Mold Remediation Worker Training Program

Course Description: The Mold Worker Certification Training course consists of topics such as: sources of indoor mold and conditions necessary for indoor mold growth; potential mold health effects; workplace hazards and safety; technical and legal considerations; an overview of how mold remediation projects are conducted; work practices for removing, cleaning, and treating mold. This course consists of eight (8) training hours that includes lectures, demonstrations, audio-visuals and hands-on training. The Mold Worker certification is presented under accreditation with Texas Administrative Code Title 25 Part 1 Chapter 295. This 8 hour course is designed for workers, maintenance personnel and other individuals who intend to conduct mold remediation and are employed by a mold remediation contractor or company.

To register for a course near you call **888.436.8338** or email **training@environmentaleducation.com** today.

To register online follow the link below:
http://environmentaleducation.com/store/viewCourse.asp?courseId=10

Environmental Education Associates is a leader in certified environmental and safety training, serving Metropolitan New York City, Long Island, and greater New York State with Training Centers in: Brooklyn, Buffalo, Rochester and Syracuse**.**

ENVIRONMENTAL EDUCATION ASSOCIATES, INC.
WWW.ENVIRONMENTALEDUCATION.COM

Mold Remediation Worker Training Program

Student Manual

Environmental Education Associates, Inc.
888 ENV EDU

PREFACE

This manual was developed to provide guidance for those who own or operate housing properties and wish to obtain a better understanding of mold issues. The procedures and practices detailed in these pages incorporate current technology at the time of printing. The reader should be advised that as technology evolves, so do the methods for identifying and remediating mold amplification site. Therefore, we emphasize the need for the reader to obtain the most up to date information available.

Many of the practices and procedures discussed in this document go beyond the minimum requirements outlined by various guidelines and regulatory agencies. The reader should refer to these guidelines for further clarification should conflicts exist. Also, the reader should be aware of existing additional practices and procedures, which may be substituted for those discussed here. Further, the practices recommended may not be appropriate for every project.

The technical expertise and common sense provided by the contractor and consultant are major components of a successful remediation project. The reader is encouraged to improve further on the techniques provided in this manual as experience is gained through field practice. This will ensure that the mold industry continues to evolve to improve all facets of remediation and worker protection.

ACKNOWLEDGEMENTS & REFERENCES

It would be impossible to acknowledge all of the individuals who have contributed to the development of this course manual in some fashion or manner. Environmental Education Associates, Inc. is extremely grateful to those who have generously shared their knowledge, expertise and experiences throughout the development process. Special thanks to Alisa Ruggiero, Dave Jones and Ralph Estep who worked tirelessly to assemble this course.

This course manual was developed though the thorough review of the applicable resources and years of safety, health and environmental experience. The goal was to compile a manual that would communicate in a simple format, the basic necessities in identifying, evaluating, and successfully remediating indoor mold amplification site while protecting the safety and health of the personnel involved, and the environment.

Materials utilized in the development of this manual should be recognized, as they were the foundation and basis in its development. These publications and sources include the following:

USEPA, "Mold Remediation in Schools and Commercial Buildings", 3/2001

Health Canada, "Fungal Contamination in Public Buildings: A Guide to Recognition and Management", 6/1995

New York City Department of Health, "Guidelines on Assessment and Remediation of Fungi in Indoor Environments", 4/2000

ACGIH, "Bioaerosols: Assessment and Control", Cincinnati, 1999

Institute of Inspection Cleaning and Restoration Certification, IICRC S500, "Standard and Reference Guide for Professional Water Damage Restoration", 1999

University of Minnesota, Environmental Health and Safety, Website, 2002

NADCA, National Air Duct Cleaners Association, "Understanding Microbial Contamination in HVAC Systems", 1996

Priority One Mitigation, "Loss Recovery Guide with Standards", 11/1999

USEPA, "Model Curriculum for Training Asbestos Abatement Contractors and Supervisors", 1995

DISCLAIMER

This manual was developed using consensus documents as guidance. This manual has no official weight or legal merit. Procedures and practices contained in this manual have not been reviewed or approved by regulatory agencies. It is the responsibility of the user to verify compliance with all applicable federal, sate of local regulatory agencies.

Environmental Education Associates, Inc. makes no representation, warranty or guarantee in connection with the materials in this course manual or the oral presentation made in connection with the materials. EEA hereby disclaims any liability or responsibility for loss or damage resulting from their use and for any violation of federal, state or municipal regulation, ordinance or law resulting directly or indirectly from their use.

Mention of any trade names, commercial products, manufacturers or other businesses in the material or by the presenter does not constitute an endorsement by EEA.

MOLD REMEDIATION WORKER TRAINING COURSE

TABLE OF CONTENTS

Chapter 1

Course Overview
&
Introduction to IAQ

COURSE OVERVIEW AND INTRODUCTION TO IAQ

OBJECTIVE

To provide a brief discussion of the issue of Indoor Air Quality and the interpretation of fungal and microbial contamination and acquaint the participants with topics of the course as they relate to investigation and remediation of indoor mold amplifiers.

LEARNING TASKS

- **Understand the course was designed for a multidisciplinary approach to fungal remediation**
- **Become familiar with the various facets of indoor air quality investigations**
- **Be introduced to potential health effects associated biological pollutants**
- **Become familiar with the contents and format of the course manual**

Concern about indoor exposure to mold and biological pollutants has been increasing as the public becomes aware that exposure to can cause a variety of health effects and symptoms, including allergic reactions. This course focuses on and presents guidelines for the investigation and remediation/cleanup of mold and moisture problems in homes, schools and commercial buildings; these guidelines include measures designed to protect the health of building occupants, investigators and remediators. It has been designed primarily for consultants, remediators, building managers, custodians and others who are responsible for commercial building and school maintenance. Using this document, individuals with little or no experience with mold remediation should be able to make a reasonable judgment as to whether the situation can be handled in –house. It will help those in charge of maintenance to evaluate an in-house remediation plan or a remediation plan submitted by an outside contractor.

What are Biological Pollutants?

Biological pollutants are or were living organisms. They promote poor indoor air quality and may be a major cause of days lost from work or school, and of doctor and hospital visits. Some can even damage surfaces inside and outside your house. Biological pollutants can travel through the air and are often invisible. Some common indoor biological pollutants are:

- **Animal Dander (minute scales from hair, feather or skin)**
- **Dust Mite and Cockroach parts**
- **Fungi (molds)**
- **Infectious agents (bacteria or viruses)**
- **Pollen**

Some of these substances are in every home and building. It is impossible to get rid of them all. Even a spotless occupied environment may permit the growth of biological pollutants. Two conditions can be found in many locations, such as bathrooms, damp or flooded basements, wet appliances (such as humidifiers or air conditioners), and even some carpets and furniture.

Modern materials and construction techniques may reduce the amount of outside air brought into buildings that may result in high moisture levels inside. Using humidifiers, un-vented heaters and air conditioners in our homes has increases the chances of moisture forming on interior surfaces. This encourages the growth of certain biological pollutants.

All of us are exposed to biological pollutants. However, the effects on our health depend upon the type and amount of biological pollution and the individual person. Some people do not experience health reactions from certain biological pollutants, while others may experience one or more of the following reactions:

- **Allergies**
- **Infectious Diseases**
- **Toxic Effects**

Allergic reactions may be the most common health problem with indoor air quality in homes, with the exception for the spread of infections indoors. An allergic reaction occurs when a substance provokes formation of antibodies in a susceptible person. These reactions may be immediate or delayed. Symptoms may include sneezing, burning of the eyes, difficulty breathing and skin rash.

Infectious diseases caused by bacteria and viruses, such as flu, measles, chicken pox and tuberculosis may be spread indoors. Most infectious diseases pass from person to person through physical contact. Crowded conditions with poor air circulation can promote this spread. Some bacteria and viruses thrive n buildings and circulate through indoor ventilation systems. For example, the bacterium causing Legionnaire's disease, a serious and sometimes lethal infection, and Pontiac Fever, a flu-like illness, have circulated in some large buildings.

Only a small group of fungi have been associated with infectious disease. Aspergillosis is an infectious disease that can occur in immunosuppressed persons. Health effects in this population can be severe. Several species of Aspergillus are known to cause Aspergillosis. The most common is fumigatus.

Exposure to this common mold, even to high concentration, is unlikely to cause infection in a healthy person.

Exposure to fungi associated with bird and bat droppings (e.g., Histoplasma capsultatum and Cryptococcus neoformans) can lead to health effects, usually transient flu-like illnesses, in healthy individuals. Severe health effects are primarily encountered in immunocompromised persons.

Toxic reactions are the least studied and understood health problem caused by some biological air pollutants in the home. Toxins can damage a variety of organs and tissues in the body, including the liver, the central nervous system, the digestive tract and the immune system.

As stated in the opening paragraph, this course is going to focus in the investigation, evaluation and remediation of fungus (molds). In conducting and indoor air quality investigation these other biological pollutants should not be discounted as a source of exposure resulting in complaints from building occupants.

Chapter 2

Background on Mold & Potential Health Effects

BACKGROUND ON MOLD & POTENTIAL HEALTH EFFECTS

OBJECTIVE

To provide a brief discussion of Mold, it's life cycle, and its ability to generate bioaerosols. Additionally, to present potential health effects of both acute and chronic exposures to both viable and non-viable mold and mold fragments.

LEARNING TASKS

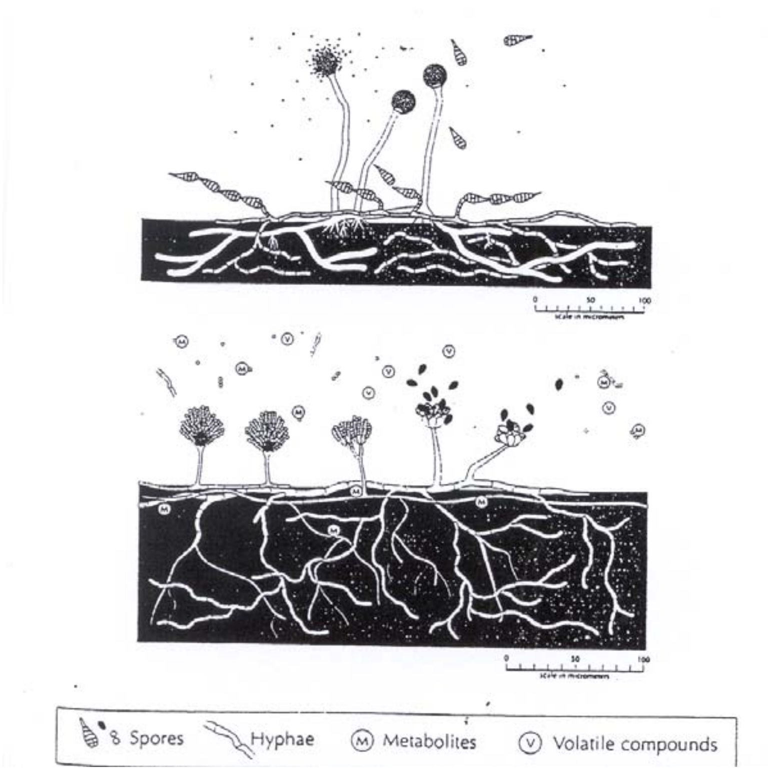
- **Understand the history of mold and its life cycle**
- **Gain a brief understanding of the means in which mold can enter the body**
- **Become familiar with the characteristics various molds identified in indoor air quality investigations**
- **Be introduced to potential health effects associated with fungal pollutants**
- **Gain a brief overview of the risks associated with exposure to fungus**

INTRODUCTION TO MOLD

Fungi can be found almost anywhere; they can grow on virtually any organic substance, as long as moisture and oxygen are present. Fungi from a kingdom of eukaryotic organisms, that is without chlorophyll, that have cells bound by rigid walls. They may be multi-cellular or uni-cellular. Multi-cellular fungi are formed of microscopic, branched filaments, called hyphae. A colony is a visible mass of interwoven hyphae that form a mycelium. Fungal colonies may appear cottony, velvety, granular or leathery and may appear in numerous color variations including black, white, reddish, greenish, yellowish and brownish. Mycelial Fungi often found growing in indoor environments include species of aspergillus, pennicilium and stachybotrys.

Other mycelial fungi include mushrooms, puffballs, truffles and braket fungi to name a few. These fungi form large, sometimes edible fruiting bodies. Often visible fungi are referred to as mold, just as a gardener would refer to an unwanted plant as a weed. For the purpose of this course fungus, fungi and mold will be used interchangeably. Fungi also have some unique benefits in the forms of common products such as bread, cheese, beer, wine and some very effective medical antibiotics.

Fungi have complex life cycles that may be sexual (teleomorphic) or asexual (anamorphic) stages. Spores may be produced in either stage. Spores are very small, light and capable of traveling long distances via air transport. All fungi are classified as heterotrophs, which means they must have external food sources, and cannot make their own carbohydrates. Fungi release enzymes to digest this carbon material and then absorb the nutrients. Water is critical to this process. During this metabolic process, fungi can release metabolites in the form volatile compounds, and in some cases depending on the fungi genus, toxins referred to as “mycotoxins”.



Examples of fungal growth showing aerial and vegetative hyphae and reproductive structures.

There are molds that can grow on wood, paper, carpet, foods and insulation. When excessive moisture accumulates in buildings or on building materials, mold growth will often occur, particularly of the moisture problem remains undiscovered or unaddressed. It is impossible to eliminate all molds and mold spores in the indoor environment. However, mold growth can be controlled indoors by controlling moisture.

Molds reproduce by making spores that usually cannot be seen without magnification. Mold spores waft through the indoor and outdoor air continually. When mold spores land on a damp spot indoors, they may begin growing and digesting whatever they are growing on in order to survive. Molds gradually destroy the things they grow on.

Many types of mold exist. All molds have the potential to cause health effects. Molds can produce allergens that can trigger allergic reactions or even asthma attacks in people allergic to mold. Others are known to produce potent toxins and/or irritants. Potential health concerns are an important reason to prevent mold growth and to remediate/clean up any existing indoor mold growth.

Since mold requires water to grow, it is important to prevent moisture problems in buildings. Moisture problems can have many causes, including uncontrolled humidity. Some moisture problems in buildings have been linked to changes in building construction practices during the 1970's, 80's and 90's. Some of these changes have resulted in buildings that are tightly sealed, but may lack adequate ventilation, potentially leading to moisture buildup. Building materials, such as drywall, may not allow moisture to escape easily. Moisture problems may include roof leaks, landscaping or gutters that direct water into or under the building, and unvented combustion appliances. Delayed maintenance or insufficient maintenance, are also associated with moisture problems in schools and large buildings. Moisture problems in portable classrooms and other temporary structure have frequently been associated with mold problems.

When mold growth occurs in buildings, some building occupants, particularly those with allergic or respiratory problems, may report adverse health problems. Remediators should avoid exposing themselves and other to mold-laden dusts as they conduct their cleanup activities. Caution should be used to prevent mold and mold spores from being dispersed throughout the air where they can be inhaled by building occupants.

PREVENTION

They key to mold control is moisture control. Solve moisture problems before they become mold problems.

- **Fix leaky plumbing and leaks in the building envelope as soon as possible.**

- **Watch for condensation and wet spots. Fix source(s) of moisture problem(s) as soon as possible.**

- **Prevent moisture due to condensation by increasing surface temperature or reducing the moisture level in the air (humidity). To**

increase surface temperature, insulate or increase air circulation. To reduce the moisture level in the air, repair leaks, increase ventilation (if outside air is cold and dry), or dehumidify (if outdoor air is warm and humid).

- **Keep heating, ventilation and air conditioning (HVAC) drip pans clean, flowing properly and unobstructed.**
- **Vent moisture-generating appliances, such as dryers, to the outside where possible.**
- **Maintain low indoor humidity, below 60% relative humidity (RH), ideally 30-50% if possible.**
- **Perform regular building/HVAC inspections and maintenance as scheduled.**
- **Clean and dry wet or damp spots within 48 hours.**
- **Don't let foundations stay wet. Provide drainage and slop the ground away from the foundation.**

HEALTH EFFECTS ASSOCIATED WITH MOLD EXPOSURE

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 reaction and aggravation of asthma symptoms; all of these symptoms could potentially be associated with mold exposure.

All molds have the potential to cause health effects. Molds produce allergens, irritants and in some cases, toxins that may cause reactions in humans. The types and severity of symptoms depend, in part, on the types of mold present, the extent of an individual's exposure, the ages of the individuals and their existing sensitivities or allergies.

Specific reactions to mold growth can include the following:

- **Allergic reactions (e.g., rhinitis and dermatitis or skin rash)**
- **Asthma**
- **Hypersensitivity Pneumonitis**
- **OTDS (Organic Toxic Dust Syndrome)**
- **Other immunological effects**

Research on mold and health effect is ongoing. This list is not intended to be all-inclusive.

The health effects listed above are well documented in humans. Evidence for other health effects in humans is less substantial and is primarily based on case reports or occupational studies.

ALLERGIC REACTIONS

Inhaling or touching mold or mold spores may cause allergic reactions in sensitive individuals. Allergic reactions to mold are common. We call substances that will cause an allergic reaction in some people antigens or allergens. These reactions can be immediate or delayed. Allergic responses include hay fever-type symptoms, such as sneezing, runny nose, red eyes and skin rash (dermatitis). Mold spores and fragments can produce allergic reactions in sensitive individuals regardless of whether the mold is dead or alive. Repeated or single exposure to mold or mold spores may cause previously non-sensitive individuals to become sensitive. Repeated exposure has the potential to increase sensitivity.

ASTHMA

Molds can trigger attacks in persons who are allergic (sensitized) to molds. The irritants produced by molds may also worsen asthma in non-allergenic (non-sensitized) people. Health experts are especially concerned about people with asthma. These people have very sensitive airways that can retract to various irritants, making breathing difficult. The number of people who have asthma related diseases have greatly increased in recent years.

HYPERSENSITIVITY PNEUMONITIS

Hypersensitivity Pneumonitis may develop following either short-term (acute) or long-term (chronic) exposure to molds. The disease resembles bacterial pneumonia and is uncommon. It appears that repeated exposure or high levels of exposure to small fungal particles are necessary for the development of HP.

IRRITANT EFFECTS

Mold exposure can cause irritation of the eyes, skin, nose, throat and lungs and can sometimes create a burning sensation in these areas.

OPPORTUNISTIC INFECTIONS

People with weakened immune systems (i.e., immune-compromised or immune-suppressed individuals) may be more vulnerable to infections by fungi. These can be from fungi present in bird droppings leading to conditions such as

Histoplasmosis. Aspergillus fumigatus, for example, has been known to infect the lungs of immune-compromised individuals. These individuals inhale the mold spores, which then start growing in their lungs. Trichoderma has also been known to infect immune-compromised children.

Healthy individuals are usually not vulnerable to opportunistic infections from airborne mold exposure. However, molds can cause common skin diseases, such as athlete's foot, as well as other infections such as yeast infections.

MOLD TOXINS (Mycotoxins)

Molds can produce toxic substances called mycotoxins. Some mycotoxins cling to the surface of mold spores; others may be found within spores. More than 200 mycotoxins have been identified from common molds, and many more remain to be identified. Some of the molds that are known to produce mycotoxins are commonly found in moisture-damaged buildings (e.g., species of Aspergillus, Pennicilium, Fusarium, Trichoderma, Stachybotrys and Memmoniella). Exposure pathways for mycotoxins can include inhalation, ingestion or skin contact. Although some mycotoxins are well known to affect humans and have been shown to be responsible for human health effects, for many mycotoxins, little information is available.

Aflatoxin B1 is perhaps the most well-known and studied mycotoxins. It scan be produced by the molds Aspergillus flavus and Aspergillus parasiticus and is one of the most potent carcinogens known. Ingestion of Aflatoxin B1 can cause liver cancer. There is also some evidence that inhalation of Aflatoxin B1 can cause lung cancer. Aflatoxin B1 has been found on contaminated grains, peanuts and other human and animal foodstuffs. However, Aspergillus flavus and Aspergillus parasiticus are not commonly found on building material or in indoor environments.

Some molds, such as Aspergillus versicolor and Stachybotrys atra (chartarum), are known to produce potent toxins under certain circumstances. Although some mycotoxins are well known to affect humans and have been shown to be responsible for human health effects, for many mycotoxins, little information is available, and in some cases research is ongoing. For example, some strains of Stachybotrys atra can produce one or more potent toxins.

Much of the information on the human health effect of inhalation exposure to mycotoxins comes from studies done in the workplace and some case studies or case reports. Many symptoms and human health effects attributed to inhalation of mycotoxins have been reported including; mucous membrane irritation, skin rash, nausea, immune system suppression, acute or chronic liver damage, acute or chronic central nervous system damage, endocrine effects and cancer. More studies are needed to get a clear picture of the health effects related to most mycotoxins.

Some molds can produce several toxins, and some molds produce mycotoxins only under certain environmental conditions. The presence of mold in a building does not necessarily mean that mycotoxins are present or that they are present in large quantities. However, it is clearly prudent to avoid exposure to molds and mycotoxins.

MICROBIAL VOLATILE ORGANIC COMPOUNDS (mVOCs)

Some compounds produced by molds are volatile and are released directly into the air. These are known as microbial volatile organic compounds (mVOCs). Because these compounds often have strong and/or unpleasant odors, they can be the source of odors associated with molds. Exposure to mVOCs from molds has been linked to symptoms such as headaches, nasal irritation, dizziness, fatigue and nausea. Research on mVOCs is still in the early phase.

GLUCANS OR FUNGAL CELL WALL COMPONENTS (aka ß-(1 3)-D-glacan)

Glucans are small pieces of the cell walls of molds, which may cause inflammatory lung and airway reactions. These glucans can affect the immune system when inhaled. Exposure to very high levels of glucans or dust mixtures including glucans may cause a flu-like illness known as Organic Dust Toxin Syndrome (ODTS). This illness has been primarily noted in agricultural and manufacturing settings. ODTS describes the abrupt onset of fever, flu-like symptoms and respiratory symptoms in the hours following a single, heavy exposure to dust containing organic material including fungi. It differs from Hypersensitivity Pneumonitis in that it is not an immune-mediated disease and does not require repeated exposures to the same causative agent. ODTS may be caused by a variety of biological agents including common species of fungi (e.g., species of Aspergillus and Pennicilium). ODTS has been documented in farm workers handling contaminated material but is also of concern to workers performing renovation work on building materials contaminated with fungi.

SPORES

Mold spores are microscopic (2-10 um) and are naturally present in both indoor and outdoor air. Molds reproduce by means of spores. Some molds have spores that are easily disturbed and waft into the air and settle repeatedly with each disturbance. Other molds have sticky spores that will cling to surfaces and are dislodged by brushing against them or by other direct contact. Spores may remain able to grow for years after they are produced. In addition, whether or not the spores are alive, the allergens in and on them may remain allergenic for years.

SUMMARY

Fungi can and do cause a myriad of disease. Potentially pathogenic fungi are not uncommon in the indoor environment, and diseases caused by indoor fungi have been documented in case reports. The burden of illness in the population attributable to fungi in private homes and public buildings is not yet known. Epidemiological studies have consistently detected an association between respiratory symptoms and home dampness and mold growth, but causality in these studies has not been established. Until the magnitude of the population risk is known, it would be prudent, based on current evidence, to eliminate indoor sources conductive to fungal growth, and when amplification sites are identified, perform remediation in accordance with recognized guidelines.

Chapter 6

Protecting the Worker: Personal Protective Equipment

PROTECTING THE WORKER: Personal Protective Equipment

OBJECTIVE

To provide a detailed discussion of the selection, use, limitations, inspection, disinfection, storage and maintenance of respirators and protective clothing used in the investigation and remediation of indoor mold amplifiers.

LEARNING TASKS

- **Recognize the need for effective respiratory protection and protective clothing for protection against fungal contaminants**
- **Understand the procedures for the proper selection of respiratory protection equipment**
- **Understand the use and limitations of respirators and protective clothing**
- **Become familiar with the concept of protection factors and how they relate to respirator selection and use**
- **Recognize the components of an effective respiratory protection and PPE program**
- **Understand the importance of proper fit testing procedures for respirators**
- **Recognize the need for and use of protective clothing and other personal protective equipment**

PROTECTING THE WORKER: PERSONAL PROTECTIVE EQUIPMENT

Investigators and contractors may frequently disturb fungi materials in the course of their duties to collect air and bulk samples and assess the condition of the material. In most cases the investigator/remediator does not know of the suspect material is a mold of concern or in fact evens contains asbestos or other environmental contaminants. Accordingly, he or she should always assume the suspect material in fact contains toxic or pathogenic fungi until proof is provided. In addition, he/she must wear appropriate personal protective equipment for his/her own protection when performing mold sampling and assessment activities. This will normally include a respirator and protective clothing. Depending on the specific project, additional protective measures may be necessary such as eye equipment.

There are three ways that hazardous materials can enter the body: through the gastrointestinal tract, usually via mouth, through the skin and through the respiratory system. Some fungi appear to pose a serious threat to the body through all three routes of entry and cause serious diseases when it enters the body through the respiratory system, especially for immune compromised individuals.

RESPIRATORY SYSTEM

The respiratory system is a gaseous (air) pump containing a series of airways leading from the nose and mouth down into the air sacs (alveoli) where there is an exchange of oxygen and carbon dioxide. The main components of the respiratory system, from top to bottom are as follows:

- Nose and mouth
- Throat
- Larynx (voice box)
- Trachea (wind pipe)
- Bronchi (branches from trachea)
- Alveoli (air sacs in the lung)
- Diaphragm and chest muscles

The human body has certain natural defenses to protect itself against inhaling dust. The most important of these is the mucouscilliary escalator. Airways of the upper respiratory tract (trachea through bronchi) are lined with cilia (hair like protrusions) covered with a layer of mucous. These cilia are constantly sweeping upward quickly, the down slowly, and thus moving the mucous and trapped materials up at a rate approximately one inch per minute. This is an important clearance mechanism, which prevents most large particles from reaching the alveoli in the lungs. Particulates trapped in the mucous are carried back up to the throat where they are swallowed or expectorated.

Unfortunately, this natural defense mechanism does not prevent all spores and hyphae from reaching the lungs where illness can occur. Accordingly, respirators must be worn to provide further protection when asbestos exposure is likely.

RESPIRATORY HAZARDS

Respiratory hazards are generally divided into two categories; toxic contaminants and oxygen deficiency. Generally, building inspections would not pose oxygen deficiency hazards. However, since there may be projects and circumstances where it can be a problem, oxygen deficiency must always be considered. For example, there could be an oxygen deficiency problem while inspecting in steam tunnels mechanical chases or boilers. Failing to consider oxygen deficiency could result in a fatality on any project.

Toxic contaminants are the more common category of respiratory hazards encountered mold jobs. Those toxic contaminants are generally subdivided into two categories: particulates and gaseous materials (or a combination or the two). With mold, it is possible to have both of these hazardous substances, as well as others, in a work area at the same time.

The control of respiratory hazards often involves three steps"

- Assessing the hazards
- Reducing or eliminating the hazards
- Providing respiratory protective equipment

The mold industry is actually based on these first two steps. Buildings and other structures are inspected or surveyed to assess potential mold hazards. When a potential mold hazard exists, a group or contractor is called upon to reduce or eliminate the hazard through removal, encapsulation or enclosure of the material. Thus, the third step, respirators, can be avoided to protect the building occupants.

RESPIRATOR CLASSIFICATIONS

There are two general categories of respiratory protection devices: air-purifying and supplied-air respirators. For most investigators and remediators, air-purifying respirators will provide the needed protection. Accordingly, the discussion of the used and limitation of supplied air respirators is limited.

Air-Purifying Respirators

These respirators remove the hazardous contaminant from the breathing air before it is inhaled. They consist of a soft, rubber face piece and a replaceable filter or cartridge. Two major sub-categories of air purifying respirators are the mechanical filter type and the chemical cartridge type. The mechanical filter variety is designed to protect against particulate contaminants such as asbestos. The chemical cartridge type protects against gaseous contaminants such as solvent vapors. Each respirator assembly is approved for a particular contaminant; care must be taken in choosing the appropriate unit. High efficiency particulate air (HEPA) filters designed for asbestos are typically purple or magenta in color. These filters will remove 99.97% of particles 0.3 micrometers or greater in diameter.

Air-purifying respirators are further categorized based on their degree of face coverage. The half-mask respirator covers half the face – from the bridge of the nose to under the chin. A full-face respirator covers the face from the forehead to under the chin. The more extensive coverage provides a better fit and a higher degree of protection. Air-purifying respirators depend upon breathing action to draw atmospheric air through the respirator filter or cartridge where it is decontaminated; hence, they are referred to as “negative pressure” respirators.

Powered Air-Purifying Respirators (PAPR)

A special subcategory of air-purifying respirator is the Powered Air-Purifying (PAPR) type. It uses the same types of cartridges and filters as regular air purifying respirators to clean the air. PAPR, however, are positive-pressure devices, which employ a portable rechargeable battery pack, and blower to force contaminated air through a filter or cartridge, where it is cleaned and supplied to the weather’s breathing zone. PAPRS are available in both tight-fitting and loose-fitting styles. Because the air is being drawn from the immediate work area, they too offer no protection against oxygen deficiency. An advantage of using a powered air-purifying respirator is that it supplies air at a positive pressure within the face piece, helmet or hood so that any leak is usually outward.

Supplied-Air Respirators

These respirators supply uncontaminated, breathing air from a source independent of the surrounding atmosphere. Air is delivered to the face piece through an airline (a hose). These respirators are often referred to as “air-line respirators”. A second type of supplied air respirator is the self-contained breathing apparatus (SCBA). The user carries the source of breathable air, usually a tank of compressed air. Airline respirators come in several distinct versions: demand, pressure-demand and continuous-flow. They are distinguished by their regulator and valve design. EPA and NIOSH recommend the pressure-demand type is supplied-air respirators are selected.

Supplied-air respirators also have limitations:

- The trailing airline restricts the user’s mobility
- The air supply of a SCBA respirator is limited

- The bulk and weight of a SCBA respirator make it impractical for strenuous work or for use in confined spaces
- Backup units or supplemental air-purifying respirators should be available of the air supply is interrupted

For additional information on supplied-air respirators see: EPA and NIOSH, *A Guide to Respiratory Protection for the Abatement Industry*, EPA-560-OPTS-86-001, September 1986, or the *NIOSH Guide to Industrial Respiratory Protection*, No. 87-116.

RESPIRATORY PROTECTION PROGRAM

Respirators are commonly used to help protect against inhalation hazards. However, a respiratory protection program is not simply donning a respirator and expecting to be adequately protected. Any employer who requires or permits employees to wear a respirator must have a written respiratory protection program. The written respiratory program establishes standard operating procedures concerning the use and maintenance or respiratory equipment. In addition to having such a written program, the employer must also be able to demonstrate that the program is enforced and updated as necessary.

The OSHA regulations spell out just what must be included in a written program. An effective respiratory program should include:

1. A written statement of company policy, including assignment of individual responsibility, accountability and authority for required activities of the respiratory protection program.
2. Written standard operating procedures governing the selection and use of respirators.
3. Respirator selection (from NIOSH approved and certified models) on the basis of hazards to which the worker is exposed.
4. Medical examination of workers to determine whether or not they may be assigned an activity where respiratory protection is required.
5. User training in the proper use and limitation of respirators (as well as a way to evaluate the skill and knowledge obtained by the worker through training).
6. Respirator fit testing.
7. Regular cleaning and disinfecting of respirators.
8. Routine inspection of respirators designated for emergency use.
9. Storage of respirators in convenient, clean and sanitary locations.
10. Surveillance of work area conditions and degree of employee exposure.
11. Regular inspection and evaluation of the continued effectiveness of the program.

All of the above items are required by OSHA if employees wear negative pressure respirators during work or if the OSHA permissible exposure limit (PEL).

Establishing a Policy

Every employer should prepare a clear concise policy regarding the use of respirators by their employees when performing mold inspection and remediation activities. This policy should serve as the guiding principal for the preparation, implementation and enforcement of an effective respiratory protection program.

Designation of a Program Administrator

A program administrator must be designated by name. This person is responsible for implementation of and adherence to the provisions of the respiratory protection program. It is usually a good idea to also designate a person who is responsible for enforcement of the procedures at each job site. Enforcement of procedures and the development of the program as a whole should be done in conjunction with and input from the employees and/or their representative(s).

Selection and Use of Respiratory Protection Equipment

The selection of appropriate respiratory equipment generally involves three steps:

1. Identifying the hazards
2. Evaluating the hazards
3. Providing proper respiratory protection equipment to suit the conditions and the individual

The purpose of inspecting buildings and structures is to determine the presence (or absence) of mold and to identify conditions that are potentially hazardous. Until the level of hazard is evaluated, Building Inspectors should assume that airborne levels could be high enough to be of concern.

The respirator selected and the respiratory program established must conform to Occupational Safety and Health Administration (OSHA) standards and guidelines published by respirator manufacturers. The OSHA respirator standard (29 CFR 1910.134) requires that only approved respirators be used. In addition, the respirator must be approved for protection specifically against mold, its spores, mycotoxins and the chemicals utilized in the remediation process.

The National Institute for Occupational Safety and Health (NIOSH) is the official respirator testing and approval agency for respirators. If the entire respirator assembly including cartridges, filters and hoses pass NIOSH test criteria, then

NIOSH issues an approval number. The letters “TC”, which indicates the respirator assembly was “Tested and Certified”, precedes the specific number. In addition to an assigned identification number associated with each unit, a label identifying the type of hazard the respirator is designed to protect against accompanies a NIOSH approved respirator. Additional information on the label, which indicates limitations and identifies the components parts approved for use with the basic unit.

Although some single-use disposable dust masks were at one time “approved” by NIOSH, they should not be used. As a rule of thumb, negative pressure, air-purifying respirators with HEPA filters may be used during mold inspections/remediation. Further, because of the potential for the release of microbial volatile organic compounds, it is strongly suggested that combination, organic vapor/acid gas/particulate cartridges be used. Specifically, cartridges with the designation of CD/CL/HC/HF/OV/SD/P100 are recommended with either full face or half mask respirators.

Protection Factors

Respirators offer varying degrees of protection against contaminants. The key to understanding the differences between types of respirators (air-purifying, powered-air purifying, air-supplied) is the amount of protection afforded the wearer. To compare these, one must understand the concept of a protection factors (PF).

A protection factor is a number obtained when the concentration of a contaminant outside the mask is divided by the concentration found inside the mask. This simple formula is illustrated below.

$$\textbf{Protection Factor (PF)} = \frac{\textbf{Concentration outside mask}}{\textbf{Concentration inside mask}}$$

The protection factor depends greatly on the fit of the mask to the wearer’s face. Accordingly, the protection offered by any one respirator will be different for each individual person. Further, the protection constantly changes depending upon the worker’s activities and even shaving habits. When a worker laughs or coughs inside the respirator, the protection factor will decrease since it will not “fit” as well during laughing or coughing. Similarly, a worker who forgot to shave one morning will not receive as much protection that day since the mask will not fit as well to the face. The importance of properly fitting the mask should now be obvious.

It is virtually impossible to measure the concentration inside the mask (where the worker is breathing) for each worker, all of the time, during the various activities he or she may be conducting. Accordingly, protection factors, based on extensive research, have been developed for different categories of respirators.

Using these protection factors, it is easy to determine what type of respirator is appropriate to maintain the concentration of contaminants inside the mask below a certain level. It should be noted that the protection factors for powered-air purifying respirators are estimated on the most recent date available. (Supplied-air respirators are not included since they are unlikely to be needed).

Medical Surveillance

Only those individuals who are medically capable to wear respiratory protection equipment shall be issued one. Before being issued a respirator, an employee will receive pertinent tests for medical and physical conditions. Medical tests to b conducted by a physician often include: pulmonary function tests, a chest x-ray (if a physician deems it necessary), electrocardiogram and any other testes deemed appropriate by the examining physician. A medical history in the form of a questionnaire is collected as well for each individual. Other factors to be considered by a physician may include: emphysema, asthma, chronic bronchitis, heart disease, anemia, hemophilia, poor eyesight, poor hearing, hernia, lack of use of fingers or hands, epileptic seizures and other factors which might inhibit the ability of an employee to wear respiratory equipment.

Employee Training Program

Each employee designated to wear a respirator must receive adequate training. The training session (initial and periodic training) should be conducted by a qualified individual to ensure that employees understand the limitations, use and maintenance of respiratory equipment. The OSHA Respiratory Protection Standards require that employee training be repeated at least annually.

Respirator Fitting

One of the most important elements of an effective respirator program is fitting. The OSHA Respirator Standard (29 CFR 1910.134) require that the fit of respirators be tested when the respirator is issued and every year thereafter for all negative pressure respirators. The fit of the respirator should also be checked each time that it is worn. Procedures for fit-testing and fit-checking should be addresses in the written respirator program.

Once the appropriate respirator has been selected for the contaminant and conditions to which an individual is exposed, the respirator must be fit-tested. A respirator will not provide protection unless the air passes through the filter or canister, or unless all of the air comes from the supply system. If the face seal is not tight or the connections are loose an individual may think he or she is breathing through the purifying system, but may actually be breathing around it.

Several different respirators may have to be tried before one is found that fits properly. For any face fitting type respirator, beards and bushy sideburns may have to be shaved. Respirator face pieces generally will not seal over them. Similarly, gum and tobacco chewing cannot be permitted since excess facial movement can break the face seal. If a person wears prescription glasses, a respirator face piece, which will accommodate the glasses, should be considered. Contact lenses should not be worn while wearing a respirator.

There are two types of user seal checks, positive and negative pressure, and there are two categories of fit testing, qualitative (pass/fail) and quantitative (measures levels within the mask).

- Negative Pressure Fit Check

For this test, the wearer closes off the inlet of the filters or cartridges by covering them with the palms of the hands or by squeezing the breathing tube so that air cannot pass through. Then inhale so that the face piece collapses slightly, and hold his/her breath for about 10 seconds. If the face piece remains slightly collapsed and no inward leakage of air is detected, the respirator passes the test. This test can only be used on respirators with tight fitting face pieces. Its potential drawback is that hand pressure can modify the face piece seal and cause false results.

- Positive Pressure Fit Check

This test is similar in principle to the negative pressure test. It is conducted by closing off the exhalation valve of the respirator and gently exhaling into the face piece. The respirator fit is considered passing if positive pressure can be built up inside the face piece without evidence of outward air leakage around the face piece. Remember that these two fit checks should also be done every time a respirator is put on.

If the respirator selected fails to pass these simple tests, the fit testing should not proceed further. Instead, another size or another brand should be donned and these tests repeated. Alternatively, it may only be necessary to adjust the straps on the respirator and repeat the test. Once the wearer has successfully passed the negative and positive fit checks, the actual fit test may be conducted. The OSHA standards permit qualitative fit testing for half mask air-purifying respirators. Quantitative fit testing is required for full-face air-purifying respirators.

FIT TESTING

Certain conditions will prevent a good respirator seal. Among these are:

- Facial hair
- Make-up

- Eyeglasses
- Missing Teeth or Dentures
- Facial Scars

Since respirators function by producing a negative [reassure in the face piece, a good seal is essential. Respirator users must pas a fit test to ensure that the selected respirator will provide a good seal. Fit tests must be performed at least annually, or following any significant weight gain/loss or oral/facial surgery.

Quantitative fit testing is not an analytical measurement. It is a subjective test to determine if there is a good face piece-to face seal by exposing the wearer to an irritant gas or aroma. If the subject does not detect the challenge substance, the fit is acceptable. Common techniques include the irritant smoke test and the banana oil test.

Quantitative fit testing is an analytical method of measuring the fit of a particular respirator by actually measuring the concentration of a contaminant and/or air pressure both inside and outside the respirator while being worn in a test atmosphere. The quantitative fit test is the preferred approach for documenting that a particular respirator is acceptable for an individual. The most common approach utilizes the Port-Account system, which involved a computer-based program that prompts and record the step and results during the fit testing process.

Cleaning and Disinfection of Respirators

Whenever possible, a respirator should be reserved for the exclusive use of a single individual. Following each use, the respirator should be cleaned and disinfected. The following procedures can be used to clean a respirator:

- Wash with a detergent or a combination detergent and disinfectant, in warm water using a brush.

- Rinse in clean water, or rinse once with a disinfectant and once with clean water. The clean water rinse is particularly important because traces of detergent or disinfectant left on the mask can cause skin irritation and/or damage respirator components.

- Air dry on a rack or hang; position the respirator so that the face piece elastomer will not be deformed during drying.

Routine Inspection of Respirators

Inspection of the respirator is an important routine task. It should be done before and after each use. The respirator should be checked for the following defects:

Air-Purifying Respirators (half mask and full face piece)

Elastometric face piece should be checked for:

1. Excessive dirt
2. Crack, tear or holes
3. Distortion from improper storage
4. Cracked, scratched or loose fitting lens
5. Broken or missing mounting clips

Head straps should be checked for:

1. Breaks or tears
2. Loss of elasticity
3. Broken or malfunctioning buckles or attachments
4. Excessively worn serration of the head harness, which might allow the face piece to slip

Inhalation valve, exhalation valve, should be checked for:

1. Detergent residue, dust particles or dirt on valve seal

PERSONAL PROTECTIVE EQUIPMENT

Site-specific operations may require the use of specialized protective equipment such as full body harnesses, safety lanyards, welding goggles, etc. Where these are used, workers must be trained in the proper use, maintenance and limitations of these devices prior to work assignment. Difficulty in decontaminating some of these items may require their disposal following the conclusion of the project.

DONNING/DOFFING

Personal protective equipment should be donned outside the work area. The procedure to be used a follows:

- Street clothes should be removed and stored in a clean location; Jewelry, watches and rings should be removed and placed in a secure area. Lockers should be provided to protect valuables.
- Coveralls, gloves and boots are then donned, and taped at the wrist and ankle. Use of coveralls with attached booties eliminates the need to tape ankles; however taping may still be advisable to prevent booties from becoming loose, resulting in trip hazards. Waists may also be taped to

provide an acceptable fit. If desired, the crotch, shoulders or other stress points may be taped to reinforce the seam.

- Respirator is then donned and checked by the positive/negative fit check procedure.
- Coverall hood is then placed over the respirator head straps and secured with tie or tape.
- Other protective equipment, such as hard hats and eye protection are then donned.

It is also important to realize that many "bargain" prices may not be a bargain at all. The less expensive coveralls often use less material. Accordingly, coveralls marked "XL" may be too small for many inspectors. Be sure to check the construction of the coveralls well. Double stitching on seams will last longer, but cost more. When leaving the work site, one should exercise care in removing protective clothing:

- HEPA vacuum off any fungal contamination and debris accumulated on the garments.
- Remove all protective garments and equipment (except respirator) in an isolated area.
- All disposable clothing should be placed in plastic bags and labeled.
- Once the plastic bag is properly sealed, respirators may be removed and cleaned, disinfected and stored as detailed in this chapter.

OTHER PERSONAL PROTECTIVE EQUIPMENT

Additional protective equipment may be necessary depending on the specific project. The most common other protective equipment will include eye protection. This is especially important when collecting samples or remediating materials located overhead. Goggles or safety glasses (with side shields) are often adequate. Hard hats, safety shoes and hearing protection may also be necessary on certain projects. All should be ANSI approved equipment.

STORAGE

PPE should be kept in clean, dry areas and separated by size. Inspections upon receipt and after each use will ensure that PPE will be ready for immediate use when needed.

SUMMARY

PPE when properly used provides a limited amount of protection to the worker. It should not be considered a substitute for proper decontamination, personal hygiene or as an invitation to take chances. Combined with the proper respiratory protection, common sense and safe work practices, exposure to mold and other hazard can be reduced to the lowest possible limits.

EEA

Chapter 7

Fungal & Microbial Remediation

FUNGAL & MICROBIAL REMEDIATION

OBJECTIVE

To provide instruction on the different levels, guidelines and state of the art work practices associated with the design and performance of fungal and microbial remediation projects.

LEARNING TASKS

- **Recognize the course was designed to incorporate various regulatory guidance on remediation into one guiding document utilizing “state of the Art” work practices and procedures.**

- **Understand federal/state employee training requirements in place.**

- **Become familiar with sequences and methods of work area preparation.**

- **Know the functions of the decontamination unit.**

- **Know procedures for entering and leaving the work area.**

- **Become familiar with the necessary tools and equipment used in the mold remediation industry.**

- **Understand the use of biocides must be done in accordance with labeling.**

FUNGAL AND MICROBIAL REMEDIATION

In all situations, the underlying cause of water accumulation must be rectified or fungal growth will recur. Any initial water infiltration should be stopped and cleaned immediately. An immediate response (within 24-48 hours) and thorough clean up, drying and/or removal of water damaged materials will prevent or limit mold growth. If the source of water is elevated humidity, relative humidity should be maintained at levels below 60% to inhibit mold growth. Emphasis should be on ensuring proper repairs of the building infrastructure so that water damage and moisture buildup does not recur.

Four different levels of abatement are described in this chapter. These four levels correspond to the following levels:

- **I. areas less than <10 square feet**
- **II. areas greater than >10 square feet up to 100 square feet**
- **III. areas greater than >100 square feet**
- **IV. remediation of HVAC systems**

The procedures described exceed those minimum recommendations as stated in noted guidelines acknowledged in the preface of the course manual. The size of the area impacted by fungal contamination primarily determines the type of remediation. The sizing levels below are based on professional judgment and practicality; currently there is not adequate data to relate the extent of contamination to frequency or severity of health effects.

The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the heath of workers performing the abatement.

The listed remediation methods were designed to achieve this goal, however, due to the general nature of these methods it is the responsibility of the people conducting remediation to ensure the methods enacted are adequate. A worksite survey for other recognized hazards should also be accomplished. This would also include a survey for asbestos containing material and lead based paint.

The listed remediation methods are not meant to exclude other similarly effective methods. Any changes to the remediation methods listed in these guidelines, however, should be carefully considered prior to implementation.

Non-porous (e.g., metals, glass and hard plastic) and semi-porous (e.g., wood and concrete) materials that are structurally sounds and are visibly moldy can be cleaned and reused. If in doubt about the structural integrity of building materials, a structural engineer may need to be consulted. Cleaning should be done using a mild detergent solution mixed with no stronger that a 1:10 concentration of hypochloite solution. Porous materials such as ceiling tiles and insulation and wallboards with more than a small area of contamination should be removed and discarded. Porous materials (e.g., fabrics and throw rugs) that can be cleaned can be reused, but disregard if possible. All materials to be reused should be dry and visibly free from mold. Reference should be made to Chapter 7, “Moisture Management and Restoration” for salvability of items. Items and building materials that are cleaned and disinfected should have routine inspections conducted to confirm that effectiveness of remediation work.

The use of gaseous ozone or chlorine dioxide for remedial purposes is not recommended. Both compounds are highly toxic and contamination of occupied space may pose a health threat. Furthermore, the effectiveness of these treatments is unproven.

Level I: Small Isolated Areas (10 sq. ft. or less) – e.g., ceiling tiles and small areas on walls

The following procedures are recommended:

a. Regular building maintenance staff can conduct remediation. Such persons should receive training on proper clean up methods, personal protection and potential health hazards. This training can be performed as part of a program to comply with the requirement of the OSHA Hazard Communication Standard (29 CFR 1910.1200).
b. Respiratory protection in accordance with the OSHA respiratory protection standard, 29 CFR 1910.134 is recommended. At a minimum, per referenced guidelines, this would include an N-95 disposable filtering face piece. Additionally, gloves, disposable suits and eye protection should be worn.
c. The work area should be unoccupied. Vacating people from spaces adjacent to the work area is not necessary, but is recommended in the presence of infants (less than 12 mos. Old), persons recovering from recent surgery, immune suppressed people or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis and severe allergies).
d. Containment of the work area is not necessary, however shutting down and isolating the HVAC should be strongly considered. Placing drop cloths beneath areas that are

going to be remediated is also suggested to contain any dust and debris that may be generated. A dust suppression method, such as misting (not soaking) surfaces with water and a mild detergent is recommended to keep spores and fragments out of the air. If the water damage was the result of sewage or dirty water backup, the area should also be misted with a 10% hypochlorite solution to kill any bacteria. Note: it is extremely important not to mix bleach (hypochlorite solutions) and ammonia products together. They will react and form highly toxic hydrochloric fumes.

e. Contaminated material that cannot be cleaned should be removed from the building or affected by double bagging the materials in two 6 mil sealed plastic bags. There are no special requirements for the disposal of moldy materials.

f. The work area, plastic drop cloths, plastic critical barriers used for sealing the HVAC system and disposable PPE used by remedial workers should also be double bagged in two 6 mil sealed plastic bags and disposed of.

g. All areas should be cleaned with a damp cloth and/or mop and a detergent solution should be left dry and visibly free from contamination and debris. If the water source is associated with black or gray water or has been associated with a long-term leak, the area should be disinfected as well.

Level II: Large Isolated Areas (10-100 sq. ft.) – e.g., several wallboard panels. A health and safety professional or an industrial hygienist with experience performing microbial investigations and remediation should be consulted prior to remediation activities to provide oversight for the project.

The following procedures are recommended:

a. Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., ½ mask or full face negative pressure air purifying respirators equipped with combination P-100/OV/HC/SD/CL/C/HF cartridges), in accordance with the OSHA respiratory protection standard (29 CFR 1910.134) is recommended. Disposable suits, gloves and eye protection should be worn.

b. The work area and areas directly adjacent should be covered with 2 layers of plastic sheeting and taped before remediation, to contain dust/debris and fungal contamination.

c. Lockout and Tagout the HVAC system, if possible, to prevent the spread of any mold spores or fragments that may become airborne during remediation activities. Seal ventilation ducts/grills in the work area and areas directly adjacent with a minimum of 1 layer or 4 mil plastic sheeting.

d. The work area and areas directly adjacent should be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis and sever allergies).
e. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation are recommended to keep spore levels to a minimum. If the water damage was the result of sewage or dirty water backup, the area should also be misted with a 10% hypochlorite solution to kill any bacteria. A surfactant can also be added to increase the penetration characteristics of the solution.
f. Contaminated materials that cannot be cleaned should be removed from the building in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
g. The work area and surrounding areas should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
h. The use of a biocide or disinfectant may be considered when immune comprised individuals may be present, moisture may be present in the future or where black or gray water has been present.
i. All areas should be left dry and visibly free from contamination and debris.
j. Air monitoring should be considered prior to occupancy to determine it the area is fit to reoccupy.

Note: if abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surface, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level III be followed.

Level III: Extensive Contamination (>100 contiguous sq. ft. in an area)

A health and safety professional or industrial hygienist with experience performing microbial investigations and/or remediation should be consulted prior to remediation activities to provide oversight for the project. The following general procedures, along with the subsequent discussion are recommended:

a. Assess the work area for recognized safety and health hazards.
b. Utilize appropriately trained personnel with proper PPE.
c. Establish a regulated area to keep out unauthorized individuals.
d. Vacate adjacent spaces if possible, especially for high-risk populations.
e. Isolate and secure the ventilation and electrical system.

f. Pre-clean all items in the work area and remove if not stationary. Seal all stationary items.
g. Construct containment.
h. Establish a decontamination area.
i. Establish negative pressure utilizing HEPA equipped air movers.
j. Wet, remove and remediate all visible mold.
k. Repair cause(s) of moisture sources and dry area.
l. Conduct thorough cleaning of work area followed by an intense visual inspection.
m. Apply antimicrobial encapsulants and/or biocides where necessary, when directed, and in accordance with applicable regulations.
n. Conduct post abatement air monitoring prior to occupancy to determine if the area is fit to reoccupy from a microbiological perspective.
o. Repair or replace all structurally damaged components.

Assessing the area of recognized safety and health hazards

Prior to remediation, the consultant designing or monitoring the project, or the mold remediation contractor bidding or commencing the project should conduct a thorough review of the work area for recognized physical, chemical and/or biological hazards besides the suspected or confirmed mold amplification sites. Considerations should be given to the source of moisture, accessibility to areas requiring remediation; facility characteristics where the identified fungal growth is and any other recognized safety and health concerns. Additionally, the contractor, building owner and project designer should make a walkthrough survey of the building or facility to inventory the work areas, not any special conditions and photograph any existing damages. Information gained can be used to prepare an abatement plan or to aid in preparation of a realistic quotation. Complete documentation of existing conditions through the use of field notes, photographs and videotape may benefit those involved if litigation should occur at a later date.

Personnel Training and Personal Protective Equipment (PPE)

Established guidelines recommend personnel trained in hazardous materials handling perform large-scale mold remediation. This training may consist of the OSHA 40 hour Hazardous Waste Operations and Emergency Response course in accordance with 29 CFR 1910.120/1926.65 or a Certified Asbestos Abatement Worker/Supervisor. If personnel hold either of these certifications, they may be so suited to perform mold remediation as long as they have received Hazard Communication training on the issues associated with mold to include at a minimum, background of mold, health effects, characteristics, work practices and personal protective equipment.

Competent persons, those capable of identifying and predicting hazards associated with mold remediation, should complete and 2-3 day course in addition to the above noted training to successfully carry out their assigned duties/responsibilities. The competent person should also ensure appropriate personal protective equipment is being selected and used to protect the workers. Chapter 6, “Protecting the Worker: Personal Protective Equipment”, of this course manuals describes program requirements for PPE to include:

- Selection based on hazards
- Training on used and limitations
- Inspection, cleaning and disinfection, storage
- Use of approved respirators and protective clothing
- Medical surveillance, when applicable
- Program evaluation

Establish a regulated area to keep out unauthorized individuals

Warning signs that demarcate regulated work areas should be displayed at each location (entrances and exits) where airborne concentrations of Fungal Contamination associated with indoor amplification sites may exist. Signs should be positioned such that any person would notice the warning before entering the area and be able to take the proper necessary protective actions.
The warning signs should contain the following information: (1) Biohazard, (2) that Authorized Personnel only are allowed in the work area and (3) that respirators and protective clothing are required before entering the area. Signs are available from most safety supply companies or asbestos/lead abatement contractor suppliers.

All entrances should be secured when removal operations are not in progress. Provisions must also be made to secure the decontamination station entrance when no one is on the job site. Security guards may be reasonable precaution, depending on the nature and location of the project. When the work area is occupied, padlocks must be removed to permit emergency escape routes. Arrows should be taped or painted on the poly-covered walls to indicate the location of exits.

Nonessential personnel should not be permitted to enter the work area. A job log should be maintained on site (in the clean area) for recording who enters the work area and the time each person enter and exits the work zone. The project supervisor (or designee) should be sure the log is maintained on a daily basis.

Vacate adjacent spaces if possible, especially for high-risk populations

Areas adjacent to mold remediation regulated areas should, if at all possible be vacated. Individuals at high-risk, such as immune compromised, very young (less than 1 yr.) or very old individuals, individuals with preexisting conditions such as Tuberculosis or HIV, should definitely be relocated. The use of Negative Pressure containments reduces this need because of its effectiveness in containing mold spores and fragments.

It is also noteworthy to state that the effectiveness of the containment can be greatly compromised in containing the contaminants if workers are not adequately decontaminating themselves and equipment when leaving the work area.

Isolate and secure the ventilation and electrical system

The HVAC system supplying the work area should be shut down and isolated to prevent entrainment and spreading of Fungal Contamination throughout the building. To avoid inadvertent of the HVAC system while removal operations are in progress, the control panel should be tagged and locked. Personnel need to be warned not to activate any control panels. HVAC system balancing needs to be considered to avoid over-pressurization in the occupied portions of buildings.

All vents and air ducts inside the work area should be covered and sealed with a minimum of one layer of 6-mil polyethylene and duct tape. The poly should be left in place until the area has passed final visual inspection and post abatement air monitoring.

HVAC filters, which may be contaminated with mold contamination, should be removed and disposed of in the same manner as the other mold contaminated materials. If the filters are contaminated, the inside walls of the air ducts are probably also contaminated and the contractor should make efforts to clean, disinfect and/or dispose of them well.

Amended water is typically used to suppress fungal contaminated material prior to removal. This creates a humid environment with damp to very wet and slippery floors. To eliminate the potential for a shock hazard, the electrical supply to the work area should be de-energized, locked out and tagged before removal operations begin. The following items need to be addressed before removal actually begins:

- Identify and de-energize electrical circuits in the work area.
- Lock the breaker box after the system has been shut down and place a warning tag on the box.
- If the breaker box can't be locked, or if it contains energized circuits for non-work areas, individual breakers may have to be locked out.
- Make provisions for supplying the work area with electricity from outside the work area that is equipped with a ground-fault circuit interrupter.

If the electrical supply cannot be disconnected, energized parts must be insulated or guarded from employee contact and any other conductive objects.

Pre-clean all items on the work area and remove if not stationary. Seal all stationary items in place and construct containment.
Before the mold remediation action begins objects should be cleaned, disinfected and/or disposed of. (See Chapter 4, "Moisture Management and Restoration"). Objects that cannot be cleaned and moved from the contaminated work area should be HEPA vacuumed or wet-wiped and covered with 6-mil thick poly sheeting. They should be securely taped with duct tape and plastic to achieve an airtight seal around the object to insure they do not become contaminated during removal project. Items not being removed may include large pieces of machinery, blackboards, water fountains, toilets, etc.

Critical Barriers- All windows, vents and other openings should be covered and sealed with 6-mil poly and duct tape. Covering windows and all other doors not being used during abatement with a separate layer of poly (called and critical barrier) before covering the walls provides a back-up layer of protection and saves time in installation because it reduces the number of edges of poly that must be cut and taped. An entrance to be used for access and egress to the work area should also be selected and if possible another area for loading out the waste once it has been containerized or bagged. This access area is most likely where the decontamination unit will be attached.

Floors- 6-mil poly sheets should be used to cover the floor in the work area. Several sheets may need to be seamed together with spray adhesive and duct tape. To check the integrity of the seal, blue or red carpenters chalk may be placed beneath the seam line. If a water leak occurs, the seam line will darken in color. Any leaks that occur should be promptly cleaned up. The poly floor sheets would be cut and peeled back to access the wet area. After mopping up the water and any contamination that leaked through, the area should be wet-wiped with clean rags. After the area dries, it is HEPA vacuumed and the peeled-back sheets are put back in place and sealed with duct tape. An additional "patch" sheet can be placed over this area and sealed with tape to provide extra protection.

After joining the sheets of poly together, the floor covering should be cut to the proper dimensions, allowing the poly to extend twenty-four inches up the wall, all the way around the room. The poly should be flush with the walls at each corner to prevent damage by foot traffic.

When the first layer of poly has been secured in place, the walls are covered with poly and second layer should be laid on the floor with the seams of the first and second layers offset. The second layer of poly should extend a few inches above the first layer on the wall and be secured with duct tape.

Potential slippery spots me be encountered when covering stairs or ramps and care must be taken to provide traction for foot traffic. Wet poly is very slippery and can create serious tripping hazards. To provide better footing, masking tape or thin wood strips can be placed on top of the poly to provide rougher surfaces.

Walls- After the first layer of poly has covered the floors and stationary objects; a layer of 4-mil poly is used to cover the walls. The lighter weight 4-mil is easier to hang and keep in place than the heavier 6-mil.

The sheets of 4 mil poly should be hung form the top of the wall, should extend across the floor area until it meets in the center of the area, where it is taped to form a single layer of material encasing the entire room except for the ceiling. Overlapping of the vertical sheets will be necessary; the seams should be sealed with adhesive duct tape.

Duct tape alone may not support the weight of the poly after exposure to the varying environmental conditions, which occur inside the work area. The sheets may be hung using a combination of nails and furring strips (small wood blocks), or adhesive and staples sealed with four-inch duct tape. Nails may cause some minor damage to the interior finish; however, it is usually more time efficient to touch up the nail holes than to repeatedly repair fallen barriers.

Light Fixtures may have to be removed or detached and suspended (bailing wire works well) to gain access to fungal amplification sites. Before beginning this task, the electrical supply should be shut off, locked and tagged. The light fixtures should be wet-wiped before they are removed from the area. If this is not feasible to remove the fixtures, they should be wet-wiped and completely enclosed with poly.

Establish a decontamination area

Employers involved in mold remediation should provide hygiene facilities to decontaminate exposed workers, equipment and clothing before such employees leave the work area. The decontamination station is designed to allow passage to and from the work area during mold remediation operations with minimal leakage of fungal contaminants to the outside area. A typical decontamination unit consists of a clean change room, a shower and an equipment room. The work area will be kept under negative air pressure 24 hours a day, including weekends, until post abatement air monitoring is achieved.

Materials used to construct a typical unit include: 2 inch by 4 inch lumber for the frame, ¼ inch to ½ inch plywood or 6-mil poly for the walls, duct tape, staples and nails. The floor should be covered with three layers of 6-mil poly.

Sections of the decontamination unit can be built separately to allow for easy disassembly and re-use (frames only, not poly) at other areas of buildings or at

other job site. Design of decontamination stations may vary with each project depending of the size of the crew and the physical constraints imposed by the facility. Typically, a decontamination chamber consists of three chambers, sometimes separated by an airlock. The three chambers are often referred to as clean room, shower and equipment room.
The clean room is an uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment. It is an area in which employees remove their street clothes, store them and don their respirators and disposable protective clothing. This room is where workers dress in clean clothes after showering. Furnishings for the clean room may include, benches, lockers for clothes and valuable and nails or hooks for hanging respirators. Extra disposable coveralls and towels can be stored in the clean change room.

The shower room may have on either side of it, 2 airlocks, with both the clean and dirty change rooms on either side of the airlocks. Workers pass through the shower room on their way to the removal area and use the showers on their way out after leaving contaminated clothing in the equipment room. Although most job specifications require only a single showerhead, installation of multiple showers may be time and cost effective if the work crew is large. OSHA requires cold and hot water with separate controls.

Shower wastewater for mold remediation jobs may be drained or collected and flushed unfiltered into the sanitary water.

Note: Established guidelines do not suggest of refer to the use of showers as part of the decontamination unit. However, considering the allergenic, pathogenic and toxigenic characteristics of mold, virus and bacteria that me be present from gray/black water in addition to the realism that personal protective equipment in the form of protective coveralls often get ripped during remediation, it would only seem logical to ensure workers are not leaving the work site with fungal contamination on their bodies and clothes. A competent person as to the extent and toxicity characteristics of the fungi/mold in question should evaluate each individual job. In some cases it may be acceptable for dry decontamination or the establishment of remote showers.

Establish negative pressure utilizing HEPA equipped air movers

The preparation phase of a mold remediation project is directed toward containing the airborne spores and fragment that will be generated during removal, primarily by constructing barriers with poly sheeting. This containment effort, along with measure to minimize airborne spore concentrations is continued throughout the removal phase. The primary methods for containment control are the use of wet removal techniques, the use of negative pressure enclosure with filtration systems and accompaniment by continuous clean up in the work area.

The planning strategy for the use of negative pressure systems in mold remediation work includes two main goals.

- Changing air within the containment area at a minimum of every 15 minutes while filtering the exhausted air through high efficiency particulate air (HEPA) filters
- Establishing conditions in which air from all portions of the sealed zone is being pulled toward the negative pressure fans and HEPA filters.

Negative pressure systems used on mold remediation projects can also accomplish several other positive effects.

- Containments of airborne spores and fragments even if the barrier is ripped or punctured.
- Lower concentration of airborne spores/fragments in the work area.
- Worker comfort and increased productivity due to air flow.
- Improved efficiency in final cleanup/post abatement air monitoring.

Remove and remediate all visible mold

The purpose of mold remediation is to remove the mold to prevent human exposure and damage to building materials and furnishings. It is necessary to clean up mold contamination, not just kill it. Dead mold is still allergenic and some dead molds are still potentially toxic.

Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, should be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags should be cleaned with a damp cloth and a detergent solution and/or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials. They can be disposed of as construction debris, assuming other environmental concerns are not present, such as asbestos or lead.

In most cases, it is possible and desirable to sterilize an area. Even though background levels of mold spores will remain in the air roughly equivalent to or less than the level in the outside air, bacteria, viruses and other pathogens may remain from the original source of water. Spores, however, will not grow if the moisture problem in the affected building is remediated.

If disinfectants or biocides are used you should always ventilate the area and follow the manufacturers instructions on the label and MSDS.

A variety of cleanup methods are available for remediating damage to buildings and furnishings damaged by mold. Options may vary from cleaning nonporous items that can be salvaged to disposing of porous items. Considerations should be evaluated as to the cost of replacement, sentimental value and feasibility of decontamination. For large-scale amplification sites, there are four basic clean-up methods.

- **Step 1- Wet, Scrape/Remove and Bag**- The first step in the removal process is to thoroughly wet the mold contaminated material with a low-pressure mist of amended water. The material should be misted lightly with amended water to initially wet the surface, and then a saturation coat is applied. The material can be wetted using a low-pressure pump system or water hose with garden sprayer attached which can mix the wetting agent with the water. A hand pump garden sprayer can be used for small projects. Removal of mold can be accomplished in two stages- gross and secondary removals. Gross removal is typically conducted with a two to four man team. The material is wet down to suppress spores and at the same time either scraped off with scrapers or the building component is simply removed, followed by debris collection with a wet vacuum.

  Wet vacuums are vacuum cleaners designed to collect water. They can be used to extract or pickup water from floors, carpets and hard surfaces where water has accumulated. They should only be used when materials are still wet and sufficient liquid is present. Using this type of vacuum on dry mold contamination may result in the release and spread of many microscopic spores.

  Consideration should be given to the purchase of HEPA filters for these units. They are commercially available and relatively inexpensive. Additionally, ensure tanks, hoses and attachments are thoroughly decontaminated after each use to prevent spread of contamination on future projects.

  One or two workers will then bag the material in 6-mil plastic bags, wrap the material in poly lay on the floor or fill plastic lined fiber drums before it has time to dry out. Rubber dustpans, plastic snow shovels, push brooms and standard house brooms should be used to collect and bag the wet material. Avoid using metal shovels or dustpans that can cause inadvertent tears in the poly floor barriers. The spray person can also check for damaged floor barriers and promptly repair them.

  Bags containing the waste material are processed for waste load-out, either by wet wiping, placing in another “clean” bag or placing into fiber drums. Removal of bags on a continual basis provides for easier movement in the work area.

After removing as much of the molded material as possible with scrapers, crews begin secondary removal. Depending on the type of substrate and extent of the mold proliferation, various techniques and tools may be required. The surface substrate may be smooth, rough or pitted and will affect the difficulty of secondary removal. Typically a combination of brushing and wet wiping is used to remove the remaining mold. High efficiency particulate air (HEPA) vacuum cleaners are also useful for removing “hard-to-get-to” residue.

Secondary removal is finished when all visual contamination is removed from the ceilings.

- **Step 2- Damp Wipe/Disinfect**- Mold can generally be removed from non-porous surfaces by wiping or scrubbing with water and detergent. It is important to dry these surfaces quickly to discourage additional mold growth. If structural items have cracks or cavities it may be impossible to completely remove. It may be beneficial to use a disinfectant or biocide to deter further growth during the drying process. For various furnishings that will not be disposed of, it is also very important to reference the products cleaning instructions to prevent further damage.

- **Step 3- HEPA Vacuum**- after materials have thoroughly dried, as determined with a moisture probe, HEPA vacuum the entire enclosure; structural components and items such that they are free from visible dust and debris.

  All double-bagged mold contaminated building materials in 6-mil poly bags should be discarded as construction debris. When removing the bags from the containment, the bags should be wiped down to remove and contamination on the outside of the bag. This will further prevent the spread of spores and mold fragments.

  Large items, such as furniture, contaminated with mold should be sealed in large sheets of poly with duct tape. These items should then be disposed of as construction debris as well.

- **Step 4- Apply Biocides and/or Protective Anti-microbial Coatings as Directed by Job Specifications.**

  Depending on the particular project, location of the project and intended occupants, the application of biocides and/or anti-microbial coatings may be specified. Read the label carefully and follow all manufacturer instructions. In reading the labels, it is important to recognize the differences of the following terms:

- Anti-microbial – Literally means “against microorganisms”. a substance, mechanism or condition that inhibits the growth or existence of an organism. A general term used to describe various compounds 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)

- Sanitizer – An agent that reduces the number of bacterial contaminants to safe levels as judged by public health requirements.

- Disinfectant – Any chemical or physical process used on objects that destroys more than99% of organisms capable of causing human disease.

- Bacteriastat/Mildewstat – A compound that suppresses bacterial or mildew growth when used according to label directions. Note the suffix “stat” refers to an inhibition of growth without necessarily resulting in the kill of the targeted organisms.

- Biocide – Any poison that kills both pathogenic and non-pathogenic living organisms. Note the suffix “cide” means to kill.

- Sporicide – A disinfectant that controls the spores of specified microorganisms when used according to label directions.

The primary benefit of using biocides is that they extend the time before microorganisms begin to grow. They are also part of the decontamination process when pathogenic organisms are present. They may play a role on mold remediation projects in the form of solving the problem or as a preventative mechanism.

Whenever using biocides, always:

- Ventilate the area
- Remember, biocides are toxic to humans, as well as mold. They are regulated under EPA’s Federal Insecticide, Fungicide and Rodenticide Act.

- Only apply products that have been tested and registered by an appropriate agency. Apply these products strictly in accordance with label directions.
- Always refer to the products MSDS, Material Safety Data Sheet, for precautions and follow the manufacturers written instructions on the label.
- Train all supervisors and employees in the handling and use of biocides.
- Do not utilize fungicides designed for outdoor use for indoor remediation projects.
- Check with your local state agency for licensure requirements when applying biocides in schools or other buildings.

Tools and Equipment

Tools and equipment which may be needed to perform large-scale remediation projects may include, but not be limited to:

- High Efficiency Particulate Air (HEPA) filtered, exhaust units
- Replacement filters
- Flexible or rigid ducts
- HEPA vacuum cleaner
- Electrical extension cords
- Airless sprayer
- Garden spray bottle
- Ground Fault Circuit Interrupter (GFCI)
- Hand pump garden sprayer (extra long hose, if needed)
- Wetting agent
- Stiff scraper, ranging in size from narrow to 4-inch wide blades
- Nylon brushes of various sizes, plastic dustpans
- Plastic snow shovels
- Brooms-standard house and push brooms, scaffold with rail tops
- Labeled, 6-mil poly bags
- Wood or fiberglass stepladders of appropriate height
- Duct tape
- Temporary lighting
- Ventilation smoke tubes and bulbs

Repair cause(s) of moisture sources and dry area

Repair of moisture sources is imperative. Microbial growth is inevitable when moisture and other conditions are present. Identification of the cause of moisture should be ascertained as well as categorization of the water source as to its origin. As the building systems are opened up during the remediation process, the psychometric chart should be consulted to ascertain that ideal conditions exist for adequately drying any structural components that are likely to remain. If conditions are not ideal, actions should be taken to promote the rapid drying of the affected areas. This can include bringing in heaters to raise the temperature or as well as commercial dehumidifiers.

Repair of replace all structurally damaged components
Any structural components that deteriorated to a point where their structural capacities are in doubt, or because of cost effectiveness, have simply been removed, need to be replaced. In some cases, such as bearing walls, a structural engineer may have to be consulted.

Conduct thorough cleaning of work area followed by an intense visual inspection
Once all of the structural components have been replaced, a thorough cleaning of the work area shall be performed. All floors and walls should be wiped down with an amended water/disinfectant solution such that there is no visible mold contamination or debris. In some cases, after the intense visible inspection, a lock down spray may be used to “capture” any microscopic spores to polyethylene.

This step can often be omitted if all of the affected area is going to be sprayed with an antimicrobial encapsulant. In this case the poly serves the additional purpose of keeping the paint contained to the affected area.

Conduct post abatement air monitoring prior to occupancy to determine if the area is fit to reoccupy
After the remediation/removal activities are complete and the area has passed an intense visual inspection, the third party consultant may perform post abatement sampling. Typically, this will be in the form of direct microscopic analysis of spores and fragments, with comparison to a control sample taken from the outside. See Chapter 5 “sampling Protocols for Mold” for evaluation of acceptable results.

Once acceptable results have been achieved, the replacement sheet rock, electrical systems, plumbing systems and other considerations can be safely addresses.

Remediation of HVAC Systems
Small Isolated Area of Contamination (<10 sq. ft.) on the HVAC

a. Regular building maintenance staff can conduct remediation. Such persons should receive training on proper clean up methods, personal protection and potential health hazards. This training can be performed as part of a program to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

b. Respiratory protection in accordance with the OSHA respiratory protection standard (29 CFR 1910.134) is recommended. At a minimum, per references guidelines, this would include an N-95 disposable filtering face piece. Additionally, glove, disposable suits and eye protection should be worn.
c. The work area should be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less the 12 months old), persons recovering from recent surgery, immune suppressed people or people with chronic inflammatory lung diseases. (e.g., asthma, hypersensitivity pneumonitis and sever allergies).
d. Containment of the work area is not necessary, however shutting down and isolating the HVAC using lock out and tag out procedures. Placing drop cloths beneath areas that are going to be remediated is also suggested to contain any dust and debris that may be generated.
e. The work area should be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
f. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation are recommended.
g. Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, should be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
h. The work area and areas immediately surrounding the work area should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
i. All areas should be left dry and visibly free from contamination and debris.
j. A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers should be consulted for the products they recommend for use in their systems.

Areas of Contamination (>10 sq. ft.) in the HVAC System
A health and safety professional or industrial hygienist with experience performing microbial investigations should be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:

a. Personnel trained in the handling of hazardous materials (see Level III remediation) and equipped with respiratory protection (e.g., ½ mask or full face negative pressure air purifying respirators equipped with combination P-100/OV/AG cartridges), in accordance with the OSHA respiratory protection standard (29 CFR

1910.134), is recommended. Disposable suits, gloves and eye protection should be worn.

b. The work area and areas directly adjacent should be covered with 2 layers of plastic sheeting and taped before remediation, to contain dust/debris.

c. Lockout and tagout the HVAC system to prevent the spread of any mold spores or fragments that may become airborne during remediation activities. Seal ventilation ducts/grills in the work area and areas directly adjacent with a minimum of 1 layer of 4-mil plastic sheeting.

d. The work area and areas directly adjacent should be unoccupied. Further vacating people from spaces near the work area are recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people or people whit chronic inflammatory lung disease.

e. Dust suppression methods, such as misting (not soaking) interior duct surfaces prior to remediation, are recommended to keep spore levels to a minimum.

f. Contaminated HVAC ductwork and components that cannot be cleaned should be removed from the building in sealed plastic bags. Many commercial products and tools are available for duct cleaning activities. An evaluation to options and costs should be considered in making the appropriate remediation decisions.

g. The work area and surrounding areas should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.

h. A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers should be consulted for the products they recommend for use in their systems.

i. All areas should be left dry and visibly free from contamination and debris.

j. Air monitoring should be considered prior to occupancy to determine if the area is fit to reoccupy.

Note: If abatement procedures are expected to generate a lot of dust (e.g., abrasive cleaning of contaminated surfaces, demolition of plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then additional precautions and remediation procedures for Level III should be considered.

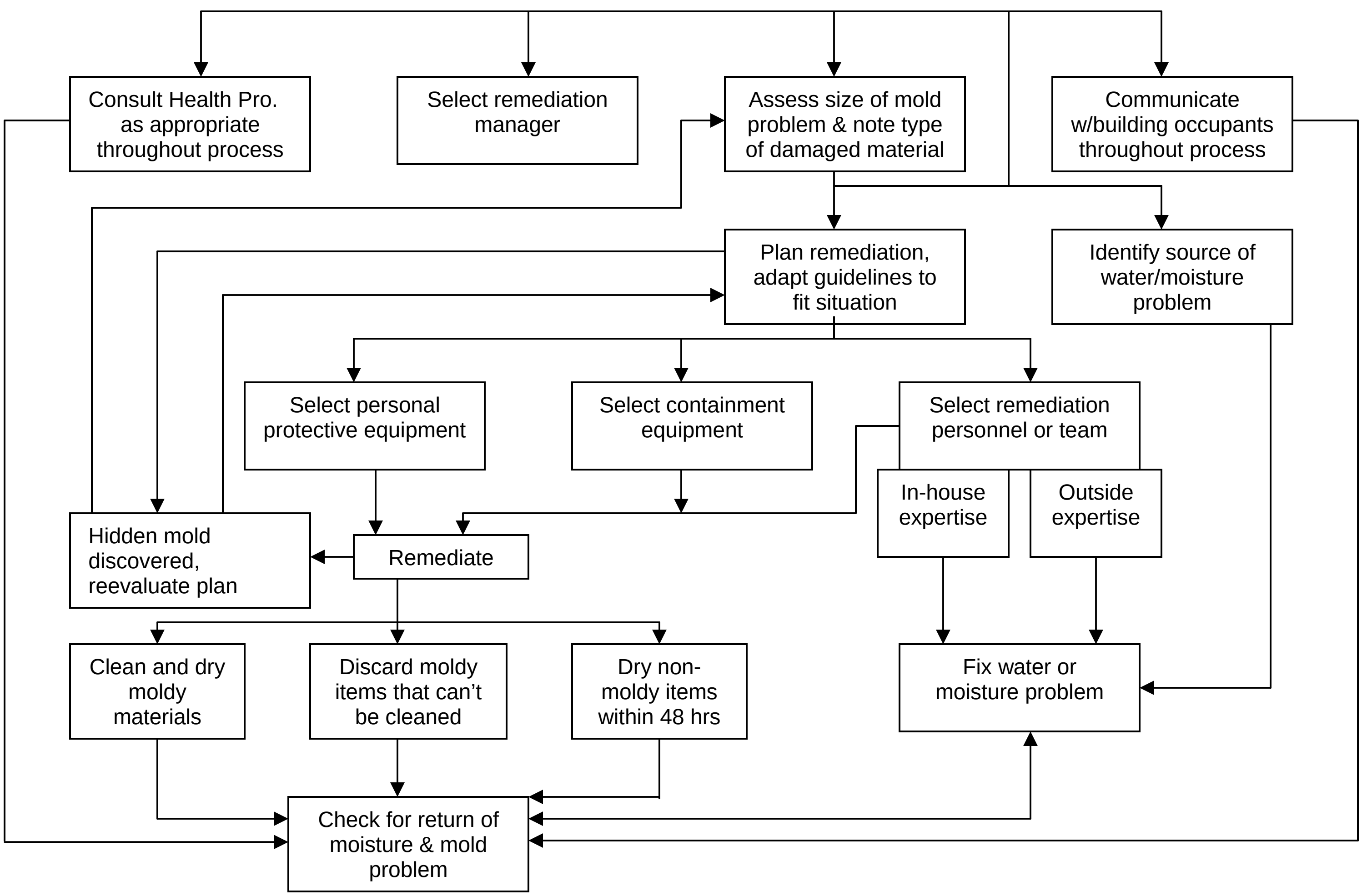
Hazard Communication

When fungal growth requiring large-scale remediation is found, the building owner, management and/or employer should notify occupants in the affected area(s) of its presence. Notification should include a description of the remedial measures to be taken and a timetable for completion. Group meetings held before and after remediation with full disclosure of plans and results can be an effective communication mechanism. Individuals with persistent health problems that appear to be related to bioaerosol exposure should see their physicians for a referral to practitioners who are trained in occupational /environmental medicine or related specialties and are knowledgeable about these types of exposures. Individuals seeking medical attention should be provided with a copy of all inspection results and interpretation to give their medical practitioners.

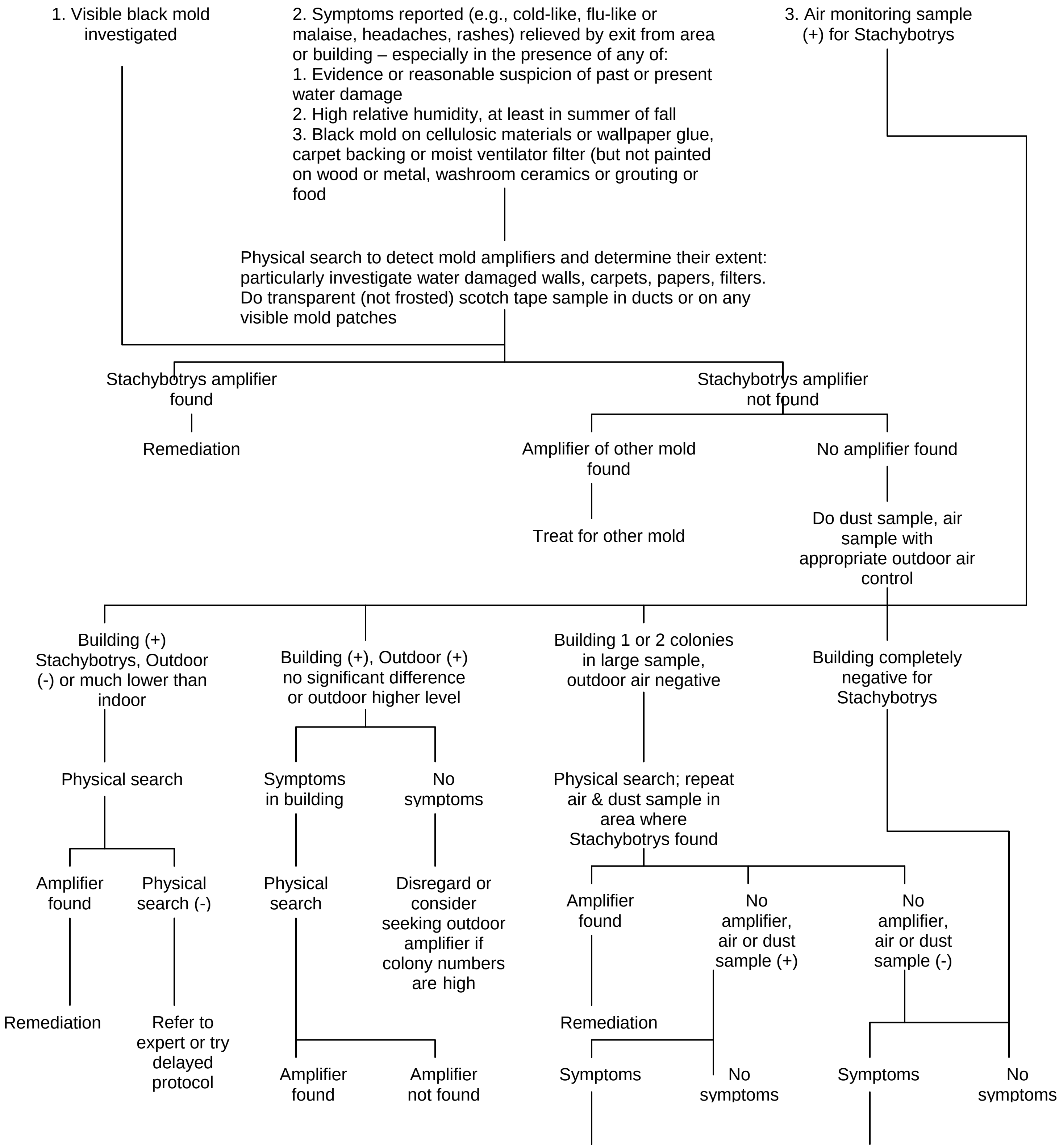
Conclusion

In summary, the prompt remediation of contaminated material and infrastructure repair must be the primary response to fungal contamination in buildings. The simplest and most expedient remediation that properly and safely removes fungal growth from buildings should not be used. In all situations, the underlying cause of water accumulation must be rectified or the fungal growth will recur. Emphasis should be placed on preventing contamination through proper building maintenance and prompt repair of water damaged areas.
Widespread contamination poses much larger problems that must be addresses on a case-by-case basis in consultation with a health and safety specialist. Effective communication with building occupants is an essential component of all remedial efforts. Individuals with persistent health problems should see their physicians for a referral to practitioners who are trained in occupational /environmental medicine or related specialties and are knowledgeable about these types of exposures.

Mold Remediation- Key Steps



Abbreviated Stachybotrys Algorithm



11/22/05

Chapter 8

Engineering Controls

NEGATIVE PRESSURE ENCLOSURES

OBJECTIVE: To provide instruction to participants on the most effective methods for containment of fungal spores and microbial fragments during a mold remediation project.

LEARNING TASKS:

- **Understand the primary methods used to contain and minimize airborne spores and fragments during a mold remediation project.**
- **Know principles and procedures for setting up a negative air filtration system on a mold remediation project.**
- **Become familiar with the uses and limitations of a negative air filtration unit.**
- **Understand the maintenance requirements associated with the operation of negative air filtration units.**

Negative Pressure Filtration Systems

The preparation phase of a mold remediation project is directed toward containing the airborne spores and fragments generated during removal, primarily, by constructing barriers with polyethylene sheeting. This containment effort, along with measures to minimize airborne mold concentrations, is continued throughout the removal phase. The primary methods for containment control are the use of wet removal techniques and the use of negative pressure filtration systems accompanied by continuous clean up in a work area sealed with polyethylene.

The planning strategy for the use of negative pressure systems in abatement work includes two main goals.

- Changing air within the containment area at a minimum of every 15 minutes while filtering the exhausted air through high efficiency particulate air (HEPA) filters.
- Establishing conditions in which air from all portions of the sealed zone is being pulled toward the negative pressure fans and HEPA filters.

Negative pressure systems used on a mold remediation project can accomplish several positive effects.

- Containment of airborne fibs even if the barrier is ripped or punctured
- Lower concentrations of airborne spores in the work area
- Worker comfort and increased productivity

- Improved efficiency in final cleanup/post abatement air monitoring

This section provides guidelines for the use of negative pressure systems in mold remediation from buildings. The manufacturer's instructions for equipment use should be followed for negative air filtration units, as well as all other equipment discussed in this manual. A negative pressure system is one, which the static pressure in an enclosed work area is lower than that of the environment outside the containment barriers.

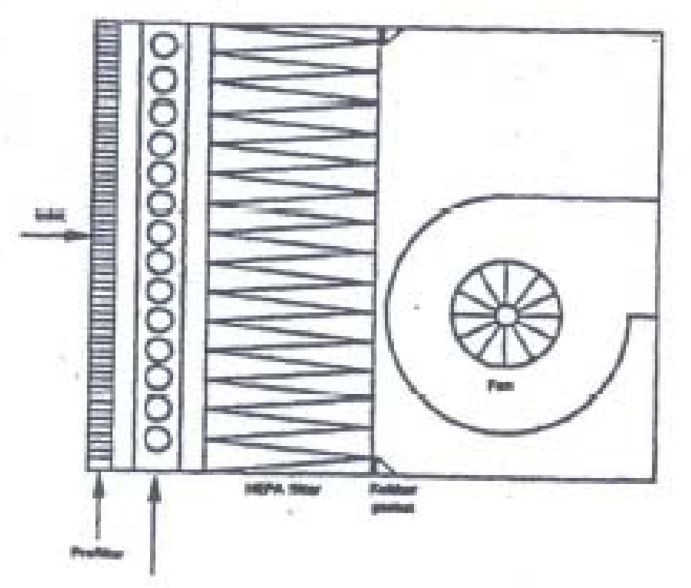
The pressure gradient is maintained by moving air from the work area to the environment outside the area via powered exhaust equipment (negative air filtration unit) at a rate that will support the desired air flow and pressure differential. Thus, the air moves into the work area through designated access spaces and any other barrier openings. Filter exhaust air by using a high-efficiency particulate air (HEPA) filter to remove mold spores and fragments.

The use of negative pressure during mold remediation helps protect against the large-scale release of spores to the surrounding area in case of a breach in the containment barrier. A negative pressure system can also reduce the concentration of airborne mold spores in the work area by increasing the dilution ventilation rate (i.e., diluting contaminated air in the work area with uncontaminated air from outside) and exhausting contaminated air through HEPA filters. The circulation of fresh air through the work area reportedly also improves worker comfort by increasing the cooling effect, which may aid the removal process by increasing job productivity.

Materials and Equipment

The Portable, HEPA-Filtered, Powered Exhaust Unit

The exhaust unit establishes lower air pressure inside than outside the enclosed work area during mold abatement by moving air from the contained work area to the outside. Basically, a unit consists of a cabinet with an opening at each end, one for air intake and one for exhaust. A fan and a series of filters are arranged inside the cabinet between the openings. The fan draws contaminated air through the intake and filters and discharges clean air through the exhaust.



Portable exhaust units used for negative pressure systems in mold remediation projects should meet the following specifications.

Structural Specifications

The cabinet should be ruggedly constructed and made of durable materials to withstand damage from rough handling and transportation. The width of the cabinet should be less than 30 inches to fit through standard-size doorways. Appropriate cabinet seals should prevent asbestos-containing dust from being emitted during use, transport, or maintenance. There should be easy access to all air filters from the intake end, the filters must be easy to replace. The unit should be mounted on casters or wheels so it can be easily moved. It also should be accessible for easy cleaning.

Fans

The fans for each unit should be sized to draw a desired air volume through the filters in the unit at a specified static pressure drop (see manufacturer's literature for this information). The unit should have an air-handling capacity of at least 1,000 to 2,000 cubic feet per minute (CFM or ft/min) (under "clean" filter conditions). The fan should be of the centrifugal type.

For large-scale abatement projects, where the use of a larger capacity, specially designed exhaust system may be more practical than several smaller units, the fan should be appropriately sized according to the proper load capacity established for the application, i.e.,

$$\text{Total ft3/min (load)} = \frac{\text{(Volume of work area in ft3) (air changes/hour)}}{\text{60 min/hr}}$$

Smaller-capacity units (e.g., 500ft3/min) equipped with appropriately sized fans and filters may be used to ventilate smaller work areas. The desired airflow could be achieved with several units.

Filters

The final filter must be the HEPA type. Each filter should have a standard nominal rating with a maximum pressure drop of 1 inch H_2O clean resistance. This pressure drop will increase as the filters load and the manufacturer's literature will indicate a clean filter pressure drop and a recommended maximum allowable pressure drop for dirty filters. The filter media (folded into closely pleated panels) must be completely sealed on all edges with a structurally rigid frame and cross-braced as required to prevent air bypassing the filter. Exact dimensions of the filter should correspond with the dimensions of the filter housing inside the cabinet or the dimensions of the filter holding frame. The recommended standard size HEPA filter is 24 inches high x 24 inches wide x 11-

1/2 inches deep. The overall dimensions and squareness should be within 1/8 inch.

A continuous rubber gasket must be located between the filter and the filter housing to form a tight seal. The size of the gasket material is dependent upon the manufacturer. (Some manufacturers use gaskets that are approximately ¼ inch thick and ¾ inch wide.) This gasket should be checked periodically for cracks and gaps. Any break in this gasket may permit significant leakage of contaminated air. Leaks in the gasket or filter will be indicated by lower than normal "clean resistance" pressure.

Each filter should be individually tested by the manufacturer to have an efficiency of not less than 99.97 percent when challenged with 0.3 micrometers (gm) dioctlyphthalate (DOP) aerosol. Testing should be in accordance with Military Standard Number 282 and Army Instruction Manual 136-300-175A. Each filter should bear a UL586 label to indicate ability to perform under specific conditions. Each filter should be marked with: the name of the manufacturer, serial number, airflow rating, efficiency and resistance, and the direction of test airflow.

Prefilters, which protect the final filter by removing the larger particles, are recommended to prolong operating life of the HEPA filter. Prefilters prevent the premature loading of the HEPA filter. They can also save energy and cost. One (minimum) or two (preferred) stages of prefiltration may be used. The first-stage prefilter should be a low efficiency type (e.g., for particles 10 pm and larger). The second-stage (or intermediate) filter should have a medium efficiency (e.g., effective particles down to 5 pm). Various types of filters and filter media for prefiltration applications are available from many manufacturers. Prefilters and intermediate filters should be installed either on or in the intake grid of the unit and held in place with special housings or clamps.

Instrumentation

Each unit should be equipped with a Magnehelic gauge or manometer to measure the pressure drop across the filters, which would indicate when filters have become loaded and need to be changed. The static pressure across the filters (resistance) increases as they become loaded with dust, affecting the ability of the unit to move air at its rated capacity.

Electrical

General

The electrical system should have a remote fuse disconnect. The fan motor should be totally enclosed, fan-cooled, and the non- overloading type. The unit may use a standard 115-V, single-phase, 60-cycle service. The National Electrical Manufacturers Association (NEMA) and Underwriter's Laboratories (UL) must approve all electrical components

Fans

The motor, fan, fan housing, and the cabinet should be grounded. All units should have an electrical (or mechanical) lockout to prevent the fan from operating without a HEPA filter.

Instrumentation

An automatic shutdown system that would stop the fan in the event of a major rupture in the HEPA filter or blocked air discharge is recommended. Optional warning lights are recommended to indicate normal operation, too high of a pressure drop across the filters (i.e., filter overloading), and too low of a pressure drop (i.e., major rupture in HEPA filter or obstructed discharge). Elapsed time meters may also be purchased to show the total accumulated hours of operation of the negative pressure units.

SETUP AND USE OF A NEGATIVE PRESSURE SYSTEM

Determining Approximate Ventilation Requirements For a Work Area

Experience with negative pressure systems on mold remediation projects indicates a recommended minimum rate of one air change every 15 minutes. The volume (in ft3) of the work area is determined by multiplying the floor area by the ceiling height. The total volumetric airflow requirement (ft3/min) for the work area is determined by dividing this volume by the recommended air change rate (i.e., one air change every 15 minutes). *
Total ft3/min = Volume of work area (ft3)/15 min**

The number of units needed for the application is determined by dividing the total ft/min by the rated capacity of the exhaust unit.

$$\text{Number of units needed} = \frac{\text{Total ft3/min}}{\text{Capacity of unit (ft/min)}}$$

Location of Exhaust Units

The exhaust unit(s) should be located so that makeup air enters the work area primarily through the decontamination facility and traverses the work area as much as possible. This may be accomplished by positioning the exhaust unit(s) at a maximum distance from the worker access opening or other makeup air sources.

Wherever practical, work area exhaust units can be located on the floor in or near unused exterior doorways or windows. The end of the unit or its exhaust duct should be placed through an opening in the plastic barrier or wall covering. The plastic around the unit or duct should then be sealed with tape.

*The recommended air exchange rate is based on engineering judgment.
**This formula is expressed differently from the one previously, but both are correct and will yield the same result.

Each unit must have a temporary electrical power (115V A-C). If necessary, three-wire extension cords can supply power to a unit. The cords must be in continuous lengths (without splice), in good condition, and should not be more than 100 feet long. They must not be fastened with staples, hung from nails, or suspended by wire. Extension cords should be off the floor and out of workers' way to protect the cords from traffic, sharp objects, and pinching.

Wherever possible, exhaust units should be vented to the outside of the building.

This may involve the use of additional lengths of flexible or rigid duct connected to the air outlet and routed to the nearer outside opening. Windowpanes may have to be removed temporarily.

Additional makeup air may be necessary to avoid creating too high of a pressure differential, which could cause the plastic coverings and temporary barriers to detach from the walls and fall. Additional makeup air also may be needed to move air most effectively through the work area. Supplemental makeup air inlets may be made by making openings in the plastic sheeting that allow air from outside the building into the work area. Auxiliary makeup air inlets should be as far as possible from the exhaust unit(s) (e.g., on an opposite wall), off the floor (preferably near the ceiling), and away from barriers that separate the work area from occupied clean areas. They should be constructed in such a fashion (using weighted flaps, etc.) that allows the openings to be sealed in case of accidental pressure differential loss. Also, the opening should be resealed whenever the negative pressure system is turned off after removal has started. Because the pressure differential (and ultimately the effectiveness of the system) is affected by the adequacy of makeup air, the number of auxiliary air inlets should be designed and placed in order to maintain adequate pressure differential and to maximize air circulation throughout the work area.

USE OF THE NEGATIVE PRESSURE SYSTEM

Testing the System

The negative pressure system should be tested before any remediation activities commence. After the work area has been prepared, the decontamination facility set up, and the exhaust unit(s) installed, the unit(s) should be started (one at a time). Observe the barriers and plastic sheeting. The plastic curtains of the decontamination facility should move slightly in toward the work area. The use of ventilation smoke tubes and an aspirator bulb is another easy and inexpensive way to visually check system performance and direction of air flow through openings in the barrier. For example, smoke emitted on the inside of the work area at a barrier should not leak outward. Smoke emitted in the shower room of the decontamination unit should move inward to the work area. Smoke tubes can also be used to check if air flow is moving inward at high and low levels of the work area.

Filter Replacement

All filters must be accessible from the work area or “contaminated” side of the barrier. Thus, personnel responsible for changing filters while the negative pressure system is in use should wear approved respirators and other protective equipment. The operating life of a HEPA filter depends on the level of particulate contamination in the environment in which it is used. During use, filters will become loaded with dust, which increases resistance to air flow and diminishes the air-handling capacity of the unit. The difference in pressure drop across the filters between “clean” and “loaded” conditions is a convenient means of estimating the extent of air-flow resistance and determining when the filters should be replaced.

When the pressure drops across the filters (as determined by the Magnehelic gauge or manometer on the unit) exceeds the pressure specified by the manufacturer, the prefilter should be replaced first. The prefilter, which fan suction will generally hold in place on the intake grill, should be removed with the unit running by carefully rolling or folding in its sides. Any spores and fragments dislodged from the prefilter during removal will be collected on the intermediate filter. The used prefilter should be wetted and placed inside a 6 mil plastic bag, sealed, labeled, and disposed of as mold waste. A new prefilter is then placed on the intake grill. Filters for prefiltration applications may be purchased as individual precut panels or in a roll of specified width that must be cut to size.

If the pressure drop still exceeds the manufacturer’s specified pressure after the prefilter has been replaced, the intermediate filter is replaced. With the unit operating, the prefilter should be removed, the intake grill or filter access opened, and the intermediate filter removed. Any dust dislodged from the intermediate filter during removal will be collected on the HEPA filter. The used intermediate filter should be wetted and placed in a seal able plastic bag (appropriately labeled) and disposed of as mold waste. A new replacement filter is then installed and the intake grill or filter access is closed. Some brands of negative air machines require removal of the prefilter to gain access to the intermediate filter. This filter should be replaced as the last step of replacing the intermediate filter.

The HEPA filter should be replaced if the prefilter and/or intermediate filter replacement does not restore the pressure drop across the filters to its original clean resistance reading or if the HEPA filter becomes damaged (HEPA filters will fail if they absorb too much moisture). The exhaust unit is shut off and disconnected from the power source to replace the HEPA filter. Used HEPA filters should be wetted and placed in a sealable plastic bag (appropriately labeled) and disposed of as mold spore waste. The gasket between the filter and the housing should be inspected for any gaps or cracks. Worn gaskets should be replaced as needed. A new HEPA filter (structurally identical to the original filter) should be installed. The intake grill and intermediate filter should be put back in place, the unit turned on, and the prefilter positioned on the intake grill. Whenever the HEPA filter is replaced, the prefilter and intermediate filter should also be replaced.

When several exhaust units are used to ventilate a work area, negative pressure can be maintained during the HEPA filter replacement and the direction of airflow into the work area will be maintained. If only two exhaust units are operating on-site, a backup unit should be available and operating before an original unit is shut down for HEPA filter replacement. An abatement enclosure should never have only one exhaust unit operating. A failure of this sole unit, for any reason, would eliminate the negative pressure in the work area. Thus, the risk of mold spores released to the outside environment is controlled with additional unit(s).

Any filters used in the system may be replaced more frequently than the pressure drop across the filters indicates is necessary. Experience has shown that prefilters, for example, should be replaced two to four times a day or when accumulations of particulate matter become visible. Intermediate filters must be replaced once every day or so, and the HEPA filter may be replaced at the beginning of each new project. Used filters must be disposed of as mold waste. Conditions in the work area dictate the frequency of filter changes. In a work area where fibers release is effectively controlled by thorough wetting and good work practices, fewer filter changes may be required than in work areas where the removal process is not well controlled. It should also be noted that the collection efficiency of a filter generally improves as particulate accumulates on it. Thus, filters can be used effectively until resistance (as a result of excessive particulate loading) diminishes the exhaust capacity of the unit.

Dismantling The System

As gross removal nears completion, filters should be checked for loading and replaced if necessary. If a prefilter is being used on the outside of the exhaust unit, it should be removed before final cleanup begins. When the negative air system is shut down at the end of the project, the filters should be left in the negative air filtration unit and the openings sealed with polyethylene and duct tape and/ or sprayed with spray polyethylene to avoid spreading contamination when the unit is moved from the work sire. Filters in the exhaust system should be replaced after final post abatement sampling is completed in order to avoid any risk of re-contaminating the area.

Tips For Using Negative Air Pressure Systems:

1. Check the integrity of the gasket between the HEPA filters and housing each time the filter is changed or after the unit has been transported to a new location.
2. A general rule of thumb for filter life during “average” removal is:
    - 2 hours for the ½” pre-filter
    - 24 hours for the 2” pre-filter
    - 500 hours for the 12’ HEPA filter

Changing out the ½” prefilter frequently (every 23-30 minutes) during “heavy” removal will prolong the life of the much more expensive HEPA filter.

3. Before removal begins, check the availability of a 20-amp circuit. Most negative air machines require 18 amps for start-up and 15 amps during normal operation.
4. Negative air units usually pull less volume than the rating assigned by the manufacturer. For instance. A unit rated at 2,000 cfm will typically pull 1300-15000 cfm. Also, as filters load, the cfm is reduced. Note: The reduced volume at the maximum accepted pressure drop (see manufacturer’s literature) should be the criteria used for this calculation. Adjust your calculations accordingly for the number of units necessary.
5. Start the negative air system before beginning work and check to see if it is functioning properly. Make sure there is adequate makeup air; otherwise the polyethylene may be pulled away from the walls.
6. Smoke tubes are useful for checking airflow inside the containment.
7. Use heavy-duty extension cords to energize the negative air filtration units. If a series of cords are connected, take necessary precautions to avoid shock hazards. Make sure the temporary electrical system is properly grounded.
8. As a rule of thumb, the containment area should be no larger than 10,000 square feet for efficient use of a negative air filtration system.
9. The negative air system is most effective in reducing fiber concentrations when laborers start removal at the farthest point from the negative air units and work toward them.
10. When venting the negative air filtration exhaust outside a window, a good seal can be formed by placing a piece of plywood with a hole cut for the flex duct in the window and sealing it with duct tape. Another seal can be formed by placing a piece of 6-mil polyethylene over the plywood template

and cutting a slit in it for insertion of the exhaust duct. Tape is used to seal the space around the slit in the polyethylene and the duct.

Summary

The effective use and maintenance of a negative air filtration unit is critical to containing and minimizing airborne spores and fragments for mold remediation projects. This is especially important when adjacent areas are occupied, cannot be evacuated, or are adjacent to an at risk population.