MOLD REMEDIATION
Participant Guide

June 2007

Acknowledgments

This curriculum has been developed by the Midwest Consortium for Hazardous Waste Worker Training under grant number D42 ES07200 and cooperative agreement U45 ES 06184 from the National Institute of Environmental Health Sciences. As a group of trainers dedicated to providing you with useful information to safeguard your health and safety, we encourage you to comment on these materials. Please give your suggestions to those teaching the program in which you are now enrolled, or forward them to the Midwest Consortium for Hazardous Waste Worker Training, University of Cincinnati, P.O. Box 670056, Cincinnati, OH 45267-0056.

Warning

 The material was prepared for use by experienced instructors in the training of persons who are or who anticipate being employed at a mold remediation worksite. Authors of this material have prepared it for the training of this category of workers as of the date specified on the title page. Users are cautioned that the subject is constantly evolving. Therefore, the material may require additions, deletions, or modifications to incorporate the effects of that evolution occurring after the date of this material preparation.

Disclaimer

There is currently no Occupational Safety and Health Administration (OSHA) regulation specifically regarding mold remediation. Some applicable regulations are: OSHA's Hand Protection Standard (29 CFR 1910.138), Eye and Face Protection Standard (29 CFR 1910.133), Respiratory Protection Standard (29 CFR 1910.134), and Personal Protective Equipment General Requirements (29 CFR 1910.132). The NYC Department of Health's "Fungi in Indoor Environments" regulation also provides useful guidelines and best practices for mold remediation.

Additional training is necessary to perform many activities. These activities include implementing the emergency response plan, identifying specific molds and associated health hazards, selecting protective equipment, and performing advanced control containment or confinement. Additional site-specific training for emergency response must be provided so that you understand how to recognize and respond to alarms at the site and can carry out any role which may be assigned during a response.

For information about further training, consult the training instructor, your company safety and health plan, or your company health and safety representative.

Midwest Consortium for Hazardous Waste Worker Training: Training Centers

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Chicago, IL 60601
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Fax.....312-362-6021

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Nashville, TN 37211
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Fax.....202-898-3403

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Washington, DC 20001
Phone 202-962-8999
Fax.....202-354-8015

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Health and Safety Department
8000 E. Jefferson Ave.
Detroit, MI 48214
Phone 313-926-5563
Fax.....313-824-4473

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Center for Labor Education and Research
1043 Building 102
1530 3rd Ave., S.
Birmingham, AL 35294-4490
Phone 205-934-8752
Fax.....205-975-5087

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SPPSR/IIR
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Phone 310-794-5964
Fax.....310-794-6410

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College of Health Professions
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Fax.....978-452-5711

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Fax.....732-235-9460

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P.O. Box 37
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Phone 504-304-3327
Fax.....504-304-3329

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INTRODUCTION

"Mold" is the word often used to describe growth on surfaces after they have become wet with water or sewage. This is a general term for a large group of organisms. Yeasts, mildew, puffballs, toadstools, mushrooms, organic rusts, and molds as a group are referred to as fungi. This group constitutes 25% of all the living matter on earth. Fungi grow and multiply by feeding on living organisms or decaying organic matter including: paper, wood, wallpaper, and some adhesives.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Define the term mold
- Identify methods to detect the presence of mold
- Identify adverse health effects caused by mold
- Identify reasons for mold remediation

Before you begin mold remediation, you need to know a few things about mold.

Mold Can be Found Anywhere

Surfaces like paper, which easily absorbs moisture, can support mold growth. It can also grow on building materials like wood, insulation, drywall, or carpet. Mold can grow on food and even furniture. It only needs three things to survive: an organic material to grow on (its food source), oxygen, and water. An organic material is any carbon-based substance. Buildings are full of organic materials, and oxygen is always in the air, so when a building experiences a moisture problem – like a leak in the HVAC system – mold can grow.

Figure 1: Mold growing on baseboards of a home

Molds Reproduce Through Spores

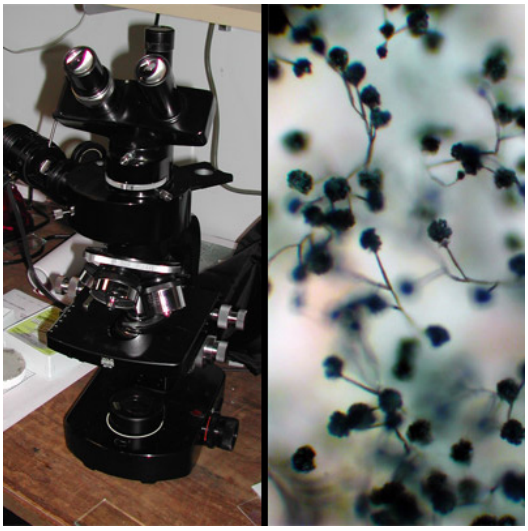


Figure 2: Magnified mold spores

Molds are not plants; they are fungi. Instead of producing seeds like plants do, they create spores in order to reproduce. Once these spores have finished developing, they are released from the mold and float through the air until they come to rest on a surface. If spores land on a surface that is both organic and damp, then mold may begin to grow. As mold grows, it slowly destroys the surface that it landed on. This is one of the reasons to prevent mold growth and to remediate it once it is discovered.

Mold spores exist both indoors and outdoors; they are so small that you generally cannot see them without the aid of a microscope. There are so many spores in the air that it is virtually impossible to rid an environment of them. However, the level of mold spores can be controlled by controlling moisture.

Mold is a Generic Term

There are many different molds, or species of molds. Several are listed in the table below, along with rates at which they grow or colonize. Note that some molds like *Candida albicans* start growing immediately, while others, like *Stachybotrys chartarum* take about a week to form a visible colony.

Mold Species	Days to Colonize
Candida albicans	1-2
Rhizopus sp.	1-2
Mucor sp.	1-2
Cyptococcus neoformans	1-2
Aspergillus sp.	2-3
Penicillium sp.	2-3
Coccidiodes immitis	4-10
Blastomyces dermatitidis	5-12
Stachybotrys chartarum	8-12

The type of mold present at a remediation site can vary, depending on how much time has passed with conditions that may foster growth.

Note: sometime “sp.” or “spp.” are used in naming the mold species. The abbreviation “sp.” indicates that the sample is all one type, but it has not been further identified. In contrast, “spp” indicates the presence of various types of mold in a sample.

Other kinds of molds include

- *Aspergillus flavis* or *A. flavis*
- *Cladosporium spp.*
- *Memnoniella*

Some molds secrete digestive enzymes and acids that can be harmful.

How is a Mold Problem Detected?

Someone typically suspects mold either because it is visible, there is water damage, or there is an unusual odor.

Visible signs of mold include:

- Darkened wallboard
- Fuzziness on upholstered surfaces

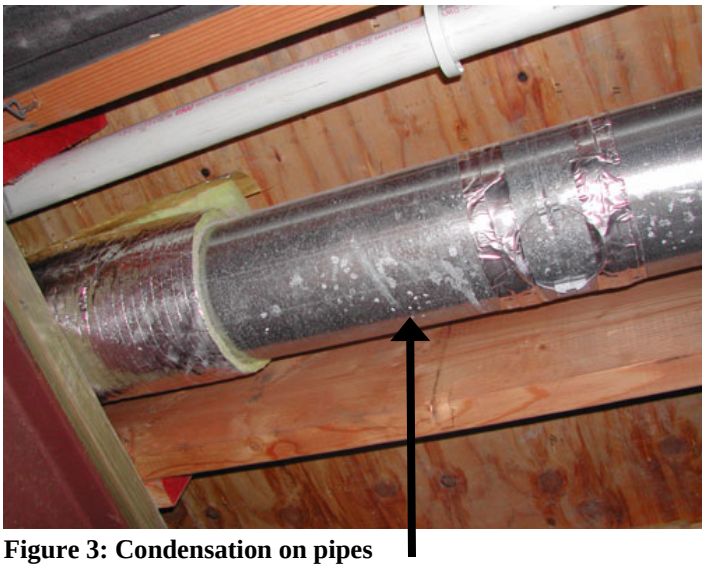


Figure 3: Condensation on pipes

Signs of water and potential damage include:

- Discolored ceiling tiles
- Standing water
- Condensation between panes of glass
- Condensation on pipes

Odors may result from molds. These are referred to as "mVOCs" or mold-related Volatile Organic Compounds. These may smell like:

- Dirty socks
- Stale, damp spaces

Note that bulk or surface sampling is **not** necessary to begin mold remediation work. If a visual inspection reveals mold growth or damage, that is sufficient reason to begin. Sampling may be conducted to identify specific contaminants and their concentrations if occupants of the building are experiencing health effects. Sampling may also be used to verify the presence of mold if there is dispute over the visual evidence (discoloration, staining).

Mold Can Cause Health Problems

All molds can potentially cause health problems in humans. However, some molds may be more likely to cause problems than others. Out of thousands of mold and fungi species, less than one hundred are associated with documented health problems in animals and humans. Some people may be allergic to different molds, causing reactions like itchy, watery eyes or even, in severe cases, an asthma attack. Molds can also release mycotoxins – or toxins from molds or fungi – that can cause health problems. These health problems are one of the main reasons that mold remediation must be done. A certain variety of mycotoxin, known as trichothecene mycotoxins, were once considered for use as biological warfare agents by the United States government. The government determined they were too dangerous to handle.

When remediation workers arrive onsite, and the occupants of the buildings are reporting health problems, workers should take extra care to protect themselves from exposure. This can be done through the use of personal protective equipment (PPE), such as an N-95 respirator. Remediation work disturbs the mold, causing even more spores and allergens to be released. Remaining building occupants should be protected by using good work practices and, if necessary, containment methods.

Mold remediation workers are at risk for developing Organic Dust Toxic Syndrome (ODTS) from exposure. ODTS may occur several hours after only a **single exposure** to some mold dusts. ODTS presents with flu-like symptoms, respiratory symptoms, and a sudden-onset fever. Hypersensitivity Pneumonitis (HP) is another health risk for mold remediation workers. This typically occurs after repeated exposure to an allergen and can result in lasting lung damage.

If you become ill for any reason during mold remediation work, visit a licensed physician.

If a building has improper or inadequate design or construction, building system failure, or inadequate maintenance, moisture can become widespread.

Mold Growth is Usually a Direct Result of Moisture

Moisture is one of the three things that mold needs to survive. Take away the moisture, and you'll likely stop the growth of mold. Moisture can come from many different types of sources in an indoor environment. Sometimes, condensation on windows can lead to a mold problem. A leaky roof, plumbing, or HVAC system could introduce moisture into the environment. Moisture from the outdoors can work its way indoors if the gutters and landscaping do not sufficiently direct water away from the building's foundation. Certain areas – like locker rooms – must be well-ventilated to keep the humidity down.

The growth of mold is affected by temperature. Most indoor molds grow well at temperatures found in occupied buildings. Light is not an important need for mold to grow; mold is often found in dark basements and crawl spaces, for example.

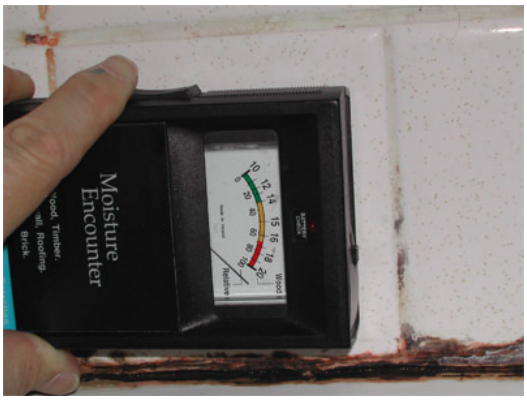


Figure 4: Moisture meter showing damp baseboards

To fix a mold problem, you must not only take out the damaged and contaminated materials, you must fix the source of the moisture as well. Humidity-related problems can be remedied by installing ventilation fans or dehumidifiers. When the relative humidity of a room or building is between 30% and 60%, mold growth will likely be held in control.

Sometimes, landscaping or fixing the gutters of a building can solve the moisture problem. If the problem is a result of faulty plumbing, a leaky roof, or a leaking HVAC (Heating, Ventilating, and Air Conditioning) system, you will need to enlist the help of professional repair workers. Proper maintenance will then be key to ensuring that the mold problem does not return to the location.

Other Causes of Indoor Air Pollution

Molds and the mold-related volatile organic compounds (mVOCs) they release are just two causes of indoor air pollution. Others include:

- a buildup of dust and byproducts of heating and cooling systems.
- cooling odors/fumes released from new carpets and furniture.
- renovation and construction activities in existing structures often displace dusts and cause odors that are unusual to occupants.
- traps in drains may dry out, allowing sewer gases into buildings.
- emissions from copiers, especially high capacity copiers and blueprint reproduction.

If indoor air pollution is wide-spread in a structure, it may be referred to as a "sick building". Occupants may have a range of reactions to the exposures, and the general phrase used to describe them is "sick building syndrome". Syndrome refers to group of symptoms that may not fit a specific diagnosis.

For more information about mold, visit the EPA's Mold homepage at: http://www.epa.gov/mold/. Click on the "Related Links" button at the far left for a list of further resources.

Why Take Action?

Mold can cause health effects. Loss of work time, medical treatment, and the burden of work-related illness on the worker and his/her family are substantial concerns requiring rapid remediation. Any contamination transmitted into the home would have a more serious effect on children.

Mold can damage property. The building and its contents are a substantial investment. Loss of use and loss of contents cost money. A timely, comprehensive remediation program will allow return to normal operations, and reduce the likelihood of a new mold growth.

Liability may result. The legal system may be used if a person believes that he/she has been harmed. A building owner or remediation supervisor may be involved if it alleged that you or your actions contributed to the harm.

Generally, no one intends to create a moldy space to harm anyone. Nonetheless, a legal claim can be made, taking time and money to resolve. Ongoing actions that will be helpful in avoiding or limiting liability include:

- Consistently use best work practices
- Update and practice required plans
- Act on employee/occupant reports of building conditions
- Practice preventive maintenance
- Keep complete and accurate records
- Review and update insurance policies

State and Local Requirements. There are not currently Federal regulations regarding mold remediation. The Environmental Protection Agency provides guidelines on procedures that can be found at: www.epa.gov/mold.

Your instructor will describe local requirements, if they exist.

Exercise: Mold in a School

Say "mold" to most people, and they'll cringe a little, thinking of the bluish-green fuzz on those old hamburger buns. Say "mold" to the parents in one Midwestern school district, and you're likely to get an earful.

Excited parents sent their fourth, fifth, and sixth graders to the newly opened intermediate school in September of 2000. Just days after school began, faculty and students experienced symptoms which ranged from itchy red eyes to a chronic cough and nausea. A science teacher strongly believed that the building was responsible for the widespread illness and, at her urging, the superintendent ordered environmental testing that November.

Figure 5: Moldy bread

The school's principal stated that the report showed levels of formaldehyde and other airborne toxins typically found in new buildings were in the clear. So why was everyone getting sick? Students and teachers both reported a moldy, musty odor. One teacher even reported seeing mold on the library's new books. Further investigation revealed that the new HVAC (heating,

ventilating, and air conditioning) system was leaking, causing widespread mold growth in the building. The principal had neglected to mention that the report also acknowledged the presence of a variety of mold that was "capable of being pathogenic to humans". By May 2001, the school nurse was seeing about 65 students a day. Most got sent home. One person had uncontrollable bronchial spasms and was dependant on an inhaler to breathe properly. Concerned parents and teachers banded together and eventually the superintendent shut down the new building for repairs. Mold had been growing rampantly in the building's wet ductwork, and was being distributed through the HVAC system to all the classrooms. Samples taken from carpets showed that mold was present which was "associated with a range of hypersensitivity diseases … known to produce mycotoxins". Cleanup work took sixteen months and $500,000.

Mold isn't just that loaf of bread that can be neatly tossed in the garbage. Certain types of mold can cause serious health problems in those who are exposed. Instances like the contamination at this intermediate school have made mold a prominent public health issue in recent years.

Questions

Based on the description of the mold problem in this Intermediate School, answer the following questions.

1. What were the initial clues that suggested the presence of mold contamination?

2. What caused the mold contamination and how did it spread?

3. What health problems were caused by exposure to the mold?

4. What laws could the parents use to require the school to remove the mold?

Summary

Mold is a general term used to describe a large group of organisms. Molds:

- Require moisture to grow.
- Can be found anywhere.
- Reproduce through spores.
- Are usually detected by sight or odor.
- Can cause serious health problems.

IF YOU BUILD IT, THEY WILL COME.

IF YOU WATER THEM, THEY WILL GROW.

Key Terms

Mold

Indoor Air Pollution/Indoor Air Quality (IAQ)

mVOC

Review Questions

1. Define the term “mold”.

2. List three clues that mold may be growing in a room.

3. List three possible health effects from exposure to mold.

4. List three reasons to remediate mold.

Background & Reading Materials

1. Ruther, Paul. “Parents and Teachers Shut Down Moldy New School.” *Everyone’s Backyard*. Vol. 20, No. 4. Winter 2002: 5-7.
2. NYC Department of Health. “Fungi in Indoor Environments.” http://www.nyc.gov/html/doh/html/epi/moldrpt1.shtml. Accessed 4/12/07.

PLANNING

The planning phrase of a project allows a broad overview of the task and selection of appropriate methods and personnel. All aspects of the project can be considered, and an approach developed to remediate the mold.

Chapter Objectives

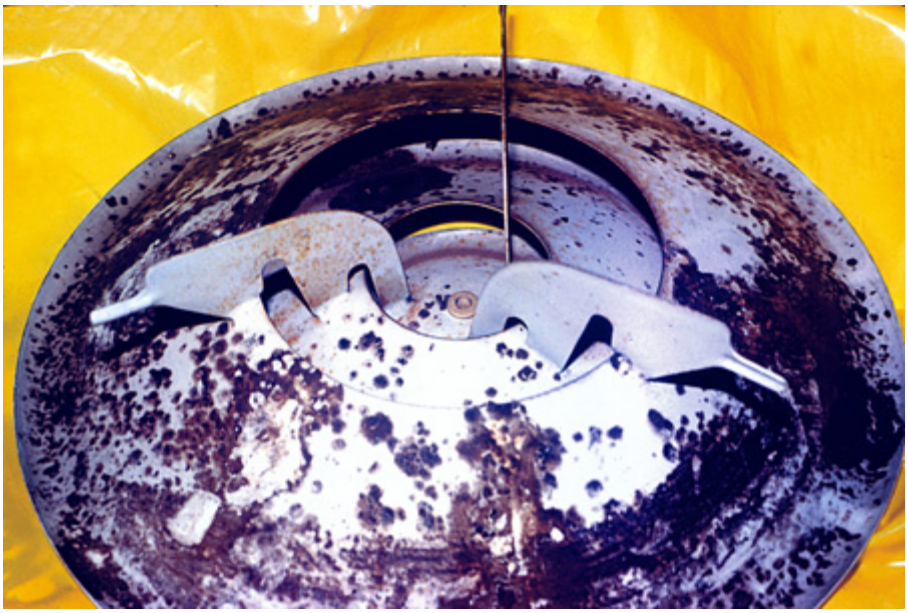
When you have completed this chapter, you will be better able to:

- Identify types of mold remediation responses.
- Identify phases in the mold remediation process.
- Identify the job duties of workers, supervisors, and owners in mold remediation.

Types of Responses

Whenever mold is suspected, an investigation should be initiated. Ideally, a plan is in place detailing who is responsible, what information is to be collected and disseminated, and how decisions are made regarding any needed remediation. Generally, investigations result in one of three responses:

1. **No remediation action** is taken when no mold is found during the investigation. This may result when the concern is odor that is related to another source. For example, off-gassing from new carpet may be transported in the ventilation system to a remote part of an office building. Occupants in the distant location may have no information regarding the carpet installation, and report the odor is possible mold because it has been very rainy during the past week. A thorough inspection of the office space reveals no water or wet areas and no visible mold. Tracing the ventilation system plans, reveals that air in the space where carpet is being laid can enter the space above the ceiling and diffuse to the remote location. The low concentration of the carpet "odor" coming from the distant installation site raised concern among employees.



2. A **small scale maintenance job** can be undertaken for remediation when the total surface area involved is less than 10 square feet. In addition, the source of the water is readily identified and is repairable, and all PPE and other equipment is available to trained personnel to perform the work. If this is a recurrence of mold in a particular location, then outside help is indicated.

3. **Remediation action** by a properly trained crew is needed when the area involved exceeds 10 square feet, the source of water is not apparent, or repair cannot be done by available personnel.

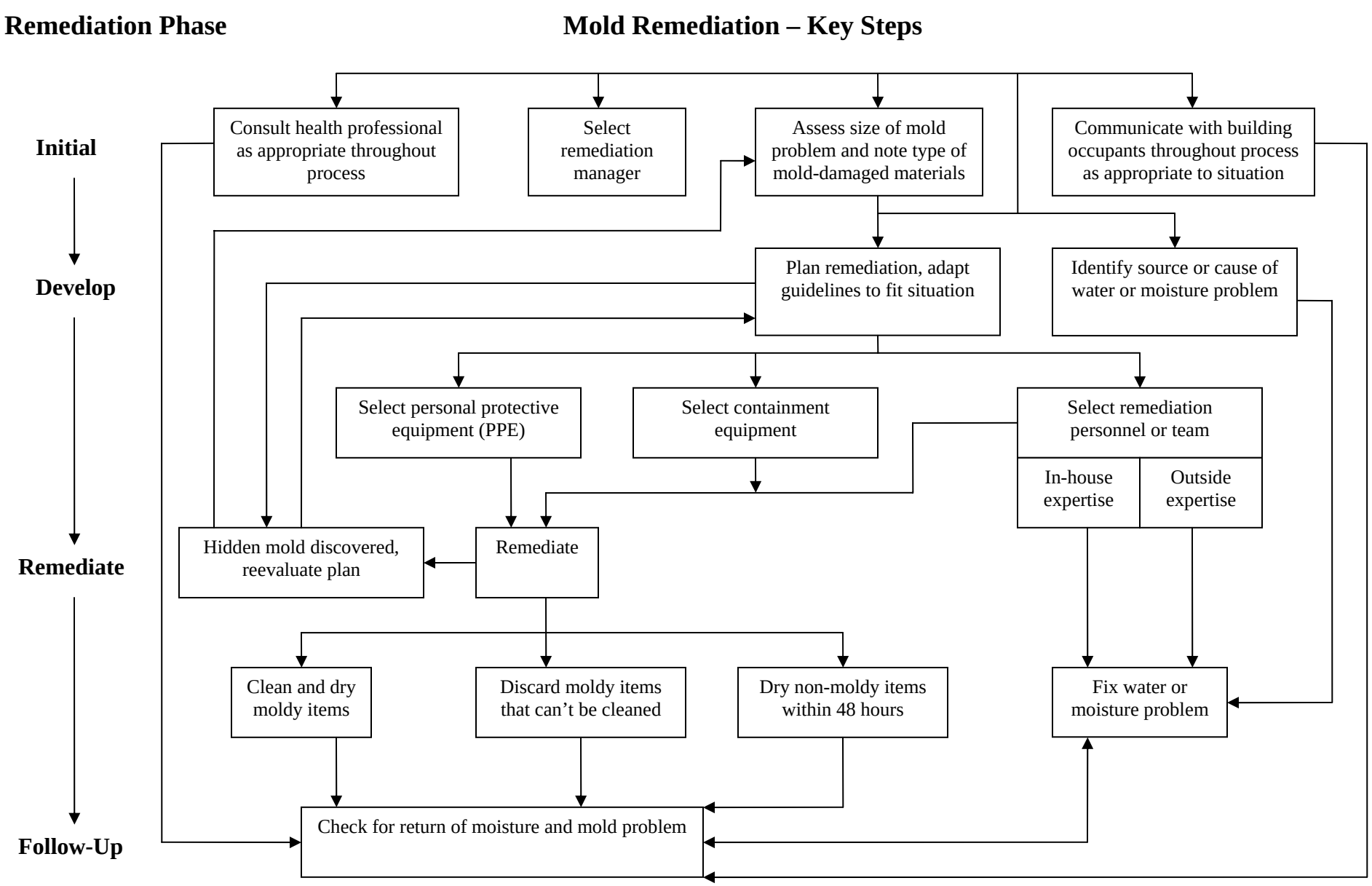
Mold remediation work is generally concerned with these activities:

- Obtaining clearance
- Containing and isolating the problem
- Protecting the worker and building occupants
- Clearing the room of movable objects
- Preparing the work area
- Setting up a negative air machine
- Remediating contamination
- Discarding waste properly
- Reducing the likelihood of recurrence
- Following up

The four phases of a remediation action are:

1. Initial investigation
2. Develop a plan
3. Remediate/Re-evaluate
4. Follow up

These phases are shown in the following figure: *Mold Remediation – Key Steps*.



Source: EPA, 402-k-01-001, March 2001, Mold Remediation in Schools and Commercial Buildings, p5.

Activities in each phase are listed below, and described in detail in Appendix A.

Phase 1: Initial Investigation

This phase has four components:

- Consult health professional, mycologist, or mold inspector, as appropriate. Keep in mind that many health professionals have limited experience and knowledge in dealing specifically with mold/fungi
- Select remediation manager
- Assess size and type of damaged materials
- Communicate with occupants or other affected parties

Note: although the arrows do not show this in the figure, it is essential that the fourth component – communication – be carried on throughout the entire remediation process. A single point of contact should be designated as the information specialist, so that everyone is told the same information. Multiple sources of information can lead to inaccuracies and delay dissemination.

Phase 2: Develop a Plan

This phase has five components:

- Plan the actions to be taken
- Identify the source of water or moisture
- Select PPE
- Select containment equipment
- Select remediation personnel or team

Phase 3: Remediate/Re-evaluate

This phase has two major components:

- Remediate using the methods described in the Plan. These may include:
  - Contain the area
  - Clean and dry moldy materials
  - Wet wipe
  - Vacuum
  - Pressure wash
  - Discard moldy items that cannot be cleaned
  - Dry non-moldy items
  - Fix water or moisture source

- Re-evaluate if or when hidden mold or other water sources found

It is very important to be alert to hidden mold and other sources of water during the remediation. Rushing through a job to stay on schedule may result in inadequate remediation and complaints from the owner.

Phase 4: Follow Up

This phase should be conducted periodically following the remediation.

Exercise: Job Duties

Based on the EPA *Mold Remediation – Key Steps* figure, answer the following questions.

1. Which of the duties listed should the owner be responsible for?

2. Which of the duties listed should the supervisor be responsible for?

3. Which of the duties listed should the workers be responsible for?

Summary

There are four phases of remediation:

1. Initial investigation
2. Develop a plan
3. Remediate/Re-evaluate
4. Follow up

Job duties are described by the EPA. Tasks differ for owners, supervisors, and workers.

Key Terms

Small scale maintenance action

Remediation action

Initial investigation

Plan

Remediate/re-evaluate

Follow-up

Review Questions

1. List three actions that may result from an investigation about possible mold.

2. What are the four phases of remediation?

3. What is your role in each phase of the remediation?

Background & Reading Materials

1. Kansas State University. "Controlling Mold Growth in the Home." http://www.oznet.k-state.edu/library/hous2/mf2141.pdf. Accessed 4/12/07.
2. EPA. 402-K-01-001. *Mold Remediation in Schools and Commercial Buildings.* March 2001. http://www.epa.gov/mold/pdfs/moldremediation.pdf. Accessed 4/12/07.
3. EPA. *A Brief Guide to Mold, Moisture, and Your Home.* http://www.epa.gov/mold/moldguide.html. Accessed 4/23/07.

PERSONAL PROTECTIVE EQUIPMENT / CHEMICAL PROTECTIVE CLOTHING

Because exposure to mold may result in serious health effects to workers who are doing the removal work, the employer must provide the appropriate respirator and protective clothing. This Personal Protective Equipment (PPE) and Chemical Protective Clothing (CPC) chapter can help ensure that you do not inhale any of the mold or get it on your clothing. You will learn about the different requirements related to the use of respirators and protective clothing. You will also practice donning and doffing this equipment.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify types of respiratory protection used during mold remediation.
- Identify OSHA requirements related to the use of respiratory protection.
- Demonstrate the inspection of respiratory protection.
- Identify OSHA requirements for the use of gloves, eye protection, and disposable clothing.
- Demonstrate storage and maintenance requirements for PPE.
- Demonstrate the donning of a PPE ensemble.
- Demonstrate the doffing of a PPE ensemble.

Respiratory Protection

Two basic types of respiratory protection are:

- **Air-Purifying Respirator (APR)**, which protects against toxic dusts, gases, and vapors by filtering the air before it enters the lungs.
- **Atmosphere-Supplying Respirator (ASR)**, which provides "breathing air from a source independent of the ambient atmosphere." ASRs include supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA).

In mold remediation projects, it is most likely that you will be using an APR particulate respirator such as:

- Single-use respirators
- Half-mask respirators
- Full-face respirators

APRs are used to protect against specific dusts, mold spores, and toxic chemicals. They work by filtering air before it is inhaled. If APRs are used, all toxic substances must be identified, and the concentration must be known and remain constant, verified by monitoring, and the filter must be selected to protect against those specific exposures. Molds can be identified by taking samples and sending them off to a lab for analysis.

Single use respirators consist of a filter and two straps to hold it in place. APRs that are half-mask or full-face consist of a facepiece with an exhalation valve and one or two filtering cartridges through which the air enters. For mold remediation projects, you will need to ensure that you use a cartridge with a HEPA filter.

All respirators should be marked "NIOSH Approved" on the container. Do not use a respirator of any type that has not been approved by NIOSH.

Single Use Respirators

A single use particulate respirator is a paper filter that is held to the face by two straps and fit to the nose by a self-molding metal strip. These may have an exhalation valve but do not use filter cartridges. They do not provide a high level of protection, but will decrease the inhalation of dusts and mold spores. They generally provide no protection against gases or vapor exposures. (Some specialized single-use respirators have been approved by NIOSH to remove "nuisance" or very low levels of organic vapors or acid gases.)

Single use particulate respirators have two designations – a letter and a number.

The letters describe the resistance to oil mist, as:

- N = Not oil resistant
- R = Resistant to oil
- P = oil Proof

Selection criteria are shown in the NIOSH Pocket Guide, Table 4. Click on: http://www.cdc.gov/niosh/npg/pgintrod.html#nrp

Generally for mold remediation, the N series is selected, as oil mist is not a primary concern. The number refers to filter efficiency, or how much of the airborne particulate is removed by the filter. Common values are:

- 95 = removes 95%
- 99 = removes 99%
- 99.97 = removes 99.97%, equivalent to 100%

An N95 single-use respirator is:

- N → not resistant to oil
- 95 → removes 95% of airborne particulate

An R100 single-use respirator is:

- R → resistant to oil
- 100 → removes 100% of particulate

The percent of particulate removed assumes a very good seal between the face and the mask.

The following donning and doffing procedures for single-use respirators come from the CDC (see background reading and materials for more information).

How to Don a Single-Use Respirator

- Select a fit-tested respirator
- Place over nose, mouth, and chin
- Fit flexible nose piece over nose bridge
- Secure on head with elastic straps
- Adjust to fit
- Perform a fit check
    - Inhale: respirator should collapse
    - Exhale: check for leakage around face
- Bear in mind that facial hair and scars can easily impact the fit of a respirator.

How to Doff a Single Use Respirator

- Lift the bottom elastic over your head first
- Then lift off the top elastic
- Discard

Half-Mask and Full-Face APRs with Flexible (Elastomeric) Face Pieces

Two types of filters are used with these APRs that have a flexible, plastic-like face piece:

- Particulate filters are used to protect against dusts, mists, and fumes.
- Chemical cartridges are used to protect against certain vapors and gases.

Filters and cartridges are selected according to specific exposures which are expected. Factors which affect how well the APR works include the size of the particles, concentration of the substance, and type of filter used. The filter(s) must be changed when loaded with the dust (particulate) or substance (chemical cartridge) or if it gets wet. Certain contaminants do not have an appropriate protective cartridge/canister due to their oxygen displacement characteristics or the fact that they are known or suspected carcinogens.

Cartridge and filter colors designate what type of particulates or chemicals are filtered. OSHA regulation 29 CFR 1910.134(j) says:

Identification of filters, cartridges, and canisters.
The employer shall ensure that all filters, cartridges and canisters used in the workplace are labeled and color coded with the NIOSH approval label and that the label is not removed and remains legible.

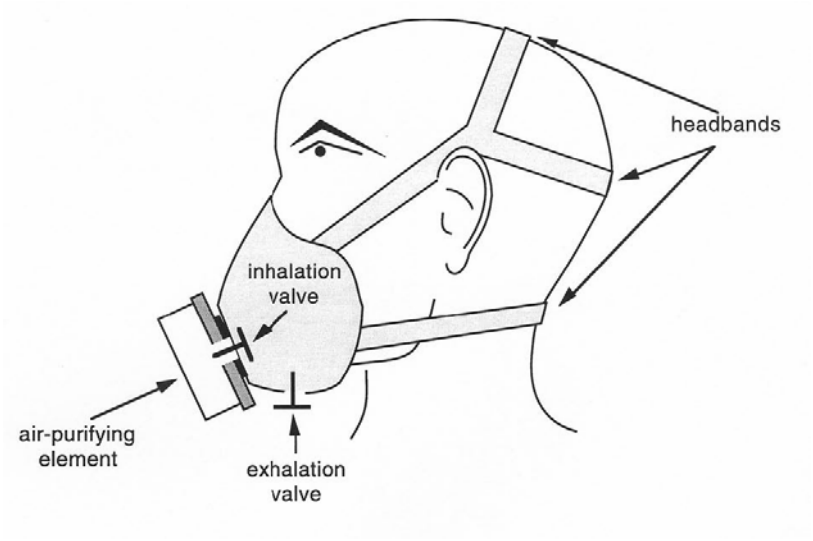
The table below lists ANSI-approved color and protection combinations.

ANSI Z88.78-2001 Respirator Filter Color Coding	
Contaminant	**Color Code**
Acid gases	White
Organic vapors	Black
Ammonia gas	Green
Ammonia and methyl amine gas	Green
Carbon monoxide gas	Blue
Acid gases and organic vapors	Yellow
Organic vapors, chlorine, chlorine dioxide, hydrogen chloride, hydrogen fluoride, sulfur dioxide, formaldehyde, hydrogen sulfide (escape only) ammonia, and methyl amine	Pale brown (tan)
Acid gases, ammonia, organic vapors, and carbon monoxide	Red
Other vapors and gases or combinations not listed above	Olive
HE (HEPA) for PAPRs	Purple
P100	Purple
P95, P99, R95, R99, R100	Orange
N95, N99, N100	Teal

How do you tell if the cartridge needs to be changed? The respirator standard 1910.134(d)(3) requires that respirators used to prevent gas or vapor exposures be equipped with an indicator showing that the cartridge has expired; this is called an End-of-Service-Life Indicator (ESLI). If no cartridge approved for a specific gas/vapor exposure has an ESLI, then the employer must use objective data to determine a change schedule. Should you smell contaminant before the cartridge has "officially expired," notify the supervisor immediately and change the cartridge. For dust, a wearer may notice that it is more difficult to breathe as the filter becomes loaded.

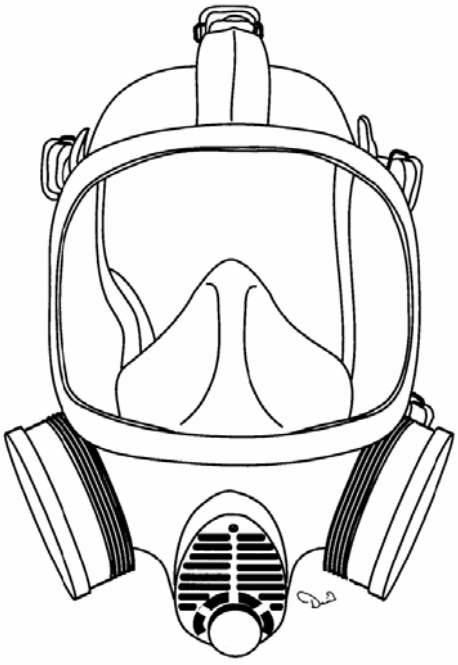
Air enters through the cartridges and exits through a valve. Also, note the proper placement of the headbands for a half-mask respirator. Half-mask respirators without the head harness (only two single straps) must not be used.

Proper Placement of Headstraps for Half-Face APR



Half-Face APR

Full-Face APR



Full-Face Respirator

Another special type of APR is a **Powered Air-Purifying Respirator** (PAPR), which pulls air through filters and blows it into the mask, thereby creating positive pressure. PAPRs consist of a hood or helmet, filter, power source, and facepiece. PAPRs can only be used in environments where the oxygen concentration ranges from 19.5% to 23.5%. This is true of **ALL** APRs.

Quarter mask APRs cover the nose and mouth, but do not extend to the chin. These offer very low protection factors and are **not** recommended for use during mold remediation.

Inspection, Maintenance, and Storage of Respirators

Proper inspection, maintenance, and storage is essential to assure that the respirator is always ready for use. Inspect before and after each use and check at least monthly, even if the respirator has not been in use. A company policy may include more frequent inspections.

For inspecting all respirators:

- Check the condition of the facepiece.
- Check the straps and the points where it attaches to the facepiece.
- Check the headbands to make sure that they can be tightened to provide a good fit, if using a respirator with a reusable facepiece.

Cleaning and disinfecting are essential elements of the respirator program.

To clean and disinfect all respirators with a reusable facepiece:

- Inspect each piece.
- Wash the facepiece.
- Air dry.
- Re-inspect.

Respirator Fit

A respirator will be effective only if there is a good seal between the facepiece and the wearer's face. Therefore, all persons wearing respirators must first be fit-tested. Fit-testing includes qualitative and quantitative testing, as well as routine positive-and negative-pressure tests. Because many different face shapes exist, the manufacturers have a number of sizes. The purpose of fit testing is to find the manufacturer/size combination which offers the best protection.

Factors such as beards, weight loss or gain, dentures, dental work, or facial injury can change the shape of the face, thus potentially changing the fit and efficiency of the respirator. If any of these factors exist, retesting is required.

A protection factor has been determined in the laboratory for each type of respirator (APR, PAPR, SCBA, etc.) and mask (half or full-face). Never assume you will get this much protection. That is why fit-testing is required.

Periodic Fit-Tests

Two types of fit-testing, qualitative and quantitative, may be used to determine the size and model of respirator that an individual should wear, as well as how good the face-to-facepiece seal is. These tests should be repeated periodically to document the respirator's effectiveness.

Qualitative Testing (with irritant or smelly substance)

- Purpose: Checks effectiveness of respirator in preventing substances from entering the facepiece.
- Method: While wearing a respirator, an individual enters a chamber or atmosphere where a test substance has been released. The test substance could be smelly (banana oil) or an irritant (special smoke tube). The wearer should not be able to detect the substance.
- Requirements: This test or its equivalent is required by OSHA 1910.134 (e) (5) at least once a year.

There are several important cautions to qualitative fit-testing. Some of the test substances may irritate the eyes or cause coughing. A poor sense of smell or taste may result in an inaccurate test. Fit-testing is often done in "ideal" environments. The fit may change after wearing the respirator several hours or during strenuous activity

Quantitative (Numerical) Testing

- Purpose: Measures effectiveness of the respirator in preventing a substance from entering the facepiece.
- Methods: While wearing a respirator modified with a probe, an individual enters a chamber. A test substance is released, and the concentrations in the air inside and outside of the respirator are measured. (Another version of this method is available which does not require a chamber or a test substance. The dust which naturally occurs in the air is measured both inside and outside the respirator.) The test is repeated while the person performs specific tasks (speaking, running in place, etc.) that may affect fit.
- Requirements: This test is not required by OSHA, but it should be done at least annually if the service is available.

This test provides an objective assessment of the effectiveness of the respirator for the person who will wear it. This test measures the fit factor (FF), which is a comparison of the concentration of the substance outside of the mask to the concentration of the substance inside of the mask. This FF is useful in determining whether the respirator will effectively protect the wearer from specific chemicals.

A disadvantage to this test is that special equipment and trained personnel are needed to administer it, although a microcomputer and software accessories can perform the calculations required.

Routine User Checks

Two types of checks, positive- and negative-pressure checks, should be done each time a respirator is donned and before each use in the field to check the seal of the respirator. They do not replace yearly fitting but provide a routine assessment as to whether the fit is still adequate.

Respirators with Reusable Face Pieces

Positive-Pressure Check:

- Purpose: Checks the apparatus for leaks at valves or other points.
- Method: Wearer covers the exhalation valve with hand and blows out. Air should escape only from around the facepiece.
- Requirements: Should be done before each use.

Negative-Pressure Check:

- Purpose: Checks the facepiece-to-face seal.
- Method: SCBA wearer disconnects the hose mask and places hands over the intake valve and inhales. APR wearer places hands over cartridges and inhales. No outside air should be felt leaking into the facepiece.
- Requirements: Should be done before each use.

Single-Use Respirators

Positive-Pressure Check:

- Purpose: Checks the respirator for major gaps at nose, cheeks, and chin.
- Method: Exhale. Check for leakage around the face.
- Requirements: Should be done before use.

Negative-Pressure Check:

- Purpose: Checks the respirator for major gaps at nose, cheeks, and chin.
- Method: Inhale. Respirator should collapse.
- Requirements: Should be done before use.

Positive- and negative-pressure checks can be done quickly and easily in the field. They do, however, have the disadvantage of relying on the wearer's ability to detect the leaks.

Exposure Limits

Enforceable exposure limits are set by OSHA. NIOSH and non-governmental agencies (such as the American Conference of Governmental Industrial Hygienists [ACGIH]) have also established limits which are used to determine exposures. These guidelines and recommendations are not legally enforced. Several exposure limits are discussed below.

Permissible Exposure Limits (PELs)

Permissible exposure limits (PELs) are legal exposure levels set by OSHA. Employers must keep exposures at or below the PELs.

Results of exposure monitoring can be requested under the OSHA Standard "Access to Employee Exposure and Medical Records" (1910.1020). Records which workers can request include either environmental information or personal medical records. According to OSHA 1910.1020(e)(1), "Whenever an employee or designated representative requests access to a record, the employer shall assure access is provided in a reasonable time, place and manner, but in no event later than fifteen working days after the request is made." The employer can comply by either making a copy of the requested record at no cost to the employee, allowing the employee to use the employer copy machine to copy the requested record, or by allowing the employee an opportunity to inspect the record.

PELs measure only airborne exposures. With some chemicals, such as bleach, you may be at risk for exposure through skin contact, but not through inhalation. Be aware of this as you calculate your total exposure during the workday. Avoid skin contact with all potentially hazardous materials.

Threshold Limit Values (TLVs)

Threshold limit values are recommendations for exposure limits which are prepared by the ACGIH, a private, non-governmental agency. TLVs, which are not legally enforceable, are reviewed and updated annually.

Recommended Exposure Levels (RELs)

Recommended exposure levels (RELs) are set by NIOSH. RELs are not legally enforceable. Most PELs, TLVs, and RELs are determined as average exposures over an 8-hour work shift. Some PELs, TLVs, and RELs have a "skin" description, which means that the material is readily absorbed through the skin.

Short-Term Exposure Limits (STELs)

These exposure limits are set by ACGIH, OSHA, and NIOSH. The STEL is a maximum average concentration a person may be exposed to over a short period of time, usually 15 minutes. It is legally enforceable if set by OSHA. STEL is sometimes abbreviated further to ST.

Ceiling Limits (C)

The ceiling limit is an exposure level set by ACGIH, OSHA, and NIOSH which should not be exceeded at any time. It is legally enforceable if set by OSHA.

Immediately Dangerous to Life and Health (IDLH)

IDLH conditions are those which pose an immediate threat to life or health or conditions that pose an immediate threat of severe exposure to contaminants which are likely to have harmful effects on health.

The current NIOSH definition for an IDLH exposure condition, as stated in the NIOSH Respirator Decision Logic (DHHS [NIOSH] Publication No. 87-108, NTIS Publication No. PB 91-151183), is a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment."

The purpose of establishing an IDLH exposure concentration is to "ensure that the worker can escape from a given contaminated environment in the event of failure of the respiratory protection equipment."

Time-Weighted Averages (TWAs)

Most PELs, TLVs, and RELs are 8-hour time-weighted average concentrations. The purpose of this type of measurement is to determine the average exposure over a typical 8-hour work shift.

Respirator Protection Factors

Respirators are selected by using respirator protection factors. These protection factors are set after testing by NIOSH and are subject to change. Protection factors vary according to the particular respirator type, with lower numbers indicating a lower degree of protection. Following is a list of respirator protection factors:

- Single use APR = 10
- 1/2-face APR = 10
- Full-face APR = 50
- PAPR = 1000, if sealing full-face piece
- PAPR = 25, if helmet or hood manufacturer has not proved a higher value

Protection factors also exist for combinations of the above respirators. In using these protection factors, you assume that the facepiece has been properly selected to provide the best possible fit. These factors do not apply for persons with beards.

Fit Factor Calculation

Proper selection of respirators can be accomplished by dividing the known chemical concentration by the protection factor. The resulting value needs to be compared to the exposure limit used by your corporation.

If the calculated ppm is higher than the exposure limit, then that type of respiratory protection would be inadequate. If the calculated ppm is lower than the exposure limit, then that type of respiratory protection should be sufficient, provided that the measured concentration will not increase.

Example

You are working at a mold remediation site where hydrogen peroxide will be used as a biocide. The safety and health supervisor measured a maximum concentration of 10 ppm of hydrogen peroxide, but OSHA's PEL allows only 1 ppm for an 8-hour work shift. Because engineering controls cannot be implemented at the site, respiratory protection must be used. What type of respiratory protection would provide adequate protection against this contaminant?

Formula

First, see if a 1/2-face APR can be used:

$$\frac{\text{measured chemical concentration in ppm}}{\text{respirator protection factor (pf)}} = \text{parts per million (ppm)}$$

$$\frac{\text{10 ppm measured}}{\text{10 pf of a half-mask APR}} = \text{1 ppm exposure inside respirator}$$

The resulting answer is 1 ppm, which means that 1 ppm of hydrogen peroxide will be present inside the facepiece of a properly fitted respirator. A concentration of 1 ppm is equal to OSHA's PEL for this contaminant, and accounting for a less-than-perfect seal to the face, this type of respiratory protection would not be adequate.

See if a full-face APR provides better protection:

$$\frac{\text{10 ppm measured}}{\text{50 pf of a full-face APR}} = \text{0.2 ppm exposure inside respirator}$$

The resulting answer is 0.2 ppm. Because 0.2 ppm is less than 1 ppm, a properly fitted full-face APR would provide adequate protection.

What Chemicals May Be Present?

Two common types of chemical exposures at mold remediation jobs are:

- mVOCs
- Biocides

The concentration of mVOCs in air may be monitored by specially trained personnel. Analysis requires chemistry laboratories equipped with gas chromatography and staffed by chemists trained in these analyses. Identification of mVOCs does not identify which mold is present, but will identify any hazardous organic vapors that may require respiratory protection.

Frequently used disinfectants are chlorine dioxide and household bleach. In high concentrations, chlorine is **very toxic** to the eyes and lungs. Skin contact should also be avoided.

Medical Fitness to Wear a Respirator

Initial medical fitness screening is conducted by a physician/licensed health (PLHCP) professional using OSHA's mandatory Medical Evaluation Questionnaire (29 CFR 1910.134 Appendix C). The PLHCP may require additional evaluation. The exam helps assure that the employee is physically capable of working with the added stress of a respirator.

Medical examinations are required for all employees who may work in atmospheres containing overexposure to hazardous substances for 30 days or more a year or as required by OSHA 1910.120(f). (OSHA1910.134 and its appendices do not state this requirement.) These medical surveillance examinations may also be used to verify respiratory fitness.

Examinations should be conducted at least once every twelve months for each employee, unless the physician believes a longer interval (not greater than two years) is appropriate. It is important that the physician understands the worker's job tasks.

Some medical conditions which may prevent an individual from wearing a respirator include:

- Lung disease.
- Claustrophobia.
- Severe high blood pressure.
- Heart disease.

Other circumstances which may prevent a worker from wearing a specific type of respirator include:

- Contact lenses.
- Eyeglasses.
- Mustache.

Special eyeglass kits (optical inserts) are available for full-facepiece respirators.

Facial Hair and Respiratory Protection

Section 29 CFR1910.134/1926.103b, Definitions, states:

> *Tight fitting facepiece means a respiratory inlet covering that forms a complete seal with the face.*

Additionally, Appendix A of 1910.134 (mandatory), states:

> *The test shall not be conducted if there is any hair growth between the skin and the facepiece sealing surface, such as stubble, beard growth, beard, mustache, or sideburns which cross the respirator sealing surface.*

OSHA's interpretation of this section is that there cannot be any facial hair when using any respirator which relies upon a good face-to-facepiece seal, such as any tight-fitting (as opposed to helmet or loose-fitting hood) air-purifying respirator. Even several days' beard growth or a heavy stubble can reduce the possibility of a face-to-facepiece seal.

The question often comes up, "Can an employer force a worker to shave his beard because he will have to wear a respirator?" The answer depends in part on whether the workplace is unionized. There have been cases where arbitration has decided on this question in the favor of the employer as well as cases that were settled in the worker's favor. The decision will turn on the facts of each individual case. You should consult your employee representative for more information.

Read an interpretation of OSHA's standard regarding facial hair online at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22273

In a non-union workplace, the employer is free to impose work rules on the employee and change them at any time consistent with the employment contract. Nothing in OSHA regulations prevents the employer from making such a change and, in fact, the law requires employees to obey OSHA standards.

In a unionized workplace, the employer cannot normally change working conditions unilaterally unless the collective bargaining agreement gives him or her that right or unless the union clearly gives up that right. Where this is not the case, the employer must normally bargain with the union for changes in wages, hours and working conditions that occur during the life of the collective agreement.

Minimum Requirements for a Respirator Program

OSHA requires that employers who make respirators available to their employees have a written respirator program with work-specific procedures. The program should be evaluated and updated at least annually or as requirements change and modified to reflect changes in the workplace.

A respirator program must include the following points:

- Medical evaluations of employees required to use respirators.
- Fit testing procedures for tight-fitting respirators.
- Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations.
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators.
- Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations.
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance.
- Procedures for regularly evaluating the effectiveness of the program.

The employer shall designate a program administrator who is qualified to oversee the respiratory protection program and conduct the required evaluations of its effectiveness. Respirator training and the required medical evaluations are provided to the employee at no cost. The respirator program also may include:

- Need for corrective lenses in full-facepiece respirators.
- Restriction of use of contact lenses.
- Communication needs.
- Guidelines for use in dangerous atmospheres, including confined spaces.
- Guidelines for use in extreme temperatures.

The respirator program will include a description of who is responsible for the various aspects of the program including selection, periodic and routine fit-testing, inspection, cleaning, repair, and maintenance. Persons using respirators under unusual conditions (e.g., a high concentration of acid vapor) should review special requirements with supervisors or the employee safety and health representatives.

Exercise: Inspecting Respirators

Your instructor will divide you into groups and provide you with several different respirators. Examine each for defects:

Single-use:

- Does it have two straps?
- Are they "stretchy"?
- Is it NIOSH-approved?

Elastomeric face pieces:

- Is the rubber cracked on the head straps or at the face seal?
- Are the head straps overly stretched?
- Does the filter screw in and out properly?

Examine each unit; for half-mask and full-face, disassemble and examine each of the pieces. Make sure you can reassemble the equipment correctly.

List the types of respirators you and your teammates inspected.

_____
_____
_____
_____
_____

List any defects you or your teammates found.

_____
_____
_____
_____
_____

Types of Chemical Protective Clothing (CPC)

The employer is responsible for selecting the appropriate protective clothing for the expected hazards. Workers must be trained in use, limitations, and care (29 CFR 1910.132).

Gloves

Gloves are required to protect the skin from contact with mold allergens (and in some cases mold toxins) and from potentially irritating cleaning solutions. Long gloves that extend to the middle of the forearm are recommended. The glove material should be selected based on the type of materials being handled. If you are using a biocide (such as chlorine bleach) or a strong cleaning solution, you should select gloves made from natural rubber, neoprene, nitrile, polyurethane or PVC. If you are using a mild detergent or plain water, ordinary household rubber gloves may be used.

Many gloves are made from latex, a substance which comes from rubber. Unfortunately, many people are sensitive or allergic to latex. If you know you are allergic to latex or if you develop a rash after wearing latex gloves, request gloves made from an alternative material. Nitrile, or synthetic rubber, gloves are often recommended in this case. Nitrile is more expensive than latex, but it also offers better puncture and abrasion resistance and is resistant to more chemicals than latex.

Eye Protection

To protect your eyes, use properly fitted goggles or a full-face respirator. Goggles must be designed to prevent the entry of dust and small particles to keep mold spores out of the eyes. Anti-fogging sprays may be useful when working in high humidity.

Safety glasses or goggles with open vent holes are not acceptable.

OSHA requires that anyone using prescription lenses be provided with eye protection that fits over the lenses without disturbing the proper positioning of the lenses.

Disposable Clothing

Disposable coveralls and suits prevent skin and clothing contact with contaminated water or mold and mold spores. Different types of protective clothing may be worn depending on various factors, such as temperature, type of contaminant, or concentration of contaminant. Workers who are pressure-washing a floor will be exposed to liquid contamination, and as such, will have to wear splash-proof protective clothing. Workers who are tearing out drywall or lumber will only be exposed to particulate matter, and so will not need to wear waterproof clothing.

Protective clothing protects not just the skin, but any clothing underneath that you will be wearing home. It helps prevent you from accidentally carrying contamination from the workplace to your car or home. Mold remediation workers will likely wear full-body protective suits. There are two main materials that these disposable suits are made from:

- **Tyvek®.** This is an inexpensive, plastic, breathable fiber and is used to create a disposable suit. It is ideal for work in hot areas, but will provide little to no protection from liquids. It is fairly puncture and abrasion-resistant.
- **Tychem QC®.** Another plastic fiber – similar to Tyvek® – that is coated in the same plastic found in Saran Wrap®. This material provides protection against liquids and a wide range of other compounds. Also inexpensive.

These full-body suits should be worn with both head covers and boot covers.

If non-disposable clothing has been worn during mold remediation activities, it should be taken off during decontamination, double-bagged, and later washed separately in 5% bleach solution.

Inspection, Maintenance, and Storage of CPC

It is important to inspect CPC for evidence of chemical damage or aging. CPC which is torn, degraded, or otherwise non-functional will not offer adequate protection to the wearer. The safety and health plan should describe or reference SOPs for CPC inspection, maintenance, and storage.

CPC should always be inspected when it is:

- Received from the distributor.
- Issued to workers.
- Put into storage.
- Taken out of storage.
- Used for training.
- Used for work.
- Sent for maintenance.

An inspection checklist should be developed for each item. Factors to consider are:

- Cuts, holes, tears, swelling, and abrasions in seams of fabric.
- Weakness in zipper or valve seals.
- Signs of contamination such as discolorations or visible chemical.
- Signs of malfunctioning exhaust valves.

> Protective equipment and clothing may be contaminated even if they do not appear discolored!

Proper maintenance can prevent CPC deficiencies and prolong its life. A detailed SOP must be developed and followed rigorously.

Proper storage is important in order to prevent suit failures. The written SOP should describe storage before the CPC is issued to the wearer (in a warehouse, on-site, etc.) as well as storage after use. Check the manufacturer's data, as most CPC used now has a shelf life.

Donning PPE Ensembles

The PPE ensemble used for the work depends on the job tasks and extent of the mold contamination. For example, the least protection needed is for small jobs. This might involve washing a painted wall that has mold on 5 square feet, and is often done by in-house maintenance workers. For this activity, the PPE will include:

1. Long-sleeved shirt and long pants
2. N-95 respirator
3. Gloves
4. Goggles

This clothing is donned in the order shown. Goggles must be donned after the N-95 respirator. Gloves may be donned last, as the worker prefers.

In an area of full containment, where the work site is isolated by polyethylene sheeting and the exhaust air goes through a high-efficiency particulate air filter, the PPE would generally include:

1. Full-body protective suit
2. Boots
3. Boot covers
4. Protective eyewear
5. Gloves
6. Respirator
7. Head cover

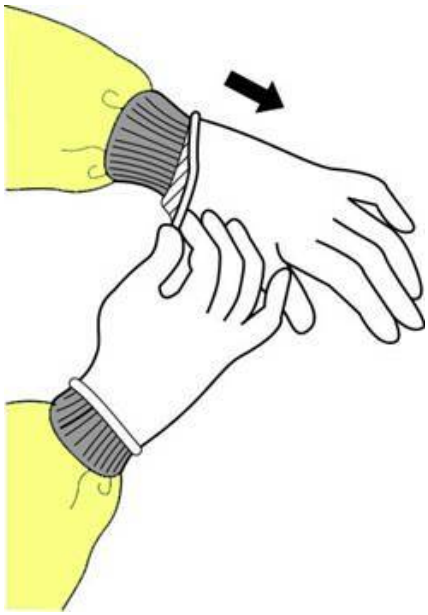
All seams (at the gloves and cuffs of the pants) should be sealed with tape. Containment will be covered in greater depth in the Work Practices chapter.

Doffing PPE Ensembles

Doffing also depends on the PPE in the protective ensemble. For small jobs, goggles are removed first, followed by the respirator and then the gloves.

To minimize the spread of contamination, gloves should be removed using one of two standard practices:

Method 1



1. Grasp one of the gloves at the cuff and pull it part of the way off. The glove will turn inside out. It is important to keep the first glove partially on your hand before removing the second glove. This protects you from touching the outside of either glove with your bare hands.
2. Leaving the first glove over your fingers, grasp the second glove near the cuff and pull it part of the way off. The glove will turn inside out. It is important to keep the second glove partially on your hand to protect you from touching the outside surface of the first glove with your bare hand.
3. Pull off the two gloves at the same time, being careful to touch only the inside surfaces of the gloves with your bare hands.
4. Dispose of the gloves by placing inside out in the trash.
5. Wash hands thoroughly.

Method 2

1. Grasp outside edge of glove near the wrist.
2. Peel away from hand turning glove inside-out.
3. Hold in opposite gloved hand.
4. Slide ungloved finger under the wrist of the remaining glove, be careful not to touch the outside of the glove.
5. Peel off from inside, creating a bag for both gloves.
6. Discard.
7. Wash hands thoroughly.

To maximize worker safety and to keep contamination from spreading, PPE should be doffed in the following order when there is no decon shower:

1. Boot covers
2. Boots
3. Full-body protective suit
4. Head cover
5. Protective eyewear
6. Respirator
7. Gloves

When a decon shower is provided:

1. Boot covers
2. Boots
3. Full-body protective suit
4. Head covers
5. Protective eyewear
6. Gloves
7. Respirator

All disposable items (suits, gloves, boot & head covers, N-95 respirators, respirator cartridges) should be properly disposed of in a waste bin. Reusable items (protective eyewear, respirator, facepieces) should be placed in a separate bin for thorough cleaning and sanitizing. Boots should be washed down before leaving the decontamination area. Following removal of PPE, all workers should thoroughly wash their hands with soap and water.

Exercise: Donning and Doffing PPE

You will be divided up into teams for this exercise. Your instructor will provide you with duct tape and a cart or table full of various types of PPE such as:

- N95 respirators
- Half-face APRs
- Full-face APRs
- Head covers
- Gloves
- Goggles
- Bootcovers
- Full-body protective suits

Using the PPE provided select an ensemble for the following three situations:

- Maximum protection
- Lowest level of protection (not none!)
- Intermediate protection

At least one team member should dress out for each of these three scenarios, and remember to seal the wrists and ankles with tape.

List the PPE you selected for the maximum protection from exposure:

_____
_____
_____
_____

List the PPE you selected for the lowest level of protection:

_____
_____
_____
_____

List the PPE you selected for an intermediate level of protection:

_____
_____
_____
_____

Describe any difficulties you encountered. How could you do better next time?

_____
_____
_____

Exercise: Cleaning, Storing, and Disposal of PPE

Following doffing, what actions are needed for each part of the ensemble? If "clean" or "store" is checked, describe how/where.

	ACTION		
	Disposal	**Clean (method)**	**Store (where)**
Gloves	☐	☐ _____	☐ _____
Goggles	☐	☐ _____	☐ _____
Head cover	☐	☐ _____	☐ _____
Boot cover	☐	☐ _____	☐ _____
Protective suit	☐	☐ _____	☐ _____
N-95	☐	☐ _____	☐ _____
Half-face respirator	☐	☐ _____	☐ _____
Full-face respirator	☐	☐ _____	☐ _____

Bringing it all Together

The following table shows PPE for various sizes of jobs. This assumes the water or moisture source responsible for the mold growth was clean (i.e. no chemical or biological hazards or waste materials present). Additional precautions must be built into the plan by the remediation manager if the water is known or suspected to be contaminated.

Scope of Project (square feet)	PPE Needed
Less than 10	N-95 respirator Gloves Goggles
10 – 100	N-95 or half-face respirator with HEPA filter Disposable coveralls Goggles / eye protection
> 100	Full-face respirator with HEPA filter Disposable full-body clothing Head covering Foot coverings Gloves

Exercise: What Would You Do?

Your instructor will put you into small groups for this activity. Read the questions carefully and examine the images provided. Discuss. Refer to the information on the previous pages as necessary.

1. You've been contracted to remediate a private residence. The owner has sent you the image you see below, along with a note saying that the entire first floor looks like this.

Select the PPE you will use:

- Gloves
- N-95 respirator
- Half-Face respirator w/ HEPA filter
- Full-Face respirator w/ HEPA filter
- Goggles
- Disposable overalls
- Disposable full-body clothing
- Head gear
- Foot coverings

Write a few notes describing what should be included in the remediation plan. What needs to be remediated? What methods will you use? Is containment necessary? If yes, what level of containment would you select? Defend your choices. What other information would be helpful?

_____
_____
_____
_____
_____

2. You've been contracted to investigate an office building. Office workers in the northwest wing, which only consists of a few small rooms, have been complaining of an odor. You and your coworkers have discovered there is mold between the 8' x 10' wall of two offices.

Select the PPE you will use:

Gloves	Goggles
N-95 respirator	Disposable overalls
Half-Face respirator w/ HEPA filter	Disposable full-body clothing
Full-Face respirator w/ HEPA filter	Head gear
	Foot covering

Write a few notes describing what should be included in the remediation plan. What needs to be remediated? What methods will you use? Is containment necessary? If yes, what level of containment would you select? Defend your choices. What other information would be helpful?

_____
_____
_____
_____
_____

3. In the break room of a local hardware store, workers recently discovered there was mold under their refrigerator. They've asked you and your co-workers to take a look and write up a plan to remediate the mold problem.

Select the PPE you will use:

Gloves	Goggles
N-95 respirator	Disposable overalls
Half-Face respirator w/ HEPA filter	Disposable full-body clothing
Full-Face respirator w/ HEPA filter	Head gear
	Foot coverings

Write a few notes describing what should be included in the remediation plan. What needs to be remediated? What methods will you use? Is containment necessary? If yes, what level of containment would you select? Defend your choices. What other information would be helpful?

_____
_____
_____
_____
_____

Summary

In this chapter, you learned about the types of respirators you will likely use as a mold remediation worker. You inspected respirators.

You also learned about different types of protective clothing that you will likely wear. You learned the proper donning and doffing procedures for PPE ensembles.

Key Terms

APR

Single-use respirator

N-95

Fit testing

User checks

PEL

Protection factor

Review Questions

1. List three types of respirators that may be used during mold remediation.

2. List five of the seven elements OSHA requires as part of a respirator program.

3. List three topics that must be included in training for use of gloves, eye protection, and protective clothing.

Background & Reading Materials

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WORK PRACTICES

When conducting work with any potentially hazardous substance, work practices are key to maintaining your health and safety.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify key safety practices.
- Demonstrate containment procedures.
- Demonstrate wet wipe procedures.
- Demonstrate wet vacuuming.
- Demonstrate the use of a dry vacuum.
- Demonstrate proper disposal of solid wastes.
- Demonstrate troubleshooting for unexpected events.

Proper Work Practices Reduce Exposure

There are five basic ways of reducing your exposure to mold and mold spores:

- **Keep disturbance to a minimum.** This means turning off HVAC systems, applying biocides and cleaners carefully, and using a HEPA filter on vacuum cleaners and air purifiers. Before remediation, establish pathways that keeps foot traffic as far from the mold source as possible.
- **Contain it.** Use plastic sheeting and duct tape to create containment units around the mold source. After removal of mold-contaminated materials such as drywall, wrap the waste in plastic and secure with tape.
- **Use amended water.** When using water to wet wipe, add a detergent or other surfactant, such as a mixture of polyoxyethylene ether and polyoxyethylene ester. This makes the water "wetter". That is, the water is better able to soak the surface to remove the mold. Be careful not to introduce too much water to the work area, and be sure to dry it thoroughly within 48 hours to prevent more mold growth.
- **Employ HEPA filters.** If wet cleaning is not feasible or appropriate for the task at hand, use a vacuum cleaner with a HEPA filter. Also, respirators should have HEPA filters.
- **Regulate air flow.** Contaminated air should flow away from workers and towards a HEPA filter. Negative-pressure air machines can be used to create the necessary air flow in a worksite. Another way to regulate air flow is to shut down HVAC systems.

In order to prevent continuing mold growth, water sources must be found and eliminated. Following a review of water sources and basic safety for remediation work, these activities will be covered:

- Containment
- Cleaning
    - Wet methods
    - Dry methods
- Disposal
- Final inspection / Reoccupancy

Identify the Source of Water or Moisture

While mold is everywhere, it does not grow without water. Making sure that the source of water or moisture has been remediated is a key element to abating mold.

> Mold will not grow if there is no water source.

Elements of a work plan completed prior to remediation should include:

- Water source identification
- Cutting off the water source
- Safe work practices

Water leaking from potable sources and HVAC systems is generally considered to be "clean". Water from sewers or other sources that may contain chemical or biological pollutants require additional considerations to assure protection. When a flood has occurred, the source may be receding, but pockets of water may remain in a structure. Any wet item is also a continuing source.

Water sources are generally grouped into these three categories:

- **Black water:** raw sewage. This type of water is heavily contaminated with viruses and bacteria.
- **Gray water:** general household wastewater (dishwasher, laundry). This water is relatively clean, but if left unattended, can quickly become an ideal environment for bacteria and mold.
- **White or clean water:** unused water, directly from water supply. This type of water is less of a problem than gray water leakage because it contains no debris. However, the moisture can lead to mold problems or water damage, and should be vacuumed up immediately.

Remediation Safety Practices

When you are removing mold, you may be exposed to safety hazards that have the potential to cause injuries. Jobs that involve lifting or moving objects, climbing ladders, or walking on slippery surfaces can result in serious injuries to you or co-workers. In this part of the chapter, you will learn about safety practices you should follow to prevent injuries that may occur during remediation activities. Information on chemical hazards are also included here.

The following are covered:

- Ergonomics
- Egress
- Walking and working surfaces
- Ladders and scaffolding
- Lock-out procedures
- Hand and portable power tools
- Compressed air use
- Electrical safety
- Confined space
- Heat and cold
- Hazard communication

Ergonomics

The weight, size and shape of materials to be moved have a direct effect on the strain to your body. If an object has to be moved, size-up the load and the job before starting work by asking yourself these questions:

- What is the weight?
- What is the size?
- What is the shape?
- Can contents or parts shift during transfer?
- What is your physical capacity to lift?
- Is there someone else to help?
- Is there a lifting device or dolly?
- Do I need tools to handle the material?

When you have a plan for the activity, use the following work guidelines.

Lifting:

- Place your feet close to the object, 8 to 12 inches apart for good balance
- Bend your knees to a comfortable degree
- Get a hand hold on the object
- Use your leg and back muscles to lift the load straight up, keeping the load close to your body
- Lift the load to the carrying position, without turning or twisting
- Observe the path you must take, making sure it is clear
- Turn your body with foot position changes
- Set the load down using leg and back muscles by bending your knees
- Release your grip

Use Teamwork:

- Large and odd-shaped loads
- Keep load at same level by all carriers (for example, when carrying carpet)

Use the Proper Equipment:

- Use a ladder; *never* use a chair, boxes or pallets

Practice Safety:

- Over-reaching and stretching cause strains
- Twisting positions cause strain while lifting or carrying
- Carrying stacks that obscure your view may result in tripping or bumping
- Unstable or uneven surfaces increase the likelihood of falls/trips/slips
- Tie down loose or shifting parts (for example, remove or secure desk drawers before moving a desk)

Choose the Right Equipment:

- Make sure tools (e.g., shovels, hammers, pry bars) are in good repair
- Handle length of tool should be appropriate for the job
- Dollys have straps
- Ladders are in good repair and of sufficient height that you do not have to approach the top rung
- Use J-handles when carrying large pieces of drywall

Egress

You may be working in a building or area where you have never worked before. Your supervisor must make sure that you know where the exits are for emergency egress if a fire, power failure, or emergency occurs.

Exits must be easy to open and clearly marked. The route to the exit cannot be blocked by debris, equipment, or other materials that would reduce your ability to leave.

Walking and Working Surfaces

The work areas may be wet which can contribute to slips and falls. Walk with extreme caution on wet surfaces. Other conditions to be aware of:

- Any changes in the grade of the surface.
  - Example:
- Changes in the walking surface.
  - Example: from linoleum in a hallway to subflooring in a room where the carpet has been removed.
- Sharp edges, nails, or staples during rip-outs.
  - Example: carpet staples, broken drywall.

Ladders and Scaffolding

Portable ladders may be needed for many activities. A few rules to use:

- Use ladders that are in good condition.
- Use ladders with non-slip bases.
- Place the ladder so that the side rails are on secure footing.
- Use the proper ladder for the job; **never** use boxes, barrels, or other unstable bases to obtain additional height – get an appropriate ladder.
- Do not use metal ladders near energized electrical equipment.
- Do not use wooden ladders, as they cannot be properly decontaminated.

If you identify a potential defect in a ladder, inform the supervisor immediately. Ladders must be inspected frequently, tagged if defective, and immediately removed from service.

The following information is taken from the OSHA e-Tool: Ladder Safety.

Loads

Self-supporting (foldout) and non-self-supporting (leaning) portable ladders must be able to support at least four times the maximum intended load, except extra-heavy-duty metal or plastic ladders, which must be able to sustain 3.3 times the maximum intended load.

Angle

- Non-self-supporting ladders, which must lean against a wall or other support, are to be positioned at such an angle that the horizontal distance from the top support to the foot of the ladder is about 1/4 the working length of the ladder.
- In the case of job-made wooden ladders, that angle should equal about 1/8 the working length. This minimizes the strain of the load on ladder joints that may not be as strong as on commercially manufactured ladders.

Rungs

- Ladder rungs, cleats, or steps must be parallel, level, and uniformly spaced when the ladder is in position for use. Rungs must be spaced between 10 and 14 inches apart.
- For extension trestle ladders, the spacing must be 8-18 inches for the base, and 6-12 inches on the extension section.
- Rungs must be so shaped that an employee's foot cannot slide off, and must be skid-resistant.

Slipping

- Ladders are to be kept free of oil, grease, wet paint, and other slipping hazards.

Other Requirements

- Foldout or stepladders must have a metal spreader or locking device to hold the front and back sections in an open position when in use. (See image at right.)
- When two or more ladders are used to reach a work area, they must be offset with a landing or platform between the ladders.

- The area around the top and bottom of ladder must be kept clear.
- Ladders must not be tied or fastened together to provide longer sections, unless they are specifically designed for such use. (See image at left.)
- Never use a ladder for any purpose other than the one for which it was designed.

For more information, see also: 29 CFR 1926.1053, Ladders.

Scaffolding requirements are found in OSHA Construction Standard 29 CFR 1926.451. Extra care should be taken when responding to emergencies on scaffolds in PPE due to restricted motion and visibility. Aerial lifts such as extendable boom platforms, serial ladders, articulated boom platforms, vertical towers, and combinations of these should be used in place of scaffolds whenever possible and practical, in accordance with OSHA 29 CFR 1926.556.

Where safety belts or other security devices are required, selection and use are covered by OSHA 29 CFR 1926.104, Full-Body Harness, Lifelines, and Lanyards.

Lock-Out Procedures

Lock-out procedures are used to prevent injury during the repair of mechanical equipment. The equipment is locked out of operation so that it will not be turned on by someone who is unaware of the activity of another responder.

> Know the site lock-out procedures BEFORE attempting any operation!

Common examples of equipment requiring lock-out include the following:

- Electrical junction boxes.
- Pipes with liquid, steam, etc.
- Mechanical equipment with moving parts (grinders, crushers, pulverizers, hydraulics).
- Spring-loaded or –activated devices.

The risk of ignition of flammable materials and electrocution is lessened by locking out an electrical circuit. Locking out a steam or hot water pipe may cut off a transmission path for vapors or fumes and prevent burns or accidental contact with the contents of the piping system.

> Never assume a machine, circuit, or pipe is locked out just because it should be. When in doubt, lock it out!

Lock-out requirements are described in 29 CFR 1910.147, The Control of Hazardous Energy (Lock-Out/Tag-Out).

During an emergency, lock-out procedures may be used for the following purposes:

- To reduce power to the area.
- To reduce material flow.
- As part of confined-space entry.

Hand and Portable Power Tools

The employer is responsible for maintaining the safe condition of tools and equipment used during the remediation process. Never use hammers with cracked or broken handles or bent wrenches or pry-bars.

Check hand-held electrical tools to assure they each is equipped with a quick-release to assure that power is shut off automatically as soon as the operator releases the control. All hand-held portable electrical tools must be double-insulated and have a grounded frame; labeling on the unit must verify these design features.

If tools are operated pneumatically, assure that the unit is secured to the hose, to prevent the tool from being disconnected. A tool retainer must be used on tools to prevent the attachment from being expelled.

Always use appropriate shields, guards and attachments to tools. For example, portable circular saws must be equipped with guards above and below the base plate or shoe. The lower guard must be operating properly—retracting when the blade is in use and automatically returning to the guard position when the tool is not energized. Nailers, staplers and other equipment with automatic feed should have a muzzle to prevent the tool from ejecting a piece unless the muzzle is in contact with the work surface.

Jacks used for support must be rated for load, and the rating must be on the unit. Semi-annual inspection for wear and general condition is required. Assure that jacks are properly blocked when necessary to provide a firm foundation.

Training in the use of powered hand tools is required for safe operation at the worksite.

Compressed Air Use

Compressors may be available at the worksite for several purposes. The downstream pressure in a compressed air line must remain below 30 psi if the nozzle is dead-ended; this can be accomplished by using a pressure relief device at the nozzle or inserting a reducer at the outlet from the compressor. Never use compressed air to clean debris from a person.

Electrical Safety

In work situations where water and electrical systems may be close to each other, care in electrical safety is required. Outlets, switches, and junction boxes should be covered. Flexible cords must be fastened so that there is no pull on the joints; any splices must be jointed with suitable devices and properly insulated. Inspect all cords daily and repair any defects immediately or remove the unit from service until a repair can be made.

Confined Space Entry

A confined space generally has three distinct properties which set it apart from other areas and dramatically increases the risk of injury or illness.

As an emergency responder, you may be called upon to work in confined spaces to control releases or rescue victims.

Properties of Confined Spaces
• Limited ways to get in and out of the space. • Not intended for continuous human occupancy. • Bodily entry is possible and work can be performed.

Some common confined spaces that may be found at mold remediation jobs are:

- Storage areas
- Cellars/basements
- HVAC systems

The OSHA Permit-Required Confined-Space Entry Standard (29 CFR 1910.146) requires that the employer survey all confined spaces and designate those for which a permit is required. Remember that in an emergency, the hazards of a space may change. For example, a ditch not usually containing any hazard could be a catch basin for spilled material. Although not designated a permit-required confined space, it has become one as a result of the release.

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

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

Rescue personnel must be informed of the hazards before entry.

Entry into confined spaces poses many dangers. Chemical vapors can accumulate quickly in confined spaces. A confined space might also contain a material that could trap a worker or a moving part that could trap or injure. Entry into confined spaces may block your view of what else is happening around you.

Lack of natural ventilation makes it easier for toxic or flammable materials to accumulate. Something as simple as rusting metal or the operation of fuel-powered engines can deplete the existing oxygen supply. Decaying organic materials such as plants or animals can create hydrogen sulfide gas.

Many toxic gases don't have any warning properties, so workers about to enter confined spaces have no way of knowing what hazards they might face without first testing the air. The most common confined-space injuries are asphyxiation from lack of oxygen, being overcome by very high concentrations of toxic vapors, or rapid skin absorption of organic solvents.

Other common confined-space hazards involve explosions or fires. Getting in and out of a confined space can cause injuries and hinder rescue efforts in emergencies. Responders who may be required to rescue victims must be provided training in the types of spaces at the facility.

Several steps must be taken to make work safer in confined spaces. Careful advance planning for confined-space entry can help minimize the risk of injury. This advance planning must include the following points:

- Identifying confined spaces. (Determine which require a permit to enter.)
- Developing written standard operating procedures (SOPs).
- Arranging for and strategically locating adequate supplies of air-supplying respirators and protective and life-saving equipment.
- Training personnel who must enter permit-required confined spaces to deal with emergency events.
- Training personnel how to monitor and properly safeguard the space before and during entry.
- Posting a qualified and trained safety attendant who is ready to provide assistance, if required, outside the confined-space entrance **at all times**.
- Training personnel to recognize when the hazards of a confined space may have changed.

The hazards of confined-space entry are further reduced by:

- Monitoring confined spaces before entry and during work for oxygen deficiency and flammable or toxic atmospheres. Monitoring must be conducted throughout the space, not just at the entry point.
- Providing appropriate ventilation before and during the work.
- Complying with the permit and logging system. Under this system, confined-space entry is permitted only after information about oxygen and toxic and flammable vapor levels has been collected. The permit must be signed by a responsible manager. No personnel can enter the confined space without a signed entry permit. Permits are valid only for a specific date, time, and place.

A confined-space entry SOP minimizes danger by trying to control factors that may cause or contribute to accidents or emergencies through careful monitoring, training, and planning. These required standard procedures are an administrative control.

Heat and Cold

Temperature puts extra physical stress on the body. Long periods of exposure to heat may cause illness, particularly if an employee is not accustomed to working in hot areas. Also, heat builds up inside protective clothing, particularly when wearing full body suits, so there is a risk of heat stress even if outside temperatures are moderate. Cold stress is less common, but may occur if work is required outdoors in winter months or in cold storage/freezer compartments.

Heat stress is probably one of the most common illnesses at any work site. Regular monitoring and other protective measures are vital. Individuals react to heat in different ways. Some factors which predispose someone to heat stress include:

- Lack of physical fitness.
- Age.
- Lack of fluid intake.
- Alcohol and drug use.
- Sunburn.
- Diarrhea.
- Infection.

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and individual characteristics.

There are several ways to help prevent heat stress:

- Drink lots of fluids frequently. One cup of water every 20 minutes will keep you more hydrated than drinking a quart every time you feel thirsty.
- Do the hardest work in the coolest parts of the day.
- When first beginning to work in a warm environment, start out slowly, doing about 20% of a full workload. Over four days, increase this workload by 20% each day, till you are working at 100% of the workload. This process is called **acclimatization**, where you train your body to get used to working with the heat.
- Wear loose and breathable clothes, such as cotton.
- Take frequent, short breaks in shaded areas.
- If the work environment is very hot, there are personal cooling devices which are designed to fit under personal protective equipment (full body suits, respirators) to keep workers from heat-related illnesses.

Signs and Symptoms of Heat Stress	
Heat Cramps	
Symptoms:	Painful muscle spasms
Cause:	Profuse sweating and drinking large amounts of water
Treatment:	Provide liquids with electrolytes (sodium, potassium) like diluted Gatorade™
Heat Exhaustion	
Symptoms:	Weakness; fatigue, dizziness; pale, cool, moist skin; heavy sweating; headache; nausea; and fainting
Cause:	Reduced blood volume resulting from dehydration from profuse sweating and insufficient replacement of water and salts
Treatment:	If worker is conscious, he or she should rest in a cool place. Replace water and electrolytes lost in sweat. If worker is unconscious, get medical help immediately. *Do not give liquids if the person is unconscious.*
Heat Stroke	
Symptoms:	Very dry, hot skin with red, mottled or bluish appearance; convulsions; confusion; unconsciousness; rapidly rising temperature
Cause:	Body becomes overheated because the worker does not sweat. Can be fatal.
Treatment:	Call for medical help immediately. Move person to a cool place. Remove PPE. Use wet towels or water and fan to cool while waiting for help.

Heat stroke is a life-threatening emergency! Medical attention is required!

Remember: Treatment of heat-related illnesses is very important to worker health, but preventive measures can keep an emergency from happening.

Specific training is required to deal with heat and cold emergencies. The potential for these stresses during work should be recognized in advance, and appropriate programs implemented to prevent injury.

Hazard Communication – Chemicals Used in Remediation

Some mold remediation methods will include a liquid or a gas. A Material Safety Data Sheet must be available for each of these materials, and each worker must receive training in the hazards of the chemical, and methods to work safely. Specific requirements are in 29 CFR 1910.1200, the Hazard Communication (HazCom) Standard from OSHA. Appendix B in this manual has more information on MSDSs, how to read an MSDS, and other labeling systems.

The use of a biocide – a chemical agent which kills living organisms, such as chlorine bleach (sodium hypochlorite) – is covered by HAZCOM. Although not recommended as a routine practice during mold remediation, there may be instances where professional judgment may indicate its use (for example, when immuno-suppressed individuals are potential occupants). In most cases, it is not possible or desirable to sterilize an area; a background level of mold spores will remain in the air (roughly equivalent to or lower than the level in outside air). These spores will not grow if the moisture problem in the building has been resolved.

If the work plan includes the use of disinfectants or biocides, always ventilate the area. Outdoor air may need to be brought in with fans. Biocides are toxic to humans, as well as to mold. When using fans, take care not to distribute mold spores throughout an unaffected area. Always also use appropriate PPE and read and follow label precautions. Never mix chlorine bleach solution with cleaning solutions or detergents that contain ammonia; toxic fumes could be produced. Also, pay attention to the length of time that a biocide must be left on the surface being cleaned in order to take full effect.

There are four classes of biocides:

- **Solids:** iodophors, hypochlorites, quaternary ammonium salts. These are often used in solution.
- **Liquids:** phenolics, alcohol, hydrogen peroxide, glutaraldehydes, chlorine bleach solution.
- **Gases:** chlorine dioxide, ozone.
- **UV Light:** this is useful only if the light can directly penetrate the mold.

Some biocides are considered pesticides, and some states require that only registered pesticide applicators apply these products in schools. Make sure anyone applying a biocide is properly licensed, if necessary.

Biocides must be used with care. Trade-names (source: Hotspot for Birds www.muliscope-com/hotspon/howcln5.htm, June 2007) and active ingredients for the solids and liquids are shown in the table below.

Biocide	Trade Names	Active Ingredient
Iodophors	Betadyne Providone Wescodyne Virac Prepodyne	Iodine
Hypochorites		Chlorine
Quarternary ammonium salts	Roccal-D	Alkyl compounds
Phenolics	Lysol LPH Staphen One-Stroke Environ O-Syn Mater	Phenolic
Alcohols		Alcohol
Hydrogen peroxide		Hydrogen peroxide
Gluteraldehydes	Wavicide-1 Wavicide-06	Gluteraldehyde
Chlorine bleach	Clorox Purex	Chlorine

These compounds are irritants to the skin, eyes and respiratory tract. Gluteraldehydes should not be used with other biocides as they can react with ammonia, phenols and oxidizing agents such as chlorine. Also keep in mind that some of these substances, such as iodine, can cause allergic reactions in some people.

Chlorine compounds are often selected as biocides. More information is found at the EPA website:
http://www.epa.gov/pesticides/factsheets/chemicals/chlorinedioxidefactsheet.htm.

Chlorine dioxide gas and ozone are used under very controlled conditions, as required concentrations exceed OSHA Permissible Exposure Limits (PELs). Special training is required for anyone using UV light, as serious skin and eye burns can result.

Containment

The purpose of containment during remediation activities is to limit release of mold into the air and surroundings, in order to minimize the exposure of remediators and building occupants to mold.

The two types of containment recommended are limited and full. In general, the size of the area helps determine the level of containment. However, a heavy growth of mold in a relatively small area could release more spores than a lighter growth of mold in a relatively large area. Choice of containment should be based on professional judgment of the contractor. The primary object of containment should be to prevent occupant and remediator exposure to mold.

Limited Containment

Limited containment, consisting of one or two chambers, is generally recommended for areas involving between 10 and 100 square feet. The enclosure around the moldy area should consist of a single layer of 6-mil, fire-retardant polyethylene sheeting. The containment should have a slit entry and covering flap on the outside of the containment area. For small areas, the polyethylene sheeting can be affixed to floors and ceilings with duct tape. For larger areas, a steel or wooden stud frame can be erected and polyethylene sheeting attached to it. The sheeting should extend approximately 8 feet from the site of the contamination.

All supply and air vents, doors, chases, and risers within the containment area must be sealed with polyethylene sheeting to minimize the migration of contaminants to other parts of the building. Heavy mold growth on ceiling tiles may impact HVAC systems if the space above the ceiling is used as a return air plenum. In this case, containment should be installed from the floor to the ceiling deck, and the filters in the air handling units serving the affected area may have to be replaced once remediation is finished.

The containment area must be maintained under negative pressure relative to surrounding areas. This will ensure that contaminated air does not flow into adjacent areas. This can be done with a HEPA-filtered fan unit exhausted outside of the building. For small, easily contained areas, an exhaust fan ducted to the outdoors can also be used. The surfaces of all objects removed from the containment area should be remediated/cleaned prior to removal. The remediation guidelines can be implemented when the containment is completely sealed and is under negative pressure relative to the surrounding area.

Full Containment

Full containment is recommended for the cleanup of mold-contaminated surface areas greater than 100 ft^2 or in any situation in which it appears likely that the occupant space would be further contaminated without full containment.

Remove furniture and fixtures from the room. If an object cannot be removed (such as a large desk which cannot fit through the door) it should be cleaned and securely wrapped in plastic and sealed with tape. Warning signs must be posted outside of all entrances to the worksite.

A typical warning sign may look like this:

DANGER

Biological Hazard

Respirator and Protective Clothing Required

Authorized Personnel Only

"DANGER" should appear in red lettering. All other text should be in black lettering, and the background color should be white.

Using plastic sheeting, create a walkway from the work area to the outside and to waste disposal areas. Use only this pathway to minimize contamination.

Double layers of polyethylene sheeting (poly) should be used to create a barrier between the moldy area and other parts of the building. A decontamination chamber or airlock should construct a single, combined entry into and exit from the remediation area. The entryways to the airlock from the outside and from the airlock to the main containment area should consist of a slit entry with covering flaps on the outside surface of each slit entry.

The chamber should be large enough to hold a waste container and allow a person to put on and remove PPE. All contaminated PPE, except respirators, should be placed in a sealed bag while in this chamber. Respirators should be worn until remediators are outside the decontamination chamber. PPE must be worn throughout the final stages of HEPA vacuuming and damp-wiping of the contained area. PPE must also be worn during HEPA vacuum filter changes or cleanup of the HEPA vacuum.

The floor of the containment area should be covered in several sheets of poly that are stuck together with spray adhesive. Multiple layers will guard against wear and tear. The poly should extend 24 inches up the wall. Staple the poly down at the edges of the floor and make sure that the poly is flush with the wall and floor. Do not cut the poly – this will increase the risk of contamination getting through the barrier.

Poly is slippery, particularly when wet. Use rubber mats or rubber-soled shoes to prevent slips, trips, and falls.

Cover uncontaminated areas of the wall with a single layer of poly, which extends from the ceiling down to within one inch of the floor. Seal seams with tape and/or spray adhesive.

Cover the floor with a second layer of poly using tape and spray adhesive so that the edges of this layer extend a few inches up the wall past the first layer. Seams on this layer should be offset from the first layer. Put a second layer of poly on the walls. Cover the ceiling with poly and secure with furring strips. The ceiling layer should extend several inches down the wall layer. Multiple layers on the walls and flooring will make final cleanup an easier process. After remediation, the first layer can be removed to dispose of the bulk of contamination, leaving the second layer for more detail-oriented cleanup.

Spray adhesive and duct tape and should be used to create seals at all seams in the poly. The ends of the duct tape should overlap.

Poly should fully cover the uncontaminated surfaces, including windows, vents, and extra doors and should extend 4-6 inches past the frames. This will help minimize the spread of contamination.

If doors and windows are part of the decontamination project, they should be covered on the outside surface for the initial cleaning. If necessary, a small follow-up cleaning effort can be initiated to remove mold from any surface not adequately cleaned (for example, the underside of a window sash).

A negative air machine (NAM) is a device which moves air and, in the process, filters all the airborne particulate matter out. The NAM will draw all mold-contaminated air out of the room, thus creating a negative pressure zone. This will draw clean air into the room, thus maximizing worker safety. The filters are rated using a Minimum Efficiency Reporting Value (MERV), an industry standard developed by the American Society of Heating, Refrigerating, and Air Conditioning Engineers. This value reports how efficient a filter is at removing particles between 0.3 and 10 micrometers in diameter. A filter with a MERV rating of 1 will work inefficiently, while a MERV 11 filter will work at an 85% efficiency rating.

Negative air machines typically use three filters:

- Front pre-filter (at least MERV 8)
- Second, finer filter (at least MERV 10)
- HEPA filter

Change-out schedules must be established and followed for these filters.

To calculate the size of the NAM that you need:

- Calculate the volume of the room (V = L x W x H)
- Decide on the number of air changes per hour desired (typically, 4 ACH)
- Calculate the number of minutes for each air change (Mins = 60 mins / X number of ACHs)
- Calculate the size of the machine needed in cubic feet per minute (Size = Volume of Room / Number of Minutes)

For example: You have a room that measures 20 feet long by 20 feet wide by 10 feet high, the volume of the room is:

V = L x W x H
V = 20’ x 20’ x 10’
V = 4000 cubic feet (ft^3)

You decide you want 4 Air Changes per Hour (ACHs). To find the number of minutes for each air change you perform the following calculations:

Mins = 60 mins / X number of ACHs
Mins = 60 mins / 4 ACHs
Mins = 15 mins

To calculate the size of the machine needed in cubic feet per minute, perform the following calculations:

Size = Volume of Room (V) / Number of Minutes (Mins)
Size = 4000 ft^3 / 15 mins
Size = 267 ft^3/min

So you need a negative air machine capable of handling greater than 267 ft^3/min in order to have 4 ACHs for a room this size.

When setting up the work area, place the NAM so that it can preferably vent to the outdoors. Set it up so as to maximize the amount of air flow in the work area and minimize the amount of dead air. Cover the NAM with plastic and use disposable plastic ducts to keep cleaning time to a minimum. Typically, mold remediators will begin work as far from the NAM as possible and work towards it. The NAM should run constantly throughout the duration of the mold remediation work, even during off-work hours.

The pressure should remain at 0.02" of water. Before each shift, the negative pressure zone should be inspected for leaks or breaches. Any problems should be fixed immediately.

NAMs come with a variety of optional features. You may find these useful:

- Auto-shutdown if the exhaust becomes clogged or the HEPA filter breaks.
- Warning lights to indicate problems in pressure (too high, too low).
- Time-keeping device which shows how long the unit (and its filters) have been running.

If the power shuts down while a NAM is in operation, work should stop and not restart until the power returns and the NAM is operating once more.

At the end of a remediation project, shut down the negative air machines, bag them, and remove them from the area. This will prevent recontamination. Only after the NAM has been removed should you remove the final layers of poly. After these layers have been removed, wet wipe the surfaces underneath with an alcohol solution and allow to dry.

HVAC Systems Considerations

When systems for heating, ventilating, and air conditioning (HVAC) become wet, they become a perfect environment for various types of microorganisms, such as mold. Once mold has contaminated an HVAC system, the mold spores can travel easily throughout the entire building, causing maximum damage to the building and potential adverse health effects to many more of the occupants. If the plenum, or the main duct junction

right above the air conditioner's evaporator coils, is contaminated with mold, then the entire building is at risk for mold contamination. All mold-infested components of an HVAC system should be inspected and thoroughly remediated. The source of water causing the mold problem should be investigated and fixed to prevent other occurrences of mold growth.

If the building is to remain partly occupied, isolate the remediation areas where HVAC systems will be cleaned and remediated by using temporary walls, plastic sheeting, or other vapor-retarding barriers. Maintain the remediation areas under negative pressure (relative to adjacent non-remediation areas) by using blowers equipped with HEPA filters (high-efficiency particulate air filters) to exhaust the area. To ensure complete isolation from the remediation areas, it may be necessary to pressurize the adjacent non-remediation areas and temporarily relocate the outdoor-air intake for the HVAC system serving the occupied areas.

Cleaning and remediation of HVAC systems may involve additional personnel. General steps for this aspect of the remediation can be found at: www.epa.gov/mold

Cleanup Methods

Following preparation of the area, cleaning will be undertaken, using wet or dry methods. The following are described:

Wet methods:

- Wet vacuum
- Wet wipe
- Pressure wash

Dry methods:

- HEPA vacuum

Disposal work practices are described. Opportunity to practice these techniques will be provided through hands-on exercises.

Wet Vacuum

Wet vacuums are vacuum cleaners designed to collect water. They can be used to remove water from floors, carpets, and hard surfaces where water has accumulated. They should not be used to vacuum porous materials, such as gypsum board. They should be used only when materials are still wet – wet vacuums may spread spores if sufficient liquid is not present. The tanks, hoses, and attachments of these vacuums should be thoroughly cleaned and dried after use since mold and mold spores may stick to the surfaces.

Wet Wipe

Mold can generally be removed from nonporous (hard) surfaces by wiping or scrubbing with water, or water and detergent (sometimes referred to as “amended water”). It is important to dry these surfaces quickly and thoroughly to discourage further mold growth. Instructions for cleaning surfaces, as listed on product labels, should always be read and followed. Porous materials that are wet and have mold growing on them may have to be discarded, since molds will infiltrate porous substances and can be difficult or impossible to remove completely.

If a biocide, such as bleach, is used, the water/biocide must be in contact with the surface long enough to kill the mold. Usually, 15 minutes or longer is required. Wet wipe with bleach solution will require keeping the surface wet or damp for the specified amount of time, prior to wet wipe with clean water. A spray bottle filled with the biocide solution is the most efficient and effective way of keeping the surface damp.

Pressure Wash

A powered water wash may be used in areas where structural supports are contaminated, and for difficult to reach locations in a building. The power of the water stream is selected to assure removal of the mold, while not causing additional damage by forcing water into other spaces. Thorough drying is required following the water wash.

HEPA Vacuum

Vacuum cleaners with high-efficiency particulate air (HEPA) filters may be used for jobs that involve large amounts of dust, mold, or other contaminants. A non-HEPA filtered vacuum cleaner will have large amounts of contaminants in its exhaust, whereas a HEPA filtered vacuum will output much cleaner air. Therefore, only a HEPA vacuum can be used in dry remediation of mold.

A space stripped of contaminated contents and thoroughly dried, should be cleaned with a thorough HEPA vacuuming. Care must be taken to assure that the filter is properly seated in the vacuum so that all the air must pass through the filter. When changing the vacuum filter, remediators should wear PPE to prevent exposure to the mold that has been captured. The filter and contents of the HEPA vacuum must be disposed of in well-sealed plastic bags.

Wet cleaning may follow removal of contamination with the HEPA vac.

Disposal

Disposal is a continuous process at a mold remediation job.

Large items that are contaminated and cannot be cleaned – such as carpeting or ceiling tiles – should be rendered unusable and removed from the site. If placed at the street for pickup, people might take the items home, believing they have use or value. The best way to protect the public is to simply cut the items into smaller pieces and wrap them securely in 4-6 mil poly, sealed with duct tape. This also prevents the spread of contaminants in the building during removal. In order to prevent contamination from becoming aerosolized during the removal process, mist hard and porous surfaces with a bleach solution.

In most cases, items made of plastics can be salvaged with time and effort to clean them. Alternatively, it may be determined that the time involved is more costly than replacement. Items made of ceramics (toilets, sinks) can be easily salvaged by a thorough cleaning and drying.

These items may not be salvageable, or worth the cost of salvaging:

- Drywall
- Plaster
- Carpets or rugs
- Wallpaper
- Drapes
- Furniture (wood, upholstered, mattresses)
- Clothing
- Books
- Magazines

These items may be salvaged by specialized personnel in some cases; precautions and packaging instructions should be obtained from the expert service in order to prevent the spread of mold spores):

- Photographs
- Legal documents
- Documents of historical significance

If in doubt, throw it out!

If mold or mold spores are left behind with water, the problem will rapidly recreate itself. Use good judgment when deciding whether or not an item can be salvaged.

Each worksite will need a work plan which outlines the materials that will be salvaged and those that will be discarded. The work plan might include guidelines like these:

- Carpeting that has been exposed to black water must be discarded. If it has been exposed to gray water for less than 48 hours, it may be cleaned by hot water extraction, treated with biocide, and dried.
- Carpet cushioning must be discarded if it has come into contact with black or gray water.
- When directly contaminated with mold, stuffed fabric (mattress, couch, cushioned desk chair) must be discarded.
- If absorbent materials (books, paper, ceiling tiles, drywall) have become saturated with contaminated water, they must be discarded.
- All potentially contaminated structural materials must be closely evaluated.
- High-value items may be cleaned by a specialist, providing he or she agrees to treat the items with biocide and submit to inspections by a third party.
- If contaminated by gray or black water, floor coverings and subfloors must be discarded.

Most of the waste generated from mold remediation will be considered ordinary municipal waste. Wastes should be completely sealed in plastic and excess air can be removed with a HEPA vacuum to reduce volume. When bagging materials, bear in mind that they may contain extra weight due to water content.

Double-bagging is recommended as the best work practice because it helps prevent ruptures in the plastic and minimizes the possibility contamination. To double-bag, one worker inside the work area seals the waste in one layer of plastic. He or she then cleans the exterior surface and sets it inside a plastic bag held by a worker who is past the airlock. This worker then seals the second layer of plastic.

To safely remove materials from the worksite:

- Bag all waste in 6-mil poly. You may store these bags in a temporary “waste load out” area.
- All materials which could puncture the plastic (glass, wood, drywall) must be double-bagged.
- HEPA vacuum or wet wipe the exterior of the plastic.
- Place fiberboard drums with locking rims in plastic bags. This will prevent the exterior of the drum from becoming contaminated while it is being filled.
- Put bags in drums. Approximately four to five bags should fit in each.
- Label the drums appropriately.
- Lock the rim.
- Before the drum leaves the waste load out area, remove the plastic bag.
- Remove drum from worksite.

In some instances, you may be required to remove water from an area before beginning mold remediation work.

- **Pumps.** These can be used to remove standing water and water below flooring.
- **Extraction Units.** Units with high vacuum capacity can be used to suction water from the area.
- **Extraction Tools.** These tools, such as vacuum squeegee wands, light wands, weighted drag wands, and hand extraction tools can also be used for water removal.

Dehumidifiers may also be used to remove moisture from the air. Refrigerant dehumidifiers work best when ambient temperature is above 68°F, otherwise, ice may form on the coils. Desiccant dehumidifiers work in a wider variety of environments. Supplemental heaters and air changers may also be useful in mold remediation work.

Exercise: Containment

In this exercise, you will practice setting up a containment area.

Materials

- Poly sheeting
- Spray adhesive
- Duct tape
- Furring strips
- Staple gun/nails

Procedure

- Develop a plan
- Cut poly
- Install

Observations

_____
_____
_____
_____
_____

How could you make your work practices safer and/or more efficient and effective?

_____
_____
_____
_____
_____

Exercise: Wet Vacuuming

In this exercise, you will practice using a wet vacuum cleaner and safely removing waste from it.

Materials

- Wet vacuum cleaner
- Plastic container for liquid waste
- GloGerm powder
- UV light
- Gloves
- Plastic sheeting
- Duct tape
- Q-tips

Procedure

1. Vacuum the indicated area which will be "contaminated" with GloGerm powder, a substance that glows under an ultraviolet (UV) light.
2. Examine the cleaned surface under UV light to see how much "contamination" remains.
3. Put on the gloves.
4. Remove waste from the vacuum, wrap it in plastic, and seal it with duct tape.
5. Examine your gloves under the UV light. Record your observations below.
6. Practice proper glove doffing procedures. Examine your bare hands under the UV light. Record your observations below.
7. Examine the exterior of the packaged waste under the UV light and take a quick sample with a Q-tip swab. Record your observations below.

Observations

_____
_____
_____
_____
_____

How could you make your work practices safer, so that next time, you spread less contamination?

_____
_____
_____

Exercise: Wet Wipe

In this exercise, you will practice a mold remediation technique known as “wet wipe” or “damp wipe”.

Materials

- Disposable rags
- GloGerm oil or powder
- Various “contaminated” surfaces: linoleum, cabinetry, painted drywall, etc
- Bucket of soapy water
- Trash can for disposal of rags
- Gloves
- UV light

Procedure

1. Examine the “contaminated” surface under the UV light. Would you describe it as being heavily, moderately, or minimally contaminated? Record your observations below.
2. Put on gloves.
3. Wipe the “contaminated” surfaces as best you can, taking care to minimize spread of contamination and splashes.
4. Examine your gloves under the UV light. Record your observations below.
5. Practice proper glove doffing procedures. Examine your bare hands under the UV light. Record your observations below.
6. Examine the cleaned surface under the UV light. How much contamination did you successfully remove? Record your observations below.

Observations

_____
_____
_____
_____
_____

How could you make your work practices safer, so that next time, you spread less contamination?

_____
_____
_____

Exercise: HEPA Vacuuming

In this exercise, you will practice using a HEPA vacuum cleaner, safely changing the vacuum's filter, and comparing performance to a non-HEPA vac.

Materials

- Vacuum cleaner with HEPA filter
- Vacuum cleaner without HEPA filter
- Contact paper
- GloGerm powder
- UV light
- Gloves
- Plastic sheeting
- Duct tape
- Q-tips

Procedure

1. Place a perforated piece of contact paper over the exhaust of each vacuum cleaner, so that some escaping particles will be trapped on the sticky side.
2. Vacuum the indicated area with both vacuum cleaners, which are "contaminated" with GloGerm powder, a substance that glows under an ultraviolet (UV) light.
3. Examine the contact paper under the UV light and record your observations below.
4. Put on the gloves.
5. Remove the filter from the HEPA vacuum, wrap it in plastic, and seal it with duct tape.
6. Examine your gloves under the UV light. Record your observations below.
7. Examine the exterior of the wrapped vacuum filter under the UV light and take a quick sample with a damp Q-tip swab. Record your observations below.

Observations

_____
_____
_____
_____
_____

How could you make your work practices safer, so that next time, you spread less contamination?

_____
_____
_____

If this was a remediation job, what PPE should be worn during vacuuming?

_____
_____
_____
_____

Exercise: Disposal of Solid Debris

In this exercise, you will practice disposing of solid wastes.

Materials

- Large pieces of lumber, drywall, carpeting, etc.
- GloGerm powder or oil
- UV light
- Gloves, eye protection
- Plastic sheeting
- Duct tape
- Hammer, saw, shears
- Large waste bin, some distance away
- Q-tips

Procedure

1. Put on gloves and eye protection.
2. Break up "contaminated" wastes into pieces with hammer, saw, and shears. This step ensures that passers-by will not try to salvage materials, thus spreading contamination to their homes or offices.
3. Wrap wastes in plastic sheeting and seal with duct tape.
4. Carry wrapped materials to the waste bin.
5. Examine your gloves under the UV light. Record your observations below.
6. Swab the exterior of a package of wrapped wastes with a Q-tip. Examine under UV light. Record your observations below.

Observations

_____
_____
_____
_____
_____

How could you make your work practices safer, so that next time, you spread less contamination?

_____
_____
_____

Final Inspection/Reoccupancy

Once remediation is completed, the first of the two containment layers may be removed. The area must then obtain clearance before signs, critical barriers, and access barriers are removed.

Visual Clearance:

- A visual inspection must reveal no signs of mold growth, dust, or smudges.
- If possible, darken the room and use a low-angle light test.

Air Clearance:

- A qualified specialist, frequently a third party, must collect and test air samples for mold spores.
- Biocides may render spores nonviable, but if the technician finds spores in the area, he or she will only be able to note their presence.
- If concentration of spores is no worse inside than outside, clearance will usually be granted.
- Molds may also be cultured, but as this process can take weeks, it is not usually part of the final criteria for clearance.
- Tape lifts may also be used to evaluate the presence of molds on furniture and carpet.

Visual inspections should be performed regularly throughout remediation efforts to evaluate progress. Tape lifts may be another useful tool in self-evaluation during the work process.

The overall plan should include having a qualified professional thoroughly evaluate the HVAC system's performance and correct it as necessary before the building is occupied again. The HVAC system performance should conform to the recommendations contained in ASHRAE Standard 62-2004, Ventilation for Acceptable Indoor Air Quality.

Before the building is occupied, it is advisable to operate the HVAC system continuously in a normal manner at a comfortable temperature for 48 to 72 hours. During this period, it may be beneficial to open the HVAC outdoor air dampers to the maximum setting that still allows you to provide the desired indoor air temperatures. If objectionable odors persist after this "flush out" period, reassess by looking for contaminated areas that were not identified earlier and continue the flush-out process until odors are no longer apparent. Replace the HVAC filters used during the flush-out prior to building occupancy.

Bringing it all Together and Troubleshooting

The following page shows EPA guidance and cleanup methods, PPE and containment for various moldy materials considered to be a large project, greater than 100 square feet.

This final exercise provides time to think about unexpected situations – which can occur at any remediation.

Guidelines for Remediating Building Materials with Mold Growth Caused by Clean Water* from the EPA's *Mold Remediation in Schools and Commercial Buildings.*

LARGE PROJECT- Total Surface Area Affected Greater Than 100 (ft^2) or Potential for Increased Occupant or Remediator Exposure During Remediation Estimated to be Significant

Material or Furnishing Affected	Personal Protective Equipment
Books and papers	**Full:** Gloves Disposable full body clothing Head gear Foot coverings Full-face respirator w/ HEPA filter
Carpet and backing	
Concrete or cinder block	
Hard surface, porous flooring (linoleum, ceramic tile, vinyl)	
Non-porous, hard surfaces (plastics, metals)	
Upholstered furniture & drapes	
Wallboard (drywall and gypsum board)	
Wood surfaces	

*Use professional judgment to determine prudent levels of Personal Protective Equipment and containment for each situation, particularly as the remediation site size increases and the potential for exposure and health effects rises. Assess the need for increased Personal Protective Equipment, if, during the remediation, more extensive contamination is encountered than was expected. These guidelines are for damage caused by clean water. If you know or suspect that the water source is contaminated with sewage, or chemical or biological pollutants, then the Occupational Safety and Health Administration (OSHA) requires PPE and containment. An experienced professional should be consulted if you and/or your remediators do not have expertise in remediating contaminated water situations.

Exercise: Unexpected Situations

What would you do if:

1. Someone slipped on wet poly and could not get up due to back pain?

2. You tried five gloves and each one tore as you donned it?

3. Behind drywall, you find dripping water?

What actions could help minimize each of these situations?

Talk in small groups and develop two more "unexpected situations" and an approach to reduce the hazard from each.

1. _____
   _____
   _____
   _____
   _____

2. _____
   _____
   _____
   _____
   _____

Exercise: Safety Practices

List one example of how each of these safety practices reduces the possibility of injury during remediation.

1. Ergonomics

2. Egress

3. Walking and working surfaces

4. Ladders and scaffolding

5. Lock-out procedures

6. Hand and portable power tools

7. Compressed air use

8. Electrical safety

9. Confined space

10. Heat and cold

11. Hazard communication

Summary

The five basic methods of reducing exposure are:

- Keep disturbance to a minimum.
- Contain it.
- Use amended water.
- Employ HEPA filters.
- Regulate air flow.

Working safely during remediation requires knowledge and skills in:

- Ergonomics
- Egress
- Walking and working surfaces
- Ladders and scaffolding
- Lock-out procedures
- Hand and portable power tools
- Compressed air use
- Electrical safety
- Confined space
- Heat and cold
- Hazard communication

Remediation techniques include:

- Wet vacuuming.
- Wet wiping.
- Pressure wash.
- HEPA vacuuming.
- Disposal of solid wastes.

Key Terms

Containment

Wet methods

Dry methods

Sources of moisture

Ergonomics

Safety practices

Gray water

Black water

White water

Amended water

Hazcom

Biocide

Review Questions

1. What is amended water?

2. What is the contaminant in all black water?

3. List five safety practices that reduce the possibility of injury during remediation.

4. Pick out a surface in the room where you are sitting that is about 100 square feet. Measure it. How close to the 100 square feet were you?

5. Why is a HEPA vacuum an essential tool for dry cleanup?

Background & Reading Materials

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DECONTAMINATION

Decontamination of workers and tools is an important way to control the spread of mold and mold-contaminated materials.

Chapter Objectives

When you have completed this chapter, you will be better able to:

- Identify the reasons for using decontamination.
- Demonstrate one decon technique.
- Identify the stations required for decontamination.
- Identify steps required to enter the work area when using wet decontamination.
- Identify steps required to leave the work area when using wet decontamination.

Decontamination

Decontamination is the process of removing and/or neutralizing contaminants that may have accumulated on PPE, personnel, and other equipment. Proper decontamination procedures include:

- Controlling hazards.
- Protecting workers from exposure to hazardous materials.
- Preventing continued contamination and permeation of hazardous material into PPE, other equipment, and tools.
- Protecting personnel outside the remediation area by minimizing the transfer of harmful materials into clean areas.
- Preventing mixing of incompatible materials.
- Preventing the uncontrolled transfer of contaminants outside the area.

Types of Decon

Handwashing.

Handwashing is a very simple, but very important means of decontamination.

Exercise: Handwashing

Effective handwashing takes at least as long as the time needed to sing "Happy Birthday".

The instructor will pass around GloGerm oil and each participant will cover his or her hands with the substance. This substance will glow under ultraviolet (UV) light. Participants will then wash their hands and examine them under the UV light to see how thoroughly washing removed contamination.

1. How long did it take you to completely clean your hands? _____

2. How many tries did it take to remove all the GloGerm oil? _____

3. What areas on your hands did you not clean in the first wash?
   Thumb
   Fingers
   Fingernails
   Creases at the joints
   Other (list) _____
   _____

4. What tools would help?
   Wash cloth
   Fingernail brush
   Other (list) _____
   _____

5. List ways you could spread contamination if handwashing is incomplete:
   _____
   _____
   _____
   _____

Setting up a 3-Station Decon

Once a shift is completed, workers should move from the remediation area through a decontamination line to ensure that no contamination leaves the workplace. A three-station decon unit is an efficient way of accomplishing this task.

A 3-station decon unit can be assembled from:

- 2 x 4" lumber
- ¼ to ½ inch plywood OR 6-mil polyethylene sheeting
- Duct tape, nails, staples, etc.

The floor should be covered by three layers of plastic sheeting. The decon unit can be built in sections, to allow for transportation and multiple configurations for various worksites. Sometimes, customized trailers are used in place of a constructed decon unit. These are more expensive, but have the advantage of being readily portable.

A 3-station unit has the following rooms or areas:

Equipment Drop Room

- Closest to the worksite
- Used to store equipment and tools
- Workers remove contaminated clothing in this room

Before you enter this room, you should brush off gross contamination. It will be used to contain dirty or contaminated:

- Tools
- Boots
- Protective eyewear

At the end of a shift, the equipment room is where you will remove and discard any disposable protective clothing, such as full-body suits, boot covers, and gloves. Waste bins should be provided for this purpose.

DO NOT take off your respirator in this room.

If at any time the equipment room becomes overly dirty or contaminated, it may be necessary to clean it with a thorough HEPA vacuuming followed by scrubbing with soap and water. Too much contamination in this area could result in so much mold being tracked into the shower room that it cannot be removed. Then the clean room would become contaminated.

Shower Room

- Between equipment drop room and clean change room
- Used to wash off contamination that may have permeated PPE

Enter this room after you have removed all protective clothing except your respirator. Soak the respirator thoroughly to clean it of contaminants. Wash both your body and hair using soap and water, paying particular attention to the fingernails and to the creases at the joints. Remove your respirator and put it in the designated bin for cleaning.

Showering reduces the possibility of contaminants following you into your home.

Clean Change Room

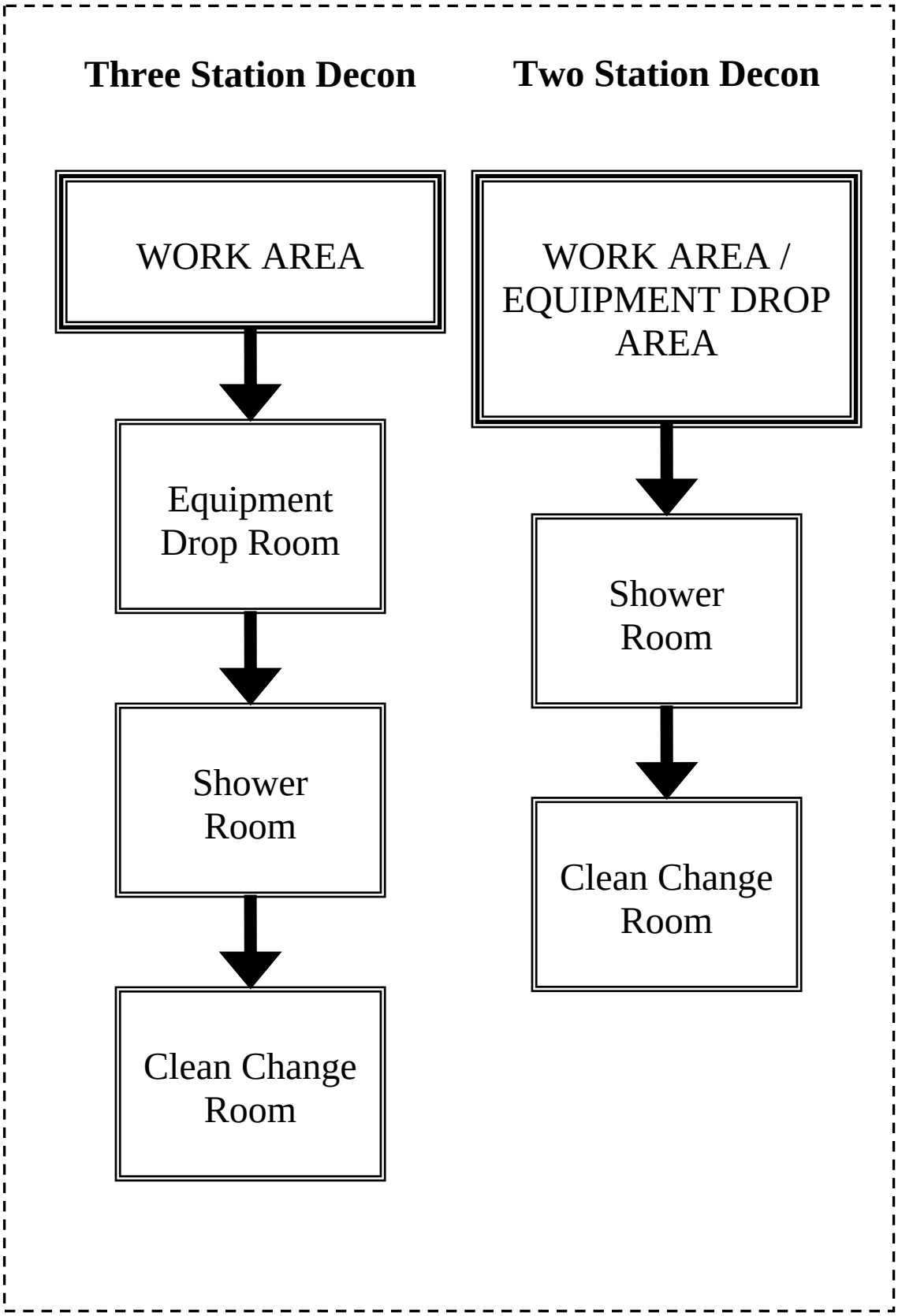
- Furthest from the worksite
- Workers change into street clothes in this room

No mold-contaminated items or persons should enter this room. Lockers and benches would be useful. This room will be used for:

- Change into work clothes (protective clothing, respirator) before work.
- Storing street clothes while the worker is on duty.
- Change back into street clothes.

2-Station Decon

You may also set up a two-chamber decontamination unit, which would consist of a clean change room and a shower. The work area would then take on the functions of the equipment drop room.


Three Station Decon
Two Station Decon
WORK AREA
Equipment Drop Room
Shower Room
Clean Change Room
WORK AREA / EQUIPMENT DROP AREA
Shower Room
Clean Change Room

Work Sequence

For both entry and exit from a wet decon unit, the steps are listed below, in order.

Steps to Enter Work Area When Wet Decontamination is Used

1. Enter the clean room.
2. Remove street clothes.
3. Don work clothes (protective clothing, respirator).
4. Seal gaps at wrists and ankles with duct tape.
5. Inspect and don respirator.
6. Put head covering on over respirator straps.
7. Move through shower room into the equipment room.
8. Don any additional PPE necessary (hardhat, etc.).
9. Pick up any tools needed.

Steps to Leave Work Area When Wet Decontamination is Used

1. Using gloved hands, brush off visible contamination.
2. Enter equipment room.
3. Doff all PPE except respirator.
4. Put all disposable items into the waste bin.
5. Put all reusable items into the decon bin.
6. Enter shower room.
7. Wet hair and respirator thoroughly and remove respirator.
8. Follow protocol for cleaning respirator.
9. Wash body and hair thoroughly.
10. Enter clean room, dry off, and redress in street clothing.
11. Store respirator.

Summary

In this chapter, you learned about decontaminations practices that will help keep you from spreading contamination outside the mold remediation area.

Key Terms

Decon

Hand washing

3-Station wet decon

2-Station wet decon

Review Questions

1. List three reasons to use a decontamination process.

2. List the stations in a 3-station decon.

3. Put the following “steps to enter when using wet decon” in order, by placing a number to the left, 1-9:

    ___ Remove street clothes.
    ___ Don work clothes (protective clothing, respirator).
    ___ Move through shower room into the equipment room.
    ___ Inspect and don respirator.
    ___ Pick up any tools needed.
    ___ Put head covering on over respirator straps.
    ___ Don any additional PPE necessary (hardhat, etc.).
    ___ Seal gaps at wrists and ankles with duct tape.
    ___ Enter the clean room.

4. Put the following steps to exit when using wet decon in order, by placing a number to the left, 1-11:

    ___ Store respirator.
    ___ Wash body and hair thoroughly.
    ___ Put all disposable items into the waste bin.
    ___ Doff all PPE except respirator.
    ___ Wet hair and respirator thoroughly and remove respirator.
    ___ Put all reusable items into the decon bin.
    ___ Enter clean room, dry off, and redress in street clothing.
    ___ Using gloved hands, brush off visible contamination.
    ___ Follow protocol for cleaning respirator.
    ___ Enter equipment room.
    ___ Enter shower room.

Background & Reading Materials

1. EPA. 402-K-01-001. *Mold Remediation in Schools and Commercial Buildings.* March 2001. http://www.epa.gov/mold/pdfs/moldremediation.pdf. Accessed 4/12/07.
2. Laborers-AGC Education and Training Fund. *Microbial Remediation*. June 2003.

SIMULATION

During this program, you will participate in a Simulation Exercise that will take at least half the day, with the rest of the day spent in critiquing and evaluating your actions. This exercise is geared to prepare you for the cleanup activities you will be doing at mold remediation sites. Book knowledge is very important, and can save lives, but it is imperative that you be able to put that knowledge into action. This simulation is an opportunity to practice and evaluate these skills.

You will begin the session by participating in a briefing, where the instructor will explain the set-up of the Simulation, each activity, and the order you will do the activities in. This is a group-oriented exercise, so you will be placed in a small group of 3-6 participants, based on the number of students in the class.

These are the activities you will engage in, not necessarily in this order:

- Donning and doffing limited PPE
- Donning and doffing full PPE
- Rug removal
- HEPA vacuuming
- Setting up a containment area
- Sealing surfaces

Pay close attention to all safety protocols and procedures you have learned in this course.

You will be wearing chemical-protective clothing and respirators, so you must present a signed doctor's note to the instructor verifying that this PPE will not have an adverse effect on your health. You are encouraged to treat this as a "real life" event and act your role as much as possible. If at any time you feel concerned about your own safety, or the safety of someone else in the area, notify the instructor IMMEDIATELY. He or she will take appropriate actions according the Emergency Response Plan for this Simulation.

Your instructor will assign team groups and provide checklists for all activities.

APPENDICES

APPENDIX A: REMEDIATION PHASES

Steps in each of the four remediation phases are detailed below.

Phase 1: Initial Investigation

Consult a Health Professional, as Appropriate

Reasons a health professional is needed when mold has been discovered in a building:

- Symptoms vary widely.
- Some people are more susceptible to molds.
- Different molds cause different symptoms.
- Molds produce other toxic compounds.
- Molds spread.
- Can help assess health risk and communicate with those affected.

The types of health concerns reported by employees, occupants, or remediation crew workers may include headaches, difficulty breathing (including symptoms resembling asthma), coughs, skin redness or itchiness, and eye redness. Other symptoms might be related to mold exposure and may need review and consultation with a health professional. Physicians most familiar with workplace reactions can be contacted through the Association of Occupational and Environmental Clinics (www.AOEC.org) or occupational medicine residency programs funded through NIOSH (http://niosh-erc.org then click on links to "academic").

Molds produce allergens and irritants that can, in sufficient quantity, be associated with human health effects. The specific reaction depends also on other health conditions, age, other exposures and the type of mold. For example, a person who has lowered immunity due to chemotherapy treatment may exhibit a different response than a part-time worker who is the center on the high school basket ball team. Persons with weakened immune systems may develop secondary infections, called opportunistic infections. *Aspergillus fumigatus* and *Trichoderma* are both documented to have caused infections in humans. If you have been diagnosed with athlete's foot or a yeast infection, you have had an infection caused by mold.

Allergic reactions result from inhaling or touching mold or the spores from mold. Both the intact spore, and fragments that may be created during cleaning operations, cause these reactions. Symptoms may include sneezing, red and irritated eyes, runny nose, fever, and skin rashes. Allergic responses can occur after many exposures, or at the first exposure. Repeated exposures are likely to increase the probability of an allergic response.

Asthma can be aggravated by molds.

Hypersensitivity pneumonitis, a condition similar to a bacterial pneumonia, is uncommon, but can develop following either one-time (acute) or repeated (chronic) exposures.

Irritation to the eyes, nose and throat as well as lower parts of the respiratory tract, and skin may occur. Redness and burning are reported.

Toxic substances produced by molds are called mycotoxins. These are found on the surface of mold spores, on the surface of fragments or within spores. Some of these toxic compounds have been shown to cause health effects, but many of the more than 200 mycotoxins in common molds have not been studied. You may have heard of aflotoxin B_1, a potent liver carcinogen that is a mycotoxin associated with peanuts and produced by *Aspergillus flavus* and *Aspergillus parasiticus.* These molds are **not** found in building materials or built structures, but the example is included here to illustrate that mycotoxins can be very harmful.

You may also have heard reports of pulmonary hemorrhage following exposure to *Stachybotrys chartarum*. This was widely reported, but further evaluation indicates that the serious health effects were likely related to other causes. This is explained further at www.cdc.gov/mold/stachy.html.

The conditions required for the production of mycotoxins vary for each mold. As with any toxic exposure, prudent practice is to minimize contact.

Molds may also produce Volatile Organic Compounds (mVOCs). These may contribute to the odor that is an early indicator of hidden mold. Some mVOCs have been associated with they symptoms of mold exposure, but little research has been conducted to characterize the compounds.

A newly developed marker of exposure is beta 1,3-d-glucan, a component of the cell walls of molds. These glucans have been shown to affect the immune system and cause inflammatory lung and airway reactions. The reaction to these glucans underscore that fragments are a health hazard, not just the intact mold spores.

Spores are small (less than 10 microns or 1/5 the diameter of a human hair) and can spread easily in air. Some spores are sticky and cling to surfaces, but can be transferred to clothing or skin by direct contact. Spores are everywhere, and can remain dormant for years, just waiting for the right conditions to grow. Even "dead" molds may contain active agents that cause allergy.

- Questions you may want to ask a health professional:

  - Have the specific molds been identified? Should they be?
  - What health effects are associated with the molds here?
  - How can I limit exposure?
  - I have asthma. Should I work here?
  - Are any routes of entry/exposure more important?
  - What do I tell my doctor if I have a concern?
  - Are there records I should keep about my work here?

- Best practices:

  - Do not touch mold or moldy surfaces with your bare hands.
  - Do not get mold, spores, or fragments in your eyes.
  - Do not breathe in mold, spores, or fragments.
  - Do not eat or drink in areas where you suspect mold is present.
  - Do not carry makeup, chewing gum, cigarettes, etc. into contaminated areas.

Select a Remediation Manager

It is likely that the manager will be selected by others. Experience in similar projects is valuable. Protection of the health of the occupants and the remediation team members must be the highest priority. The manager will also be key in assuring that communication is adequate and timely.

Assess the Size and Type of Damaged Materials

In order to plan for the remediation, the size and types of damaged materials must be known. As a remediation worker, this will likely be done prior to your activity at the site.

Communicate with Occupants and Other Affected Parties

As a remediation worker, you must be informed of the hazards and trained appropriately in remediation methods, hazard of chemicals used (Hazard Communication), and use of all PPE. Good communication, as part of a remediation plan, will keep both workers and building occupants informed of the project timeline and status, and how to minimize any identified hazards.

Communication with affected parties throughout the process of plan development is advised. A briefing on the final plan, so that everyone knows what they may see, and the timeline, will help alleviate concerns as the work is initiated.

Communication with building occupants is essential for successful mold remediation. Some occupants will naturally be concerned about mold growth in their building and the potential health impacts. Occupants' perceptions of the health risk may rise if they perceive that information is being withheld from them. The status of the building investigation and remediation should be openly communicated including information on any known or suspected health risks.

Small remediation efforts will usually not require a formal communication process, but do be sure to take individual concerns seriously and use common sense when deciding whether formal communications are required. Individuals managing medium or large remediation efforts should make sure they understand and address the concerns of building occupants and communicate clearly what has to be done as well as possible health concerns.

Communication approaches include regular memos and/or meetings with occupants (with time allotted for questions and answers), depending on the scope of the remediation and the level of occupant interest. Tell the occupants about the size of the project, planned activities, and remediation timetable. Send or post regular updates on the remediation progress, and send or post a final memo when the project is completed or hold a final meeting. Try and resolve issues and occupant concerns as they come up. When building-wide communications are frequent and open, those managing the remediation can direct more time toward resolving the problem and less time responding to occupant concerns.

If possible remediation activities should be scheduled during off-hours when building occupants are less likely to be affected. Communication is important if occupants are relocated during remediation. The decision to relocate should consider the size of the area affected, the extent and types of health effects exhibited by the occupants, and the

potential health risks associated with debris and activities during the remediation project. When considering the issue of relocation, be sure to inquire about, accommodate, and plan for individuals with asthma, allergies, compromised immune systems, and other health-related concerns. Smooth the relocation process and give occupants an opportunity to participate in resolution of the problem by clearly explaining the disruption of the workplace and work schedules. Notify individuals of relocation efforts in advance, if possible.

Special communication strategies may be desirable if you are treating a mold problem in a school. Teachers, parents, and other locally affected groups should be notified of significant issues as soon as they are identified. Consider holding a special meeting to provide parents with an opportunity to learn about the problem and ask questions of school authorities, particularly if it is necessary/advisable to ensure that the school is vacated during remediation.

What would you say if:

1. An occupant asked you during a lunch break if the mold was a really serious hazard?

2. A news reporter stopped you as you left the site and asked how the job was going?

The results contained in a Final Report should be presented in an understandable form to all stakeholders.

Phase 2: Develop a Plan

Plan the Actions to be Taken

The manager should develop or oversee the development of a unified plan that includes:

- Identification of the source(s) of water or moisture.
- Cleanup methods.
- PPE required for the job.
- Containment system.

The selection of a properly trained remediation crew is essential to the completion of the plan.

Factors that may be considered in developing the plan include:

- Moisture problems in the building.
- Duration materials have been wet.
- Hidden or remote sources of water.
- Reported odors.
- Visible damage.
- Recent maintenance of renovations in the structure.

Any plan will be tailored to the size of the problem that is immediately identified, and expected "hidden" aspects that may be identified when the work is initiated. A first action may be to shut down the ventilation system; this may cause an increase in odors.

Adapt Guidelines to Situation: Cleanup Methods

Four basic methods are available, and may be modified by the Remediation Manager to fit the situation.

- **Method 1:** Wet vacuum.
- **Method 2:** Damp wipe (wet wipe) with plain water, water/detergent, or specialized cleaner for wood floors. Disinfectants may be used to remediate black water contamination.
- **Method 3:** High-efficiency particulate air (HEPA) vacuum.
- **Method 4:** Discard in sealed plastic.

Note that methods 1, 2, and 3 generate waste that must be sealed in plastic for disposal. Clean water used in remediation may generate black water.

Some remediation activities may also include pressure-washing or wet abrasive blasting prior to wet vacuuming. This is particularly likely if structural elements are contaminated with mold. The water used often contains a biocide that will penetrate the subsurface of the material and prevent re-growth of mold. Debris should be collected and packaged in drums.

Extremely valuable items may be saved through methods described by a restoration water damage specialist. If this specialist is on-site, special packaging and temperature control directions will be specified.

A sample remediation plan might include the following specific guidelines:

- **Painted indoor surfaces:** Scrub with one cup chlorine bleach mixed with one gallon water. May add liquid dishwashing detergent to solution. Rinse. Dry.
- **Bathrooms:** Scrub surfaces with solution of one gallon water, one cup chlorine bleach, one tablespoon detergent. Use toothbrush to clean grout. Rinse. Dry.

- **Painted outdoor surfaces:** Scrub with solution of 1/3 cup detergent, 1 quart bleach, 3 quarts water. Rinse. Dry. Repaint.
- **Asphalt shingles:** Scrub with a solution of three parts bleach to one part water. Use one gallon of solution per 30 to 50 square feet. Treat the roof in strips, working from the top, down. Be aware of slippery footing.
- **Wood shingles, decks:** Scrub surfaces with solution 1 quart bleach, 3 ounces trisodium phosphate, 1 ounce detergent, 3 quarts water. Rinse, do not allow to remain wet for over 60 minutes. Use calcium hypochlorite (used for algae control in pools) for stubborn areas. Repeat as necessary. Do not use in direct sunlight.
- **Leathers:** Wipe visible mold away with cloth dipped in a solution of 1 cup denatured alcohol to 1 cup water. Dry. Leather is susceptible to damage from cleaning compounds. If detergent is necessary to remove mold, wipe with a thick foam of soap suds instead of soapy water.
- **Carpets:** Discard and replace moldy carpet pads. Shampoo. Expose mold to direct sunlight. Paint carpet backing with a solution of ¼ teaspoon bleach to 1 cup water. Rinse multiple times. Dry thoroughly. Use fans to speed up drying process.

You may use chemicals (such as biocides to kill molds) during the cleanup process. These fall under the Occupational Safety and Health Administration's (OSHA's) Hazard Communication (HazCom) Standard. HazCom requires that employers provide their employees with training on how to safely use chemicals in the workplace. You must be aware of potential health effects and hazards of all chemicals and how to prevent exposure to them. HazCom applies to both general industry (29 CFR 1910.1200) and for the construction industry (29 CFR 1926.59).

HazCom does not cover mold. Though you should be well-informed of the hazards associated with mold, HazCom does not cover mold or waste generated during remediation. You must receive training for chemicals that you will use in the cleanup process, such as bleach, ammonia, or chlorine dioxide.

Identify the Source of Water or Moisture

While mold is everywhere, it does not grow without water. Making sure that the source of water or moisture has been remediated is a key element to abating mold.

Mold will not grow if there is no water source.

Elements of a work plan completed prior to remediation should include:

- Water source identification
- Cutting off the water source
- Safe work practices

Water leaking from potable sources and HVAC systems is generally considered to be "clean". Water from sewers or other sources that may contain chemical or biological pollutants require additional considerations to assure protection. When a flood has occurred, the source may be receding, but pockets of water may remain in a structure. Any wet item is also a continuing source.

Water sources are generally grouped into these three categories:

- **Black water:** raw sewage. This type of water is heavily contaminated with viruses and bacteria.
- **Gray water:** general household wastewater (dishwasher, laundry). This water is relatively clean, but if left unattended, can quickly become an ideal environment for bacteria and mold.
- **White or clean water:** unused water, directly from water supply. This type of water is less of a problem than gray water leakage because it contains no debris. However, the moisture can lead to mold problems or water damage, and should be vacuumed up immediately.

Select Personal Protective Equipment

To prevent exposure to mold, you want to prevent:

- Inhalation.
- Skin contact.
- Eye contact.
- Ingestion.
- Introduction under the skin (or into a cut).

Remediation activities require respiratory protection and protective clothing. There are three levels of PPE in mold remediation:

- **Minimum:** gloves
  N95 respirator
  goggles/eye protection
  long sleeves/pants

- **Limited:** gloves
  N95 or half-face respirator with HEPA filter
  goggles/eye protection
  disposable overalls

- **Full:** gloves
  full face respirator with HEPA filter
  goggles/eye protection
  disposable full body clothing
  head cover
  foot coverings

Additional protective gear such as a hard hat, safety shoes, or reflective clothing may be needed for construction or maintenance activities.

The selection of PPE is highly driven by the size of the job and water source.

- Clean water source: The larger the job, the higher the level of PPE.
- Contaminated water source: Full PPE required.

Select Containment Equipment

Two types of containment are available for mold remediation:

- **Limited:** Polyethylene sheeting, ceiling to floor of affected area.
  Slit entry and cover flap.
  Maintain area under negative pressure with HEPA filtered fan unit.
  Block supply and return air vents within containment area.

- **Full:** Two layers of fire-retardant polyethylene sheet with one airlock chamber.
  Maintain area under negative pressure with HEPA filtered fan exhausted outside the building.
  Block supply and return air vents within the containment area.

The selection of containment is highly driven by the size of the job and water source.

- Clean water source: The larger the job, the higher the level of containment.
- Contaminated water source: Containment required by OSHA.

Select Remediation Personnel or Team

The number of personnel required depends on the size of the project. Training for the team members must assure that they are adequately prepared to use the PPE and perform the cleanup tasks. This may include medical clearance for the use of respiratory protection. The team members should have training in the major remediation tasks, such as:

- Wet vac
- Wet wipe
- Pressure wash
- HEPA vac
- Discarding contaminated materials

While it may seem that anyone can do these tasks, if not done well and completely, the mold growth will not be abated. Mold may be spread to other areas and unnecessary exposure to humans may result.

Experience in working in containment areas is also an advantage. The remediation team members must be able to recognize breaches in the containment, and take actions as detailed in the plan.

If contaminated water is known or suspected, additional information and training may be needed.

Phase 3: Remediate

See methods in work practices chapter.

Communication is a key step in this phase, as well.

Phase 4: Follow-up

Follow-up activities include evaluation of moisture, inspection and implementation of a preventive maintenance plan to help assure that moisture does not lead to further mold growth. Communication continues to be a key step in Phase 4, as well.

Check for Return of Moisture and Mold

Moisture Measurement

Moisture is key to the growth of mold. Once remediation efforts have been finalized, it is therefore a good move to check the moisture levels in the building using a moisture meter. This does not measure the amount of moisture directly available to mold, but it does provide a good guideline for how well the moisture problem has been resolved.

Moisture meters typically work by either inserting a probe into the material to be tested or by simply pressing the probe against the material's surface. They can measure moisture content in:

- Carpet
- Drywall
- Wood
- Brick
- Concrete

In order to obtain an accurate reading for wooden materials, the type of wood must be known. For all other types of materials, only a relative reading may be obtained.

Moisture Percentage and Degree of Rot in Wood	
0%	**---**
15%	**No rot**
20%	**Dry rot**
25%	**Wet rot**

You may also choose to monitor the relative humidity of the air. Relative humidity is a comparison of how much moisture is in the air compared to how much moisture air at that given temperature could theoretically hold. Relative air humidity over 60% is likely to lead to mold growth.

Visual Inspection

After you are certain that you have fixed the moisture problem, conduct a visual inspection of the remediated site. Your work is **not** complete if you can:

- See mold.
- See mold-damaged materials.
- Smell a moldy odor (like gym shoes or dirty socks).

After work is completed, the site should be revisited to check for signs of mold growth or water damage/leakage.

Maintenance to Prevent/Fix Future Leaks Promptly

After a building is occupied again, someone should be designated and trained to make frequent (for example, weekly) checks of the HVAC system to ensure that it is operating properly. During these checks, inspect the HVAC system filters and replace them when necessary. Gradually reduce the frequency of the HVAC system checks to monthly or quarterly inspections, depending on the routine operation and maintenance specifications for the HVAC system.

A routine operation and maintenance program must be in place for the HVAC system, develop and institute such a program. At a minimum, include the following routine procedures: inspection and maintenance of HVAC components, calibration of HVAC system controls, and testing and balancing of the HVAC system.

Maintain the interior temperature and relative humidity to conform with the ranges recommended in ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy.

Fix any future water or humidity problems immediately. Implement remediation plan as necessary, if mold damage is discovered during repair work.

Checklist

A checklist is shown on the next page that may be useful to assure all aspects are considered.

Basic Checklist for Mold Remediation*

Use this basic checklist as an on-the-job tool to help outline the steps of mold remediation.

Investigate and evaluate moisture and mold problems

- Assess size of moldy area (square feet)
- Consider the possibility of hidden mold
- Clean up small mold problems and fix moisture problems before they become large problems
- Select remediation manager for medium or large size mold problem
- Investigate areas associated with occupant complaints
- Identify source(s) or cause of water or moisture problem(s)
- Note type of water-damaged materials (wallboard, carpet, etc.)
- Check inside air ducts and air handling units
- Throughout process, consult qualified professional if necessary or desired

Communicate with building occupants at all stages of process, as appropriate

- Designate contact person for questions and comments about medium or large scale remediation as needed

Plan remediation

- Adapt or modify remediation guidelines to fit your situation; use professional judgment
- Plan to dry wet, non-moldy materials within 48 hours to prevent mold growth
- Select cleanup methods for moldy items
- Select Personal Protective Equipment (PPE) to protect remediators
- Select containment equipment to protect building occupants

Remediate moisture and mold problems

- Fix moisture problem, implement repair plan and/or maintenance plan
- Dry wet, non-moldy materials within 48 hours to prevent mold growth
- Clean and dry moldy materials
- Discard moldy porous items that cannot be cleaned

Follow-up

- Communicate completion with building occupants
- Measure moisture levels
- Do a visual inspection
- Complete maintenance to fix or prevent leaks promptly

*Adapted from EPA. 402-K-01-001. Mold Remediation in Schools and Commercial Buildings. March 2001: 27. http://www.epa.gov/mold/pdfs/moldremediation.pdf. Accessed 4/12/07.

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APPENDIX B: MATERIALS IDENTIFICATION

This section will cover MSDSs in detail. It is important to understand how to use an MSDS because they may assist in identifying a contaminant at a meth lab. In addition to MSDSs it is important to properly label all containers to assist with materials identification.

While it is important to know and understand labeling of hazardous materials, it is also important to remember that just because a jar or package is labeled, you should not be certain that the material indicated is in the package or jar. Meth labs are labs in name only. They are places where illegal drugs are manufactured and proper labeling procedures are often not followed.

Recognizing Chemical and Biological Hazards – Labels and Placards

It is important to understand the systems which are used to identify hazardous materials. Identification information is included on labels fixed to small containers (drums, packages, boxes) and placards fixed to large containers (trailers, rail cars, tanks). There are several different systems; one or more may be used at the plant by contract personnel or companies which supply raw materials. Some of these systems are described below.

Emergency Response Guidebook – System of Placards and Labels

This is enforced by the Department of Transportation (DOT).

What does the DOT system look like?

- Diamond-shaped.
- Color-coded.

Color	Hazard
Orange	Explosive
Red	Flammable or combustible
Green	Non-flammable gas
Yellow	Reactive oxidizer or organic peroxide
White	Poisonous or toxic
White and red vertical stripes	Flammable solid
White top with black bottom	Corrosive
Two colors	Two major hazards
Blue	Dangerous when wet
Yellow top with white bottom	Radioactive
White top with red bottom	Spontaneously combustible

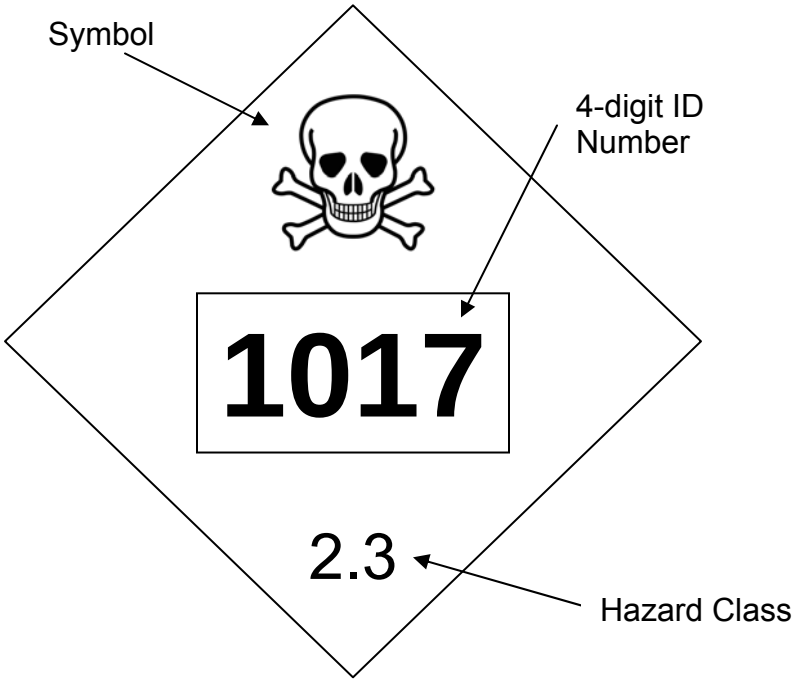
- Word-coded (hazard class name).
    - For Example:
        - Explosives
        - Blasting Agents
        - Dangerous (may be used with mixed loads).
- Symbol-coded.

Symbol	Hazard
Bursting ball	Explosive
Flame	Flammable
W with slash	Dangerous when wet
Skull and crossbones	Poisonous
Circle and flame	Oxidizing material
Cylinder	Non-flammable gas
Propeller / trefoil	Radioactive
Test tube / hand / metal	Corrosive
Special symbol	Infectious

- Number-coded.
    - A four-digit number in the center identifies a specific compound. These identified in the Emergency Response Guidebook. For example, 1223 is kerosene. This number may be in the center of the placard or on an orange-colored panel placard.
    - A one-digit number at the bottom is the Hazard Identification Code.

#	**Hazard Class**
1	Explosives
2	Gases (compressed, liquefied, or dissolved under pressure)
3	Flammable liquids
4	Flammable solids or substances, spontaneously combustible materials, and dangerous when wet materials / water-reactive materials
5	Oxidizing substances and organic peroxides
6	Poisonous and infectious substances
7	Radioactive substances
8	Corrosives
9	Miscellaneous dangerous substances / organisms

The image displayed below is a prototype of what a chlorine placard would look like. This placard tells you that the substance is Poisonous (the skull and crossbones and the white background), a Gas (Hazard Class 2), and Chlorine (the four-digit number 1017).



The Chlorine placard is called a "number placard," which means that the number in the center of the placard specifies the exact contents of the container. "Word placards" are so named because a word designating a type of hazard (e.g., flammable) will be printed in the middle of the placard. Number placards must be displayed on large portable tanks, tank trucks, and rail cars. A word placard means that drums or smaller containers are present.

You can find more information on what these numbers and symbols mean in a DOT chart and the Emergency Response Guidebook. To use the guidebook, you need to know either the chemical name or the identification number. If you know the name, look in the blue pages to find the guide number. The guide in the white pages with orange tops contains more detailed information on the chemical. If you know the number, look in the yellow pages to find the guide number. The guide in the white pages with orange tops contains more detailed information on the chemical.

National Fire Protection Association (NFPA)—704 System

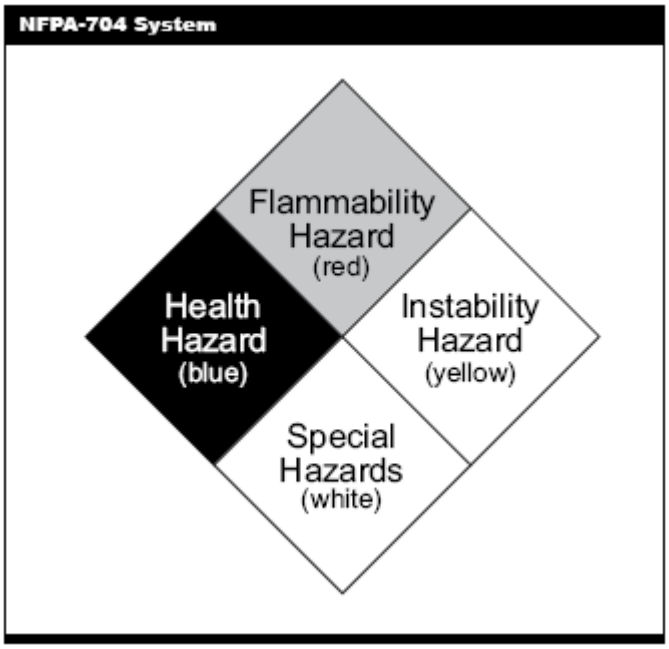
The National Fire Protection Association (NFPA) system may be used on storage vessels and containers at a stationary facility. Some facilities may use this system throughout their departments and put the NFPA label on all hazardous materials. The facility's hazard communication training can inform the worker if this warning system is being used at the work site.

What does the NFPA system look like?

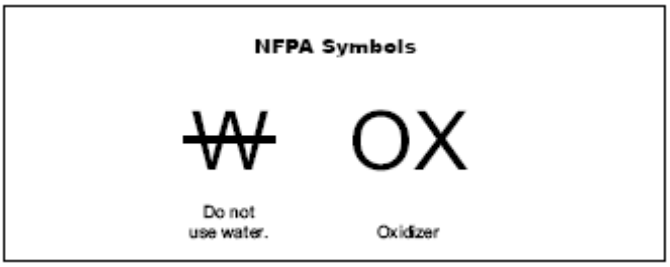
- Diamond-shaped.
- Color-coded in four small diamonds.

Color	Hazard
Red	Flammability
Blue	Health
Yellow	Instability
White	Special Hazards

- Number-coded in the red, blue, and yellow diamonds. This ranks the potential flammability, health, and instability hazard. Ranges from 0 (least hazard) to 4 (highest hazard).



The Special Hazards (white) section of the NFPA-704 label may contain symbols (examples shown below) that give more information about the chemical. The following symbols might be found in the Special Hazards (white) section of the NFPA-704 label.



The Hazardous Materials Information System (HMIS)

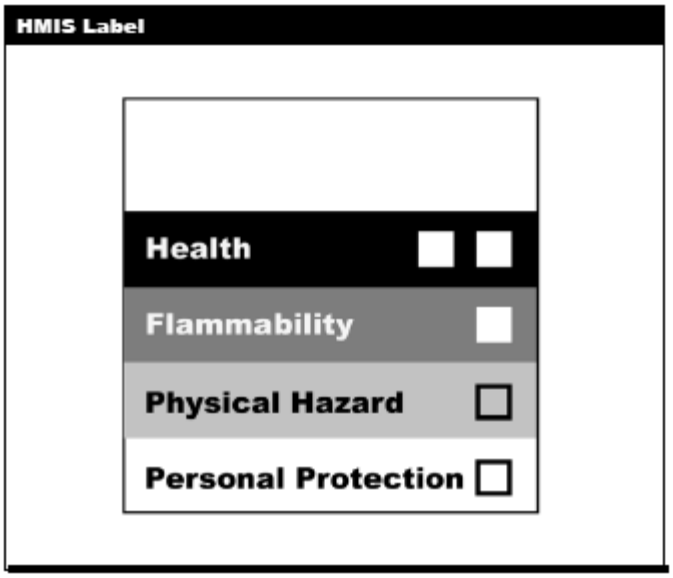
These labels are used on storage vessels and containers.

What does the HMIS label look like?

- Rectangular.
- Color-coded. This long-standing system is currently being revised. The new color-codes alert workers to:

Color	Hazard
Blue	Health risk
Red	Flammability
Orange	Physical hazards
White	Personal protection

- Number-coded.
- Ranks the potential health, flammability, and physical hazard. Ranges from 0 (minimal hazard) to 4 (severe hazard).
- Letter-coded.
- Tells you what personal protective equipment you should use to protect yourself when working with the material. Capital letters range from A (safety glasses) to K (full protective suit with gloves, boots, a hood or mask, and an air line or Self-Contained Breathing Apparatus). If the personal protection is coded X, specialized handling procedures are needed. Lower-case letters n through u, w, y, and z are codes for specific protective equipment. For example, q represents boots, and u represents an organic vapor respirator. A chart outlining each letter code should be available wherever these labels are used.



Two boxes appear next to Health. The first box contains an asterisk (*) if the material poses a risk of a chronic health effect; otherwise, a slash (/) should be in the box. The box on the right contains the numerical hazard rating (0–4). Alternatively, the two symbols may be combined in the box on the right. For example, 3*.

The part of the body affected by exposure is also designated: blood, eye, nervous system, kidney, liver, reproductive, skin, respiratory. Icons are available for each.

Physical hazards include: water-reactive, organic peroxides, explosives, compressed gases, pyrophorics, oxidizers, and unstable reactives. Each hazard is represented by an icon.

A Hazard Summary Label is available for shipped containers; it has more complete information on health hazards, routes of exposure, and physical hazards.

Infectious Materials Symbols

The most common type of packaged biological waste is probably infectious waste from a hospital or other health care facility. This type of waste should be in boxes, plastic containers, or **red** plastic bags marked on all sides with the **fluorescent orange** infectious materials symbol shown below.

Examples of infectious materials include used needles and syringes, soiled bandages, test tubes, and disposable vials. Less frequently encountered biological hazards would include biological research materials such as genetic materials and viral and bacterial cultures. If the research materials involve biological agents, the containers should be clearly marked.

Documentation – Material Safety Data Sheets (MSDSs)

MSDSs are available describing hazardous chemicals that might be used in mold remediation.

MSDSs are required by the OSHA Hazard Communication Standard (29 CFR 1910.1200). No standard format is required; however, the following information must be provided:

- Contact Person at Manufacturer/Supplier.
- Hazardous Ingredients/Identity Information.
- Physical/Chemical Characteristics.
- Fire and Explosion Hazard.
- Health Hazard Data.
- Reactivity Data.
- Precautions for Safe Handling, Use, and Disposal.
- Control Measures.
- Date of Writing or Revising MSDS.
- Primary Route of Entry.
- Exposure Limits.
- Emergency and First Aid Procedures.
- Work Practices/Personal Protective Equipment.

Review of information on MSDSs is an essential part of handling hazardous materials and emergency situations and planning response actions.

An example of how to read a material safety data sheet is shown on the next few pages.

How to Read Each Section of an MSDS

Section I: Material Identification

Section I: Material Identification		
Manufacturer's Name	**Emergency Telephone No.**	**Date**
Westlake CA&O	(270) 395-4151	11/01/99
Address		
2468 Industrial Parkway PO Box 527 Calvert City, KY 42029		
Chemical Name and Synonyms	**Trade Name and Synonyms**	
Chlorine	Does not apply.	
Chemical Family	**Formula**	
Halogens	Cl_2 (Cl-Cl)	

Section I identifies the product and manufacturer or supplier. The name of the product that appears in this section must be exactly the same as the name on the container label. The manufacturer's name, address, and phone number are also listed. If more than one name is used for a specific chemical, both names should be listed. Chemical formulas and the NFPA fire diamond showing degrees of hazard may be listed for quick identification but are not required. Finally, the date of the preparation must be indicated. This date is important because MSDSs prepared before November 25, 1985, when the new requirements went into effect, may not be in full compliance with the law; also, the date will help determine whether the most recent revision is available at the site.

Section II: Hazardous Ingredients

Section II: Hazardous Ingredients			
Paints, Solvents, & Preservatives	**CAS Registry No.**	**Percent**	**TLV (Units)**
Chlorine	7782-50-5	> 99.5%	0.5 ppm (1 ppm STEL)

Any chemical comprising 1% or more of the product (or 0.1% if it is a carcinogen) and known to have hazardous properties must be listed in this section. Next to each hazardous ingredient, the MSDS preparer must list the OSHA Permissible Exposure Limit (PEL), which is the amount to which a worker can be legally exposed. The PEL may be listed in parts per million (ppm) or in milligrams per cubic meter (mg/m3). Legal limits have been set for only about 500 substances, so the ingredient you encounter may not have an OSHA PEL.

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The Chemical Abstracts Service (CAS) registry number is a specific number for each chemical. One six-digit number is assigned to each chemical.

Another organization which recommends exposure limits is the National Institute for Occupational Safety and Health (NIOSH). NIOSH limits tend to be the lowest and should be listed if one has been set. The manufacturer may also list its own recommended limit. In general, the lower the exposure limit (PEL or TLV), the more hazardous the substance is. You may see the notation "skin" after a PEL or TLV. This notation indicates that the chemical can be easily absorbed into the body through the skin.

Percentages of ingredients may be listed but are not required by law, which makes it difficult to determine if all ingredients have been listed. It is also more difficult to evaluate the hazards of the chemical without percentages. For this reason, the employer should request percentage information from the chemical supplier.

Finally, trade secret claims have to be identified on the MSDS for any hazardous ingredients that are being withheld. These claims are usually indicated by the phrase "Proprietary Information," "Confidential," or something similar.

Section III: Physical and Chemical Characteristics

Section III: Physical Data	
Boiling Point (°F) -29°F	**Specific Gravity** Dry Gas: 2.48 @ 0°C Liquid: 1.47 @ 0.4°C
Vapor Pressure 73 psia @ 50°F	**Percent, Volatile by Volume (%)** > 99.5
Vapor Density 2.5 (Air = 1)	**Evaporation Rate (__ =) (Butyl Acetate=1)**
Solubility in Water Slight	**Appearance and Odor** Greenish-yellow gas or amber liquid. Pungent, suffocating bleach-like odor.

This section tells you whether the material is a solid, liquid, vapor, or gas, etc. The description listed here should match the appearance of the material you are using.

Boiling point, vapor pressure, vapor density, solubility, and specific gravity were defined earlier in this chapter. The percent volatile is an indication of how much could evaporate into the air; the value is given in percent of the volume. For example, a container of degreaser would have a value of 100%. The value for a paint product might be 40%.

Evaporation rate indicates how fast the material will evaporate compared with a reference compound such as butyl acetate. If the rate is less than 1, the material evaporates less rapidly.

The appearance and odor may help you to identify what you are working with. Remember that the odor or smell is a poor measure of the concentration of the substance in the air. Although the nose can detect the presence of some chemicals, many substances can reach hazardous levels with no noticeable odor. Some people have a poor sense of smell. Also, you may lose your ability to smell a particular substance over a period of time due to the nerve endings in the nose blocking out the odor (olfactory fatigue).

Section IV: Fire and Explosion Hazard Data

Section IV: Fire and Explosion Hazard Data
Flash Point Test is not applicable to gases. Not combustible. Chlorine can support combustion and is a serious fire risk.
Extinguishing Media For small fires use dry chemical or carbon dioxide. For large fires use water spray, fog, or foam.
Special Firefighting Procedures Wear full face positive pressure self-contained breathing apparatus (SCBA). Wear full protective gear to prevent all body contact (moisture or water and chlorine can form hydrochloric and hypochlorous acids which are corrosive). Personnel not having suitable protection must leave the area to prevent exposure to toxic gases from the fire. Use water to keep fire-exposed containers cool (if containers are not leaking). Use water spray to direct escaping gas away from workers if it is necessary to stop the flow of gas. In enclosed or poorly ventilated areas, wear SCBA during cleanup immediately after a fire as well as during the attack phase of firefighting operations.
Unusual Fire and Explosion Hazards Chlorine and water can be very corrosive. Corrosion of metal containers can make leaks worse. Although non-flammable, chlorine is a strong oxidizer and will support the burning of most combustible materials. Flammable gases and vapors can form explosive mixtures with chlorine. Chlorine can react violently when in contact with many materials and generate heat with possible flammable or explosive vapors. Chlorine gas is heavier than air and will collect in low-lying areas.
Explosive Characteristics Containers heated by fire can explode.

Section IV provides information on how to prevent and fight fires and explosions. This section will also list the type of fire extinguisher which should be used and whether special protective equipment is needed for fighting fires. This information on the MSDS may be inadequate to respond to emergency situations because of the number of chemicals that may be involved.

Under state Right-to-Know laws and the new federal Community Right-to-Know law, firefighters have the right to review workplace chemical inventories and MSDSs and to inspect the workplace in order to plan for and prevent fires and explosions.

Section V: Health Hazard Data

Section V: Health Hazard Data

Threshold Limit Value

0.5 ppm (1 ppm STEL)

Primary Routes of Exposure

Inhalation, skin and eye contact

Effects of Overexposure

Acute: Low concentrations of chlorine can cause itching and burning of the eyes, nose, throat and respiratory tract. At high concentrations chlorine is a respiratory poison. Irritant effects become severe and may be accompanied by tearing of the eyes, headache, coughing, choking, chest pain, shortness of breath, dizziness, nausea, vomiting, unconsciousness and death. Bronchitis and accumulation of fluid in the lungs (chemical pneumonia) may occur hours after exposure to high levels. Liquid as well as vapor contact can cause irritation, burns and blisters. Ingestion can cause nausea and severe burns of the mouth, esophagus and stomach.

Chronic: Prolonged or repeated overexposure may result in many or all of the effects reported for acute exposure (including pulmonary function effects).

Emergency and First Aid Procedures

Inhalation (of process emissions): Take proper precautions to ensure rescuer safety before attempting rescue (wear appropriate protective equipment and utilize the "buddy system"). Remove source of chlorine or move victim to fresh air. If breathing has stopped, trained personnel should immediately begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR). Avoid mouth-to-mouth contact. Oxygen may be beneficial if administered by a person trained in its use, preferably on a physician's advise. Obtain medical attention immediately.

Eye Contact: Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 20 minutes while the eyelid(s) are open. Take care not to rinse contaminated water into the non-affected eye. If irritation persists, obtain medical attention immediately.

Skin Contact: As quickly as possible, flush contaminated area with lukewarm, gently running water for at least 20 minutes. Under running water, remove contaminated clothing, shoes, and leather watchbands and belts. If irritation persists, obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before re-use, or, discard.

Ingestion: Not an anticipated hazard.

This section should list any harmful effects that may be caused by the chemicals listed in the Hazardous Ingredients section. The health hazards may be acute (short-term) or chronic (long-term). In addition to listing the health hazards, the MSDS must also detail the routes of entry, signs and symptoms of exposure, medical conditions aggravated by exposures, and emergency and First Aid procedures.

Section VI: Reactivity Data

Section VI: Reactivity Data	
Stability	**Conditions to Avoid**
Stable	None
Incompatibility	
Chlorine is extremely reactive. Liquid or gaseous chlorine can react violently with many combustible materials and other chemicals, including water. Metal halides, carbon, finely divided metals and sulfides can accelerate the rate of chlorine reactions. Hydrocarbon gases, e.g., methane, acetylene, ethylene or ethane, can react explosively if initiated by sunlight or a catalyst. Liquid or solid hydrocarbons, e.g., natural or synthetic rubbers, naphtha, turpentine, gasoline, fuel gas, lubricating oils, greases or waxes, can react violently. Metals, e.g., finely powdered aluminum, brass, copper, manganese, tin, steel and iron, can react vigorously or explosively with chlorine. Nitrogen compounds, e.g., ammonia and other nitrogen compounds, can react with chlorine to form highly explosive nitrogen trichloride. Non-metals, e.g., phosphorous, boron, activated carbon and silicon can ignite on contact with gaseous chlorine at room temperature. Certain concentrations of chlorine-hydrogen can explode by spark ignition. Chlorine is strongly corrosive to most metals in the presence of moisture. Copper may burn spontaneously. Chlorine reacts with most metals at high temperatures. Titanium will burn at ambient temperature in the presence of dry chlorine.	
Hazardous Decomposition Products	
Hydrogen chloride may form from chlorine in the presence of water vapor.	
Hazardous Polymerization	
Will not occur.	

Section VI provides information on conditions that could cause the product to react dangerously or decompose and release dangerous materials. A complete MSDS will tell you whether the substance is likely to break down or react with other substances, what conditions are likely to cause the substance to change its composition, and what new hazards might result. This information can be very valuable if a substance makes contact with heated surfaces or is mixed with other chemicals. This information usually pertains to immediate reactions.

Section VII: Spill or Leak Procedures

Section VII: Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled

Restrict access to the area until completion of the cleanup. Issue a warning: POISON GAS. DO NOT TOUCH SPILLED LIQUID. Do no use water on a chlorine leak (corrosion of the container can occur, increasing the leak). Shut off leak if safe to do so. Wear NIOSH-approved, self-contained, full-face, positive pressure respirator and full protective clothing capable of protection from both liquid and gas phases. Persons without suitable respiratory and body protection must leave the area.

The following evacuation guide was developed by the U.S. Department of Transportation (DOT): Spill or leak from a smaller container or small leak from a tank - isolate in all directions 250 feet. Large spill from a tank or from a number of containers - first, isolate 520 feet in all directions; secondly, evacuate in a downwind direction 1.3 miles wide and 2.0 miles long. Keep upwind from leak. Vapors are heavier than air and pockets of chlorine are likely to be trapped in low-lying areas. Use water spray on the chlorine vapor cloud to reduce vapors. Do not flush into public sewer or water systems. Chlorine can be neutralized with caustic soda or soda ash.

Alkaline solutions for absorbing chlorine can be prepared as follows:

- For 100 pound containers: 125 lbs. of caustic soda and 40 gallons of water
- For 2,000 pound containers: 2,500 lbs. of caustic soda and 800 gallons of water
- For 100 pound containers: 300 lbs. of soda ash and 100 gallons of water
- For 2,000 pound containers: 6,000 lbs. of soda ash and 2,000 gallons of water

CAUTION: Observe appropriate safety precautions for handling alkaline chemicals. Heat will be generated during the neutralization process.

Waste Disposal Methods

Due to its inherent properties, hazardous conditions may result if the material is managed improperly. It is recommended that any containerized waste chlorine be managed as hazardous waste in accordance with all applicable federal, state, and local health and environmental laws and regulations.

This section will explain what steps to take in the event of a release or spill, how to dispose of waste material, what precautions to take in handling and storing the material, and any other precautionary measures that might be appropriate. In this section many MSDSs will simply warn, “avoid breathing gases and vapors.” This section should provide information on whether to evacuate, what type of emergency respirators to have on hand, and how to clean up large and small spills.

Section VIII: Special Protection Information

Section VIII: Special Protection Information
Ventilation Effective exhaust ventilation should always be provided to draw fumes or vapors away from workers to prevent routine inhalation. Ventilation should be adequate to maintain the ambient workplace atmosphere below the legislated levels listed in Section II. **Respiratory Protection** Use NIOSH approved acid gas cartridge or canister respirator for routine work purposes when concentrations are above the permissible exposure limits. Use full facepiece respirators when concentrations are irritating to the eyes. A cartridge-type escape respirator should be carried at all times when handling chlorine for escape only in case of a spill or leak. Re-enter area only with NIOSH approved, self-contained breathing apparatus with full facepiece. The respiratory use limitations made by NIOSH or the manufacturer must be observed. Respiratory protection programs must be in accordance with 29 CFR 1910.134. **Eye/Face Protection** Non-ventilated chemical safety goggles or a full face shield. **Skin Protection** Wear impervious gloves, coveralls, boots and/or other resistance protective clothing. Safety shower/eyewash fountain should be readily available in the work area. Some operations may require the use of an impervious full-body encapsulating suit and respiratory protection. Note: Neoprene, polyvinyl chloride (PVC), Viton, and chlorinated polyethylene show good resistance to chlorine. **Additional** Do not eat, drink or smoke in work areas. Maintain good housekeeping.

Section VIII will generally describe only the minimum measures that are necessary to reduce exposures to hazardous substances.

First, it must indicate if ventilation is necessary to adequately remove air contaminants.

This section should also list the specific respiratory protection that is required. The MSDS must also list the specific protective glove that is required. As with respirators, the type of glove necessary depends on the substance and the manner in which it is being used. The MSDS should specify the appropriate material (viton, rubber, polyvinyl alcohol, etc.) to use with the product.

Section VIII will also list eye protection and other protective clothing or equipment which should be used.

Section IX: Special Precautions

Section IX: Special Precautions
Material Handling Do not use near welding operations, flames or hot surfaces. Move cylinders by hand truck or cart designed for that purpose. Do not lift cylinders by their caps. Do not handle cylinders with oily hands. Secure cylinders in place in an upright position at all times. Do not drop cylinders or permit them to strike each other. Leave valve cap on cylinder until cylinder is secured and ready for use. Close all valves when not in actual use. Insure valves on gas cylinders are fully opened when gas is used. Open and shut valves at least once a day while cylinder is in use to avoid valve "freezing". Use smallest possible amounts in designated areas with adequate ventilation. Have emergency equipment for fires, spills and leaks readily available. Wash thoroughly after handling product. Provide a safety shower/eyewash station in handling area. An emergency contingency program should be developed for facilities handling chlorine. **Storage** Store in steel pressure cylinders in a cool, dry area outdoors or in well-ventilated, detached or segregated areas of noncombustible construction. Keep out of direct sunlight and away from heat and ignition sources. Cylinder temperatures should never exceed 51°C (125oF). Isolate from incompatible materials. Store cylinders upright on a level floor secured in position and protected from physical damage. Use corrosion resistant lighting and ventilation systems in the storage area. Keep cylinder valve cover on. Label empty cylinders. Store full cylinders separately from empty cylinders. Avoid storing cylinders for more than six months. Comply with applicable regulations for the storage and handling of compressed gases.

Special precautions are noted in this section. Handling and storage precautions might indicate incompatible chemicals or specific storage containers. Section IX may also give a shelf-life warning or discuss the material's potential to react.

Limitations of MSDSs

Although MSDSs contain important information, there are a number of limitations to their use during an emergency. Some of these limitations are listed below.

- Limited information.
    - The information may be incomplete or inaccurate.
    - Space on the form may be inadequate.
    - The information may not be relevant for the remediation activity.
- Insufficient time to read the information.
- Insufficient time to call the manufacturer's/supplier's contact person.
- Not immediately available.
    - MSDS may not be located at the remediation site.