape, spray glue or specialized fasteners. One or two layers of polyethylene may be used to cover an enclosure or to erect additional isolation barriers.

HEPA-filtered air filtration devices (AFDs), when used as negative air machines (NAMs), are installed to create negative pressure differentials in relation to surrounding areas. In 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 or extensive mold growth is present or suspected, and cannot be effectively controlled and remediated with source and local containment methods.

In a full-scale containment, the entire room or building section is designated as the work or 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 should be sealed off with polyethylene 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 (contaminated area) and surrounding clean areas.

Decontamination chambers are used for entry to and exit from a work area. These chambers also are used for decontaminating the exterior surfaces of plastic bags or sheeting used to contain 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, covered with one or two layers of polyethylene. Plastic flaps (e.g., "Z", "T" or triple-flap doors) can be installed on the entry and exit side using single or double layers of polyethylene. Prefabricated decontamination chambers also are available.

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. Three-stage decontamination chambers are used in asbestos abatement projects. They can include a dirty room, shower or pass-through area, and cleanroom. At present, there is no scientific evidence to justify the use of showers in mold decontamination systems. (ACGIH, 1999)

In situations where an entire building is affected by Condition 2 or 3 mold, containment might not be necessary. However, decontamination chambers, air pressure differentials, make-up air and other engineering controls may be required to address worker protection issues.

Containment Maintenance

Contaminated materials should not be disturbed until containment is erected, a negative air system is installed, and the containment's performance is checked. Also, containment should not be removed until demolition, remediation, clean-up, post-remediation evaluation by the remediator, and post-remediation verification by an indoor environmental professional (IEP) when required, have been completed.

The integrity of containment should be maintained throughout the remediation process including post-remediation evaluation. Tape can fail to hold up the polyethylene containment in hot and humid environments. Too much negative pressure can collapse containments, especially during unsupervised periods (e.g., nighttime). Remediators should monitor and document containment performance at appropriate intervals.

Containment barriers should be constructed so that, if pressure differentials are lost, containment flaps will close. Work should be stopped any time there is a breach in containment or loss of pressurization, and not resumed until the containment has been repaired and pressure differentials re-established. It is recommended that any breach in the containment's integrity be reported immediately to a supervisor.

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

Pressure Differentials

Pressure differentials are used to manage airflow. Professional judgment determines how air flow is managed and pressure differentials are applied. If pressure differentials are used, contaminated areas should be negatively pressurized relative to unaffected or clean areas of a building to prevent cross-contamination.

Generally, when pressure differentials are used, they should be created using HEPA air filtration devices (AFDs) used as negative air machines (NAMs). An AFD can be set up as a negative or positive air system, or as an air scrubber.

Pressure differentials can be monitored by analog or digital manometers, smoke tube or pencils, or visual inspection, (e.g., curvature of plastic sheeting). It is recommended that polyethylene containment be installed in a tight manner. Billowing containment barriers can indicate the airflow direction. In sensitive environments, such as daycare or healthcare facilities, alarmed or alert pressure differential monitoring systems with data logging capability should be used. In sensitive environments, multiple AFDs should be used when appropriate and operated on separate electric circuits where available.

"A pressure differential of ≥5 Pa (0.02 in. w.g.), which is recommended for asbestos abatement work (OSHA, 1994), may be adequate to contain dust and spores. However, an even higher pressure difference; e.g., -7 Pa (-0.028 in. w.g.) may be necessary in some cases." (Alevantis et al., 1996; ACGIH, 1999) Two-hundred-fifty (250) Pascals (Pa) equals one (1) inch of water gauge pressure (in. w.g.). These pressure differential guidelines are consistent with prudent industrial hygiene principles and have been adopted in the mold remediation industry.

Air Flow and Exchange Rates

Air exchanges are used to dilute airborne fungal concentrations in work or containment areas. This helps reduce worker exposure and facilitates the clean-up effort. Airflow direction should 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." One cubic foot of exhausted air requires one cubic foot of replacement or make-up air. Negative pressure differentials can create a risk of carbon monoxide exposure from backdrafting, 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 can 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. In cold climates, negative pressure can draw cold or freezing air into an indoor environment potentially creating unwanted condensation or freezing. Remediators should exercise care to avoid such unintended consequences when managing airflow on remediation projects.

Industrial hygiene practices recommend a minimum of four air changes per hour for contaminant ventilation and dilution. The minimum number of NAMs required to achieve the desired air changes per hour (ACH) is determined by calculating the CFM needed using the following formula:

$$\text{CFM required} = \frac{\text{room volume (ft}^3\text{) x number of ACH}}{\text{60 minutes}}$$

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).

Air Filtration Devices

Air moving devices with filters are referred to as air filtration devices (AFDs). AFDs 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. AFDs 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 (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 filter (usually pleated) and finally, a HEPA filter. The preliminary and secondary filters trap larger particles to prevent damage and premature loading of the HEPA filter. Filters should be selected and installed according to equipment manufacturer specifications.

Flexible ductwork 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, strangulations, constrictions, and other restrictions can decrease airflow, thereby increasing static pressure.

AFDs should be cleaned and inspected for proper performance prior to use at a job site. The performance of a unit may be evaluated with a laser particle counter or other appropriate method. If unexpected pressure drops occur, all units and containment barriers should be inspected and re-secured as necessary. If pressure has been lost, work should cease until the appropriate pressure differential is re-established. It is recommended that AFD operation be inspected before starting work, and before leaving work each day. It is recommended that local and full-containment systems in sensitive areas be monitored at all times, including days when work is not being performed. Data logging manometers or other methods can be beneficial in documenting containment integrity, breach or failures.

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. When using an AFD as an air scrubber, care should be taken to prevent positive pressurization of the contaminated area, thereby causing a release of contaminants into unaffected parts of the building. Air scrubbers can have performance limitations that can increase airborne particulate levels, due to a combination of factors including, but not limited to: the equipment's limited capture zone, stratification of air, stagnant air spaces, and stirring up particles from a contained area. It is recommended that particle counters be used to monitor the environment when AFDs are used as air scrubbers. The remediator needs to consider capture zone, air stratification and dead zone when employing air scrubbers.

Equipment manufacturers use a variety of methods to determine when to change filters. These can include indicator lights, pressure gauges or other devices. The filter change frequency is determined by the work activity; amount of dust created and captured, and filter capacity. When the AFD is inside a contained work area, the pre- and secondary filter changes should be performed with the unit operating. This prevents releasing contaminants from filters into the workspace. HEPA filters should be changed with the unit turned off in negatively pressurized contained area, or by removing the AFD from the job site to an area that would not be adversely impacted by a release of contaminants.

The air intake side of an AFD used in a contaminated area should be sealed before turning it off to avoid releasing contaminants. The intake side of an AFD that contains accumulated mold spores and fragments should remain sealed when not in operation and while being transported or stored. Sealing the exhaust side of the unit can trap moisture and result in internal condensation and mold growth in the filters. After use and prior to removal from the project site, the exterior of the AFD should be cleaned, dried and subsequently stored in a dry environment. In humid work and storage conditions, trapped mold spores can colonize on moist HEPA paper filter elements, thereby necessitating earlier filter replacement.

Exhaust air from HEPA AFDs should be vented outdoors. If circumstances prevent exhausting the AFD outside, then a deviation from the standard may be necessary (e.g., using redundant HEPA AFDs in series). Particle monitoring should be performed when discharging exhaust air into occupied portions of a building.

HEPA Vacuums

For the purposes of this document, HEPA vacuum units are defined as those designed to effectively filter particles to HEPA levels (99.97% of particles at 0.3 microns). Only well-constructed professional HEPA vacuums should be used in mold remediation projects so that fungal spores and fragments are retained. Most units that filter to this level are designed and marketed by a manufacturer for use in cleaning up hazardous materials, such as lead and asbestos. Other units are 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.

Remediation workers should not use regular shop-type or standard consumer vacuums, because they are not designed to prevent mold spores and fragments from passing through the equipment and re-entering the air. Remediation workers should use HEPA vacuums when performing remediation.

HEPA units should 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 can potentially result in harmful particles escaping. HEPA vacuum cleaners function best if bags are not full. Hoses, filter bags and assemblies should be checked any time a drop in suction occurs or when the bag is changed. HEPA vacuum cleaners should be serviced within the capture zone of an AFD, or outdoors using appropriate precautionary measures.

Before HEPA vacuums are removed from containment areas, the unit's exterior should be thoroughly cleaned to remove dust and spores. This cleaning includes the exterior of the hose. Openings, such as filter and vacuum hose inlets, should 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 should not be substituted for a HEPA vacuum during remediation. Other vacuum units can 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 can contain a filter marketed as "HEPA," which may be built-in or sold with the machine as an after-market 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 - These machines should 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; or 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 require decontamination after use.

Misting

Misting is a method of atomizing water or other aqueous solutions into the air for the purpose of controlling airborne and surface particulates during remediation. Applying misting during demolition, prior to removing contaminant or during final cleaning, is controversial in the remediation industry. Some remediators routinely advocate using misting techniques in the field, while others believe misting is inappropriate and do not use such techniques.

Some documents and organizations recommend using misting during mold remediation. Other research indicates that the hydrophobic nature of mold spores and hyphae unreasonably promotes aerosolization of mold spores and growth fragments during the misting process, and introduces moisture into the work environment possibly promoting further mold growth. Further research is needed to determine the effectiveness and propriety of using misting during mold remediation. Therefore, if deemed acceptable, in the professional judgment of a remediator, misting may be considered for dust suppression and clean-up purposes, when applied in conjunction with adequate engineering controls.

Spraying, wetting or misting moldy building materials can release or disperse mold spores, and mold growth may be promoted by introducing excessive moisture. When mold remediation occurs concurrently with asbestos abatement or other types of demolition where misting water is required, mold remediation shall 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.

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 Condition 2 or 3 portions of a building requires cleaning after use. It may be possible to precondition make-up air in Condition 1 areas of the building to provide dehumidification of the make-up air for the work zone. (See also Chapter 5 *Equipment, Tools and Materials*)

Caution

Remediators are faced with a challenge when drying contaminated structures. The goal is to achieve acceptable drying while not cross-contaminating other areas of the structure, or contents. In order to accomplish this, air pressure differentials between suspected uncontaminated and contaminated areas should be carefully managed. There should be balance between dehumidification capacity and air movement capacity used to create any air pressure differentials. With high negative pressure in contaminated areas, and under certain ambient conditions, there can be a potential for drawing humid air from outside into the structure, which could slow, stop or reverse the drying process.

With proper controls, some remediation processes, such as demolition, may proceed while drying is underway. However, it is critical that remaining structural materials reach the drying goal of acceptable moisture content (MC) before remediation work can be completed.

REMEDIATION WORK PROCEDURES

Technical Specifications and Report Review

When available, remediators should attempt to obtain environmental reports describing the nature and extent of existing mold contamination. Remediators should review available documents related to the project, and understand the project objectives, 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, or written protocols or technical specifications.

In cases where enough information is currently available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, including contents, the remediator should develop work plans, protocols and specifications following this standard. In cases where there is not enough information available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, including contents, remediators should use an environmental report provided by an IEP, as a result of the pre-remediation assessment, to develop the work plan.

The extent and details provide by the IEP can vary greatly. Some protocols may or may not be detailed, and contain technical specifications, site monitoring, or independent oversight. If incomplete or inadequate technical specifications for mold remediation are provided by an IEP, then remediators should seek clarification and, thereafter as necessary, design and implement their own protocols and work plans, and provide them to appropriate materially interested parties for review and approval when necessary. It is recommended that remediators without professional liability insurance avoid selling work plans that they do not implement.

When post-remediation verification is conducted, it should be performed by an independent IEP. This in no way is intended to prevent remediators from performing their own post-remediation evaluation.

Preliminary Steps

In order to implement remediation work plans, protocols or technical specifications, remediators should 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 owner, manager or a building representative be present during the walk through.

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

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

Contents should be evaluated to determine salvability, and how they should be handled. Remediators should 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 a remediation area, they should be protected. Exercise caution when wrapping salvageable items in polyethylene to prevent trapping residual moisture.

The HVAC and air conveyance system should be evaluated to determine if they have been contaminated or impacted by pre-existing conditions. For more information, see Chapter 12, *HVAC Remediation*.

Containment Set-up

Remediation workers should verify that the ventilating 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.

Remediators should determine the necessity, extent and location of containment. Containment should be erected in a manner that mitigates the potential for cross-contamination, and exposing workers and occupants to contamination. Regulated materials, such as lead or asbestos, require specific mitigation and remediation protocols. The presence of these and other regulated materials take precedence over mold remediation, and they shall be addressed according to applicable federal, state, provincial and local laws and regulations.

Remediation workers should consider whether floors, walls and ceilings require a polyethylene barrier erected over them; or if they can be left uncovered for later cleaning. Containment barriers on surfaces can cause condensation, change pressure differentials, or trap moisture or Condition 2 contamination on surfaces.

Containment barriers should be used to separate Condition 1 areas from Condition 2 or 3 areas. 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. Containment areas should 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. Remediators should consider and mitigate, where possible, the potential for collateral or consequential damage at the point where the containment barrier is joined to a structure's finish materials. It is recommended that a description of and responsibility for repair of such damage be established prior to starting a project.

When a decontamination chamber is used, an appropriate entry and exit should be established, which is attached to the containment as a transitional space between work areas and unaffected areas of a building. Remediators should install containment flaps to provide a neutral pressure zone, or to control makeup air passing through the chamber. Small containments for smaller contaminated areas may not require a decontamination area. Tack mats can be placed immediately outside the entrance of a decontamination chamber to limit contaminants from being tracked into unaffected areas after removing disposable protective clothing (booties).

Negative pressure differentials should be established and maintained with one or more AFDs set up in a negative-air mode. Depending on circumstances, airflow controls can be established before or after containment is installed. HEPA vacuum cleaners can also be used in small local containments to create a pressure differential.

Signage

Remediators should post warning signs stating that mold remediation is in progress. Remediators should restrict access to work or containment areas, and signs should be conspicuously placed at entrances to work areas and in areas of potential entry. (See Chapter 6 *Safety and Health*)

Suit Up and Entry

When working in areas where there is mold contamination and other potential hazards, appropriate PPE shall be worn for worker safety. Remediators may suit up with one or two layers of disposable protective clothing with attached hood and booties, in conjunction with appropriate gloves, respirator, and eye protection. Remediators shall check respiratory PPE prior to entering a containment area to ensure that it is functioning properly. Remediators shall be aware that entry into confined spaces can require additional measures to meet regulations and safety requirements. (See Chapter 6 *Safety and Health*)

Demolition and Surface Cleaning

Remediating building materials that are Condition 3 depends upon the materials porosity and susceptibility. Porous building materials (e.g., drywall, insulation, and ceiling tiles) that are Condition 3 should be removed and discarded. Other materials that are semi-porous (e.g., wood studs) can be HEPA vacuumed and either wire brushed or sanded, then damp wiped. Small isolated areas of mold growth on a surface layer of condensation on enamel-painted walls or other non-porous surfaces, and mold growth has not resulted in concealed areas, usually can be removed by HEPA-vacuuming and damp wiping as part of a regular maintenance program.

New construction materials should not be installed until post-remediation evaluation, or post-remediation verification, if necessary, indicates that installation is appropriate. However, if new construction materials must be installed for structural integrity prior to completion of the remediation, those materials should also be cleaned along with the rest of the affected area. Remediators should use the appropriate cleaning procedures for the surface material being remediated.

During demolition, mold spores can be easily dislodged and aerosolized, especially from dry materials. Care should be taken to limit the release of airborne spores, thereby reducing worker exposure and clean-up efforts. Remediators should minimize dust generation and aerosolization. For example, mold-contaminated carpet can be covered with polyethylene sheeting before removal. Misting can be useful in this regard, if deemed appropriate in a remediator's professional judgment.

Workers should avoid crushing materials and other actions that could cause dust generation and dispersal of fungal spores and fragments. Techniques that limit dust aerosolization should be used in conjunction with HEPA-vacuuming to control and remove dust immediately. Remediators shall wear appropriate PPE.

Contaminated building materials should be removed carefully in as large a section as possible and bagged or wrapped, preferably in 6-mil heavy-gauge polyethylene disposal bags or sheeting. Spraying, wetting or misting moldy building materials can release or disperse mold spores, and mold growth can be promoted by introducing excess moisture. When mold remediation occurs concurrently with asbestos abatement, or other types of demolition where misting water is required, mold remediation shall 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 with polyethylene, to isolate the mold before misting materials to be removed;
- using pump-up sprayers or devices that control the flow and spread of water, rather than hoses;
- using only the amount of water necessary to satisfy regulatory requirements. Construction

and finish materials that are wetted or dampened from misting should be dried to prevent mold growth;

- immediately cleaning up or extracting spilled or run-off water;
- monitoring specific humidity throughout the process and using dehumidification to quickly dry the environment to humidity levels that do not promote mold amplification, and
- bagging or wrapping wet materials immediately in heavy-gauge polyethylene and removing them from the building for proper disposal.

Contaminated materials can be removed carefully with razor knives or utility knives by 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 contaminated materials with a hammer or crow bar, or using electric saws without dust collecting devices is not recommended.

The cutting depth of saw blades should 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 promotes safety by preventing possible cutting of plumbing, electrical or other components that can be hidden within the cavity. Removal is completed by scoring the backing paper with a razor knife or utility knife.

Insulation should be removed carefully and bagged immediately, preferably in 6-mil disposable polyethylene bags. A razor knife or utility knife is recommended for cutting paper or foil backings, rather than tearing it into pieces.

Work areas should 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 helps prevent failing post-remediation verification. Remaining drywall screws, nails and small debris should be bagged and removed.

Mold growth on wood framing members should be removed by HEPA-vacuuming followed by damp-wiping, wire-brushing, sanding, or other appropriate method, while using HEPA-vacuuming or performing removal within the capture zone of an AFD, along with other appropriate controls. HEPA vacuum-assisted power tools have been developed for the asbestos and lead abatement industry. These tools may also be used in mold remediation.

Bagged materials should be sealed inside a second bag before moving them outside a containment area (double bagging), if they are going to pass through Condition 1 areas of the building, to prevent potential cross-contamination. Sharp items capable of puncturing polyethylene material should be packaged before being bagged or wrapped in manner that prevents them from penetrating packaging material. Mold-contaminated materials, such as building framing, casements, cabinets, tubs, showers, doors, and appliances may not require bagging or wrapping, if removal can be accomplished by direct access to an outside secure disposal location, and handling such materials does not pose a cross-contamination source during removal.

Remaining interior surfaces and containment materials should be cleaned using HEPA-vacuuming and damp wiping. During damp wiping, the amount of water should 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 state that mold contamination should be controlled as close to its source as possible. Further, mold should be physically removed during remediation. Attempts to kill, encapsulate or inhibit mold, instead of proper source removal, generally are not adequate. (See Principles, Standard Section 4.3 and 4.4) However, unique circumstances can arise for which antimicrobial or biocides sealants may be considered in specific situations.

It is recognized that remediation projects are unique, and that in certain circumstances, common sense, experience and professional judgment may justify deviation from this Standard. It is the responsibility of remediators to determine and verify on a case-by-case basis that application of this Standard is appropriate.

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 a Condition 3 area for extended periods by using long-term engineering controls, encapsulants, sealants or other methods. Allowing mold or moisture conditions to remain is strongly discouraged, since it can compromise the health of occupants, further damage building materials, and expose remediators to liability and other consequences. However, when deviations of this kind from this Standard are considered, it is recommended that remediators advise customers in writing that controlling mold or moisture conditions in place can:

- 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.

It is recommended that remediators advise customers that follow-up assessment of affected areas by an IEP may be appropriate when:

- affected areas become visibly damaged;
- a change in the condition of the material or its surroundings occurs;
- there are health complaints, or
- engineering solutions fail.

Since deviation from the source removal principle occurred, periodic assessments may be advisable. It is recommended that remediators consult with appropriate technical professionals or attorneys for specific language to use in written communications with customers.

Disposal of Contaminated Materials

Bagged or wrapped materials should be handled carefully and not dropped, thrown or handled roughly while moving them to a disposal container or site. Bagged or wrapped materials should be placed in a reasonably secure location or transport vehicle, after removing them from the building.

Personal protective equipment, including respirators, is not required outside while transporting bagged or wrapped materials.

If bagged or wrapped disposal materials rupture outside the containment, but inside the building, remediation workers shall don appropriate PPE. Workers should secure the area from public access, initiate clean-up (HEPA-vacuuming), and contain the debris. It is recommended that dumpsters with contaminated debris be kept reasonably secure.

Mold-contaminated gypsum board and other structural materials that are not regulated (i.e., those that do not contain asbestos, lead or other regulated 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 and shall be followed. Placing descriptive warning labels on bags and wrapped materials describing the contents, is recommended to discourage individuals from opening or removing them from the disposal site. It is recommended that label language be factual, not overstated or unnecessarily alarming.

Clean-up

To achieve Condition 1 in a work area after demolition has been completed, it is important to clean it adequately by thoroughly removing dust and debris. Post-remediation evaluation and verification requires relatively dust-free surfaces. Dilution is the process of deliberately drawing conditioned (filtered) makeup air into the containment. Air inside the contained area is then HEPA filtered. During this process, cleaning procedures inside containment should 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 toward 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 dilution, and HEPA filtration can be helpful to determine when to repeat the HEPA-vacuuming-and-damp-wiping process. HEPA-vacuuming and damp wiping should include entry and exit chambers ceilings, walls, flaps and floor of remediation areas.

To ensure that visible dust and debris have been removed, a final inspection of containment areas should be conducted by the remediator as part of the post-remediation evaluation, prior to post-remediation verification by an IEP. Dust, which may have settled outside the containment area, should be removed by HEPA-vacuuming and damp wiping.

Physically removing mold growth and spores is the guiding principle for mold remediation. Indiscriminate biocide or antimicrobial application is discouraged. Biocide application is not considered effective as a substitute for proper source removal, however, there may be specific instances where professional judgment dictates that biocides be applied (e.g., bacterial contamination as addressed in IICRC S500). Killing microorganisms with biocides does not typically destroy their antigenic or toxigenic properties. Remediators shall follow federal, state, provincial, and local laws and regulations, as well as product label directions. Misapplication of biocides is a federal violation under the U.S. Federal Insecticide, Fungicide, Rodenticide Act (FIFRA). Specifications that are not consistent with biocide regulations and labeling instructions can be in violation of the law, and they can create liability for the remediator.

Using antimicrobials, fungicidal coatings, mold-resistant coatings, or sealants (products applied into or onto a material to "suppress or retard future growth") during mold remediation, as a substitute for proper source removal, is discouraged. However, there may be specific instances where professional judgment dictates that antimicrobials be applied. Soil, bio-films or organic matter residues from inadequate cleaning, or which accumulate on surfaces treated with these types of products generally render them less effective. Products of these types can interfere with post-remediation verification. If used, they should be applied after remediation and post-remediation verification is completed.

If antimicrobials, fungicidal coatings, mold-resistant coatings, or sealants are used, they shall be applied according to regulations and label directions. Remediators should consider that applying these products can change the permeability of materials, can cause condensation problems and trap moisture, and result in future deterioration and potential liability. Remediators should consider that products of this type can change the flammability of the materials to which they are applied. Remediators can refer to Chapter 5 (*Equipment, Tools and Materials*) for additional information when considering whether use of products of these types is appropriate or inappropriate.

Containment Exit Protocol

After bagging or wrapping, demolition debris is moved to an exit chamber. The outside of bags or wrapped materials should be HEPA-vacuumed or damp wiped, and thereafter, should be placed into a second bag or wrapping and sealed before they are moved from the exit chamber. Tools and equipment being removed from a containment area should be wiped off and placed in clean sealed bags for detailed cleaning off-site, using appropriate precautions. Vacuuming and damp-wiping tools, HEPA vacuum cleaners, and AFDs, before they are removed from a containment area, should be accomplished. Sealing the intake (contaminated) side of AFDs before turning the equipment off should be accomplished to prevent back flushing of filtered contaminants. Wrapping an entire unit with stretch wrap or other non-porous materials, before removing it from a contained area, also is recommended.

If two entry and exit chambers are 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 exterior 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 coverall 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 shall not be reused, but rather disposed 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

Post-remediation evaluation should be conducted by remediators to evaluate whether or not remediation has been completed. This evaluation involves implementing internal quality control procedures. It can include visual inspection, olfactory evaluation, laser particle counting and moisture measurements.

Remediated structures and systems can be considered clean when contamination, unrestorable contaminated materials and debris have been removed, and surfaces are visibly free of dust. The term "visibly" can include direct and indirect observation (e.g., using a white or black towel to wipe a surface to observe for cleanliness). Also, remediated areas should be free of malodors associated with microorganisms. At that point, it is probable that the structure and systems have been returned to Condition 1. The evaluation can also include moisture measurements and the use of a laser particle counter. If visible mold, dust or debris have not been removed, malodors are present, or initial cleaning is questionable, repeating the cleaning process may be warranted.

Post-Remediation Verification

Following post-remediation evaluation by the remediator, it may be requested or required to verify the return of a structure, systems or contents to Condition 1. In such situations, post-remediation verification should be performed by an independent IEP. It is recommended that the criteria and process used in the post-remediation verification be documented.

Breakdown of Containment

Containment materials should be HEPA-vacuumed and damp-wiped before containment is dismantled. Before breaking down containment, a thorough post-remediation evaluation of the cleaned containment area should be conducted. When post-remediation verification is requested or required, the containment should pass the verification process before being dismantled.

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Chapter 12

HVAC Remediation

THE RELATIONSHIP BETWEEN A BUILDING AND ITS HVAC SYSTEM

Heating, Ventilating and Air-Conditioning (HVAC) systems have a major impact on controlling conditions that lead to water vapor condensing on surfaces. The design, installation, operation and maintenance of HVAC systems are important factors in controlling microorganism germination, growth, amplification and dissemination. In addition, mold growth from other causes can be carried to the interior of HVAC system components where it can accumulate and degrade system operation. When system operation is affected, this can result in poor environmental control that allows widespread condensation to form. This 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 circulates air from the occupied space through the air filter, return grills, return ducting, heating or cooling coils, and through supply ducting into the occupied space. HVAC mechanical components can be located in various areas of the occupied space, outdoors, or in other locations. Residential systems vary in configuration and type from one part of North America to another; however, within each region, HVAC systems are generally similar in design.

Typically, many airborne spores are in the range of one to five micrometers in diameter, but can appear in clumps or in growth structures two to ten times that size. Airborne fragments of mold, such as hyphal fragments, can be much smaller, in sub-micron sizes, or also can agglomerate or form larger clumps. Conventional HVAC system filters with a Minimum Efficiency Reporting Value (MERV) 6 rating or less are not effective at stopping the distribution of particles in this size range throughout an HVAC system. In systems with filters of MERV ratings of 11 or higher, a substantial amount of bioaerosol is captured. Completely containing or eliminating contamination in HVAC systems requires HEPA filtration, which is 99.97% efficient in removing particles at 0.3 microns aerodynamic diameter, and more efficient in removing particles both larger and smaller.

OVERVIEW OF HVAC OPERATIONS AND PARTICULATE IMPLICATIONS

Up-flow Systems

In a vertically mounted, up-flow HVAC system, air is drawn through the bottom of the system and discharged out the top. Typically, these systems are located within the conditioned portion of the residence, in a basement, or within a closet constructed of wood and drywall materials. In addition, the return-air plenum often is a part of this enclosure, with openings covered by a metal grill. Organic construction materials can provide an excellent food source for mold contamination if moisture from the HVAC is allowed to accumulate on or penetrate into them.

Down-flow Systems

In a down-flow HVAC system, the air being conditioned enters the unit from the top and is discharged out the bottom of the air handler. Often, vertical down-flow systems are installed in a closet or garage, with the ductwork located in a crawlspace under the occupied space. Because of the location of these components, moisture can infiltrate or accumulate within mechanical system components, which is conducive to mold growth. Generally, these systems are difficult to service because working conditions are confined and access is often limited.

Horizontal Systems

Horizontal HVAC systems are designed to allow air to flow from left to right or right to left. Often, these systems are found in attics or underneath houses. These units are designed to be used in-line with corresponding return and supply main trunk lines. Major considerations when working on these types of units include: the ambient temperature surrounding the unit; general service access to the unit and associated ductwork; safety difficulties while working in confined attic spaces (such as drywall breakthrough and ceiling cracking), and the possibility of excess moisture being collected and retained before being detected.

Ductwork

HVAC ductwork consists of several types of materials including fiberglass duct board, galvanized metal duct with interior fiberglass linings, galvanized metal duct with fiberglass exterior wrap, and insulated flexible ducting. Generally, ductwork with a non-porous internal surface (e.g., galvanized sheet metal) responds well to remediation. Galvanized sheet metal can withstand the aggressive cleaning techniques necessary for removing Condition 3 contamination. However, sections of internally lined ductwork, duct board or flexible ductwork that have Condition 3 contamination cannot be successfully cleaned, and therefore, such ducting with Condition 3 should be removed and replaced.

Commercial HVAC Systems and Components

Commercial mechanical systems incorporate more variations and combinations of HVAC system design and components, compared to residential systems. Common commercial systems can include, but are not limited to: single zone; multi-zone; constant-volume; variable-volume; double-duct or dual-duct, and induction systems. Commercial systems are larger and more complex to inspect and service than residential systems. Commercial systems have additional components, including mixing boxes, chillers, and variable air volume (VAV) boxes.

HVAC Operational Issues

When a building is being remediated, special attention should be given to remediating the HVAC system that supports the indoor environment where remediation is taking place. Also, the HVAC system should be inspected in the manner described within this section and returned to Condition 1 as part of the overall mold remediation project. It is recommended that HVAC deficiencies be identified for correction by the customer's HVAC service contractor. Otherwise, the remediation can fail and growth can return, adversely affecting environmental conditions within the building.

In some cases, there can be mold growth without an identifiable source of water. This can be related to the interaction between a building and its HVAC or ventilation system, or other causes. Part of the purpose of an HVAC system is to maintain psychrometric conditions that prevent formation of condensation on surfaces within a building that can result in mold growth. Condensation forms when the temperature of a surface drops below the dew point of the surrounding air. This can occur under a variety of climatic conditions, at 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 can result in condensation forming regardless of geographic region or location.

In addition to the HVAC system, a building and its construction can create the potential for condensation. Building pressurization, selection and placement of vapor barriers, unexpected events, such as: flooding; infiltration of moist air; poorly or improperly controlled air movement, and even the selection and method of installing building materials, can impact condensation. A complete discussion of building science and factors that can lead to forming condensation is beyond the scope of this chapter. For further information on building science, see Chapter 4, *Building and Material Science*.

In situations with visible surface mold growth or suspected hidden growth, the cause should be identified and moisture sources controlled or corrected before remediating either the building components or the HVAC system. Excessive indoor moisture loads can often be beyond the capacity of a properly designed, maintained and operated HVAC system. In addition, HVAC functional, operational or design problems can negatively impact the indoor environment, or result in potential risk of recurring mold contamination. Remediating the HVAC system alone might not be sufficient to prevent future mold growth. Since mold remediation does not include activities that would modify either a building or its mechanical systems from their original design, the services of a specialized expert (e.g., mechanical or professional engineer) may be needed to recommend measures, or perform HVAC system repairs or modifications that mitigate the likelihood of recurring mold contamination. Implementing such measures is not necessarily the responsibility, nor within the expertise, of the remediator. At a minimum, however, customers should be advised by remediators of known HVAC conditions that put the integrity of the building at risk.

HVAC ENGINEERING CONSIDERATIONS

HVAC systems should be inspected for cleanliness and returned to Condition 1 as part of a building remediation. The National Air Duct Cleaners Association (NADCA) standard, *Assessment, Cleaning and Restoration of HVAC Systems* (ACR 2006) includes specifications for acceptable levels of cleanliness for HVAC systems and appropriate inspection techniques. It is recommended that HVAC system remediation be scheduled after other building remediation is completed, in order to avoid cross-migration of particulate into the mechanical system. When this is not possible and the environment is Condition 2 or 3, HVAC system components should be isolated from the environment as part of the overall building remediation strategy. Remediated HVAC system components that can potentially be exposed to recontamination during ongoing building remediation activities, should be re-assessed after building component demolition procedures and reconstruction activities are complete. Re-assessment should be conducted before removing containments or other engineering controls.

It may be necessary to provide temporary heating, cooling or other environmental controls within areas undergoing remediation. Often, the condition of makeup air drawn through the containment will provide satisfactory working conditions. When supplemental systems are used inside containments, equipment should be decontaminated and bagged or wrapped prior to being removed from the workspace. When air-handling systems are operational, remediators should consider where to locate containment so that contaminants are not drawn into the fresh-air intake and that the negative pressure created by the fresh-air intake does not adversely affect the pressurization differential of the contained area.

In addition to a cleanliness inspection, a complete engineering assessment of the design and working condition of the entire HVAC system should be considered, depending on the Conditions (1, 2 or 3) that exist in a project. This is especially important if temperature or relative humidity cannot be maintained within the affected area in compliance with the requirements of American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standards 62.1 or 62.2; if temperatures, relative humidity or airflow vary between different areas of the building, or if mechanical components are not in good working condition or repair. There are four reasons this is important to the success of a remediation project:

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

The description of what constitutes an adequate engineering evaluation of HVAC system condition and capacity is beyond the scope of this chapter. It is recommended that qualified engineering professionals or licensed HVAC contractors be consulted for such an evaluation. Air Conditioning Contractors of America (ACCA), National Air Filtration Association (NAFA), ASHRAE, North American Insulation Manufacturers Association (NAIMA), and Sheet Metal Air Conditioning Contractors National Association (SMACNA), and their published guidance documents, provide construction standards, or design guidance for proper sizing, design and layout of HVAC systems. Regardless of compliance with the latest HVAC system guidance, at a minimum, modifications to an HVAC system shall conform to applicable building codes.

Filtration is important in decreasing the spread of mold spores from one part of a building to another. Filtration upgrades should be considered in buildings that have experienced Condition 3 contamination as part of a strategy to prevent future problems. In many cases, existing filter housings or tracks can accommodate upgraded filtration. In others, modifications should 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 should not occur.

HVAC System Cleaning and NADCA ACR 2006

If enough information is currently available to determine that Condition 2 or 3 exists throughout affected systems, remediation work plans, protocols and specifications can be developed. In situations where there is visible mold growth and it cannot be determined that Condition 2 or 3 exists throughout the affected system, remediators should engage or recommend that customers or clients engage an IEP to assess the affected system (see Chapter 8, *Inspection and Preliminary Determination*).

Once the HVAC system's condition has been assessed for cleanliness, and mechanical corrections or enhancements have been completed, cleaning should be carried out in accordance with procedures described in NADCA ACR 2006, which is incorporated herein by reference, or equivalent industry standards. The sequence of activities (assessment, mechanical corrections and enhancement, cleaning) is determined based on the collective professional judgment of certified/licensed professionals, and the conditions within the building being remediated. A major factor impacting decisions about the sequence of such activities is the potential for contamination of the HVAC system during remediation of the building.

Using a Mechanical System as a Dehumidification Device

Using an HVAC system is often considered, during the initial evaluation of a moisture-related problem, to assist in the dehumidification process. One function of HVAC systems is their ability to extract moisture from the air. Therefore, they may be used in designing a moisture removal strategy. The HVAC systems total moisture-removal capacity is dependent upon criteria such as: original design intent, climatic conditions of the region, current weather, engineering design of the system itself (e.g., reheat coils), and a number of other factors.

When considering use of an HVAC system for dehumidification, it is recommended that the following be considered:

- operational building pressurization during HVAC usage;
- airflow volume across the evaporative coil;
- fresh air intake status;
- air distribution network and potential for particle migration;
- protection of the mechanical system for the duration of the project;
- reheat coil operation and sequencing;
- decontamination of the HVAC system after use;
- the original engineering design for the HVAC system;
- impact on the overall building strategy, and
- migration of particulate to unintended areas.

In some cases, proposed use of the HVAC system can require the expertise of a mechanical engineer to inspect the system's original design intent and limitations when used for the dehumidification process. An inspection is often conducted to determine if the proposed usage plan of the HVAC system can operate within the demands of the overall project. The mechanical system can usually be used in some capacity for project management and additional dehumidification. It is not uncommon to discover HVAC systems that are oversized for the space they serve, which can dramatically alter the HVAC system's moisture removal ability. In some cases, using the HVAC system can actually work against the overall moisture removal strategy.

Using mechanical systems during remediation often results in the need to decontaminate the system after remediation and prior to post-remediation verification. In order to determine if the HVAC system needs remediation, it should be inspected and cleaned using the procedures outlined in the *NADCA ACR 2006*, or equivalent industry standards.

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 2006. Multiple cleanings might be required to achieve a satisfactory level of cleanliness. On occasions, more rigorous criteria can be specified, including surface testing procedures normally used on surfaces outside an HVAC system; however, interpretation of test results may be more difficult than with exterior environmental surfaces and air samples.

The complex nature of the interior structure of an HVAC system provides reservoirs for both spores and microbial growth. There can be numerous potential amplification sites within an HVAC system's interior components that may or may not be of concern. Individuals procuring and interpreting such samples should be IEPs with specific training in identifying mold issues within HVAC systems.

The interior of evaporators or cooling coils can be especially difficult to clean through all layers of the coil. Evaporator and other coils with depths greater than four rows are especially difficult to both clean and inspect for cleanliness. One technique available is to calculate the difference in pressure drop across (or airflow through) the coil before and after cleaning. Then, these measurements can be compared to known manufacturer specifications when available. If a satisfactory level of cleanliness cannot be achieved, replacing coils is recommended. Coils that are not completely cleaned restrict airflow and have reduced latent capacity. Such coils are more at risk for contributing to future microbial growth.

Special attention should be given to inspecting fan blades and blower wheels. Bacterial and fungal growth on these components can lead to rusting or pitting and premature metal decay. A heavily fouled blower wheel may only be capable of a fraction of the air movement of a wheel with smooth, clean surfaces.

In cases where fan and blower surfaces cannot be returned to a smooth surface condition, the component should 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.

Accumulated fungal growth is difficult to clean from coil fin surfaces. Often cleaning agents (high and low pH) are required due to the difficulty of removing impacted particulate within the coil's air stream surfaces. These HVAC coil cleaners can potentially cause damage to heat-transfer surfaces. Damage can range from pitting of surfaces (which interferes with flow of condensate from fin surfaces) to accelerated component deterioration. Also, residues from such cleaners 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. Application equipment and techniques can be tested on scrap before using them in the field.

HVAC components should 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. Normally, it is not necessary to build containment for HVAC system cleaning. Procedures described in NADCA ACR 2006 are designed to prevent the release of spores or other contamination during cleaning.

Under unusual circumstances or in sensitive locations, such as active healthcare facilities, containment should be constructed. In addition, if an air handler is located in an equipment room, which is also part of the conditioned space, containment should be constructed. Air handlers located outdoors or on rooftops require only limited containment procedures during cleaning. Remediators should use appropriate personal protective equipment while cleaning HVAC systems, and isolate the portion of the system being cleaned from uncontaminated areas by blocking air ducts or supply vents. Sufficient ventilation is needed to dilute emissions from cleaning products used. Residue from cleaning products should be completely rinsed from surfaces before the equipment is placed back into operation.

Plenums, with interior-lined fiberglass or other porous insulation, are sites where mold contamination is likely to occur. Flexible duct sections are handled as indicated in NADCA ACR 2006. When visible growth is present and penetrates below the surface of the fiberglass coating, replacing or upgrading components might be necessary. Any action taken should be in accord with NADCA ACR 2006, or an equivalent industry standard.

Using an antimicrobial product may be considered, to inhibit future mold growth in an HVAC system, but only after mechanical surface cleaning has been performed and the need for such treatment has been deemed necessary. Antimicrobial use should never be substituted for completely removing mold contamination. In addition, products used shall 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. Care should be taken to use antimicrobial products in compliance with applicable regulations. If label directions cannot be followed completely, use shall be avoided.

On occasion, using a sealant, coating or other product in an HVAC system may be considered for a variety of purposes. Such use may include, but is not limited to:

- smoothing the interior profile of surfaces within HVAC systems to improve the ability to clean;
- reducing the probability that surfaces may acquire foreign materials that could support future microbial activity;
- repairing or restoring mechanical insulation or linings, and

- installing a sealant or coating film containing active ingredients that may inhibit future mold growth in an HVAC system.

In all cases, using sealants, coatings or other products should not be substituted for removing viable mold or fungal fragments. Such products shall be used in accordance with safety regulations.

Coatings and sealants used in HVAC systems, which claim antimicrobial performance, shall be registered by the EPA or other applicable regulatory agency specifically 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, including the use of personal protective equipment, such use shall be avoided.

Coatings and sealant products that do not claim antimicrobial performance, and in which antimicrobial ingredients protect from microbial growth only on or in the coating film, do not need to be registered by the EPA. Such products fall within the scope of the Treated Articles Exemption of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). However, coatings to be used in HVAC systems are often required to have been tested to the performance protocols of the National Fire Protection Association (NFPA) 90A/90B.

For more information concerning the use of chemical products inside HVAC systems, it is recommended that remediators consult the most current versions of the NADCA Fact Sheets pertaining to the use of disinfectants, sanitizers and coatings in HVAC applications.

REFERENCES

ANSI/ACCA 6 HVAC System Cleanliness: 2007

Chapter 13

Contents Remediation

INTRODUCTION

Effective remediation of contents that were in 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 to the structure, to the probable condition of contents located in different areas;
  - visually inspecting for evidence of mold contamination, and possibly correlating the inspection with the results of a pre-remediation assessment performed by an indoor environmental professional (IEP), to determine the contents' Condition (1, 2 or 3);
  - determining the basic composition of content materials. Contents composition and condition determine their ability to be cleaned. General categories of content material composition are defined for purposes of this chapter as follows:
    - **Porous** – Materials that easily absorb or adsorb moisture, and, if organic, can easily support fungal growth (e.g., clothing and other textiles, padded or upholstered items, leather, taxidermy, paper goods, and many types of fine art);
    - **Semi-porous** – Materials that absorb or adsorb moisture slowly and, if organic, can support fungal growth (e.g., unfinished wood, masonry), and
    - **Non-porous** – Materials that do not absorb or adsorb moisture, or those that have been surface treated and do not easily support fungal growth (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.

INSPECTION AND EVALUATION FOR RESTORABILITY

The restorability of contents is dependent upon the following:

- 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 contents items may be categorized in one of three ways:

- restore – Items that will be cleaned to Condition 1 and returned to the customer;
- dispose – Items that will not be cleaned because either the customer does not want them or remediation costs exceed the item's value. (See "Disposal" section below);
- preserve – Items that are irreplaceable but cannot be returned to Condition 1. This category only applies to irreplaceable porous or irreplaceable semi-porous items with Condition 3 contamination. When preservation is required, remediators should follow the additional precautions set forth in the "Unrestorable Contents" section below.

The Condition of contents can be determined when the inspection provides:

- enough information to determine that Condition 1 exists throughout the structure, systems, or area, and therefore, no remediation of contents is required; or
- enough information to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, and therefore, an assumption can be made that all contents are either Condition 2 or 3; or
- there is not enough information available to determine that Condition 2 or 3 exists throughout the affected structure, systems, or area, and therefore, the remediator should engage, or recommend to customers or clients that they engage, an IEP to assess the contents to make the determination. When sampling is requested or required, it is recommended that a cross-section of content types be included and that an independent IEP should conduct such activities.

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 removing or containing them to prevent them from becoming contaminated. In most cases, Condition 3 can be determined by a visual inspection. 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.

Contents Services	**Porous**	**Semi-porous**	**Nonporous**	**Irreplaceable Porous**	**Irreplaceable Semi-porous**	**Irreplaceable Nonporous**
Condition 3	Preserve or Dispose	Dispose	Restore	Preserve	Preserve	Restore
Condition 2	Restore	Restore	Restore	Restore	Restore	Restore

Materially interested parties should participate in decisions about whether to restore or dispose of contents. Recommendations supplied by an IEP can be beneficial in making these decisions. The property owner, owner's representative, IEP, remediator and others may be involved in the contents remediation decision-making process.

REMOVING CONTENTS FROM AFFECTED AREAS

Before removing potentially contaminated contents from a contaminated area to a cleaner area or to another location, remediators or other qualified professionals should:

- inspect all contents prior to inventory;
- document the condition of the contents, including actual or perceived value of one or more of the "other types of value" mentioned above;
- photo-document the placement and condition of contents;
- separate affected from unaffected contents where practical, and
- ensure that clients agree and authorize disposal of contaminated contents in writing before disposal.

Contaminated or potentially contaminated contents should be appropriately packaged or decontaminated, when moved into or through uncontaminated areas (Condition 1) to prevent spreading contaminants into unaffected areas and exposing workers or occupants to contaminants. The exterior of the packaging on its way through a decontamination chamber system should be decontaminated by cleaning or wrapping a fresh layer of packaging material around the item just before it exits the decontamination chamber system. Care should be taken when packaging items not to trap moisture inside packaging, especially if contents are to be moved into a storage area where environmental conditions may be different.

Inventory, Packing, Transport and Storage

Before contents are packed out, a detailed inventory should be prepared containing at least the following information:

- description of each item;
- quantity of each item;
- condition (1, 2, or 3) of each item;
- location of each item within the structure, and
- an individually assigned inventory number for each item, box, or group of items.

Customers should sign a form accepting the inventory as representative of the existence and actual physical condition of the contents before a remediator assumes responsibility for contents transport and processing. Contents should be packed, transported and stored using appropriate measures to minimize breakage or damage, loss, exposure to employees, occupants or the public, and, contamination or cross-contamination of unaffected areas of the building. Vehicles, equipment, storage vaults or facilities that become contaminated in the course of remediation should be decontaminated.

Storage conditions should be controlled while contents are in the remediator's custody to minimize conditions favorable to mold growth. Contaminated contents should be cleaned as soon as practical, rather than being stored for long periods while contaminated. Cleaned contents should be stored in a clean area that is separate from the area where contaminated contents are stored. They should not be returned to contaminated areas of the structure until both have attained Condition 1. In some cases, it may be necessary to add desiccant material to packaged contents to adsorb moisture and prevent moisture-related damage.

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 physically removing 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. It is recommended that appropriate appearance enhancement processes be applied to the items after their return to Condition 1 has been completed.

As with structural remediation, additional damage can 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 should be documented, and materially interested parties 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:

- 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:

- 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 can be significantly less efficient than well-designed plant facilities, and
- if contents are not removed from a contaminated part of the building, they can require several “rounds” of cleaning, similar to the structural materials.

Advantages of in-plant cleaning include:

- minimizing 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:

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

Whether contents are cleaned onsite or in-plant, appropriate precautions should be taken to prevent spreading contaminants from work or storage areas into unaffected areas.

Outdoors versus Multi-stage Cleaning Chamber

Condition 2 or 3 contents should be cleaned either outdoors or in a multi-stage cleaning chamber.

Outdoors

When cleaning contents outdoors:

- work performed without containment should 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 shall wear appropriate PPE.

Remediators should 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

A multi-stage cleaning chamber 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 recontaminating the item as it is being cleaned. For the system to be effective, appropriate airflow and air pressure relationships should be maintained.

Laminar-airflow, high-volume single and multi-stage cleaning chambers are safe and efficient, and allow the potential use of techniques, such as air washing and abrasive blasting, which 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, remediators should choose the most appropriate 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. Also, a combination of methods may be necessary to facilitate the remediation of contents.

Air-based Methods

- HEPA-vacuuming – This method uses a vacuum with a filter that is 99.97% efficient in removing particles at 0.3 micrometers. It is recommended that this method be applied at least three times in a cross pattern to each affected item.
- Air-washing – This method uses an air stream to blow mold spores and fragments off surfaces, which can result in aerosolization, and create the potential for massive exposures to workers and occupants. This method should be used outdoors or in a laminar airflow, high-volume cleaning chamber, or in other situations where engineering controls are adequate to prevent excessive buildup of contaminants. A downdraft-cleaning table, attached to a HEPA AFD, can be used to minimize contaminant dispersal.

Heat

Methods involving controlled application of heat to a structure have been reported to be an effective form of biological control, which might or might not kill some fungal spores and vegetative structures. This process is a developing technology and should be evaluated and understood before use. It is important to note that killing mold and fungal spores has not been shown to eliminate the contaminants, or their allergenic or toxigenic properties.

Air-washing is most appropriate for semi-porous and non-porous contents. However, air washing has the potential to drive mold spores and fragments deeper into porous materials (e.g., upholstered furnishings).

Liquid-based Methods

Liquid-based cleaning methods rely 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 relative humidity. High-pressure

washing techniques should be limited to situations in which aerosolization is not a critical factor (e.g., outdoors).

Using liquid-applied coatings to cover the surfaces of contents, which cannot be adequately cleaned (and disinfected or sanitized when appropriate), is not recommended. However, using coatings to seal surfaces, or restore the appearance of a material can be a useful practice, especially on porous or semi-porous materials from which the damage from mold cannot be fully eliminated (e.g., shellac, varnish, lacquer, water-based acrylics over unfinished wood).

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, and
- abrasive media blasting (e.g., dry ice, soda, sand).

These techniques should be used with caution, especially those involving abrasive blasting. By definition, abrasive blasting methods have a strong tendency to aerosolize particles they remove from surfaces. This can lead to extremely high levels of contaminants in air, potentially creating unacceptable exposure for workers or occupants, or allowing contaminants to spread into previously unaffected areas. Some media can also create a difficult cleanup problem (e.g., sand, soda, sponge corn husks, and rice hulls) or lead to the development of unacceptable worker exposure (e.g., dry ice blasting in an enclosed space creating excessive levels of CO_2 in the work area).

Abrasive blasting techniques should 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 removing contaminants is the primary focus of mold remediation, it is recommended that customer expectations be addressed, and that contents be "appearance enhanced" to the extent practical before being returned to the customer. The presence of visible stains is not an indication that an item is contaminated. Removing mold stains can be included in appearance enhancement. This may involve polishing, waxing, buffing and other services.

CLEANING POROUS, SEMI-POROUS AND NON-POROUS CONTENTS

Generally, Condition 3 porous contents are not restorable. It is recommended that special care be taken with porous Condition 1 contents to prevent potential contamination, which can occur while contents are stored in an off-site facility. HEPA-vacuuming and brushing, with soft-bristle or tampico brushs, while on a downdraft cleaning table, are the most commonly used methods for cleaning Condition 2 porous contents. Air washing, in the proper situation, also can be effective on many porous items. However, air washing should be performed in a controlled work area, where the massive aerosolization associated with this method will not pose a health risk to workers or occupants during the process.

Most cleaning processes should 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 after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods. It is recommended that the appearance-enhancement process take place after Condition 1 has been obtained.

The following matrices describe cleaning procedures to be used with items of different composition in different Conditions of contamination. In most cases, Condition 3 can be determined by a visual inspection.

Porous Items		
Category	**Condition 2**	**Condition 3**
General	Most items are cleanable. After carefully examining items for unrestorable water damage, the proper cleaning method should selected be based on material composition and manufacturer instructions. Knowing the type of contaminated fabric is critical to determining the type of remediation needed, such as multiple launderings. Recent research showed that *Aspergillus* spores were trapped and retained to a much greater degree in cotton fabrics than in synthetics, such as rayon, nylon and polyester. Both laundering and dry cleaning provide physical removal of mold spores and related fragments of growth. With heavy mold odors, a deodorization process, such as confined use of ozone, may be desirable before or following laundering or dry cleaning. Most cleaning processes should start and end with HEPA-vacuuming. Rapid drying after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods.	Condition 3 porous contents generally are not restorable, and disposal normally is recommended. All items should be examined first for unrestorable water damage before extensive attempts to remove mold growth are made. Usually, unrestorable, due to staining, discoloration or fiber damage. However, if an item is of sufficient value (e.g., sentimental, monetary, legal, artistic, cultural, or historical), cleaning may be attempted, using techniques described for Condition 2. If heavy odors exist, multiple cleanings and deodorizing attempts may be needed. Organic materials that are highly susceptible to mold growth, such as leather objects, animal trophy heads, and similar items, are not restorable when Condition 3. Most cleaning processes should start and end with HEPA-vacuuming. Rapid drying after wet cleaning and appearance enhancement,, as necessary, follows most cleaning methods.
Porous Textiles: clothing, fabric, and other textile items	Usually can be laundered or dry-cleaned as appropriate for the fabric as shown on the manufacturer's label. **Laundering:** Using detergent in the laundering process facilitates removing contaminants. Laundry sanitizers can be added, if textile manufacturer directions permit. They might help reduce microorganism growth, and significantly reduce odors. For those fabrics that are not chlorine bleach safe, addition of oxygen bleaches, such as sodium perborate or sodium percarbonate can provide similar benefits, if permitted by manufacturer directions. The laundering process also can be enhanced by increasing the water temperature. Care should be taken not to exceed the manufacturer's water temperature recommendations. **Dry Cleaning:** As with laundering, dry cleaning typically will follow manufacturer label recommendations, as well as those standard quality practices of the dry cleaning industry, relative to fabric or material type. In addition to the traditional solvent-based	Usually unrestorable, due to staining, discoloration or fiber damage. However, if the item is of sufficient value (e.g., sentimental, monetary, legal, artistic, cultural, or historical), cleaning may be attempted, using the techniques described for Condition 2. If heavy odors exist, multiple cleanings and deodorization attempts may be needed. For items of high financial or sentimental value, specialty remediation techniques may be possible.

Porous Items		
Category	**Condition 2**	**Condition 3**
	process, new liquid carbon dioxide dry cleaning and other alternatives are available, and can be better suited for some items. As with laundering, the primary goal of dry cleaning is the physical removal of contaminants and associated odors, rather than killing microorganisms. 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 materially interested parties.	
Porous Furnishings: area rugs, loose carpet, upholstery, mattresses, wicker, and similar items	Most cleaning processes should 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, deodorizing 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 (see IICRC S500, Chapter 16 *Contents Evaluation and Restoration*). Determining the severity of contamination may necessitate an assessment. Spreading 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 should 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 items such as pillows, mattresses and or leather products have been used while contaminated, attempts to return the item to Condition 1 usually are unsuccessful. Disposal is recommended. Rapid drying after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods.	Usually cannot be effectively remediated and restored to an acceptable condition due to staining and other problems as listed for clothing above. If cleaning is attempted, follow recommendations for Condition 2. Most cleaning processes should start and end with HEPA-vacuuming.

Porous Items		
Category	**Condition 2**	**Condition 3**
Paper Goods: books, documents, manuscripts, family records, scrapbooks, photographs, and similar items	Most cleaning processes should start and end with HEPA - vacuuming. Clean by HEPA-vacuuming and dry brushing or other surface cleaning method, while on a downdraft cleaning table. Air washing can be effective. However, air washing should 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 after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods. Valuable or irreplaceable documents that cannot be cleaned or decontaminated may be encased, laminated or otherwise sealed.	Remediation is difficult, costly, and may not be cost-effective if items lack significant value (e.g., sentimental, monetary, legal, artistic, cultural, or historical) Cleaning may require a specialized conservation process, and might not be successful. Valuable or irreplaceable documents that cannot be cleaned or decontaminated may be encased, laminated or otherwise isolated
Fine Art: paintings, sculpture, works of art, and similar items	Remediating mold-contaminated fine art at Condition 2 should be performed only by qualified, experienced specialists, primarily due to the high value of items involved. Actual cleaning techniques parallel those for similar items in other categories, but often require extensive knowledge of the type of artwork in question to avoid damage to the piece.	Remediating mold-contaminated fine art at Condition 3 might not be completely successful, and can be quite expensive. These services should be performed by qualified, experienced, specialists.

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

Semi-porous Items		
Category	**Condition 2**	**Condition 3**
Semi-porous Items: primarily unfinished wood	All items should be examined first for unrestorable water damage. Cleaning usually is accomplished by HEPA- vacuuming 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 should be performed only in a properly controlled work area using controlled techniques, where the massive aerosolization they cause will not pose a health risk to workers or occupants. (See Chapter 5, *Equipment Tools and Materials* for more information). Thorough brushing, while on a downdraft-cleaning table, is another possible cleaning technique. Using liquids, especially water-based solutions, can cause staining or discoloration of wood. Appearance enhancement, as necessary, follows all cleaning methods. Using liquid-applied coatings to cover surfaces of contents that cannot be adequately cleaned (and disinfected or sanitized when appropriate) is not recommended. However, usingcoatings to seal surfaces, or restore the appearance of a material, can be a useful practice, especially on porous or semi-porous materials from which the damage from mold cannot be fully eliminated (e.g., shellac, varnish, lacquer, water-based acrylics over unfinished wood).	All items should be examined first for unrestorable water damage 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. Most cleaning processes should 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 should be performed only in a properly controlled work area using controlled techniques, where the massive aerosolization it causes will not pose a health risk to workers or occupants. (See Chapter 5, *Equipment, Tools and Materials* for more information). End results of such aggressive cleaning methods may result in an appearance that is unacceptable to customers. Attempts should be made to determine if results will be acceptable before extensive cleaning is performed. Using liquids, especially water-based solutions, can cause staining or discoloring wood. Appearance enhancement, as necessary, follows all cleaning methods.

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

Nonporous Items		
Category	**Condition 2**	**Condition 3**
Nonporous items: finished wood, glass, metal, plastic, electronics, and similar items	All items should be examined first for unrestorable water damage. Usually, cleaning can be accomplished by using one or a combination of the following: detergent washing and rinsing; ultrasonic cleaning, or HEPA vacuuming plus damp wiping with a suitable cleaning agent. Cleaning agents should contain surfactants or detergents designed for the use and purpose of removing surface dirt or mold growth. Remediators may clean (and disinfect or sanitize, when appropriate) with a biocide if, in their professional judgment, such use would be appropriate. However, indiscriminate biocide use is discouraged, and biocides should not be used instead of proper cleaning. Biocides should only be used in accordance with the product label instructions that have been approved and registered by the EPA or other applicable regulatory agency. The addition of this statement will advise remediators that biocide use is a possibility for these contents, but that there are limitations that should be carefully considered before using these products, and that indiscriminate use, or use instead of adequate cleaning, is not proper remediation. Rapid drying after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods.	All items should be examined first for unrestorable 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 unrestorable due to corrosion, which can be accelerated by acids produced by fungal growth. Usually, cleaning can be accomplished by using one or a combination of the following: detergent washing and rinsing; ultrasonic cleaning, or HEPA vacuuming plus damp wiping with a suitable cleaning agent. Cleaning agents should contain surfactants or detergents designed for the use and purpose of removing surface dirt and or mold growth. Most cleaning processes should start and end with HEPA-vacuuming. Remediators may clean (and disinfect or sanitize when appropriate) with a biocide if, in their professional judgment, such use would be appropriate. However, indiscriminate biocide use is discouraged, and biocides should not be used instead of proper cleaning. Biocides should only be used in accordance with product label instructions that have been approved and registered by the EPA or other applicable regulatory agency. This statement advises remediators that biocide use is a possibility for these contents, but that there are limitations that should be carefully considered before using these products, and that indiscriminate use, or use instead of adequate cleaning, is not proper remediation. Rapid drying after wet cleaning and appearance enhancement, as necessary, follows most cleaning methods.

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 can 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.

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 might prevent or arrest mold growth if wet books are dried quickly);
- area rug cleaning and repair;
- electronics and machinery restoration;
- 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 materially interested parties should 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, they should be inventoried, photo-documented, and removed or disposed of in compliance with the removal and disposal recommendations in this document.

Unrestorable contents should not be disposed of without the express written permission of the customer, the adjuster (if applicable), and 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 customers that have not been restored to Condition 1, or when performing preservation services on irreplaceable items (also see "Inspection and Evaluation for Restorability" section above), remediators should inform customers of the circumstances involved (i.e., why the contents were not restored to Condition 1), advise customers in writing of the potential consequences of accepting contaminated contents, and attempt to obtain a written waiver and release of liability from customers for those potential consequences.

DISPOSAL

Waste Material Handling

Waste materials should 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. Mold-contaminated, unrestorable contents should be handled and removed carefully, preferably packaged in heavy-gauge polyethylene, such as 6-mil disposal bags, or securely wrapped in 6-mil polyethylene sheeting, unless contents are disposed directly through a waste-out tunnel or transfer system. Sharp items capable of puncturing polyethylene material should be packaged in such a way as to prevent them from penetrating the material before being bagged or wrapped. Polyethylene surfaces should be HEPA-vacuumed, damp wiped with an appropriate cleaning agent, double-bagged or wrapped in a fresh layer of polyethylene just prior to being removed from the contaminated area or decontamination chamber. Respirators are not required outside while transporting double-bagged materials. Bags should not be dropped, thrown or handled roughly. If bagged or wrapped disposal materials rupture outside the containment, transporting workers shall 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 practical, 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 and shall be followed. Placing descriptive warning 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 overstated or unnecessarily alarming.

POST-REMEDIATION EVALUATION

Post-remediation evaluation should be conducted by remediators to evaluate whether or not remediation has been completed. This evaluation involves implementing internal quality control procedures. The evaluation begins with subjective criteria that include, but are not limited to, visual inspection focusing on acceptable removal of visible mold, and olfactory inspection focusing on removal of malodor.

Remediated contents can be considered clean when contamination, unrestorable contaminated items and debris have been removed, and surfaces are visibly free of dust. The term “visibly” can include direct and indirect observation (e.g., using white or black towels to wipe surfaces to observe for cleanliness). Also, remediated contents should be free of malodors associated with microorganisms. At that point, it is probable that the contents have been returned to Condition 1. The evaluation can also include moisture measurements. If the visible mold, dust or debris has not been removed, malodors are present, or initial cleaning is questionable, either repeat processing may be warranted or items may be categorized as not restorable.

POST-REMEDIATION VERIFICATION

Following post-remediation evaluation by the remediator, it may be requested or required to verify the return of the structure, systems or contents to Condition 1. In such situations, post-remediation verification should be performed by an independent IEP. It is recommended that the criteria and process used in the post-remediation verification be documented.

Post-remediation verification can include subjective and objective criteria. Subjective criteria include, but are not limited to, visual inspection, and odor detection and characterization. Objective criteria include but are not limited to, analytical testing (e.g., moisture monitoring, temperature and relative humidity) and environmental sampling. If customers do not agree to have the remediation of the contents verified, remediators can refer to Chapter 9, *Limitations, Complexities, Complications and Conflicts.* When post-remediation verification is not performed on contents, remediators should inform customer of the circumstances involved, advise customers in writing of the potential consequences of accepting contaminated contents, and attempt to obtain a written waiver and release of liability from customers for those potential consequences.

Post-remediation verification provides a measure of assurance, within sampling, testing and analysis limitations, that contents have been remediated to Condition 1. When sampling is requested or required, it is recommended that a cross-section of content types be included, and that an independent IEP should conduct such activities.

Industry Acronyms

Organizations, Titles, and Regulations and Other Acronyms

A2LA - The American Association for Laboratory Accreditation
ACCA - Air Conditioning Contractors of America
ACGIH - American Council Conference of Governmental Industrial Hygienists
AHAM - American Home Appliance Manufacturers
AIHA - American Industrial Hygienist Association
AmIAQ Council – American Indoor Air Quality Council
ANSI - American National Standards Institute
ASCR – Association Specialist Cleaning and Restoration
ASHRAE - American Society of Heating, Refrigeration and Air-Conditioning Engineers
ASTM - American Society for Testing and Materials

BDMA – British Damage Management Association
BSI - British Standards Institute

CAIH - Certified Associate Industrial Hygienist
CCOHS - Canadian Centre for Occupational Health and Safety
CDC - Centers for Disease Control and Prevention
CEPA - Canadian Environmental Protection Act
CFR - Code of Federal Regulations
CIH - Certified Industrial Hygienist
CPSC - Consumer Products Safety Commission
CRCII - Carpet and Rug Cleaners Institute of Illinois
CSA - Canadian Standards Association

DOT - Department of Transportation
DrPH - Doctor Public Health

EPA - Environmental Protection Agency

FHA - Federal Housing Administration
FIFRA - Federal Insecticide, Fungicide and Rodenticide Act

IAQA - Indoor Air Quality Association
IEI - Indoor Environmental Institute
IEP - indoor environmental professional (term of art, not used as a designation)
IESO – Indoor Environmental Standards Organization
IH - Industrial Hygienist (term of art, not used as a designation)
IICRC - Institute of Inspection, Cleaning and Restoration Certification
ISO - International Standards Organization

MPH - Master of Public Health
MS (MSc) - Master of Science

NADCA – National Air Duct Cleaning Association
NELAP The National Environmental Laboratory Accreditation Program
NIOSH - National Institute for Occupational Safety and Health
NOFMA - National Oak Flooring Manufacturers Association

OSHA - Occupational Safety and Health Administration

PE - Professional Engineer
PhD – Doctor of Philosophy

REA - Registered Environmental Assessor, California Environmental Protection Administration
RIA – Restoration Industry Association (formerly ASCR)

SCRT – Society of Cleaning and Restoration Technicians (formerly ISCT)

TSCA - Toxic Substances Control Act

UL - Underwriters Laboratory

WHO - World Health Organization

Glossary of Terms

S520 Mold Remediation Standard Glossary of Terms

[A]

above grade:
1. Any floor that is above the level of the surrounding ground on which the structure is built.
2. A suspended floor, usually wood on joists, with a minimum of 18" of ventilated airspace below, located above the level of the ground outside the structure.

abrasion – The wearing away of a solid surface or coating material by friction.
abrasive – A material used to scour, scrub or polish. Abrasive particles are used in such products as cleansers, pumice stone, scouring pads and hand cleaners.
absolute humidity – The ratio of the mass of water vapor to the mass of dry air; humidity ratio.
absorption:
1. The property of a fiber, yarn or fabric or other material which enables it to attract and hold gases or liquids within its pores by capillary, osmotic, solvent or chemical action. cp. "adsorption"
2. To take a substance into the body through surfaces such as the lungs, gastrointestinal tract, or skin, and ultimately into body fluids or tissues.

action level – Term used by OSHA and NIOSH to express the level of toxicant that requires actions that may include medical surveillance, periodic air monitoring, training , and warning signs. Action levels are usually one-half of the permissible exposure level (PEL).
activated carbon – A highly adsorbent form of granular carbon treated with high temperature and used to remove odors and toxic substances from liquids or gases, through adsorption or filtration. cp. "adsorption"
actual growth – Molds that have colonized a substrate, formed fungal mycelia, growth structures and spores; are active or dormant; visible or hidden.
acute effect – A(n adverse) manifestation in a human or animal body, resulting immediately or shortly after exposure to a substance or condition. The manifestation may be one or more symptoms, or a subclinical physiological effect. Example: rhinorrhea (runny nose), cough, headache and fatigue occurring within minutes to hours after occupants re-enter a building heavily contaminated with mold. Compare with “chronic effect.”
acute exposure – An event or series of events over a brief time period, in which one or more substances are inhaled, ingested, or dermally absorbed by one or more individuals, which may result in one or more adverse health effects. Absorption of a substance as a result of an acute exposure may be prevented by a respirator, gloves, goggles, and other personal protective equipment, or ventilation equipment. Acute exposures are usually characterized as lasting seconds to minutes or hours, but no longer than one day.
acute toxicity – An adverse effect resulting immediately or shortly after exposure to one or more substances, resulting from the toxicological properties of that substance(s). The extent of toxicity is dependent upon the actual dosage of substance(s) that enters the body, as well as the duration, intensity, route, and form of exposure, and the health of the affected individual and ability to metabolize the substance. Commonly referred to as “poisoning.”
adhesives – A substance used to hold materials together by surface attachment. In textiles, materials that cause fiber, yarns or fabrics to stick together or stick to other materials (e.g., subfloorings).
adsorption – The condensation of thin layers of molecules of gases, liquids or dissolved substances on the surfaces of solids. Usually, there is no chemical or physical change in the material used as the adsorbent. For example, *silica gel* is an adsorbent used in desiccant dehumidification. cp. "absorption"
adverse health effect – Any abnormal, harmful, or undesirable effect on the physical, biochemical, biological or behavioral well being of a person or animal, as a result of acute or chronic exposure to a pollutant or other substances.
aerobic – An organism that is living, active or occurring only in the presence of oxygen (e.g., most fungi are aerobic).
aerosol – A suspended liquid or solid particle in a gas (e.g., air). A fine aerial suspension of particles sufficiently

small in size to confer some degree of stability from sedimentation; i.e., fog or smoke.
air – A mixture of gases constituting a compressed fluid tied to the planet by gravitational attraction. Air is 78% nitrogen, 20.9% oxygen, 1% argon and 0.1% a mixture of carbon dioxide, helium and hundreds of other gases originating from natural and man-made sources.
air balancing – The appropriate distribution and delivery of proper quantities of air to building space. Generally this includes, but is not limited to, mixing fresh (outside) air with air that is recirculated through a building's Heating Ventilating Air Conditioning (HVAC) system.
air changes per hour (ACH) – Volume of air moved in one hour. One air change per hour in a room, home or building means that all the air in each of those environments will be replaced in one hour.
air cleaning – An indoor air quality (IAQ) control strategy to remove various airborne particulates or gases from the air. The three types of air cleaning most commonly used are: particulate filtration, electrostatic precipitation, and gas sorption. cp. "air conveyance system"
Air Conditioning Contractors of America (ACCA) – A national non-profit trade association for air conditioning contractors to work together to improve their industry and promote good practices through technical training, standard setting and writing, and developing marketing resources.
air contaminant – Smoke, soot, fly ash, dust, cinders, gases, vapors, odors, toxic or radioactive substance, waste, particulate, solid, liquid or gaseous matter, or any other material in the air, excluding uncombined water.
air drying – Removal of moisture from materials (usually structural wood) using natural circulation rather than kiln drying.
air exchange rate – Expressed in two ways:

1. The speed (number of times) outdoor air replaces indoor air expressed in air changes per hour (ACH).
2. The number of times the ventilation system replaces the air within a room or area within a building.

air filtration device (AFD) – Depending on the mode of use, an AFD that filters (usually HEPA) and recirculates air is referred to as an air scrubber. One that filters air and creates negative pressure is referred to as a negative air machine.
airflow – The volume flow rate of an air stream. Generally measured in CFM. One of several ways of evaluating vacuum and air mover efficiency and HVAC performance. cp. "vacuum pressure"
air handling unit (AHU) – cp. "air conveyance system"
air line respirator – A respirator that is connected to a compressed breathing air source by a hose of small inside diameter. The air is delivered continuously or intermittently in sufficient volume to meet the wearer's breathing requirements, and meet OSHA breathing air standards. cp. "atmospheric supplying respirator"
airlock – A system that permits entry and egress with minimum airflow between a contaminated and uncontaminated area. Normally it consists of two curtained doorways separated by a distance of at least three feet, enabling a person to pass through one door opening into the airlock, allowing the doorway sheeting to overlap and close off the doorway before proceeding through the second doorway. This prevents flow-through contamination.
airmover – A specialized mechanically operated evaporative drying unit, incorporating an electric motor, fan and specially designed housing for use in drying carpet or cushion, and subfloors or structural components (wood floors, walls, crawlspaces, etc.), often by injecting copious air movement over or under the carpet, or inside structural cavities or air spaces.
air-purifying respirator – A respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element. An air-purifying respirator shall be used only when there is sufficient oxygen to sustain life, and the air contaminant level is below the concentration limits of the device.
airway – Any conducting segment of the respiratory tract through which air passes during breathing (e.g., bronchial tubes).
alcohol – A class of colorless, volatile, flammable, organic – “dry solvents” containing one or more hydroxyl groups (OH). Alcohols are used as cosolvents in some cleaning or spotting compounds. The alcohols commonly used in light duty and liquid laundry detergents are isopropanol or ethanol (isopropyl or ethyl alcohol). In detergents they control viscosity, act as solvents for other ingredients, and provide resistance to freezing temperatures encountered in shipping, storage and use. Alcohols also may be used in a 60-90% concentration for disinfecting; cp. “disinfectant, antimicrobial”
allergen – A biological or synthetic substance primarily composed of protein that acts as an antigen and elicits an

allergic (immediate hypersensitivity) response. Examples include pollens, animal danders, dust mite fecal particles, and certain fungus spores (mold).

allergic reaction – A specific, immediate hypersensitivity immunological response resulting from exposure (usually inhalation) to an allergen by an immunologically sensitized person. Depending on the nature of the allergen and the immunological status of the individual, the usually reaction is rhinitis and conjunctivitis (i.e., runny nose, nasal congestion, watery and itchy eyes), and sneezing. Other allergic reactions include asthma, urticaria (hives), or anaphylaxis. The response can be immediate or delayed (by hours). Other physiologically and medically different types of immunological responses (e.g., delayed, T-cell mediated hypersensitivity) may be colloquially referred to as 'allergic reactions.'

allergic rhinitis – An immediate hypersensitivity response mediated by the antibody class known as immunoglobulin E (IgE), resulting in inflammation of the mucous membranes in the eyes, nose and sometimes lungs following inhalation exposure to one or more allergens. cp. "allergic reaction"

Alternaria – A fungus that is commonly found in the outdoor environment (e.g., soil, leaves) and indoors on cellulosic substrata. A well recognized outdoor airborne allergen.

alveolar – Pertaining to air sacs (alveoli) of the lung where gas exchange occurs between the lung and the blood stream.

ambient air – The air outside of or surrounding an object; generally referred to as the air within a structure or area.

American Conference of Governmental Industrial Hygienists (ACGIH) – An organization of professional personnel including governmental agencies or educational institutions located in Cincinnati, OH 45211 (513-661-7881), which is engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits for hundreds of chemical substances and physical agents. cp. "TLV"

American Home Appliance Manufacturers (AHAM) – An association representing manufacturers of home appliances (dehumidifiers, etc.), which is headquartered in Washington, D.C.

American Industrial Hygiene Association (AIHA) – An association representing and setting standards for industrial hygienists (703-849-8888).

American National Standards Institute (ANSI) – A privately funded, voluntary membership organization headquartered in New York City, which identifies industrial and public needs for national consensus standards, and coordinates development of such standards (212-642-4900). Many ANSI standards relate to safe design/performance of equipment, such as safety shoes, eyeglasses, smoke detectors, fire pumps and household appliances. It also specifies safe practices or procedures, such as noise measurement, testing of fire extinguisher and flame arresters, industrial lighting practices, and the use of abrasive wheels.

American Society for Testing and Materials (ASTM) – An organization located in Philadelphia, PA (215-299-5400) with voluntary members representing a broad spectrum of individuals, agencies and industries who are concerned with testing standards for a variety of materials. As the world's largest source of voluntary consensus standards for materials, products, systems and services, ASTM is a resource for sampling and testing methods, health and safety of materials, safe performance guidelines, and effects of physical and biological agents and chemicals.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) – A society of professional engineers that sets standards for heating, ventilating and air conditioning (HVAC) equipment, and for equipment and materials relating thereto. They are the authoritative technical body for standards and procedures for indoor air comfort and health. Standards include: *Standard 52* for testing air filters by means of discoloration; *Standard 62* Ventilation for Acceptable Indoor Air Quality which prescribes minimum ventilation levels for buildings for both comfort and health.

amplification – The rapid increase and spread of active mold growth due to the combination of unabated availability of moisture, susceptible organic substrate, and optimal environmental temperature.

amplifier – A condition that encourages biocontaminants to grow or increase in concentration. These conditions may involve food sources, temperature, light, air movement, and moisture.

anaerobic – An organism that is found living, active, or occurring in the absence of free oxygen.

antibiotic – An organic chemical substance produced by microorganisms that has the capacity in dilute solutions to destroy or inhibit the growth of bacteria and other microorganisms. An antibiotic is used most often at low concentrations in the treatment of infectious diseases of man, animals and plants.

antigen – A substance that induces an immune response (one type of which is an ‘allergic reaction’) by interacting with a T cell receptor or an immunoglobulin antibody.
antimicrobial – Literally, "against microorganisms." A substance, mechanism, or condition that inhibits the growth or existence of an organism. A general term used to describe various compounds, often built into consumer products or materials, that have the ability to limit, control, or stop the growth of microorganisms (fungi, bacteria, viruses and other organisms). The EPA uses the definition “Antimicrobial pesticides are substances or mixtures of substances used to destroy or suppress the growth of harmful organisms, whether bacteria, viruses or fungi on inanimate objects and surfaces.” Antimicrobial products which claim to kill microorganisms must be registered in many countries with a regulatory authority (The USEPA’s Antimicrobials Division under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) in the United States; the EU Biocidal Products Directive establishes regulation for both antimicrobial products and other non-agricultural pesticides in European Union member states), and use is restricted to the scope of the product label. cp. “biocide, disinfectant, sanitizer”
asbestos – A naturally occurring mineral fiber that is highly flame-resistant. In the US, asbestos (mostly as chrysotile) is sometimes found in common, pre-1980 construction materials including: siding, pipe lagging, sprayed-on fireproofing and soundproofing, paints, caulking, insulation materials, ceiling tiles, vinyl asbestos tile floor coverings, etc. At one time asbestos fiber was used in theater curtains, ironing board covers, potholders and other fabrics where flameproofing and heat resistance were required. Chronic inhalational exposure to asbestos is causally associated with increased risk for certain forms of lung cancer, mesothelioma (a rare form of cancer of the lining of the lung), and interstitial lung disease (asbestosis).
asbestos abatement – Procedures to control fiber release from ACM in a building, or to remove it entirely. These may involve removal, encapsulation, repair, enclosure, encasement, and operations and maintenance programs.
asbestos containing material (ACM) – Any material containing one or more percent of asbestos.
aspergillosis – An infectious or immunological respiratory disease caused by inhalation of spores of some species of *Aspergillus* (e.g., *A. fumigatus*).
Aspergillus – Any of a genus of ascomycetous fungi with branched or radiating sporophores, including many common molds, some of which are pathogenic. Generally, *Aspergillus* fungi proliferate in warm moist environments suitable for human habitation. Some *Aspergillus* species, e.g., *A. flavus, A. fumigatus, A. versicolor*, which commonly are found in water-damaged environments, can produce toxins. They should be dealt with using extreme caution.
asphyxiant – A vapor or gas that limits or prohibits the body's ability to uptake or metabolize (use) oxygen. ‘Simple asphyxiants’ (e.g., methane) such as in confined spaces reduce the oxygen concentration in the air (normally about 21%) to dangerous levels (16% or lower). Chemical asphyxiants (e.g., carbon monoxide and hydrogen sulfide) affect certain cells ability to bind or metabolize oxygen. Asphyxiation results in neurological injury or death.
assessment – A process performed by an indoor environmental professional (IEP) that includes the evaluation of data obtained from a building history and inspection to formulate an initial hypothesis about the origin, identity, location and extent of amplification of mold contamination. If necessary, a sampling plan is developed, and samples are collected and sent to a qualified laboratory for analysis. The subsequent data is interpreted by the IEP. The IEP or other qualified individual may then develop a remediation plan.
Association of Specialist in Cleaning and Restoration (ASCR) – Association located in Columbia, MD (443-878-1000) provides certification for the cleaning and restoration industry. Now known as Restoration Industry Association (RIA)
asthma – A disease marked by recurrent attacks of difficult or labored breathing, wheezing, or cough resulting from hyper-responsiveness of the bronchi. The disease may develop in childhood or adulthood; may be caused or triggered by allergic, irritant/toxic, physiological or often unknown factors.
atmosphere supplying respirator – A respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.
atmospheric conditions, standard – An ASTM standard testing atmospheric condition, with moisture equilibrium of 65% RH (±2%) and temperature of 70ºF (±2%)/21ºC (±1%).

atom – Individual component of a molecule.
atopic – A genetically determined state of hypersensitivity to environmental allergens.

[B]

back pressure – Pressure against the flow of liquids or air due to various imposed constrictions; e.g., air pressure working against a fan (airmover) within an air stream that is being compressed, as under a carpet during drying procedures.
bacteria – Extremely small (generally from 0.4-10 microns in diameter), single-cell microscopic organisms. They are the most numerous organisms on earth and are found everywhere, especially in soil and water. Because they are microscopic, they easily become airborne, and they are carried in water as well. Some bacteria are able to form spores during hostile growth conditions and these spores are some of the most resistant forms of life known. Bacteria reproduce at a rapid rate given proper growth conditions (food source, moisture, temperature). Most are saprophytic (feed on non-living organisms), though many are parasitic (feed on living organisms). Most bacteria (and their odors) are killed or controlled with extreme heat and sunlight (ultraviolet), or by such chemicals as alcohol, chlorine, ammonium chlorides and others. cp. "endotoxin"
bactericide – A substance that kills bacteria, both pathogenic and nonpathogenic, though not necessarily all their spores, when used according to label directions. It differs from a germicide in that it does not claim to kill fungi, viruses and other microorganisms that are not bacteria.
bacteriostat – A substance, usually chemical, that prevents the growth of specific bacteria but does not kill bacteria or bacterial spores when used according to label directions. Sometimes the only difference that determines EPA registration as bacteriostatic or bactericidal is the substance, contact time, temperature or pH.
baghouse filter – Large fabric bags used to eliminate intermediate and large particles from an air conveyance system. The device functions similar to several vacuum cleaner bags, passing the air and some microscopic particles, while entrapping larger particles. Generally, a baghouse filter is able to trap up to 85% of particles of one micron or greater in size.
balanced drying – The equalization of evaporation and dehumidification. An ideal drying situation in which the rate of evaporation of moisture from structure and contents is equal to or slightly less than the rate of dehumidification or moisture removal from the air. The objective in balanced drying is to prevent moisture absorption from the air into unaffected materials and thus, to minimize or eliminate secondary damage.
bearing wall – A wall that supports a vertical load.
below grade – Below ground level, usually a basement. Partially or completely below ground level and in direct contact with the ground. cp. "above grade, on grade"
bioaerosols – Airborne particles that are living or originate from living organisms; i.e., culturable, non-culturable and dead microorganisms) and fragments, toxins, and particulate waste products from all varieties of living things.
biocide – A substance, compound or product designed or formulated to kill living organisms, both pathogenic and nonpathogenic. Products which claim to kill organisms must be registered in many countries with a regulatory authority (The USEPA's Antimicrobials Division under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) in the United States; the EU Biocidal Products Directive establishes regulation for both antimicrobial products and other non-agricultural pesticides in European Union member states), and use is restricted to the scope of the product label. cp. "antimicrobial, disinfectant" "sanitizer."
biodegradable – Capable of being broken down into innocuous (harmless) products (water, carbon dioxide) by the action of living organisms or other biological processes. Most of today's textile cleaning detergents are biodegradable.
biodeterioration – The deterioration of valuable materials due to biological activity. The agents of deterioration (vectors) may be microbes, insects, rodents or other higher animals and plants.
biofilm – A matrix of microorganisms, organic and inorganic materials that combine to create a layer or "film" on a substrate.
biological contaminants – Unwanted agents (disease or allergy causing) that are derived from or are living organisms (including viruses, bacteria, fungi, and protozoa, arthropods and mammal and bird antigens), that can be inhaled and can cause many types of health effects, including allergic reactions, respiratory disorders, hypersensitivity diseases, and infectious diseases. Also referred to as *microbiologicals* or *microbials*.

biohazard – Any biological material that can cause harm to living organisms.
biopollutants – Organisms, or their derivatives, which are living or have lived, and which are unwanted in the earth's air, water or environment. Examples include: bacteria, fungi, viruses, and derivatives from mammals, arthropods and plants.
bleach – A cleaning, sanitizing and color removing material that functions through a chemical reaction called oxidation. Bleaches often are used with detergents, or by themselves to break chemical, rather than physical bonds, as detergents do. Common bleaches used in cleaning are available in granular or aqueous mixtures of sodium hypochlorite (chlorine bleach), hydrogen peroxide, and sodium perborate. cp. "chlorine bleach, oxidizing agent, reducing agent, sodium hypochlorite, hydrogen peroxide"
bloodborne pathogens – Harmful microorganisms present in blood or other potentially infectious materials, that could cause disease or death in humans. Included among these microorganisms are hepatitis B virus (HBV) and human immunodeficiency virus (HIV).
borescope – A device that can be inserted at an access point to focus on and view inaccessible surfaces, such as interior walls of ductwork. A monitor or camera can be attached to pictorially document internal surface conditions.
bottom plate – The lower part of a wall frame, which rests upon and is attached to the floor.
British thermal unit (Btu) – A measurement of heat energy: The quantity of heat required to raise the temperature of one pound of distilled water one degree Fahrenheit, at or near the temperature of maximum water density ($39^oF/4^oC$).
bronchial – Pertaining to airways of the bronchi of the lung, the airways that conduct air between the throat and the alveoli. The bronchi are affected in several diseases, including asthma.
building envelope – The elements of a building, including all external materials, windows and walls, which enclose internal spaces.
building related illness (BRI) – A diagnostic term that refers to a disease related to working and living in a building with a specific indoor air quality problem or contaminant that has been identified and measured. Examples include asthma, humidifier fever, and carbon monoxide toxicity. (cp building-related symptoms and sick building syndrome)

[C]

C – The element "carbon."
calcium chloride – A highly hygroscopic compound ($CaCl_2$) used in an anhydrous (dry) state for testing moisture content of various surfaces. A dry sample is weighed, then placed on a surface (concrete slab) and allowed to absorb moisture for a specified time. Then the sample is weighed again to determine the weight of moisture absorption.
can – When the term *can* is used in this document, it signifies an ability or possibility open to a user of the document, and it means that a referenced practice or procedure is possible or capable of application, but is not a component of the accepted “standard of care” to be followed.
Canadian Centre for Occupational Health and Safety (CCOHS) – The Canadian equivalent to the US OSHA, headquartered in Hamilton, Ontario (1-800 263-8276). cp. "OSHA"
Canadian Environmental Protection Act (CEPA) – A Canadian legislative act administered by Environment Canada and Health Canada beginning in 1988. CEPA is the cornerstone of federal environmental legislation since the 1980s, which addresses controlling toxic substances, preventing environmental harm rather than merely reacting to dangerous conditions after the fact, providing coherence among powers and authorities under federal environmental statutes, enforcing federal regulations, and encouraging penalties for environmental offenses. Environment Canada, Environmental Protection is located in Hull, Quebec; (819-953-1652).
Canadian Public Health Association (CPHA) – An organization responsible for the representation of public health interests located in Ottawa, Ontario and through whom IARC publications may be obtained (613-725-3769).
Canadian Standards Association (CSA) – Canadian organization (cp. "Underwriters Laboratory") responsible for the establishment of product and testing standards. cp. "ISO, ANSI, UL"
capillary action – The movement of a liquid through a slender pathway. It is caused by adhesion, cohesion and surface tension in liquids and their contact with the solid pathway.

carbon monoxide (CO) – A colorless, odorless, asphyxiant gas that results from incomplete combustion of carbon. The EPA ambient air quality TLV for carbon monoxide is 35 ppm for 1 hour, and 9 ppm for an 8-hour period.

carcinogen – A substance or agent that can initiate genetic damage or promote a growth of cancerous tumors or cells in humans or animals. Examples of human carcinogens include cigarette smoke (lung cancer), asbestos (lung cancer), and benzene (leukemia).

carcinogenic – A property of a substance or condition that with sufficient exposure can initiate or promote growth of a cancerous tumor or cells.

carpet dryer – cp. "airmover"

Categories of Water (1-3) – The categories of water, as defined by this document, refer to the range of contamination in water, considering both its originating source and its quality after it contacts materials present on the job site. Time and temperature can also affect the quality of water, thereby changing its category. Restorers should consider potential contamination, defined as the presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment; and may produce adverse health effects, cause damage to structure and contents or adversely affect the operation or function of building systems.

The categories are divided into the following:

- **Category 1:** Category 1 water originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. Examples of Category 1 water sources can include, but are not limited to: broken water supply lines; tub or sink overflows with no contaminants; appliance malfunctions involving water-supply lines; melting ice or snow; falling rainwater; broken toilet tanks, and toilet bowls that do not contain contaminants or additives. However, once clean water leaves the exit point, it might not remain clean once it contacts other surfaces or materials.

  The cleanliness of Category 1 water may deteriorate to Category 2 or 3 for many reasons, including but not limited to: contact with building materials, systems and contents; mixing with soils and other contaminants. Some factors that influence the potential organic and inorganic load in a structure include the age and history of the structure, previous water losses, general housekeeping, the type of use of the structure (e.g., nursing home, hospital, day care, warehouse, veterinary clinic), and elapsed time or elevated temperature. Odors can indicate that Category 1 water has deteriorated.
- **Category 2:** Category 2 water contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Category 2 water can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). Examples of category 2 water sources can include, but are not limited to: discharge from dishwashers or washing machines; overflows from washing machines; overflows from toilet bowls on the room side of the trap with some urine but no feces; seepage due to hydrostatic pressure; broken aquariums and punctured water beds.

  The cleanliness of Category 2 water can deteriorate for many reasons, including but not limited to: contact with building materials, systems, and contents; mixing with soils and other contaminants. Some factors that influence the potential organic and inorganic load in a structure include the age and history of the structure, previous water losses, general housekeeping, the type of use of the structure, and elapsed time or elevated temperature.
- **Category 3:** Category 3 water is grossly contaminated and can contain pathogenic, toxigenic or other harmful agents. Examples of Category 3 water sources can include, but are not limited to: sewage; toilet backflows that originate from beyond the toilet trap regardless of visible content or color; all forms of flooding from seawater; ground surface water and rising water from rivers or streams, and other contaminated water entering or affecting the indoor environment, such as wind-driven rain from hurricanes, tropical storms, or other weather-related events. Such water sources may carry silt, organic matter, pesticides, heavy metals, regulated materials, or toxic organic substances.
- **Special Situations:** If a regulated or hazardous material is part of a water damage restoration project, then a specialized expert might be necessary to assist in damage assessment, and government regulations apply. Regulated materials posing potential or recognized health risks might include, but are not limited to: arsenic, mercury, lead, asbestos, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, caustic chemicals, radiological residues. For situations involving visible or suspected mold, refer to IICRC S520

Standard and Reference Guide for Professional Mold Remediation.

caustic – The property of a chemical (usually a base) that enables it to burn, corrode, dissolve or eat away other substances. When the term caustic is used alone, it usually refers to sodium hydroxide, which is used in manufacturing hard soap. It also refers to caustic potash (potassium hydroxide), which is used in manufacturing soft soap.

cc – Cubic centimeter. A volume measurement in the metric system that is equal in capacity to one milliliter (ml), or approximately 20 drops. There are 16.4 cc in one cubic inch of air volume.

cell – The smallest structural part of living matter capable of functioning as an independent unit.

cellulose – A polysaccharide carbohydrate consisting of β(1-4)-linked glucose units in linear chain that is a basic building block of plant cells; cellulosic materials in buildings include wood, paper and natural fiber textiles.

Celsius (C) – An international thermometric scale (cp. "centigrade").

Centers for Disease Control and Prevention (CDC) – A U.S. federal agency located in Atlanta, Georgia, that monitors communicable diseases and specializes in the medical aspects of indoor air quality: (404) 639-3311.

centigrade (c or C) – A scale for measuring temperature. On the centigrade scale, water boils at 100° and freezes at 0° (cp. "Fahrenheit").

certificate of satisfaction – A document certifying that the remediation project has been completed in substantial conformance with the remediation plan, protocol, specification, or contract, and that the completed work is accepted and approved by the party requesting and receiving the remediation services.

chemical cartridge respirator – An air purifying respirator that uses a chemical filter to remove certain gases and vapors from inhaled air. This type respirator is effective for concentrations no more than ten times the TLV of the contaminant, if the contaminant has warning properties (odor or irritation) below the TLV.

chemical time dependent sensitization (CTDS) – Another term for multiple chemical sensitivities (MCS) or idiopathic environmental illness (IEI).

chlorine bleach – Strong oxidizing agents that have one or more chlorine atoms in their molecular makeup. Liquid chlorine bleach products for home use are normally 5.25% to 6.00% solutions of sodium hypochlorite (NaClO). Chlorine bleach also may be found in bathroom cleansers, dish-washing compounds, and powdered laundry detergents (potassium or sodium dichloroisocyanurate). Chlorine bleach should not be used with silk, wool, chlorine sensitive dyes and on certain stains, such as rust, which it can set. In a 0.5% solution (mixed 1:11 with most household bleach formulations), chlorine bleach can be an effective germicide. The addition of ammonia or acids to chlorine bleach liberates toxic chlorine gas.

chronic effect – A(n adverse) manifestation in a human or animal body, resulting in symptoms that develop slowly over a prolonged period, or that occur frequently, or that occur after some latency period. Examples include cancer, asbestosis, and irreversible damage to certain organs.

chronic exposure – Long-term, recurrent or continuous contact with a substance, lasting from several weeks up to as long as a lifetime.

chronic toxicity – An adverse effect resulting from either repeated or prolonged (i.e., chronic) exposures or a delayed effect from an earlier exposure to one or more substances, resulting from the toxicological properties of that (those) substance(s). The extent of toxicity is dependent upon the actual dosage of substance(s) that enters the body, as well as the duration, intensity, route, and form of exposure, and the health of the affected individual and metabolism (detoxification) of the substance(s).

-cide or -cidal – A suffix that implies that a substance has the ability to kill most microorganisms; e.g., bactericide, virucide, fungicide, sporicide, etc.

Cladosporium **-** A fungus commonly found in the outdoor environment (e.g., soil, leaves).

claims made insurance – An insurance policy that is written on a Claims Made basis will pay for claims made against the insured and reported to the insurance company during the policy period. Under a claims made policy the insurance must be in force and the event that leads to the claim must occur subsequent to the Retro Active date on the policy in order for the claim to be covered. The Retro Active date on a Claims Made policy is usually the first year Claims Made insurance was purchased. By continuously renewing Claims Made policies, the insurance buyer can insure operations performed in prior insured years under the policy in effect during the current period. Claims Made policies provide an extended discovery clause to allow the insured to purchase a period of coverage in which to report claims under the policy. It is difficult to buy and sell firms under a claims made policy and it is also difficult to retire or close the business because insurance still needs to be purchased even after the doors are closed. Switching from an Occurrence based policy is inexpensive, but switching back from Claims Made to Occurrence based coverage is both difficult and expensive, because the new Occurrence based underwriter needs to pick up all of the loss exposures of the prospective year plus all of the prior acts which were insured under Claims Made policies in prior years. For this reason, Occurrence-based coverage is preferable if it is available at a reasonable price. General Liability and Contractors Pollution Liability is available on a Claims Made or Occurrence basis. Professional liability insurance is universally Claims Made coverage.

cleaning – The traditional activity of removing contaminants, pollutants and undesired substances from an environment or surface to reduce damage or harm to human health or valuable materials. Cleaning is the process of locating, identifying, containing, removing and properly disposing of unwanted substances from an environment or material.

cleanroom – As used in abatement and remediation projects, an uncontaminated room that has facilities for storing employees' street clothing and uncontaminated materials and equipment.

colony forming units (CFU) – A descriptive acronym used in assessing the growth of microorganisms on fabrics or surfaces. CFU/m^3 is an abbreviation for *colony forming units per cubic meter of air*, or the number of microorganisms that were able to grow on the collection media found from the sampled air volume (m^3).

complexities – Any condition that causes the job to become more difficult or detailed, but work can still be performed adequately.

complications – The act of becoming complex, intricate, or perplexing. A "complication" is generally any condition that arises after the start of work that causes or necessitates a change in the scope of activities.

conflicts – Limitations, complexities, or complications that result in a disagreement between the parties involved as to how the remediation is to be performed.

condensation – A deposit of moisture droplets from humid air on surfaces that are cooler than that air. Condensation will form when warm, moist air contacts a cooler surface causing the air to be reduced to the dew point temperature. cp. "dew point, saturation point"

conditioned air – Air that has been heated, cooled or dehumidified to maintain an interior space within the human comfort zone.

Condition – For the purpose of this standard, Conditions 1, 2, and 3 are defined for indoor environments. Definitions for each Condition are:

- **Condition 1 (normal fungal ecology) –** an indoor environment that may have settled spores, fungal fragments or traces of actual growth whose identity, location and quantity is reflective of a normal fungal ecology for a similar indoor environment.
- **Condition 2 (settled spores) -** an indoor environment which is primarily contaminated with settled spores that were dispersed directly or indirectly from, and reflective of, the fungal ecology of a Condition 3 area, and which may have traces of actual growth.
- **Condition 3 (actual growth) -** an indoor environment contaminated with the presence of actual mold growth and associated spores. Actual growth includes growth that is active or dormant, visible or hidden.

confined space – Any area that has: limited openings for entry and exit; where escape would be difficult in an emergency; which lacks ventilation; which contains known or potential hazards, and which is not intended nor designed for continuous human occupancy.

confluent – Presence or growth of microorganisms across a continuous surface or area.

conidiophore – Simple or complex hyphal structure, including the conidiogenous cells, that produces the conidia (asexual mold spores).

conidium – Asexual spores produced by mold species.

contiguous – see "**c**onfluent"

consequential damage – Loss of value that does not arise as a direct result of an event, but which is incidental to it. cp. "secondary damage"

containment – A precaution used to minimize cross-contamination from affected to unaffected areas by traffic or material handling. Containment normally consists of 6-mil polyethylene sheeting, often in combination with negative air pressure, to prevent cross-contamination.

contaminant – Any physical, chemical, biological or radioactive substance that can have an adverse effect on air, water or soil, or on any interior or exterior surface.

Contaminated (contamination) – The presence of indoor mold growth or mold spores, whose identity, location and quantity are not reflective of a normal fungal ecology for similar indoor environments, and which may produce adverse health effects, cause damage to materials or adversely affect the operation or function of building systems.

contractor – An individual or firm that agrees, usually based on predetermined terms and specifications, to provide labor and materials and to be responsible for work (a specific job, overall construction or reconstruction). General contractors assume overall responsibility for overall job coordination, performance and completion, while a subcontractor usually assumes responsibility for only a portion of the total work required to complete a project. (cp. “remediator”)

contractor pollution liability insurance – A Contractors Pollution liability Insurance policy insures the described operations of the named insured against claims for Bodily Injury, Property Damage, Clean-up expenses and defense as a result of a release of a pollutant. For remediation contractors, fungus and mold need to be added to the definition of pollutants by endorsement in most policies. These insurance policies do not have any insurance industry standards. Obtaining the advice of a specialized environmental insurance professional is recommended before purchasing one of these policies.

convection – The transfer of heat through the movement of a liquid or gas.

convection current – The upward movement of air caused by thermal expansion.

crawlspace – The enclosed ground area bounded by foundation walls located beneath an elevated floor, usually not excavated and finished, that allows access to utilities and other services. This is in contrast to basements and slabs on grade.

critical barrier – One or more layers of polyethylene sealed over openings into a work area or any other similarly placed physical barrier. It should be sufficient to prevent airborne contaminants in a work area from migrating into an adjacent area.

cross-contamination – The spread of contaminants from an affected area to an unaffected area.

cubic feet per minute (CFM) – A measure of the volume airflow, or of a substance flowing through air within a fixed period of time. Indoors, CFM is the amount of air measured in cubic feet that is delivered and exchanged in one minute. Along with lift ("Hg or "H_2O), CFM is one of the major methods of determining vacuuming efficiency.

[D]

daily humidity record – A form used to record the temperature and humidity readings taken each day on an extensive water damage restorations job, particularly involving structural drying, to chronicle the progress of restoration from start to finish.

dampers – Controls that vary airflow through an air outlet, inlet or duct. A damper position may be immoveable, manually adjustable or part of an automated control system.

decomposition – Breakdown of material or substance (by heat, chemical reaction, electrolysis, decay or other processes) into parts, or elements or simpler compounds.

decontamination:

1. Disinfection or sterilization of infected articles to make them suitable for use.
2. The use of physical or chemical means to remove, make inactive, or destroy bloodborne pathogens on a surface or item to the point at which they are no longer capable of transmitting infectious materials, and the surface is rendered safe for handling, use or disposal.

decontamination area – An enclosed area adjacent to and connected to a regulated work area. It consists of various rooms, which are used for the decontamination of workers, equipment and materials.

dehumidification – The process of reducing the moisture content of air. cp. "relative humidity"

deodorant – A chemical or gas that covers, modifies, removes or destroys odor causing agents. cp. ", disinfectant, sanitizer, oxidizing agent"

depressurization – A condition that occurs when air pressure inside a structure is lower than air pressure outside.

detergent – A cleaning agent. Usually, the term detergent refers to a prepared compound that may include surfactants, builders, dry solvents, softeners, brighteners, fragrances, etc. but does not include pure soap.

dew point – The temperature at which humidity in air reaches saturation (100% RH) and will condense from that air to form condensation or "dew" on surfaces. Fog (condensed moisture on small particles within the air) forms in air when dry bulb temperature and dew point are within 2^{o}F, plus or minus, of each other.

dilution ventilation – Airflow designed to dilute contaminants to acceptable levels. Also referred to as general exhaust ventilation . cp. " exhaust ventilation "
disinfectant – Any chemical or physical process used on surfaces and objects that destroys more than 99.99% of microorganisms in a specific period of time. Disinfectants kill microorganisms but may not kill all their spores. Descriptions of products of this type generally include the suffix "-cide," meaning to "kill"; e.g., bactericide, fungicide, virucide.
dry bulb temperature – The temperature registered by a thermometer with a dry sensing bulb. cp. "wet bulb temperature"
dry rot – A condition of decomposition of timber in which the composition of the wood is changed by fungal activity, but the wood has not been subjected to water damage or moisture accumulation; associated with activity of the basidiomycete Serpula when water necessary for fungal metabolism is transported form the soil through hyphal structures called rhizomorphs.
drywall – An interior wall or ceiling covering consisting of gypsum (i.e., hydrated calcium sulfate, $CaSO_4 \cdot 2H_2O$) to form a rigid core material sandwiched between cellulosic outer coverings. Brand names include Sheetrock® and **Gyprock**®. cp. “gypsum, plasterboard”
due diligence – Proper care, attention or persistence in doing a thing; such a measure of prudence, activity, or assiduity, as is properly to be expected from, and ordinarily exercised by, a reasonable and prudent person under the particular facts and circumstances.

[E]

encapsulant – A coating or sealant formulated to be applied over an existing substance in a building that will provide a permanent barrier between the coated substance and the living environment. Encapsulants are commonly used in the abatement of asbestos-containing materials and lead based paints as an abatement method because of the relatively lower cost and lesser generation of airborne contaminants and hazardous waste versus removal. Mold should be removed, and should not be encapsulated. Fungicidal coatings and Mold-resistant coatings are used after mold removal. cp. “fungicidal coatings, mold- resistant coatings, encasement”
endotoxin – A lipopolysaccharide molecule that is part of the outer cell wall of gram-negative bacteria. When ingested or respired, or through internal infection (e.g., after abdominal surgery), endotoxins can cause sepsis, leading to fever, changes in white blood cell counts, increased airway resistance, shock, and even death.
engineering controls – Using methods, equipment or containment in such a manner that they limit the exposure of remediation workers and occupants to contaminants and prevent the introduction of contaminants to surrounding uncontaminated areas and contents.
environment – The sum of all external conditions affecting the life of an organism.
Environmental Protection Agency (EPA) – A U.S. federal agency with environmental protection regulatory and enforcement authority. Administers Clean Air Act, Clean Water Act, FIFRA, RCRA, TSCA, and other Federal environmental laws.
EPA Registration Number – A unique compound number assigned by the EPA to individual registered products. The number consists of two parts separated by a dash; e.g., 123-456. The first part designates the registrant; the second identifies the specific product registered by that registrant. An EPA-registration number with three parts indicates a subregistered product. All products which make up pesticidal claims, i.e., biocides and antimicrobials which claim to kill a type of microorganism, are required by law to be EPA-registered and to have the EPA-registration number clearly listed on the product label.
epidemiology – The study of the distribution and determinants (i.e., causes and contributory factors) of diseases and medical conditions in particular populations. Epidemiology is the scientific foundation for public health and as well as the cornerstone for clinical diagnosis, treatment, and prevention of human diseases.
equilibrium moisture content (EMC) – The condition in which the moisture content of a structural material has stabilized in relation to relative humidity and temperature of surrounding air; i.e., no more moisture absorption can occur at that temperature and humidity.
equilibrium relative humidity (ERH) – The ERH is the relative humidity of the air when it is in equilibrium with the built environment (i.e., the air is neither gaining moisture from, nor losing it to the material; or the point at which a hygroscopic material is neither gaining nor losing moisture). cp. “water activity”
equipment decontamination enclosure system – That portion of a decontamination enclosure system designed

for controlled transfer of materials and equipment in or out of a work area. Typically, it consists of a processing area and a holding area.
equipment room – A contaminated area or room that is part of the worker decontamination enclosure system. It has provisions for storing contaminated clothing and equipment.
exhaust ventilation – Mechanical removal of air from a portion of a building (e.g., piece of equipment, room or general area).
exposure – Contact with a substance or environmental condition through one or more routes of entry (inhalation, ingestion, skin absorption) into the body. The Federal Hazard Communication Standard includes both accidental and possible exposures in its definition of exposure. OSHA Standards define "exposure" as the airborne concentration to which a worker would inhale even with the use of a respirator. cp. "TLV."
exposure incident – A specific eye, mouth, other mucous membrane, non-intact skin, or parenteral (puncture or penetration) contact with blood or other potentially infectious material that results from the performance of an employee's duties.

[F]

Fahrenheit (f or F) – A scale for measuring temperature. On the Fahrenheit scale, water boils at 212° and freezes at 32°. Fahrenheit is converted to degrees centigrade (Celsius) by subtracting 32, and multiplying by 5/9ths. cp. "centigrade"
Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) – U.S. federal law administered by EPA under this act require that certain useful poisons, such as chemical pesticides, sold to the public contain labels that carry health hazard warnings to protect users.
Federal Register (FR) – A daily publication of Federal department regulations that are promulgated under a particular law.
fiberglass – Flexible, non-flammable fiber formed by the extrusion of glass filaments, used primarily in drapery fabrics and insulation, and found in structures with rigid flame and sun resistance specifications.
filtering facepiece (dust mask) – A negative-pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.
first aid – Emergency measures to be taken when a person is suffering from injury or overexposure to a hazardous material, before regular medical help can be obtained.
fit test – Use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.
floor covering – Any of several types and constructions of decorative materials that cover floors in homes and businesses, e.g., carpet, sheet vinyl, VCT, etc.
Food and Drug Administration (FDA) – A government agency located in Washington D.C. that under the provisions of the Federal Food, Drug and Cosmetic Act, the US FDA established requirements for the labeling of foods and drugs to protect consumers from misbranded, unwholesome, ineffective and hazardous products. FDA also regulates materials for food contact service, and the conditions under which such materials are approved.
formaldehyde – A pungent, colorless gas (HCHO) that is used in building construction to manufacture compounds and resins found in particle board, paneling and plastics. It enters indoor air through off-gassing from building components. Acute exposures to the relatively low concentrations of formaldehyde measured in residential and workplace settings can cause symptoms of irritation of the mucous membranes of the eyes, nose and throat. Acute exposures to high concentrations in occupational settings are associated with asthma, and chronic exposures of similar magnitude have been associated with increased risk of lung cancer.
friable – Easily crumbled or pulverized. Friable materials are easily suspended in air currents and from there, they may enter the respiratory system of humans.
friable asbestos – Any materials that contain greater than one percent asbestos, and which can be crumbled, pulverized or reduced to a powder by hand pressure. This also may include previously non-friable material that becomes broken or damaged by mechanical force.
fungicidal coatings – EPA-registered antimicrobial sealants designed to deliver antimicrobial activity on pre-cleaned surfaces, while also providing long-term inhibition of fungal growth on treated surfaces. Fungicidal coatings kill residual mold and mildew present after pre-cleaning or the use of a disinfectant sanitizer, and should not be used as encapsulants over active mold growth. cp. "fungicide, mold-resistant coatings"
fungicide – Antimicrobial substances, compounds, or products (often chemical) formulated and used specifically

to prevent, control, or kill fungi. Products which claim to kill organisms must be registered in many countries with a regulatory authority (The USEPA's Antimicrobials Division under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) in the United States; the EU Biocidal Products Directive establishes regulation for both antimicrobial products and other non-agricultural pesticides in European Union member states), and use is restricted to the scope of the product label. cp. "biocides"
fungistat (fungistatic) – A chemical that prevents or inhibits the growth of fungi but does not necessarily kill them or their spores.
fungus (plural "fungi") – The Kingdom Fungi is one of the kingdoms into which living things are categorized. Fungi have distinct nuclei and include a variety of types, such as molds, mildews, yeasts, and mushrooms. Fungi produce spores that range in size generally from 2 to 20 microns. Unicellular fungi are called yeasts. Filamentous fungi formed by long chains of cells (hyphae) are called molds. Macroscopic fruiting bodies of fungi are called mushrooms. Fungi are ubiquitous and are primarily found in moist environments.

[G]

germicide – A compound that kills disease causing microorganisms. Products are regulated and registered by the EPA, and must be used according to label directions: cp. " antimicrobial, bactericide, disinfectant, sanitizer"

grade – The level of the floor covering installation as related to the soil or ground level outside the structure. Below-grade installations may be subject to wetting from ground water infiltrating through walls, due to hydrostatic pressure.

grains (of moisture) per pound (gpp) – A unit for measuring specific humidity, or the weight of moisture in air, expressed as grains per pound (gpp) of dry air. It is determined by use of a psychrometric chart or calculator when *temperature* and *humidity* are known. 7000 grains equals one pound of water, which is approximately one pint (8.34 lb/gal / 8 = 1.043 pints).

gram (g) – A metric unit for mass weight. One gram is about 4/100th of an ounce, or one ounce U.S. is about 28 grams. One pound is 454 grams. One teaspoon of sugar weighs about eight (8) grams.

grams per kilogram (g/kg) – An expression of dose used in oral and dermal toxicology testing of laboratory animals to indicate the grams of substance dose per kilogram of animal body weight. cp. "kilogram"
gypsum (gypsum board) – A widely available chalk-like mineral, $CaSO_4 2H_2O$, consisting of hydrous calcium sulfate. It is used in plaster of Paris and in making plasterboard (drywall, Sheetrock®, gyprock).

[H]

hand protection – Reference to specific types of gloves or other hand protection required to prevent harmful exposure to hazardous materials, or physical (e.g., cutting) hazards.

hazardous material (HAZMAT) – A virgin product or material that has not been recycled or reclaimed, has a use to a user or facility, and meets the definitions of certain DOT classification as defined in the Code of Federal Regulations. A chemical in sufficient quantity or concentration to pose a threat to health or property; or which can cause injury due to its nature, or its properties.

hazardous waste – By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. It possesses at least one of four characteristics: ignitability, corrosivity, reactivity or toxicity.
HEPA filter – **H**igh **E**fficiency **P**articulate **A**ir filter, describes an air filter that removes 99.97% of particles at 0.3 microns in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.
Hepatitis – A disease of inflammation of the liver caused by acute or chronic infection with certain viruses or other pathogens. Viruses associated with human hepatitis include Hepatitis A (acute), B and C (chronic), and others (currently designated D through G).
humidity – The measure of moisture in the atmosphere. From an air quality standpoint, humidity in a built environment should be maintained between 30 and 50%, according to the CPSC. Excessive humidity is encountered above 60% relative humidity, with humidity above 70% creating an atmosphere that is conducive to rapid microorganism growth.
humidity gradient – The relative humidity in a boundary layer of air over a surface, with humidity nearest the

surface layer being 100%, then 99% in the next layer, 98% and so on, until it merges with the RH of ambient air.
HVAC system – **H**eating, **Ve**ntilating, **A**ir **C**onditioning system (often pronounced "H-vac"). cp. "air conveyance system"
hydrogen peroxide (H_2O_2) – A colorless, heavy, strongly oxidizing liquid. An unstable compound, capable of reacting explosively with combustibles and used principally in aqueous solution as an antiseptic, bleaching agent, Oxidizing agent, and laboratory reagent. Bleach normally used in a three percent (3%) solution for disinfecting.
hydrostatic – Relating to pressures exerted by fluids (e.g., water may exert hydrostatic pressure on below-grade exterior walls and slab subflooring, eventually causing flooring installation or IAQ problems, or even water damage claims. This usually indicates that the water table is higher than the slab.).
hygrometer – Any of a variety of instruments used for measuring the humidity in air. cp. "moisture meter"
hygroscopic – A material that readily absorbs and retains moisture or water vapor from air. cp. "humectant"
hypersensitivity – An exaggerated response by the immune system to an allergen. Often used incorrectly to describe individual health effects that are different or of greater magnitude than those observed in most individuals in response to exposure to the same substance or environmental condition.
hypersensitivity diseases – A group of respiratory diseases, including humidifier fever, that involve inflammation of the lungs following exposure to animal antigens or other biologicals. Most forms of hypersensitivity diseases are thought to be caused by an allergic reaction triggered by repeated exposures to these contaminants. Hypersensitivity diseases clearly associated with indoor air quality are asthma, rhinitis, and hypersensitivity pneumonitis. Humidifier fever may be an exception, distinguished from other forms of diseases by the fact that it does not appear to involve an allergic reaction.
hypersensitivity pneumonitis (HP; extrinsic allergic alveolitis) – A disease of the lung tissue (parenchyma) resulting from immunological sensitization to high concentrations of inhaled organic biological dusts and also certain low molecular weight chemicals. The acute form of the disease is characterized by fever, cough, shortness of breath, and muscle aches 4-12 hours of exposure, with symptoms remitting within hours to days. A sub-acute and chronic form of disease with exposure to lower concentrations of antigens may result in a more insidious onset of shortness of breath and fibrosis of the lungs. Examples of HP diseases due to specific occupations include farmer's lung, bird-breeder's lung, and maple bark stripper's lung. Confirmed cases of HP occurring in mold-contaminated indoor, non-industrial environments are rare. See Health Effects chapter.
hypochlorite – A salt or ester of hypochlorous acid (HOCl). The active bleaching and disinfecting ingredient in liquid chlorine bleach. cp. "sodium hypochlorite"

[I]

idiopathic environmental intolerance (IEI) – A WHO term created to describe multiple chemical sensitivity (MCS).
immediately dangerous to life or health (IDLH) – NIOSH terminology for any atmosphere that poses an immediate hazard to life, or produces an immediate, irreversible debilitating effect; an international term that expresses, in parts per million, a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects, or prevent escape from such an environment." (NIOSH June 1997). OSHA's IDHL definition for respiratory protection reads "An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere." (OSHA 29 CFR 1910.134)
immediately dangerous to life or health (IDLH) – NIOSH terminology for any atmosphere that poses an immediate hazard to life, or produces an immediate, irreversible debilitating effect; an international term that expresses, in parts per million, a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects, or prevent escape from such an environment." (NIOSH June 1997). OSHA's IDHL definition for respiratory protection reads "An atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere." (OSHA 29 CFR 1910.134)
immunocompromised individual – A person in whom one or more parts of the normal immune system is affected by a specific disease or condition, such that the person is at increased susceptibility to acquiring certain infections or otherwise defending the body against the effects of certain foreign substances. Common examples of diseases which cause immunocompromised states include: AIDS; effects of chemotherapy on bone marrow;

multiple myeloma; Hodgkin's disease; and inherited immunoglobulin deficiencies.
incubation:

1. Maintaining cultures of microorganisms at a temperature favorable to their growth.
2. The period between the infection of an individual by a pathogen and the manifestation of the disease caused by that microorganism.

indoor air – The breathing air inside an inhabited structure.
inches of water lift – A measurement of vacuum efficiency (suction); cp. "water lift"
indoor air quality (IAQ) – A term used to describe the "purity" or quality of the air breathed by occupants of an indoor or enclosed environment.
indoor air pollution (IAP) – A term used to describe an indoor environment that has pollutants in it.
Indoor Air Quality Association (IAQA) – An association located in Rockville, MD that provides education and training in indoor air quality to its members, (301-231-8388).
Indoor Environmental Institute (IEI) – A non-profit organization that provides certification for indoor environmental consultants.
indoor environmental professional (IEP) – An individual who is qualified by knowledge, skill, education, training, certification and experience to perform an assessment of the fungal ecology of structures, systems and contents at a job site, create a sampling strategy, sample the indoor environment and submit to an appropriate laboratory, interpret laboratory data and determine Condition 1, 2 and 3 for the purpose of establishing a scope of work and verifying the return of the fungal ecology to Condition 1.
indoor environmental quality (IEQ) – A term used to describe the quality of the indoor or enclosed environment including the purity of the air and the cleanliness or sanitary state of environmental surfaces or materials.
Indoor Environmental Standards Organization (IESO) – An organization located in Rockville, MD that writes standards, (800-406-0256).
industrial hygienist (IH) – A professional qualified by education, training and experience to anticipate, recognize, evaluate and develop controls for occupational health hazards.
infection – A condition in which pathogens have entered the body and produced an adverse reaction.
inorganic – Composed of matter other than that derived from plants or animals, i.e., mineral. Not organic.
inspection – An inspection is the gathering of information regarding the mold and moisture status of the building, system, contents or area in question.
Institute of Inspection, Cleaning and Restoration Certification, Inc. (IICRC) – An international, non-profit, industry-controlled certification and standard setting organization providing certification through education for the professional inspection, cleaning and restoration service industries: 360-693-5675; FAX 360-693-4858; iicrc@iicrc.org; web page - www.iicrc.org
International Standards Organization (ISO) – An organization made up of experts from various scientific disciplines that represent many countries. The ISO meets every 18 months to establish internationally acceptable standards for testing a wide range of goods and materials.
inventory – A listing or tabulation of items comprising a category (contents, parts, customer goods) of property.
irritant – A substance which, by contact with the eye, skin or respiratory system during a single exposure or multiple exposures, in sufficient concentration for adequate time, causes or is capable of causing an inflammatory response typically as a result of the toxicological effects of that substance directly on the contacted organ(s). Some substances with irritant properties can also produce toxicological or immunological effects on the same or other organ systems with higher exposures (dosages).

[J]

[K]

Kilogram (kg) – A metric unit of weight, equivalent to approximately 2.2 U.S. pounds. cp. "g/kg, "g, "mg"

[L]

laminar airflow – The flow of air along a defined path
lift – One of several ways of evaluating vacuum efficiency. cp. "vacuum pressure"

limitations – The act of limiting or the state of being limited constrained or restricted. A “limitation” is a restriction that is placed upon the remediator that results in a limit on the scope or on the remediation activities.
liter (l) – A metric unit of capacity. A liter is a little more than one quart (one liter = approx. 33.8 oz. and approx 3.78 liters = one U.S. gallon).
loss assessment – The process of collecting the necessary data to make an evaluation of a loss. This can include, but may not be limited to: interviews, site inspection, and physical and instrumental measurements.

[M]

m^3 – Cubic meter. A metric measure of volume, about 35.3 cubic feet, or 1.3 cubic yards.
make-up air - Air that is brought into a building from outdoors through the ventilation system, and that has not been circulated previously through the building's HVAC system.
manometer – An analog or digital instrument that measures the static air pressure differential between two or more adjacent areas.
materially interested parties – An individual or entity substantially and directly affected by the mold remediation project.
Material Safety Data Sheet (MSDS) – Document that chemical manufacturers shall supply with their hazardous products to describe the chemical's general properties, its hazards, first aid and medical treatment for exposures, and how to safely use, handle and store it.
may – When the term *may* is used in this document, it signifies permission expressed by the document, and means that a referenced practice or procedure is permissible within the limits of this document, but is not a component of the accepted “standard of care” to be followed.
mesophilic – Able to grow under moderate temperature and humidity (moisture) conditions (e.g., certain fungi).
metabolite – Any substance produced in or by biological processes.
Meter (m) – A unit of length in the metric system measure of volume.
microbe (microorganism) – An extremely small life form that usually is visible only with the aid of a microscope (e.g., animals, protozoa, algae, bacteria, fungi, virus, etc.).
microbial ecology – The science that examines the relationships between microorganisms and the biotic and abiotic environment.
microbial volatile organic compound (MVOC) – Musty, moldy, or mildewy odors produced by metabolically active bacteria and fungi. MVOCs are primarily a number of alcohols and include such compounds as geosmin and 1-octen-3-ol. Although health effects have not been attributed to MVOC exposures, their presence is an indicator of microbial growth and the need for proper remediation practices and the use of PPE.
microbiological sampling – A method of analyzing small biocontaminants in air, water or on surfaces. Complications arise in microbiological sampling based on the season of the year, variable humidity, variable environmental activities (indoor and out) and the need to use specific culture media to test for specific types of biocontaminants.
microclimate – The climate of a small, specific place within an area as contrasted with the climate of the entire area.
micron (μ) – Micrometer. A metric unit of measure that is equal to one millionth of a meter and is used commonly in particle measurement. A micron is approximately 1/25,400 of an inch.
microgram (μg) – One millionth of a gram: e.g., μg/m^3 = micrograms of dust per cubic meter of air.
migration – Gradual movement of moisture, usually on a horizontal plane, as it is absorbed by materials outward from its source or point of origin. cp. "wicking"
mil – A measure of thickness usually describing vinyl wear layers, plastic film, trash bags, or liners. One mil equals one one-thousandth (1/1000) of an inch.
mildew – A white growth on plant surfaces produced by parasitic fungi. cp. "fungi"
mildewcide – Any of various products used to retard or prevent the growth of mildew. Widely used compounds include benzoic acid, formaldehyde, cresols, phenols and organic derivatives or salts of copper, zinc and mercury. cp. “Fungicide”
mildewstat – Any of various products used to limit or control growth of mildew (i.e., mold). cp. “fungistat”
milligram – A metric unit of measurement. There are 1,000 milligrams in one gram (g) of a substance. cp. "gram"

milligrams per cubic meter (**mg/m^3**) – A metric weight/volume ratio used to express concentrations of dusts, gases, fumes or mists in air.
milligrams per kilogram (**mg/kg)** – A metric weight ratio used to express toxicological doses. cp. "g/kg"
mini-containment (enclosure) – Small confined areas that may be used where glove-bag enclosures are not feasible. The use of mini-enclosures should be approved by a project manager. They should be constructed using 6-mil polyethylene that is attached or glued to walls or floors, and they should be small enough for only one worker who can enter the enclosure at a time, complete the remediation work and pass out the containerized debris. The worker should have available a change room contiguous to the work area where he can clean his coveralls prior to leaving the area.
mitigation:

1. Measures taken to reduce adverse effects on the environment.
2. "Reasonable and prudent" steps taken under the terms of an insurance policy to limit loss (preserve, protect and secure property from further damage).

moisture content (MC) - The percentage or weight of moisture in materials, as compared to the weight of that material when completely dry (oven dried).
moisture detector – An instrument that has two stainless steel probes designed to penetrate the primary and secondary backing of carpet. When moisture is encountered in the carpet, cushion or subfloor materials, a circuit is completed between the two probes and a light or buzzer will sound to indicate the presence of that water.
moisture meter – An electronic moisture sensing device used to measure the internal moisture percentage of various construction materials, such as wood, gypsum board, masonry, etc. There are two general categories of moisture meters: *penetrating and non-penetrating.* Penetrating meters use sharp pins or probes that are inserted into materials to measure the moisture percentage contained therein. Non-penetrating meters transmit electrical impulses into the material and measures resistance in order to electronically determine moisture content. Different settings on non-penetrating meters enable technicians to detect moisture in materials of various densities; i.e., wood, drywall, masonry; however, absorption or direct contact with the moisture and the material being tested is required for accurate readings from non-penetrating moisture meters. cp. "hygrometer, moisture detector"
mold – Molds are a group of microscopic organisms that are a part of the kingdom Fungi. They generally reproduce by means of spores and are ubiquitous. In nature, most molds are an essential part of the ecosystem to degrade organic materials, and are harmless or beneficial to humans and other animals with whom they may have contact. A few such molds under certain conditions are potentially allergenic, infectious, or toxic to humans and other animals. Growth and dissemination of certain types (taxa) of mold and their spores in indoor (building) environments as a result of water intrusion onto certain building materials can degrade materials and presents certain unique health risks to humans.
Often, the terms mold and fungi are used interchangeably. cp. “fungus”
mold-resistant coatings – Coatings and sealants that contain EPA-registered antimicrobials intended to inhibit mold growth on or in the coating film. Mold-resistant coatings should not be used as encapsulants over active mold growth, but are intended for use after mold removal. cp. “fungicidal coatings”
molecule – The smallest unit into which matter may be subdivided and still maintain the original characteristics of that substance.
multiple chemical sensitivity (MCS) – A recurrent disorder in which selected individuals report an array of symptoms, involving multiple organ systems, after perceived or actual exposure to very low concentrations of certain common environmental chemicals or other agents, sometimes including mold. The symptoms, which may be disabling, are characteristically not corroborated through physical examination or standard diagnostic testing methods by a physician. The disorder is usually acquired after an initial (often acute) environmental exposure or injury.
mycelium – The mass of hyphae that is the vegetative form of a fungus.
mycotoxin – A potentially harmful naturally occurring, secondary metabolite produced by some fungi, especially molds. Some mycotoxins are beneficial to humans or other animals, e.g., Penicillin produced by certain taxa of *Penicillium*. Other mycotoxins are potentially toxic or fatal with even small doses, e.g., liver toxicity from ingestion to aflataxoins produced by *Aspergillus flavus.* Many of the taxa of molds commonly identified as colonizing on water-damaged building materials (e.g., *Stachybotrys chartarum, Aspergillus versicolor,*

Trichoderma) and which are associated with building-related health effects are known to produce one or more classes of mycotoxins in both the surface growth structures (hyphae) and reproductive structures (conidiophores and spores). The role and mechanism by which these mycotoxins (particularly the class known as trichothecenes) may cause adverse health effects in occupants of water-damaged, mold-contaminated buildings presently is incompletely understood. See Health Effects chapter.

[N]

NADCA – **National Air Duct Cleaners Association** (NADCA) – An association located in Washington DC that provides education and training to its members, writes standards for air duct cleaning (ACR 2006) and is a certifying body.(202-737-2926).

National Institute for Occupational Safety and Health (NIOSH) – An agency of the Public Health Service, U.S. Department of Health and Human Services (DHHS) located in Washington D.C. A Federal agency that recommends occupational exposure limits for various substances, and assists OSHA and MSHA in occupational safety and health investigations and research.

natural law – A law or body of laws that derives from nature and is believed to be binding upon human actions apart from or in conjunction with laws established by human authority.

natural ventilation – Air movement through a structure caused by wind, temperature difference (convection currents), or other non-mechanical factors.

negative air machine (NAM) – A machine used to establish negative pressure in an indoor space.

negative pressure – A condition that exists in a building when less air is supplied to a space than is exhausted from that space, so that the air pressure within that space is less than that in surrounding areas. cp. "positive pressure, static pressure"

nonporous – A material that does not absorb, nor is it easily penetrated by liquids, especially water. Generally, non-porous materials have a permeance factor of less than one. cp. "porous"

normal fungal ecology (Condition 1) – An indoor environment that may have settled spores, fungal fragments or traces of actual growth whose identity, location and quantity are reflective of a normal fungal ecology for a similar indoor environment.

[O]

Occupation Safety and Health Administration (OSHA) – A Federal regulatory agency (division of the U.S. Department of Labor) located in Washington D.C. with safety and health regulatory and enforcement authority for most U.S. workplaces.

occurrence based insurance coverage – An insurance policy written on an occurrence basis pays for losses that occur during the policy period, regardless of when they are reported. General Liability and Contractors Pollution Liability policies are available on an Occurrence Basis. In general, occurrence based policies offer many advantages to the insurance buyer. If given a choice, Occurrence-based policies are preferable to Claims Made policies.

olfactory – Relating to the sense of smell. The olfactory nerve endings (epithelium), located in the nasal cavity, sense and transmit the sensation of smell to the olfactory lobe, located at the base of the frontal lobe of the brain. The olfactory lobe interprets the sensation of odor and transmits that information to the brain.

on grade – On the level of the surrounding ground or in contact with fill material that is in direct contact with the ground; e.g., "on-grade construction."

open drying system – A water damage drying situation in which outside humidity is low (<50% RH) and, therefore, windows or doors may be opened in order to exchange (weather conditions permitting) humid air inside the structure with air outside the structure that is much lower in relative humidity. cp. "closed drying system"

organic – Of, related to or arising in a bodily organ; materials or chemicals containing carbon atoms. Substances derived from living organisms (plant or animal).

organic vapor respirator – A respiratory protection device that employs cartridges (activated carbon) capable of removing most organic solvent vapors from respired air. cp. "respiratory protection"

organism – An individual animal or plant life form.

oriented strand board (OSB) – A particle panel composed of strand-type flakes that are aligned in directions to make the panel stronger, stiffer, and with improved dimensional properties.

overexposure – Exposure to a hazardous material beyond allowable exposure levels.
oxidizer – see "oxidizing agent"
oxidizing agent (oxidizer) – A chemical compound that readily transfers oxygen atoms or a substance that gains electrons in a redox chemical reaction
oxidizing bleach – An agent that removes color by adding oxygen to a chromophore or portion of the molecule responsible for color - rendering it colorless (e.g., benzoyl peroxide, sodium perborate, hydrogen peroxide, sodium hypochlorite). cp. "oxidizing agent"
oxygen deficient atmosphere – Any atmosphere with an oxygen content below 19.5% by volume.
ozone (O_3) – A powerful oxidizing agent formed by combining oxygen molecules (O_2) with an additional atom of oxygen, which reaction yields O_3 or ozone gas.

[P]

parasitic fungi or bacteria – Microorganisms that obtain their food by absorbing minerals, sugar and moisture from the living material (plant or animal host) on which they grow.
particulates – Fine liquid (other than water) or solid particles such as dust, smoke, mist, fumes and fog found in air and emissions.
parts per billion (ppb) – A unit for measuring the concentration of a gas or vapor in air, expressed as parts of the material per billion parts of air. Ppb is usually used to express measurements of extremely low concentrations of unusually toxic gases or vapors. The term is used also to indicate the concentration of a particular substance in a liquid or solid. To place this measurement in perspective, one part per billion is analogous to one second every 32 years, or one penny out of $10,000,000.
parts per million (ppm) – A unit for measuring the concentration of a gas or vapor in air, expressed as parts of the material per million parts of air. Ppb is used also to indicate the concentration of a particular substance in a liquid or solid. To place this measurement in perspective, one part per million is analogous to one inch in sixteen miles; or one penny out of $10,000.
pasteurization – A process to eliminate pathogens and reduce the overall concentrations of microorganisms by maintaining specific temperature and duration in a substrate, often approximately 68 C for 30 minutes.
pathogen – A specific microorganism, such as a bacterium or virus, that causes disease in humans, animals or plants; e.g., influenza, chicken pox, measles, pulmonary tuberculosis, small pox (adj. pathogenic). Although an infected individual is usually the source of most pathogens, many are communicated by airborne transmissions.
Penicillium – Any of a genus of saprophytic fungi (blue-green molds) that commonly are found on moist, non-living, organic matter (e.g., bread, fruits). Generally, *Penicillium* relatively low moisture (water activity) and moderate temperature for optimum growth.
Permissible Exposure Limit (PEL) – OSHA's maximum allowable (usually inhalational) limit for a substance to which a worker may be exposed (usually expressed as a time-weighted average over the course of an 8-hour work day) to prevent adverse health effects in most of the workers exposed to that substance. Substances and conditions, including mold growth and other IAQ contaminants, in non-industrial workplaces or any residential settings are not regulated by PELs.
peroxide – Any of several oxidizing compounds, but usually a reference to hydrogen peroxide (H_2O_2). cp. "hydrogen peroxide"
personal property – Articles that are moveable and are separate from the structure, e.g., contents.
personal protective equipment (PPE) – Safety items designed to prevent exposure to potential hazards. Examples include: respirators, gloves, goggles, protective clothing and boots.
pesticide – A substance intended to control, prevent the growth of, or kill a pest, except for those found on or in humans or animals. Included are insecticides, rodenticides, herbicides, bactericides, fungicides, and virucides. Some pesticides adversely affect the color or fastness of dyestuffs. cp. "biocide"
plaster – A powder mixed with sand and water and applied over a plaster base to form a hard finish surface on walls and ceilings; also, the surface itself.
plaster board – Wallboard made of a core of gypsum sandwiched between surface coatings, usually paper. cp. "gypsum board"
plenum – see "air plenum, air conveyance system"
porous (porosity) – The measure of the void spaces in a material, and is measured as a fraction, between 0–1, or

as a percent between 0–100%. The porosity of a material determines its permeability or ability to allow liquids or gases to pass through. Porous is the state of having porosity. Permeable; having the ability to allow liquids or gases to pass through.

positive pressure – A condition in which more air is supplied to a space than is exhausted; thus, the air pressure within that space is greater than that in surrounding areas. cp. "negative pressure, static pressure"

post-remediation – Following remediation; after the removal of contaminants and contaminated materials.

post-remediation evaluation – An inspection performed by a remediator after a remediation project, which can include visual and olfactory methodologies to confirm that the remediation process has been completed.

post-remediation verification – An inspection and assessment performed by an IEP after a remediation project, which can include visual, odor detection, analytical testing or environmental sampling methodologies to verify that the structure, system or contents have been returned to Condition 1.

powered air-purifying respirator (PAPR) – An air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

preliminary determination – A conclusion drawn from the collection, analysis and summary of information obtained during an initial inspection and evaluation to identify areas of moisture intrusion and actual or potential mold growth.

pre-remediation assessment – The determination by an IEP of Condition 1, 2, and 3 for the purpose of establishing a scope of work.

pre-remediation inspection – The inspection by a remediator to implement or verify the remediation protocol by ascertaining work site conditions and the extent of work site preparation and to establish project scheduling.

pre-remediation sampling – A preliminary inspection creating a sampling strategy and performing sampling services in order to establish Condition 1, 2 and 3 of structures, systems and contents.

presumed asbestos containing material (PACM) – Material that can be presumed to contain asbestos based on age of building or material type. cp. “asbestos containing material”

prevalent level samples – Air samples taken under normal conditions; also known as ambient background samples.

primary damage – Damage sustained as a result of direct contact with contaminants (water, soot, fire, body fluids, etc.). Examples include: staining, swelling, dissolving, cupping and buckling of hardwood, delamination of furnishings and fixtures, migration of dyes, weakening of adhesives, rusting or corrosion, microbial contamination, etc. cp. "secondary damage"

principles of drying – Underlying, broad-based, general principles that guide and support professional drying. There are four general principles are: extraction, promoting evaporation, promoting dehumidification and controlling temperature. (ref. IICRC S500)

professional errors and omissions liability insurance (E&O) – A professional liability policy insures claims that arise out of the named insured’s described professional services. In general, this is very broad insurance coverage if the appropriate description of the insured professional services is used. Professional E&O polices are sold separately, or as a coverage part in package insurance policies along with General Liability and Contractors Pollution Liability coverage parts. Underwriters usually only sell professional liability insurance to degreed professional service providers.

Property Loss Research Bureau (PLRB) – A trade association of property and casualty insurers whose mission is to provide cutting-edge claims-oriented information to its members and the industry.

psychrometric chart – A chart consisting of lines and curves that shows the relationship between air volume, temperature and relative humidity, and from which a variety of other information (specific humidity, dew point, vapor pressure, wet bulb temperature, etc.) relating to drying may be determined. (ref. IICRC S500)

psychrometry – The study of the relationship between air, humidity and temperature, and their effect on various materials and comfort levels (adj. - psychrometric; ref. IICRC S500).

pulmonary – Relating to, or associated with, the lungs.

putrefaction – Decomposition of organic matter, especially the anaerobic splitting of proteins by bacteria and fungi, with the resulting formation of foul smelling gases resulting from incomplete oxidation.

[Q]

quality control –Activities by remediators that are designed to assure the effectiveness of a remediation process.

quaternary ammonium chloride ("quat,"”QAC”) – A cationic surfactant used primarily to disinfect (usually in 0.4 to 1.6% concentrations) or sanitize. Quats may destroy microorganisms by rupturing their cell walls, or interrupting cellular metabolism, or via a combination of these actions. They also are used as antistats and softening agents. cp. "disinfectant"

[R]

recommended – When the term *recommended* is used in this document, it means that the practice or procedure is advised or suggested.
relative humidity (RH) – The relationship between air volume and the amount of moisture it holds at a specific temperature expressed as a percentage of that air's total moisture holding capacity; i.e., the amount of moisture in a given volume of air, expressed as a percentage of the total moisture holding capacity of that volume of air, at a given temperature. As temperature increases, humidity "relative" to total air volume decreases; conversely, as temperature decreases, RH increases. cp. "specific humidity, vapor pressure"
remediation – the process of removing contamination consistent with this Standard.
remediation contractor – the remediation company or firm that is responsible for the remediation project.
remediation supervisor – an individual trained to supervise work being conducted by remediation workers.
remediation worker – A trained individual who works for a company that provides remediation services.
Remediator – when the term “remediator” is used in the S520, it refers to either the remediation contractor or the remediation worker.
reservoir – The "container" in which microorganisms grow and develop. Most biopollutants, for example, are found in reservoirs such as standing water or decaying matter.
respiratory protection – Referring to one of several pieces of personal protective equipment intended to prevent or reduce inhalation of one or more airborne contaminant(s).
respiratory system – Of or pertaining to the parts of the body concerned with the intake, exchange, and removal of oxygen into and from the body. This includes the lungs, trachea, mouth and nose.
restorative drying – The removal of water and excess moisture and humidity from a structure and damaged materials following an unwanted release or infiltration of water from several possible sources, and returning that structure and its components and contents to a pre-damage state of moisture content and humidity. There are four principles involved in restorative drying: mechanical extraction of excess water; promotion of evaporation through air movement; temperature control, and dehumidification. cp. "principles of drying"
restore – To return to a normal, former or pre-damage state.
restorer – The contractor or firm that is responsible for the restoration of damaged structures or contents.
Restricted Use Pesticide (RUP) - A biocide/pesticide that requires technician training and licensing, usually by the state or province, before application is permitted.
revolutions per minute (rpm) – A measurement of speed.
risk – The probability of injury, disease or death under specific circumstances. In quantitative terms, risk is expressed in values ranging from zero representing the certainty that harm will not occur to one representing the certainty that harm will occur.
risk assessment:

1. The use of factual information to define the nature and impact of an adverse effect from exposure of individuals or populations to hazardous materials and situations.
2. The quantitative or qualitative evaluation to determine the probability of an adverse effect to human health or the environment by the presence or potential presence or use of specific pollutants.

risk communication – The exchange of information about health or environmental risks between risk assessors, risk managers, the general public, and other interest groups such as the news media.
risk management – The process of evaluating alternative responses to risks and selecting among them. Risk Management includes consideration of technical, scientific, social, economic and political information.
routes of exposure – The means by which a substance may gain entry into an organism, such as inhalation, ingestion and skin absorption (and technically, intravenous, subcutaneous, and intramuscular injections).

[S]

S500 – IICRC Standard and Reference Guide for Professional Water Damage Restoration, Third Edition

published in 2006.
sanitation – The control of physical factors in the human environment that could harm development, health or survival. The process of bringing an environment to a state that will not harm human health.
sanitizer – Any chemical, physical process, or condition applied to a surface or environment that creates a condition of acceptable health risk EPA considers an antimicrobial to be a sanitizer when it reduces, but does not necessarily eliminate, the microorganisms on a treated surface. Sanitizers used on non-food contact surfaces must reduce the number of microbes by at least 99.9% within a specified time limit. Products must prove control of a required set of microorganisms under specified conditions before they can claim to be sanitizers. Products are tested using AOAC test methods as designated by the EPA. Some sanitizing products, as approved by the appropriate regulatory authority and as delineated on a product's approved label, may be usable in mold remediation and restoration on some porous and semi-porous structural surfaces and materials (as well as some contents). Descriptions of products of this type may include the suffix "-stat," meaning "to prevent, limit or control"; e.g., bacteriostat, fungistat. cp. "sterilize, disinfect"
saprophytic (fungi or bacteria) – Those organisms which live on decaying or decomposing organic plant matter. They secrete digesting enzymes to break down organic molecules, and absorb the products of digestion for continued growth.
saprophyte – Fungi or bacteria that live on dead or decaying organic plant matter. cp. "parasitic"
scope of work – The work plan or protocol for the remediation project. It identifies who will be responsible for the various components of the plan and how it will be implemented.
secondary damage – Damage to materials or contents sustained from indirect or prolonged exposure to disaster contaminants; e.g., migrating or absorbed moisture or humidity, mold growth, acid residue discoloration, etc. cp. "primary damage"
self-contained breathing apparatus (SCBA) – An atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user; a respiratory protection device that consists of a supply (tank) or a means (air hose) of supplying respirable air or oxygen; or an oxygen generating material. Any of these must be carried by the wearer.
sensitization – A change in the body's immunological response to the presence of a foreign substance (antigen). Depending on the nature of the antigen and the route of exposure, sensitization may result in an allergic versus other type of immunological hypersensitivity response manifested in one or more organ systems. Examples include: sensitization to grass pollens resulting in allergic rhinitis; sensitization to peanut proteins in small children resulting in anaphylaxis; and sensitization to proteins of thermophilic bacteria in wet hay resulting in farmer's lung.
shall – When the term *shall* (previously "must") is used in this document, it means that the practice or procedure is mandatory due to natural law or regulatory requirements, including occupational, public health and other relevant laws, rules or regulations, and is therefore a component of the accepted "standard of care" to be followed.
short-term exposure limit (STEL) – Toxicity terminology that refers to short exposures to a TLV for 5-15 minutes, generally not to be exceeded more than four times per day.
should – When the term *should* (previously "highly recommended") is used in this document, it means that the practice or procedure is a component of the accepted "standard of care" to be followed, while not mandatory by regulatory requirement.
sick building syndrome (SBS) – A term developed in the 1970s that describes a constellation of unexplained respiratory and non-respiratory symptoms experienced by a disproportionately large number of occupants of a building that occur only when they are inside the building, and which resolve immediately or soon after leaving the building each time. Extensive research on the etiology of SBS has been conducted over the past 35 years. Increasingly the cause of SBS in many commercial and residential buildings has been found to be related to water intrusion and mold contamination. See Health Effects chapter; cp building-related illness; building-related symptoms.
sodium hypochlorite – Chlorine bleach (NaClO)
species (sp) – Taxonomic classification of organisms below the level of genus, as Latin or Greek derivations, species names are written in italics and includes both the genus name and species epithet.
specific humidity – The weight of suspended moisture in air expressed in grains per pound (gpp) of dry air (14 cubic feet of dry air equals one pound). 7000 grains of water vapor equals one pound (1.043 pints) of water. As

specific humidity changes, there is a corresponding change in vapor pressure. cp. "relative humidity, grains per pound, vapor pressure"

splash goggles – Eye protection made of a corrosion resistant material that fits snugly against the face, and has indirect ventilation ports.

spore – A dormant, usually unicellular, reproductive propagule from which fungi or bacteria germinate when appropriate growth conditions are present. Spores are bodies that permit survival of a microorganism during unfavorable growth conditions (food source, temperature, moisture). Inhalation of spores can cause allergic reactions or other health problems in sensitive persons.

sporicide – An agent that has the ability to control or destroy the microbial spores that germinate into bacteria or fungi, when used according to label directions. Products which claim to kill organisms must be registered in many countries with a regulatory authority (such as the EPA in the United States). cp. "bactericide, biocide, fungicide, disinfectant"

stack effect – Stack effect is the movement of air into and out of buildings, chimneys, flue gas stacks, or other containers, and is driven by buoyancy. Buoyancy occurs due to a difference in indoor-to-outdoor air density resulting from temperature and moisture differences. In larger buildings the stack effect can overpower the mechanical system and disrupt normal ventilation and circulation.

Stachybotrys chartarum – A black mold associated with prolonged water damage of building materials, particularly cellulosic materials, such as wallpaper, wallboard, and ceiling tiles. Most strains of *Stachybotrys* are capable of producing trichothecene mycotoxins.

standard of care – Practices that are common to reasonably prudent members of the trade who are recognized in the industry as qualified and competent.

-stat - A suffix meaning to limit or control growth, as in fungistat, bacteriostat, etc. cp. "-cide"

static pressure – A condition in which an equal amount of air is supplied to and exhausted from a space. This produces equilibrium. cp. "positive pressure, negative pressure"

sterilize – Use of a physical or chemical procedure to destroy all microbial life including highly resistant bacterial endospores. cp. "disinfectant, sanitizer"

structural pasteurization – An engineered process in which high temperatures are introduced to a structure or portion of a structure for the purpose of reducing bio-organisms to acceptable levels without damage to the structure.

subfloor – The surface laid across floor joists and beneath the finish flooring or "decking" material.

substrate – A layer of material or substance below the surface. The substrate may refer to the backing system to which pile yarns are attached or inserted. Generally, the term substrate refers to the subflooring material directly beneath an installed carpet and cushion.

supplied-air respirator (SAR) or airline respirator – Per OSHA and NIOSH an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

[T]

T-flap door – A doorway closure designed to minimize airflow between two areas. A T-flap can be constructed while erecting containment by cutting an upside down ‘T’ into the polyethylene barrier and covering the opening with another polyethylene sheet.

thermal – Pertaining to heat or temperature.

thermal death time (TDT) – The amount of time required at a particular temperature to kill a specified number of organisms.

Threshold Limit Value (TLV®) – A term used by the ACGIH to express the airborne concentration (ppm) of a material to which *nearly* all persons can be exposed day after day without adverse health effects; occupational exposure limit (OEL) is an equivalent term.

tight-fitting facepiece – A respiratory inlet covering that forms a complete seal with the face.

toxicity – The sum adverse effects resulting from exposure to a material, generally through the mouth, skin or respiratory tract.

toxic substance – Any chemical or agents containing one or more such chemicals that, with sufficient exposure can cause acute or chronic injury to the human body resulting from a chemical reaction with one or more organ systems.

toxin – A chemical agent capable of producing a toxicological (“poisonous”) response in a human or other animal. Toxins can be chemical or biological, natural or man-made in origin. cp. “endotoxin, mycotoxin”

triple-flap door – A pass-through door way designed to minimize airflow between areas of a building. A triple-flap door consists of three layers of polyethylene that cover an opening in the containment area.

Tyvek® – Registered trademark of DuPont for spun-bonded, high-density, non-woven fabric made of fused fibers and used for wall coverings or wall paper backings, protective clothing, vacuum filter bags, and other uses.

[U]

ultraviolet (UV) light – Light at the violet end of the light spectrum that is normally not visible to the human eye. UV light waves are shorter than visible light waves and longer than X-rays.

Ultra-low Particulate Air (ULPA) – 99.997% efficient filters remove particles at 0.13 microns in diameter.

Underwriters Laboratory (UL) – An organization that tests manufactured products for safety and either approves or disapproves them for their intended use with authorization to use the label "UL approved." cp. "Canadian Standards Association"

unsanitary water – Water that is non-potable (not fit for human consumption) and usually contains chemicals or microorganisms that would cause sickness or disease. cp. "categories of water"

[V]

vacuuming – The act of removing particles or moisture from a surface by means of mechanical suction combined with airflow.

vapor – The gaseous form of a solid or liquid substance formed as it evaporates at atmospheric temperature and pressure.

vapor barrier – Materials or coatings through which moisture cannot easily pass (perm factor of one or less). Vapor barriers may exist in the form of plastic sheeting, vinyl floor coverings, floor finishes (e.g., polyurethane), or even paint.

ventilation:

1. Air exchange from one area to another, usually from inside to out. Circulating fresh air to replace contaminated air.
2. Air entering a building through open windows or doors or drawn by fans from inside or outside the built environment.

ventilation rate – The rate at which outside air enters and leaves a building. It is expressed in one of two ways: the number of changes of outside air per unit of time (air exchanges per hour, or "ACH"), or the rate at which a volume of outside air enters per unit of time (cubic feet per minute, or "CFM").

virus – Parasitic submicroscopic organisms (0.03-0.25 microns) that lack the energy generating enzyme systems necessary to reproduce independent of living host cells. Most viruses and some bacteria and fungi are pathogenic - able to cause disease in humans. There have been over 120 viruses identified from human feces and urine. Sewage viruses include: *rotavirus*, causing severe diarrhea (life threatening in children), *hepatitis A*, causing gastroenteritis and liver inflammation, *adenoviruses*, causing respiratory and eye infection, and *Norwalk virus*, causing gastroenteritis.

visual inspection – The process of: 1) evaluating a structure for the presence of contaminated material prior to beginning remediation work; 2) looking for conditions that, if not corrected during the project, can lead to incomplete removal of contamination, and 3) examining the work area for evidence that the project has been completed successfully.

volatile:

1. A substance that evaporates readily.
2. Property of a substance that allows it to transition to gas phase from a liquid or solid phase.

volatile organic compound (VOC) – Any organic compound that enters a gas phase; especially that which adversely affects air quality in a built environment. Typically gas phase VOCs are generated by paints, stains, adhesives, dyes, solvents, caulks, cleaners, pesticides, building materials or office machines. Over 900 different gas phase VOCs have been identified in indoor air; the health effects of some are known, for others they are unknown. In sufficient quantities, these health effects range from sensory irritation (eye, nose and throat irritation), to headaches, dizziness, and visual disorders, to neurotoxicity (memory impairment), hepatotoxicity and even carcinogenic effects. At present, not much is known about what health effects occur at the levels of gas phase VOCs typically found in public and commercial buildings.

[W]

wallboard – Flat wood or gypsum composition sheeting used to provide a smooth, finished surface on wall frames. cp. "gypsum"

water activity (a_w) – The amount of free water available for microorganism growth on a substrate. a_w is comparable to the equilibrium relative humidity (ERH) of a material, which is the relative humidity taken at the surface or "boundary layer" of a material. A reading of 80% relative humidity taken at the surface of a material equates to an a_w of 0.8. Most bacteria require >0.95 a_w (95% ERH) and many molds require >0.88 a_w (88% ERH). However, some xerotolerant (dry tolerant) molds, such as *Penicillium* and *Aspergillus*, which can produce potent allergens and toxins, can grow between 0.66-0.70 a_w (66-70% ERH).

water lift ("H_2O) – A measure of a vacuum's ability to raise a vertical column of water in a standard test gauge a specific number of inches. To convert water lift to mercury lift ("Hg), divide by 13.4 (i.e., mercury is 13.4 times heavier than water).

Water-vapor pressure:

1. The pressure exerted by a saturated vapor above its own liquid in a closed container. When quality control tests are performed on products, the test temperature is usually 100^{o}F/38^{o}C and the vapor pressure is expressed as pounds per square inch (psig or psia); but vapor pressures reported on MSDS forms are in millimeters of mercury (mmHg) at 68^{o}F/20^{o}C) unless stated otherwise.
2. The pressure exerted by the molecules of a liquid on surrounding surfaces, expressed in inches of mercury ("Hg). Moisture is absorbed by and moves through materials to equalize vapor pressure. In order to promote rapid drying of a surface, surrounding vapor pressure must be reduced through drying or dehumidification of the air.

wet bulb temperature – The temperature registered by a thermometer with a moist "sock" covering the sensing bulb. This reading is always lower than dry bulb temperature; e.g., 80^{o}F dry bulb equals approximately 68^{o}F wet bulb.

work authorization – A form which, when properly executed, allows an individual or company to work on the premises or property of another, often under the terms of the owners insurance policy.

World Health Organization (WHO) – A United Nations agency to coordinate international health activities and to help governments improve health services.

[X]

xerotolerant (xerophilic) – Dry tolerant; e.g., molds that grow at 0.66-0.70 water activity (a_w) or 66-70% equilibrium relative humidity (ERH), compared to most molds, which require a_w of 0.9. Xerotolerant molds include *Penicillium* and *Aspergillus*, which are capable of producing potent allergens and toxins.

[Y]

yeast – A budding unicellular fungus, some are used extensively in food production (baking, brewing) while others can cause specific opportunistic infections in human organisms.

[Z]

Z-flap door – A doorway closure designed to minimize airflow between two areas. A-Z flap can be constructed while erecting containment by overlapping polyethylene sheeting over the doorway as the room is wrapped.

Conversion Charts

Metric Conversions

Length:

To convert: Multiply by:

inches to millimeters........ 25.4
inches to centimeters........ 2.54
inches to meters............ 0.0254
feet to millimeters......... 304.8
feet to centimeters.......... 30.48
feet to meters................ 0.3048
yards to meters............. 0.9144
miles to kilometers......... 1.609

Volume and Capacity:

cu in to centimeters...... 16.387
cubic inches to liters 0.016387
cu ft to cu meters....... 0.02832
cu ft to liters.................. 28.32
pints (US) to liters....... 0.4732
quarts (US) to liters..... 0.9463
gallons (US) to liters..... 3.785
cu yds to cu meters...... 0.7646
oz (fluid) to cu cm....... 28.574

Area:

sq in to sq millimeters.. 645.16
sq in to sq cm.............. 6.4516
sq ft to sq centimeters.. 929.03
sq ft to sq meters.......... 0.0929
sq yds to sq meters....... 0.8361

Mass:

ounces to grams.............. 28.35
ounces to kilograms.... 0.02835
pounds to kilograms..... 0.4536
tons to kilograms............. 1016
long tons to metric tons.. 1.016
grains/lb to grams/kilo.... 0.143

Temperature Conversions

°C=	< °F/°C >	=°F	°C=	< °F/°C >	=°F
-17.8	**0**	32	25.6	**78**	172.4
-15	**5**	41	26.1	**79**	174.2
-12.2	**10**	50	26.7	**80**	176
- 9.4	**15**	59	27.2	**81**	177.8
- 6.7	**20**	68	27.8	**82**	179.6
- 3.9	**25**	77	28.3	**83**	181.4
- 1.1	**30**	86	28.9	**84**	183.2
0	**32**	89.6	29.4	**85**	185
0.6	**33**	91.4	30	**86**	186.8
1.1	**34**	93.2	30.6	**87**	188.6
1.7	**35**	95	31.1	**88**	190.4
2.2	**36**	96.8	31.7	**89**	192.2
2.8	**37**	98.6	32.2	**90**	194
3.3	**38**	100.4	32.8	**91**	195.8
3.9	**39**	102.2	33.3	**92**	197.6
4.4	**40**	104	33.9	**93**	199.4
5	**41**	105.8	34.4	**94**	201.2
5.6	**42**	107.6	35	**95**	203
6.1	**43**	109.4	35.6	**96**	204.8
6.7	**44**	111.2	36.1	**97**	206.6
7.2	**45**	113	36.7	**98**	208.4
7.8	**46**	114.8	37.2	**99**	210.2
8.3	**47**	116.6	37.8	**100**	212
8.9	**48**	118.4	40.6	**105**	221
9.4	**49**	120.2	43.3	**110**	230
10	**50**	122	46.1	**115**	239
10.6	**51**	123.8	48.8	**120**	248
11.1	**52**	125.6	51.7	**125**	257
11.7	**53**	127.4	54.4	**130**	266
12.2	**54**	129.2	57.2	**135**	275
12.8	**55**	131	60	**140**	284
13.3	**56**	132.8	62.8	**145**	293
13.9	**57**	134.6	65.6	**150**	302
14.4	**58**	136.4	68.3	**155**	311
15	**59**	138.2	71	**160**	320
15.6	**60**	140	73.9	**165**	329
16.1	**61**	141.8	76.7	**170**	338
16.7	**62**	143.6	79.4	**175**	347
17.2	**63**	145.4	82	**180**	356
17.8	**64**	147.2	87.8	**190**	374
18.3	**65**	149	93	**200**	392
18.9	**66**	150.8	98.9	**210**	410
19.4	**67**	152.6	104	**220**	428
20	**68**	154.4	110	**230**	446
20.6	**69**	156.2	115.6	**240**	464
21.1	**70**	158	121.1	**250**	482
21.7	**71**	159.8	126.7	**260**	500
22.2	**72**	161.6	132.2	**270**	518
22.8	**73**	163.4	135	**275**	527
23.3	**74**	165.2	137.8	**280**	536
23.9	**75**	167	143.3	**290**	554
24.4	**76**	168.8	148.9	**300**	572
25	**77**	170.6	162.8	**325**	617

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